Draft Updated Agenda
Climate Legislative and Executive Workgroup
September 27, 2013, 9:00 – 1:00 p.m.
504 15th Avenue SW, State Capitol Campus, Olympia
John A. Cherberg Building, Senate Hearing Room 3

Meeting Purpose: Hear about and provide input on the agenda and approach for the Spokane and Seattle Public Hearings; hear follow-up information in response to questions asked about Task 1 (Analysis of WA GHG Emissions & Related Energy Consumption) and the GHG emissions forecast; and hear a presentation on, ask questions about, and discuss the results of SAIC Task 3 (Evaluation of Federal Policies) and SAIC Task 2 (Evaluation of Comprehensive Greenhouse Gas Reduction Programs Outside of Washington State).

Time	Item	Materials
9:00 a.m. (0:10)	**Welcome/Introductions** (Governor Inslee and Bob Wheeler) • Review agenda • Review and accept draft 9/11/13 meeting summary o CLEW input on level of detail • Review work plan	**Tab 1** • Draft agenda **Tab 2** • Draft 9/11/13 Meeting Summary • Draft Work Plan • Summary of Communications
9:10 a.m. (0:20)	**Public Hearings Preparation** (Bob Wheeler) • Review and confirm public hearing agenda and approach	**Tab 3** • AIF Public Hearings • Draft agendas 10/16 and 10/23
9:30 a.m. (0:15)	**Response on questions from Task 1 – Analysis of WA GHG Emissions & Related Energy Consumption** (Christina Waldron and facilitated discussion) • Review of questions and presentation of responses • Q&A • Additional comments	**Tab 4** • AIF Task 1 Questions
9:45 a.m. (0:15)	**Status Update on Progress of GHG Emissions Forecast** (Christina Waldron and facilitated discussion) • Overview of the process, schedule, and updated table on historical and projected WA GHG emissions • Discussion	**Tab 5** • Schematic of GHG Emissions Forecast • Updated table of WA's historical and projected GHG emissions • Per capita GHG Emissions

10:00 a.m. (0:45)	**Presentation on Task 3 – Evaluation of Federal Policies** (Christina Waldron, Michael Mondshine, Tim Kidman, and facilitated discussion) • Overview of big picture—how far can we get with Federal policies? • Presentation of Task 3 outcomes • Q&As • Discussion	**Tab 6** • AIF Task 3 • SAIC Final Report for Task 3
10:45 a.m. (0:15)	**Break**	
11:00 a.m. (1:55)	**Presentation on Task 2 – Evaluation of Comprehensive GHG Emissions Reduction Programs Outside of WA** (Christina Waldron, Michael Mondshine, Tim Kidman, and facilitated discussion) • Overview of big picture – what other policies are being implemented beyond the State of WA and the federal government? What policies can fill the gaps to meet WA's GHG reduction goals? • Presentation of Task 2 outcomes • Q&As • Discussion	**Tab 7** • AIF Task 2 • SAIC Final Report for Task 2

12:55 p.m.
(0:05)
	Next Steps (Bob Wheeler)
	• Initial agenda topics for next meeting
	    o CLEW members to come with list of actions/policies they want CLEW to consider
	• Next meeting
	    o Finalize time of 10/14 meeting
	• Comments on meeting	

1:00 p.m.	**Adjourn** (Governor Inslee)	

Future CLEW Meetings:

Date	Time	Location	Basic Topics
Monday, October 14th	2:00-4:00 pm*	Olympia, House Hearing Room A	Identify possible policies/actions
Wednesday, November 6th	2:00-4:00 pm	Olympia, Senate Hearing Room 3	Develop Recommendations
Thursday, November 21st	2:00-4:00 pm	Olympia, Senate Hearing Room 3 (to be confirmed)	Prioritize policies/actions
Friday, December 13th	2:00-4:00 pm	Olympia, House Hearing Room A	Finalize report and policies/actions

**Please note it is under consideration to move the 10/14 meeting time to 10:00 am to 12:00 pm.*

Future Public Hearings:

Date	Time	Location	Basic Topics
Wednesday, October 16th	5:00-7:00 pm	**Spokane**: Music Auditorium on the Spokane Falls Community College C campus	Public Hearing
Wednesday, October 23rd	6:00-8:00 pm	**Seattle**: Bell Harbor International Conference Center	Public Hearing
Friday, December 6th	2:00-4:00 pm	**Olympia**: House Hearing Room A - State Capitol Campus	Public Hearing on the draft report

Climate Legislative and Executive Workgroup (CLEW)
DRAFT Meeting Summary

September 11, 2013, 1:30 – 3:30 p.m.

Action Items

	Requested Action	Person Responsible
1.	Update CLEW charge on Operating Procedures and poster to convey the full Workgroup charge from the statute.	Triangle
2.	Update the Work Plan to discuss timeline and funding for actions/policies earlier in the process rather than at the final meeting.	Triangle
3.	Work with CLEW to determine if a 4th public hearing in in Eastern Washington is needed in December.	Triangle
4.	In the calculation of WA's coal consumption, clarify out-of-state coal for Task 4.	SAIC
5.	Look into the Zero Emission Standard for the Purchasing of Clean Cars.	SAIC
6.	Explain why building emissions rise in the later years, even though the building code stays in place for all new buildings.	SAIC
7.	Confirm GHG reductions from: a. I-937. b. Emission Performance Standards (TransAlta coal). c. WA State Energy Code (distinguish commercial and residential—is the 24% residential reduction and 18% commercial reduction just for new buildings, not for the entire stock of existing buildings?)	SAIC/State Agencies
8.	Update the GHG emission forecasts for 2020 and 2035 to account for Centralia, ideally by the September 27th meeting if possible. Provide GHG emission forecasts on a per capita basis, comparing WA to US.	SAIC/State Agencies
9.	Update the table of historical and projected emissions to show specific industry sectors, which would provide a baseline of CO_2 output to use as the basis for comparison.	Ecology

Welcome/Introductions

Governor Inslee called the meeting to order at 1:35 p.m. and shared reasons to be optimistic for the Workgroup successfully achieving its goals. Bob Wheeler (facilitator) then briefly reviewed the agenda.

Operating Procedures

The facilitator reviewed the draft Operating Procedures, which outline the roles and responsibilities of the Chair and Facilitator as well as the decision-making process for determining the content of the Workgroup report.

Questions and Comments

- *Will recommendations from individual CLEW members come in the form of minority reports?* Yes.
- *Is the Workgroup charge pulled verbatim from the statute?* Triangle will check and update the Operating Procedures and poster.
- *Do the Operating Procedures apply to the public hearings?* No, Triangle will develop a set of ground rules for the public that will address how the meetings will be run, time limitations for public comments, appropriate behavior, etc.
- *It was noted that cost-benefit analysis will be important for the group to address.*

Pending the requested revision to the Workgroup charge, CLEW adopted the Operating Procedures by consensus.

Work Plan

The Facilitator introduced the draft CLEW work plan, which reflects what is expected to be accomplished at each meeting and upcoming deadlines. It is a working document that will be reviewed at each meeting and updated throughout the process. The Facilitator briefly walked CLEW members through the document, noting that October 14th is an important meeting, as each CLEW member will share a list of actions/policies that they want the group to consider.

Questions and Comments

- *CLEW previously discussed only having two public meetings. Will there be two or three?* There will be three; the first two will focus on actions/policies that should be considered for the report, and the third will focus on the draft report itself.
- *There should be multiple ways of providing comments rather than the public hearings so that people across the state can provide comment (e.g. tweets, emails, etc.).* The process currently provides a few ways for the public to comment, including email, comment forms, and the meetings themselves.
- *Should there be an additional public meeting in Eastern WA?* CLEW will make a decision at a later date.
- *There was a request for the Facilitator to help manage the flow, timing, and amount of information provided to CLEW members and their staff in order to give more time to review the materials and respond.* Given the project's tight timelines, the facilitation team is working with CLEW staff to provide materials and information in a timely fashion.

- *It will be important to talk about the timeline and funding for actions/policies early on in the process rather than at the final meeting.* Triangle will revise the Work Plan to reflect this point.

Interview Summary

The Facilitator thanked CLEW members for participating in the interviews. Triangle met in person with everyone except Representative Short, who was interviewed via phone because of her location. The Facilitator then briefly summarized the hopes, concerns, and areas of agreement that were heard.

Questions and Comments

- *While full consensus is not anticipated for every action and policy, there is the desire for CLEW to reach consensus on as many items as possible.*

Presentation on Task 1 – Analysis of Washington Greenhouse Gas Emissions & Related Energy Consumption

Project Big Picture

Christina Waldron and Matthew Cleaver, SAIC, explained Task 1's Scope of Work (SOW) and how it fits into the overall picture. Task 1 provides analysis of Washington's greenhouse gas (GHG) emissions and related energy consumption, and sets the stage for all further analyses by showing where WA State is now, what the GHG drivers are, and what trends exist. Task 1 also provides context for evaluating potential new policies by demonstrating how much we can expect to achieve through WA's existing policies. It was noted that the SOW does not include associated costs or lessons learned. Upcoming analyses will include:

- Task 2 – evaluate GHG emissions reduction programs outside of Washington.
- Task 3 – quantify federal policies' contribution to WA State's emissions reduction.
- Task 4 (Final Report) – consider results from Tasks 1-3, including policy interactions.
- Task 5 – provide technical support to CLEW for meetings and public hearings, make adjustments to analysis provided in Tasks 1-3, or offer new analyses as directed.

Task 1 Presentation

➢ TASK 1a—WA State's Total Energy Consumption and Expenditures

Task 1a focused on WA State's consumption and expenditures of fossil fuel energy. SAIC reviewed five different graphs.

- Graph 1 showed WA Fuel Consumption by Fuel Type. It was noted that coal only included in-state consumption.
- Graph 2 showed the relationship between consumption and expenditures from 1990-2010. Expenditures have been dropping in the last few years because fossil fuel prices are continuing to rise.
    - *Has the increase in WA State's population affected expenditures?* Yes, having more people in the State has led to higher expenditures, but petroleum prices are a key factor in expenditures.

- Graph 3 showed WA's per capita energy consumption in relation to nearby states. WA consumes slightly less than Idaho and Montana per capita, and a little more than Oregon and California.
- Graph 4 showed WA's total energy consumption in 2011. The top three areas of consumption included hydroelectric power, motor gasoline, and natural gas. It was noted that coal only included in-state consumption.
    - *There was a request for out-of-state coal to be included.*
    - *Does this graph take hydropower exports into account?*
        - It was determined later in the meeting that no further action was required as, consistent with state policy, GHG emissions are credited to the place where the power is consumed, not where it is generated.
- Graph 5 showed 2010 WA GHG emissions by source. Automobile gasoline is by far the largest source, followed by electricity from coal (includes out-of-state coal), Residential Commercial Industrial (RCI) natural gas, RCI oil, aviation, and automobile diesel. This information will be helpful for Task 2 in selecting policies that target the largest emission sources.

➢ TASK 1b—Evaluation of Existing Policies that will Contribute to GHG Targets

Task 1b evaluates nine existing policies that will contribute to WA's GHG reduction targets. Christina Waldron, SAIC Project Manager, started the presentation of this task by stating that some questions have been raised about how SAIC's emission reduction estimates differ from the State's. SAIC and the State have committed to working on this between now and the September 27th meeting.

In comparing the nine existing policies, SAIC noted that the Washington State Energy Code and the purchase of clean cars have the biggest impacts on GHG emission reductions at the State level. In the table showing all existing policies and associated GHG emission reductions in target years, it was explained that one cannot add all the columns together for a GHG emission reduction total; in this case, GHG reductions are not additive as the interactions between the policies have not been accounted for. The reduction estimates only reflect the policies as written, as if they were operating in isolation. With those introductory comments, Matt Cleaver, SAIC representative responsible for Task 1, began reviewing SAIC's findings for each of the existing nine policies.

1. Renewable Fuel Standard (RFS)
    - **Definition**: This policy specifies that starting in 2008, at least 2% of all gas sold in WA must be ethanol and that 2% of all diesel must be biodiesel or renewable diesel.
    - This policy is hard to enforce and is not turning out to be practical as written.
    - For this policy to be viable it must be modified, which would require legislative action.
    - The projected GHG emission reductions assume legislative action is taken to establish a 5% universal standard.

    Questions and Comments
    - *Are the numbers shown in the table cumulative or yearly reductions?*
        - The table reflects the reductions that you will see in each of the target years.

2. Washington State Energy Code
   - **Definition**: This policy requires that building energy codes must achieve a 70% reduction in annual net energy consumption for new residential and commercial buildings by 2031.
   - So far, commercial and residential buildings are meeting their goals and are expected to continue doing so.
   - SAIC used state data wherever possible.

   Questions and Comments
   - *Are the GHG emission reductions additive, or do they actually decrease from 2035 to 2050?*
     - Reductions are based on projections through 2031, but since this policy ends in 2031, the savings are constant after 2031. While there will likely be new technologies, energy codes, and policies that will continue savings after 2031, this was not modeled and savings were kept constant after 2031. The GHG emission reductions decrease from 4.5 in 2035 to 4.1 in 2050 because buildings will continue to be built, but the amount of savings stays constant.
   - *There was a request for consistent assumptions across policies. It is confusing that RFS assumed a change in policy, and this one does not.*
     - It was noted that consistent assumptions across policies was given significant consideration and discussed with the State, however it was decided that there was not a universal template that could logically be applied for all nine policies.
   - ***The State commented that SAIC was modeling each policy "as the policy is intended to work."***

3. GHG Emissions Performance Standards (EPS)
   - **Definition**: This policy sets a standard for "baseload electricity generation" (i.e. electricity producers must stay below a certain level of GHG emissions), which is the lower of 970 pounds per megawatt-hour (lb/MWh) or the average available GHG emissions output of combined cycle combustion turbines (CCCT).
   - SAIC identified which resources would be impacted by this policy and worked with the State Energy Office to find the baseload coal in-state and out-of-state feeding electricity to WA. Centralia is the main resource that is being affected by this policy.
   - SAIC reported that this analysis attributed Centralia's phase-out entirely to the EPS policy, even though many factors can affect such a closure. This assumption was developed in conjunction with the State Energy Office.

   Questions and Comments
   - *How did you factor in the Centralia emissions?*
     - SAIC identified which resources would be impacted by the policy and worked with the State Energy Office and found the baseload coal and natural gas electric generation plants in-state and out-of-state that are feeding electricity to Washington. It was determined that Centralia was the plant being affected by this policy. While there are several factors that affect plant closures, in this analysis, SAIC attributed Centralia's closure to EPS, so they included the emission reductions from Centralia in this quantification.
   - *What year do you attribute the quantifications of emissions reductions to? 2035?*

    - Since the first unit of Centralia does not close until the end of 2020, SAIC assumed that, according to the Business as Usual (BAU) baseline, power would continue to feed WA through 2020, resulting in no reductions in 2020.
    - The 2.9 $MMTCO_2e$ of reductions are attributed to the retrofit from coal to natural gas.
- *A concern was expressed that the 2.9 $MMTCO_2e$ figure is much lower than it should be. EPS will result in greater emissions reductions.*
    - SAIC worked with the Energy Office to determine how much power WA actually consumes through Centralia. Centralia can sell power on the market, and only a portion of its power is consumed in the State. Further, there is no requirement for a private company to disclose where it is selling its power, so the information is not available to directly make this determination. SAIC estimated the amount of Centralia power that would continue to feed WA by adding 1) power from Centralia's Power Purchase Agreement with PSE, which is just a portion of the amount of power consumed in WA, and 2) half of the remaining State fuel mix. (SAIC and the State Energy Office assumed that half of those market purchases were attributed to Centralia.)
- *This figure should be revisited because many expected a greater reduction. When the Legislature discussed decommissioning Centralia, it was felt that doing so would produce significant enough emissions reductions to help meet the 2020 goal. It is critical to know what emissions are actually being reduced and whether reductions are based on a 1400 megawatt capacity. The Task 1 Report should more thoroughly discuss this transition.*
    - EPS is a leadership preventative policy. It helps reduce additional growth in coal fire power coming into the state. Even though large reductions are not seen on paper, they serve a purpose to prevent further emissions.
    - It is worth revisiting the numbers and walking through the methodology to see if CLEW agrees with the assumptions made.
    - The rough calculation to date is that the 1400 megawatts capacity at Centralia is usually operated at around 1100-1200 megawatts, which results in roughly 10 million metric tons of CO_2 per year coming out of the facility. Assuming almost half of the plant's production is replaced with natural gas, emissions are reduced to 4.5 or 5.0. WA consumes roughly half of what is produced, so emissions are reduced to about 3.
- *Moving forward, it is important to remember that carbon is credited to the place where the power is consumed, not where it is generated. For example, if one of these policies resulted in a reduction of coal emissions in WA but the electricity was consumed outside of WA, the policy would not be credited for that savings. This convention was agreed to by the States as the protocol in order to not double count emissions.*

4. Appliance Standards
    - **Definition**: This policy established efficiency standards for products not yet superseded by Federal standards, which include five product types (wine chillers designed and sold for use by an individual; hot water dispensers and mini-tank electric water heaters; bottle-type water dispensers; pool heaters, residential pool pumps, and portable electric spas; and commercial hot food holding cabinets).

- Quantifiable data was not available for these products, so SAIC contacted State agency staff and the Appliance Standards Awareness Project (ASAP) to inquire about any data or analyses on these products; however, no analyses or data were available. Therefore, while this policy is moving forward, SAIC was not able to quantify relative reductions from these appliances.
- While this policy will likely not result in huge reductions, it enables WA to take a leadership role and help push federal policy in areas that are not covered. That said, several State policies have been superseded by Federal policy.

5. Energy Independence Act (I-937)
   - **Definition**: This policy requires state electric utilities serving 25,000 or more customers (currently 17) to obtain 15% of their electricity from new renewable sources by 2020 and undertake all cost-effective energy conservation actions.
   - The policy is moving forward, and it is assumed that these utilities will meet their goals between now and 2016.
   - Conservation was included in SAIC's quantifications. SAIC used the Northwest Power and Conservation Council's "conservation calculator" to determine the amount of load that would actually be reduced from conservation efforts if all cost-effective measures were implemented.
   - This policy contains "cost cap" provisions, which state that a utility does not have to meet the 15% renewables target if it reaches a financial cap on the way to obtaining renewable energy. Therefore, for the 2020 projection, SAIC assumed utilities would meet their targets until at least 2016, after which some would reach the cost cap measure, only resulting in an estimated 12% renewable use by 2020.

Questions and Comments

- *What portion of the 11.2 figure represents conservation versus renewables?*
  - While conservation accounted for significant reductions, renewables accounted for the majority of reductions.
- *How do you attribute emissions reductions to conservation?*
  - SAIC will work to clarify its assumptions regarding the conservation portion of I-937, which was based on 6^{th} Power Plan.
- *Regarding the cost cap provisions, it would be helpful to look at whether the right kind of conservation mechanisms are included in I-937 to ensure we have the ability to do as much conservation as possible and get credit for it. There is a desire for SAIC to look at similar types of policies in Task 2.*
- *What were your assumptions regarding in-state and out-of-state use of wind power generated in WA?*
  - All electricity generation in the State is accounted for on a net consumption basis. SAIC looked at the amount of renewable power that would need to come into the State to replace the amount of fossil fuel power that was being reduced. SAIC assumed that high-emitting fossil fuel sources would be replaced first. In the projection of the fuel mix going forward, SAIC assumed that all fuel sources will replace coal and natural gas, but that renewable energy sources will replace most of this coal and natural gas.
- *Is the 11.2 figure a bit padded by wind power?*

    - SAIC is committed to exploring this further and finding the source of the discrepancy, which appears to relate to the fluctuation between hydro and wind. It will revisit these numbers with the Energy Office, who calculated a lower number.
- ***Going forward, there will be no one golden number that can be estimated for reductions. It was suggested that SAIC provide a range of reductions and include which assumptions lead to the high or low number so that CLEW can make decisions based on the assumptions they determine.***
    - SAIC is planning to provide ranges in Task 2.

6. Energy Efficiency and Energy Consumption Programs for Public Buildings
    - **Definition**: This policy requires certain state-funded "major facility projects" to meet high performance building standards (e.g. LEED Silver, the Evergreen Sustainable Development Standard, etc.). These high performance building requirements apply to state agencies, state institutions of higher education, and public school districts.
    - SAIC estimated efficiency gains based on projected square footage increases and the amount of public buildings that would be built.
    - The GHG emission reductions associated with this policy are relatively low because it applies to a relatively small number of buildings when looking at the State as a whole.
    - SAIC did not originally have data for the K-12 floor space forecast, but that data is now included.
    - It was noted that this policy will interact with the Energy Code policy.

7. Conversion of Public Fleet to Clean Fuels
    - **Definition**: This policy requires all state agency and local government vehicles to have 40% of their fuel usage converted to electricity or biofuel by 2013, and 100% by 2015, to the extent practicable.
    - SAIC focused on the language "to the extent practicable." In instances when biodiesel or electricity is not practical, compressed natural gas, liquefied natural gas, and propane may be substituted.
    - Ethanol-consuming vehicles are not projected to grow out to the target years.
    - After looking at the national trends from the US Energy Information Administration over the target years, SAIC assumed there would be an increase in electric vehicles in WA.
    - Electric vehicles are assumed to replace 60% of agency gas vehicles in 2020, 75% in 2035, and 85% in 2050.

Questions and Comments
- *Does the estimate of 85% include fleets, or is it across the board?*
    - This quantification is across the board and does not take individual agencies into account.
- *The Legislature passed legislation to modify and relax the requirements for local governments. Was this taken into account?*
    - This came up late in the analysis, and it is not accounted for.

8. Purchasing of Clean Cars
    - **Definition**: The Clean Car Law states that new vehicles must meet certain clean air standards to be registered, leased, rented, licensed, or sold for use in WA. The standards include California's Low Emission Vehicle (LEV) III standards and Pavley Standards.
    - WA has adopted the standards and they are being implemented.
    - For the Pavley Standards, there was a study of the reductions that would be achieved for each state which is where SAIC got the 5 MMT figure. While there has been some question as to whether this is an overestimate or underestimate, this was the best available estimate given the existing data. SAIC took a ratio of the Pavley estimate and applied it to a California study done on the LEV III standards, which is how the reduction in emissions was estimated.

    Questions and Comments
    - *Do we have any cost estimates from CA on how expensive these vehicles are?*
        - SAIC did not look at this since it is not in their Scope.
        - It was noted that CLEW staff can find this information pretty easily.
    - *It was noted that Ecology must update WA rules every time CA updates its rules. There is an element of the CA policy (Zero Emission Standard) that we don't implement here.*
        - SAIC will be looking into this factor further.

9. Growth Management Act
    - **Definition**: This policy created a framework for comprehensive land use planning, reducing urban sprawl and encouraging compact development. It does not require local government planning to encourage compact transit oriented development.
    - SAIC assumed that the growth of emissions reductions would level off, but this is uncertain.

    Questions and Comments
    - *It was noted that SAIC is assuming that the Growth Management Act is working as it is supposed to, i.e. reduce sprawl. It is possible, however, that GMA might have resulted in more sprawl.*
    - *Do the estimates for 2020, 2035, and 2050 reflect reductions that would not have occurred without the policy?*
        - Yes, the estimates are based off the Business As Usual model.
    - *Is it correct to say that economic growth might eliminate the savings?*
        - Yes. Even though the sum of these policies has achieved savings, we cannot count on 2020 emissions decreasing the specified amount. Task 2 will take more of a net reduction approach, showing where existing policies are reducing emissions, where there will be future efficiency gains, and what is left that needs to be targeted by future policies.

➢ Task 1c—Non-Energy Sources of GHG emissions

SAIC briefly reviewed Task 1c, which analyzes the State's non-energy sources of GHG emissions. Industrial Processes, which include manufacturing of cement, petrochemicals, and aluminum, account for 3.8 million metric tons of CO2 equivalents ($MMTCO_2e$), or 4% of WA's total emissions in 2010. Waste Management, which includes landfills, wastewater treatment, and composting, accounts for 3.8 million $MMTCO_2e$, or 4% of WA's total emissions in 2010. Agriculture, which includes enteric fermentation by livestock, manure management, and agricultural soils, accounts for 5.2 $MMTCO_2e$, or 5.4% of WA's total emissions in 2010.

➢ Task 1d—WA State Counties' and City of Seattle's GHG Reduction Initiatives

SAIC briefly reviewed a table reflecting the various GHG reduction initiatives. It was noted that this is not an exhaustive list, but it demonstrates that a lot is happening around the State. Some drivers include cost savings, compliance with State law, individual jurisdictional climate goals, and compliance with state and federal funding requirements.

➢ Task 1e—Overall Effect on Global GHG Levels if WA Achieves its Targets

If Washington was a country, it would be 43rd on the list of GHG emitters, falling between Kuwait and Chile.

Ecology's Projection of WA GHG Emissions and Science Sources

Hedia Adelsman, Department of Ecology, spoke about Ecology's projection of WA GHG emissions and science sources, using a summary table provided to CLEW.

Questions/Comments

- *Does the column labeled "Projected GHG Emissions $MMTCO_2e$ 2020[3]" assume implementation of State and Federal policies?*
    - Yes[1], the State and Federal actions accounted for are listed on the back of the handout.
- *What additional action is needed to reach WA's goals?*
    - Task 2 will show several options and what different policies offer.
- *Since 2005, WA has put enough policies in place to get the State roughly half way to its goals. We need to figure out a way to get the rest of the way there. A few policies, such as the Federal CAFE standards, are not included yet, so we will eventually need to redo the projections.*
- *It will be important for CLEW to consider whether policy gains will continue with rising populations because there will likely be an erosion of gains over time.*
- *Cost-benefit analysis is key.*
- *There was a request for the table of historical and projected emissions to show specific industry groups, which would provide a baseline of CO_2 output to use as the basis for comparison.*
    - Ecology will work to update this document prior to the next meeting.
- *There was a request for updated Business As Usual data. It will be hard to come up with recommendations without having a clear sense of where we are since this data has not been updated since 2010. The GHG emission forecasts do not include Centralia.*

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[1] Note for clarification: After the meeting, it was determined that not all State and Federal actions were accounted for.

- *We still don't have a good sense of how far emissions reductions have taken us (e.g. RFS, Centralia, etc.). We need a clear inventory of how we have gotten to where we are (potentially half way to meeting the 2020 goal) and what policies got us there.*
- *It will be important to have a per capita understanding of emissions. This will help show where we are as citizens and place what needs to happen with reductions in context.*
- *CLEW is being asked to make important decisions without enough information up front, such as what's working, what's not, and how much it is costing. We might have the cart before the horse at this point, and it is therefore hard to tell if we are on the right track to get at our needs. It will be important to see where we are as a state and where reductions are attributable to.*

Recap of Task 1 Next Steps

The Governor made the following closing observations:

- The GHG emission forecasts for 2020 and 2035 need to be updated to account for Centralia, ideally by the September 27th meeting if possible, but before the public meetings.
- SAIC will work with the State agencies between now and September 27th to confirm the GHG reductions for I-937, Emission Performance Standards, and Washington State Energy Code.
- SAIC will look into the Zero Emission Standard for the Purchasing of Clean Cars analysis.
- This discussion has underscored the fact that the technical analysis is not done yet; there is more information to generate.

Next Steps

The Facilitator reviewed the September 27th meeting date and tentative agenda. The Governor expressed his feeling that the meeting was productive, but that there was more work to be done. The Governor adjourned the meeting at 3:38 p.m.

Climate Legislative and Executive Workgroup WORK PLAN
DRAFT v. 9-20-13

The Climate Legislative and Executive Workgroup (CLEW) is charged with recommending "actions and policies to reduce greenhouse gas emissions [in Washington State] that, if implemented would ensure achievement of the state's emissions targets in RCW 70.235 [set by the 2008 Legislature]. The recommendations must be prioritized to ensure the greatest amount of environmental benefit for each dollar spent and based on measures of environmental effectiveness, including consideration of current best science, the effectiveness of the program and policies in terms of costs, benefits, and results, and how best to administer the program and policies. The work group recommendations must include a timeline for actions and funding needed to implement the recommendations." The goal is for CLEW to report their recommendations to the State Legislature by December 31, 2013.

Meeting	Location	Objective	Desired Outcomes	Resources Needed (materials, people, etc.)
September 11 1:30–3:30	Olympia	1) Review agenda, draft Operating Procedures (including decision-making process), Work Plan, and interview summary 2) SAIC presentation on Task 1 outcomes 3) Task 1 Q&As, discussion/ feedback from CLEW Draft Questions for CLEW: a. Did we miss anything? b. Most compelling points presented? c. How comfortable are we with the outcomes? d. Can we learn anything from our current policies that	• Understand CLEW member perspectives • Understand overall plan from now until December • Understand Task 1 Outcomes and clarify questions • Agree on decision-making process and operating procedures	• Meeting agenda • Agenda Information Form "AIF" for Task 1 • Draft Operating Procedures • Draft Work Plan • Interview Summary • SAIC Final Report for Task 1

Meeting	Location	Objective	Desired Outcomes	Resources Needed (materials, people, etc.)
		may inform future policies? 4) Next Steps		
September 27 9:00–1:00	Olympia	1) Introductions 2) Review and accept meeting summary 3) Work Plan review 4) Review and confirm public meeting agendas and approach 5) Responses to Task 1 questions asked at 9/11 meeting 6) Update on GHG emissions forecast 7) SAIC presentation on Task 3 then Task 2, Q&As, discussion 8) Next Steps	• Reach a common understanding of what comes next • Finalize approach for public meetings • Learn about and discuss Task 2 and Task 3 outcomes • Provide input on potential policies for WA and Federal policies relating to WA	• Meeting agenda • AIFs • 9/11 draft Meeting Summary • Draft 10/16 and 10/23 public meeting agendas • Work Plan • SAIC Task 2 and 3 reports • Updated table of WA's historical and projected GHG emissions
October 14 2:00-4:00 (potential change to 10:00-12:00)	Olympia	1) Introductions 2) Review and accept meeting summary 3) Work Plan review 4) Final preparation and discussion on 10/16 and 10/23 public meetings 5) Presentation of SAIC Final Report 6) Presentation by each CLEW member on their list of desired actions/policies for	• Develop broad list of possible policies and actions for consideration at future CLEW meetings • Complete preparations for public meetings	• Meeting agenda • AIFs • 9/27 draft Meeting Summary • Work Plan • SAIC final report • Other SAIC materials?

Meeting	Location	Objective	Desired Outcomes	Resources Needed (materials, people, etc.)
		consideration 7) Discuss and reach initial agreement on broad list of possible policies and actions		
October 16—Public 5:00-7:00	Spokane	Listening Session to hear public comments on the process and any specific actions they would like to have included. 1) Introductions (CLEW, alternates, SAIC, and Triangle) 2) Triangle Presentation (CLEW charge, WA GHG goals, timeline, ground rules, meeting approach) 3) Public comments (2 min/ person, will have signed up in advance) 4) Next Steps ***Note: More discussion on public meeting details is needed as we learn more on projected attendance***	• Hear from the public on this effort • Write summary of verbal public comment • CLEW staff will consider all written comments turned in by public	• Meeting agenda • Annotated meeting agenda • Informational handout • Commenter registration cards • Written comment sheets • Sign-in sheets • Posters for sign-in area • Triangle PowerPoint • Directional signs (arrows pointing to the room, etc.) • 2 boxes for receiving comment sheets • Ground rules on flip chart paper
October 23—Public 6:00-8:00	Seattle	Listening Session to hear public comments on the process and any specific actions they would like to have included. 1) Introductions (CLEW,	• Hear from the public on this effort • Write summary of verbal public comment • CLEW staff will consider all written comments turned in by	• Meeting agenda • Annotated meeting agenda • Informational handout • Commenter registration cards

Meeting	Location	Objective	Desired Outcomes	Resources Needed (materials, people, etc.)
		alternates, SAIC, and Triangle) 2) Triangle Presentation (CLEW charge, WA GHG goals, timeline, ground rules, meeting approach) 3) Public comments (2 min/ person, will have signed up in advance) 4) Next Steps ***Note: More discussion on public meeting details is needed as we learn more on projected attendance***	public	• Written comment sheets • Sign-in sheets • Posters for sign-in area • Triangle PowerPoint • Directional signs (arrows pointing to the room, etc.) • 2 boxes for receiving comment sheets • Ground rules on flip chart paper
November 6 2:00–4:00	Olympia	1) Introductions 2) Review and accept meeting summary and public comment summaries 3) Work Plan review, where are we, modifications needed? 4) Review and discuss public meetings outcomes and approach for December 6th meeting 5) Review outline of report (staff) 6) SAIC presentation on analysis of possible policies and actions, Q&A,	• Draft list of recommendations to serve as basis for Report Draft #1	• Meeting agenda • AIFs • 10/14 draft Meeting Summary • Public comment summaries from 10/16 and 10/23 • Work Plan • SAIC materials? • Options for Prioritization Process (dots, clickers, colors, etc.)

Meeting	Location	Objective	Desired Outcomes	Resources Needed (materials, people, etc.)
		discussion a. Compare potential WA actions to Federal policies and other actions elsewhere 7) Develop draft list of recommendations 8) Discuss and decide on process/criteria for prioritization of policies and actions on 11/21 9) Discuss timeline and funding for actions 10) Next Steps		
November 21 2:00–4:00	Olympia	1) Introductions 2) Review and accept meeting summary 3) Work Plan review 4) Prioritize policies and actions on the table 5) Discuss timeline and funding for actions 6) Review draft report and provide input on requested revisions 7) Final preparation and discussion on 12/6 public meeting	• Prioritized list of policies and actions • Direction from CLEW for Draft Report #2	• Meeting agenda • AIFs • 11/6 draft Meeting Summary • Work Plan • Draft Report #1 • SAIC materials? • Process for Prioritization
December 6—Public	Olympia	Listening Session to hear public comments on the process and	• Hear from the public on the draft report	• Meeting agenda • Annotated meeting

Meeting	Location	Objective	Desired Outcomes	Resources Needed (materials, people, etc.)
2:00-4:00		any specific actions they would like to have included. 1) Introductions (CLEW, alternates, SAIC, and Triangle) 2) Triangle Presentation (CLEW charge, WA GHG goals, timeline, ground rules, meeting approach) 3) Public comments **on draft report** (2 min/ person, will have signed up in advance) 4) Next Steps ***Note: More discussion on public meeting details is needed as we learn more on projected attendance***	• Write summary of verbal public comment • CLEW staff will consider all written comments turned in by public	agenda • Informational handout • Commenter registration cards • Written comment sheets • Sign-in sheets • Posters for sign-in area • Triangle PowerPoint • Directional signs (arrows pointing to the room, etc.) • 2 boxes for receiving comment sheets • Ground rules on flip chart paper
December 13 2:00-4:00	Olympia	1) Introductions 2) Review and accept meeting summary and public comment summary 3) Review Draft Report #3 4) Discuss final proposed policies and actions 5) Conclude discussion on timeline and funding for actions 6) Approve report pending discussed changes	• Finalize proposed policies and actions • Address timeline and funding for actions • Clear next steps • Approve report	• Meeting agenda • AIFs • 11/21 draft Meeting Summary • 12/6 public comment summary • Work Plan • Draft Report #3 • SAIC materials?

Meeting	Location	Objective	Desired Outcomes	Resources Needed (materials, people, etc.)
		7) Evaluation of process 8) Identify next steps a. Agreement on communication with CLEW, constituencies, Legislature, colleagues, and the public		

Schematic of Determining Forecast Gap of GHG Emissions in 2020, 2035, and 2050

v. 9/24/13

Steps:

Date:

Step 1: SAIC will present to the Workgroup, using updated GHG emissions forecast from Ecology (Inventory 2013):

- Emissions: total WA and by sector
- Projected emissions to 2050

Note: The forecast will not include GHG reductions from current State or Federal policies (however, limited reductions are included in the historical data)

Date: September 27 Meeting

↓

Step 2: SAIC will quantify GHG emission reductions as a result of current State policies *(Task 1)* and Federal policies *(Task 3)* and complete a gap analysis to determine what more needs to be done to achieve WA's GHG emission reduction targets.

Note: SAIC will update the projection of GHG emission reductions by sector for each of the current policies in 2020, 2035, and 2050.

Date: September 27th – October 14th

↓

Step 3: Using the projections from Tasks 1 and 3 and the WA statutory GHG reductions, SAIC will present a progress report on existing policies, what additional reductions are needed to achieve statutory limits, and a portfolio of policy options.

Note: This information can be used by the Workgroup for recommending actions and policies.

Date: October 14 Meeting

Updated Washington State's GHG Emissions – Historical and Projected to 2020, 2035 and 2050

Ecology updated the projection of WA's GHG emissions between 2010 and 2050 based on sector-specific energy use, population, and employment growth rates. The following information was used:

- Population Estimates and Forecasts by Year: 2000-2040, issued by OFM in 2011.
- 2013 Employment Projections to 2020, developed by WA Employment Security Department.
- The 2013 Annual Energy Outlook with energy projection to 2040.

The historical and projected GHG emissions between 1990 and 2050 for each sector of the economy are shown in Table 1. Please note there is a high degree of uncertainty in extending the projection out to 2050 (the population, energy outlook and employment are projected only to 2040; we assumed the same level of growth from 2035 to 2040 continuing past 2040).

The updated projected GHG emissions for 2020 and 2035 (2050 is a new addition) are lower than the original projections done in 2010. There are several reasons:

- Population growth projections for 2000-2040 are lower. For example, the population growth from 2010 to 2020 is now projected at around 1% versus 1.22%; and from 2020 to 2030, 1.07% versus .9%.
- The new employment growth projections are slightly less than originally (the 2010 forecast included impacts of the economy on jobs)
- The energy projections to 2040 from the 2013 Annual Energy outlook are based on lower emissions factors than originally used, reflecting cleaner electricity and cleaner fuels/cars. This is difficult to estimate.

The State's GHG emissions for 2020, 2035, and 2050 based RCW 70.235.020:

- **88.4 MMTCO_2e** by 2020 (1990 levels)
- **66.3 MMTCO_2e** by 2035 (25 percent below 1990 levels)
- **44.2 MMTCO_2e** by 2050 (50 percent below 1990 levels)

Comparison of GHG reductions required by RCW 70.235.020 to projected emissions:

	70.235.020 reductions MMTCO_2e	Projected GHG emissions MMTCO_2e	Difference MMTCO_2e
2020	88.4	101.3 (originally 104.6)	**12.9**
2035	66.3	111.7 (originally 114.2)	**45.4**
2050	44.2	135.0 (originally 139.0)	**90.8**

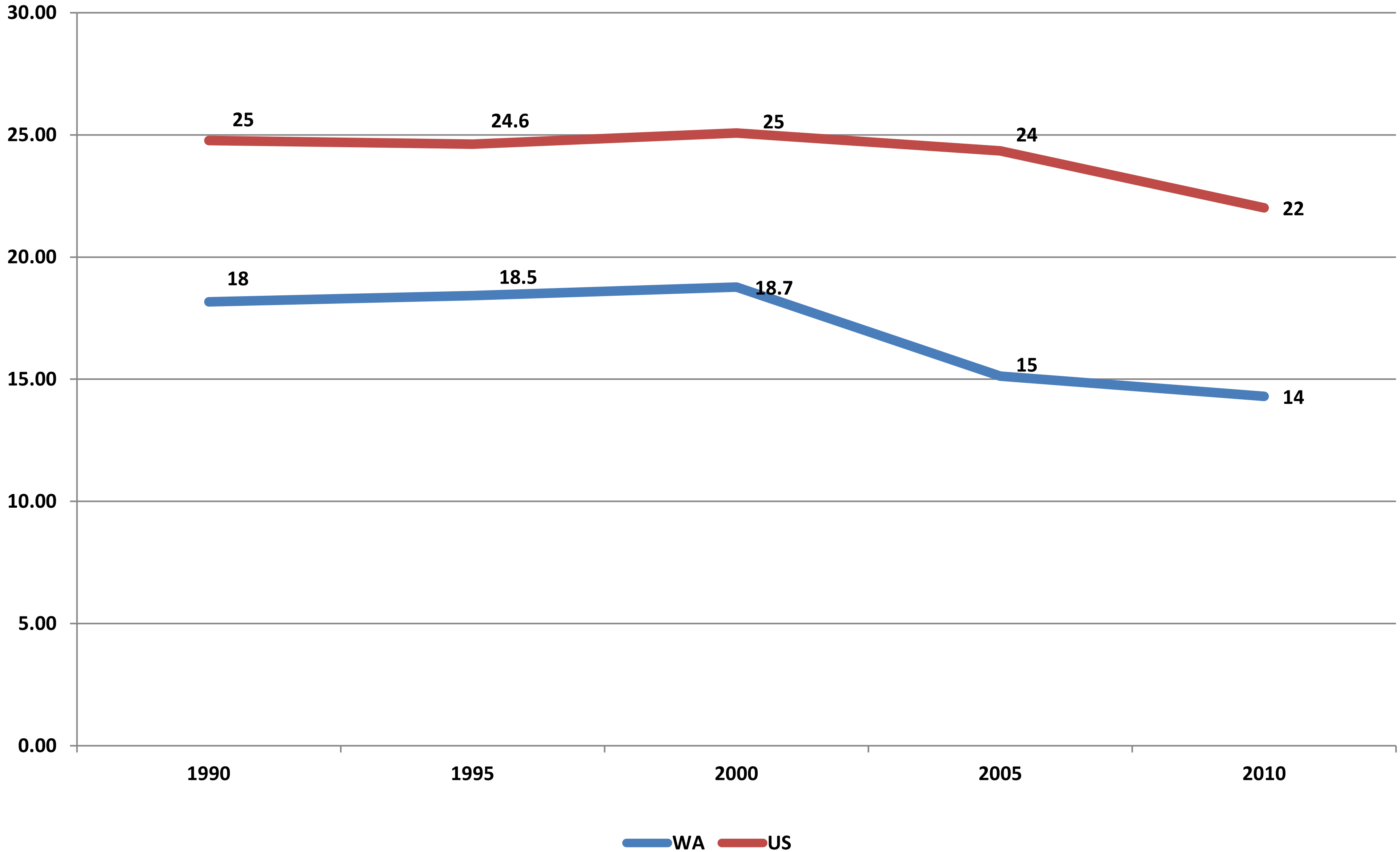
Washington State's GHG Emissions -- Historical and Projected to 2020, 2035, and 2050
v9-24-13

Million Metric Tons CO2e	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Electricity, Net Consumption-based	**16.9**	**19.4**	**23.3**	**18.8**	**20.7**	**18.9**	**18.4**	**18.9**	**19.7**	**20.4**	**21.0**	**21.6**	**22.1**
Coal	16.8	16.4	17.4	15.2	15.8	15.1	14.8	14.1	14.4	15.0	15.6	16.2	16.8
Natural Gas	0.1	2.9	5.3	3.6	4.8	3.7	3.6	4.8	5.2	5.3	5.3	5.3	5.3
Petroleum	0.0	0.2	0.6	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Residential/ Commerical/ Indusrial	**17.5**	**21.1**	**20.3**	**19.7**	**19.7**	**22.0**	**21.7**	**21.1**	**21.0**	**20.8**	**20.6**	**20.3**	**20.1**
Coal	0.6	0.6	0.3	0.1	0.2	0.3	0.3	0.2	0.3	0.3	0.3	0.3	0.3
Natural Gas	8.6	11.3	11.3	10.4	9.8	11.9	11.9	11.9	11.9	11.9	11.8	11.8	11.7
Oil	8.1	9.0	8.5	9.0	9.5	9.5	9.3	8.7	8.6	8.4	8.2	8.0	7.8
Wood (CH4 and N2O)	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Transportation	**37.5**	**43.0**	**47.0**	**44.0**	**42.2**	**44.7**	**44.8**	**44.8**	**45.3**	**46.5**	**48.1**	**50.4**	**53.5**
Onroad Gasoline	20.4	23.0	24.7	23.9	21.9	22.3	21.2	19.7	18.5	17.5	16.5	15.6	14.8
Onroad Diesel	4.1	5.3	7.6	7.1	8.0	9.4	9.7	9.1	10.5	10.0	10.5	11.0	11.6
Marine Vessels	2.6	4.0	3.7	3.3	3.0	3.9	4.5	5.1	5.9	6.8	7.8	8.9	10.3
Jet Fuel and Aviation Gasoline	9.1	9.3	10.0	7.7	8.1	7.7	7.9	9.1	8.4	9.6	9.8	10.1	10.3
Rail	0.8	0.6	0.3	1.3	0.5	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Natural Gas, LPG	0.6	0.7	0.6	0.7	0.7	0.6	0.7	0.9	1.3	1.8	2.6	3.8	5.6
Fossil Fuel Industry	**0.5**	**0.7**	**0.7**	**0.8**	**0.7**	**0.7**	**0.7**	**0.7**	**0.8**	**0.8**	**0.8**	**0.8**	**0.9**
Natural Gas Industry(CH4)	0.5	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9
Coal Mining (CH4)	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil Industry (CH4)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Industrial Processes	**7.0**	**7.4**	**10.0**	**3.8**	**3.8**	**4.7**	**5.6**	**6.9**	**8.5**	**10.9**	**13.9**	**17.8**	**22.9**
Cement Manufacture (CO2)	0.2	0.5	0.5	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Aluminum Production (CO2, PFC)	5.9	5.6	7.4	0.8	0.5	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.3
Limestone and Dolomite Use (CO2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Soda Ash	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ODS Substitutes (HFC, PFC and SF6)	0.0	0.5	1.6	2.1	2.5	3.4	4.5	5.8	7.6	9.9	12.8	16.8	21.8
Semiconductor Manufacturing (HFC, PFC, SF6)	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Electric Power T&D (SF6)	0.8	0.6	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
Waste Management	**2.6**	**2.8**	**3.2**	**2.5**	**3.8**	**4.2**	**4.8**	**5.3**	**6.0**	**6.7**	**7.5**	**8.4**	**9.4**
Solid Waste Management	2.1	2.3	2.6	1.9	3.1	3.5	3.9	4.4	5.0	5.7	6.4	6.4	8.1
Wastewater Management	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.9	1.0	1.0	1.1	1.1	1.3
Agriculture	**6.4**	**6.4**	**6.1**	**5.7**	**5.2**	**5.3**	**5.3**	**5.4**	**5.5**	**5.6**	**5.7**	**5.9**	**6.1**
Enteric Fermentation	2.0	2.4	2.2	2.1	2.0	2.0	2.0	2.0	1.9	1.9	1.9	1.9	1.9
Manure Management	0.7	0.8	1.0	1.1	1.1	1.2	1.3	1.5	1.6	1.8	2.0	2.2	2.4
Agriculture Soils	3.7	3.2	2.9	2.5	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.8
Total Gross Emissions	**88.4**	**100.8**	**110.6**	**95.3**	**96.1**	**100.5**	**101.3**	**103.1**	**106.8**	**111.7**	**117.6**	**125.2**	**135.0**
WA Population (Million)	4.9	5.5	5.9	6.3	6.7	7.0	7.4	7.8	8.2	8.5	8.8		
WA Per Capita Emissions (metric tons CO2e)	18	18	19	15	14	14	14	13	13	13	13		
USA Per Capita Gross Emissions (metric tons CO2e)					22								

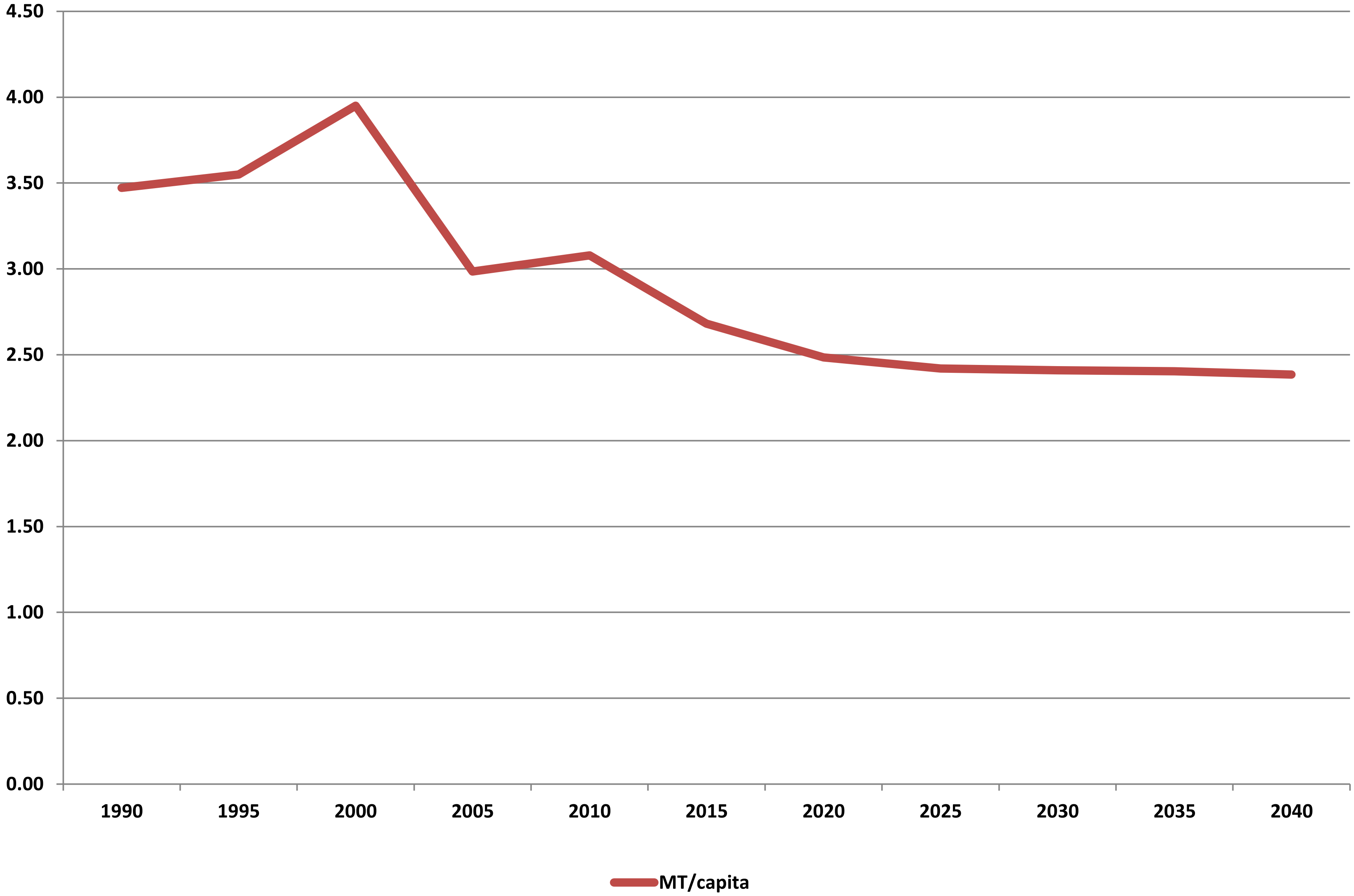
Note: the GHG emissions redudctions from the TransAlta agreement are not included in the projections.
They are part of the quantification of current state policies and will be included in the gap analysis.

Historical Per Capita GHG Emissions

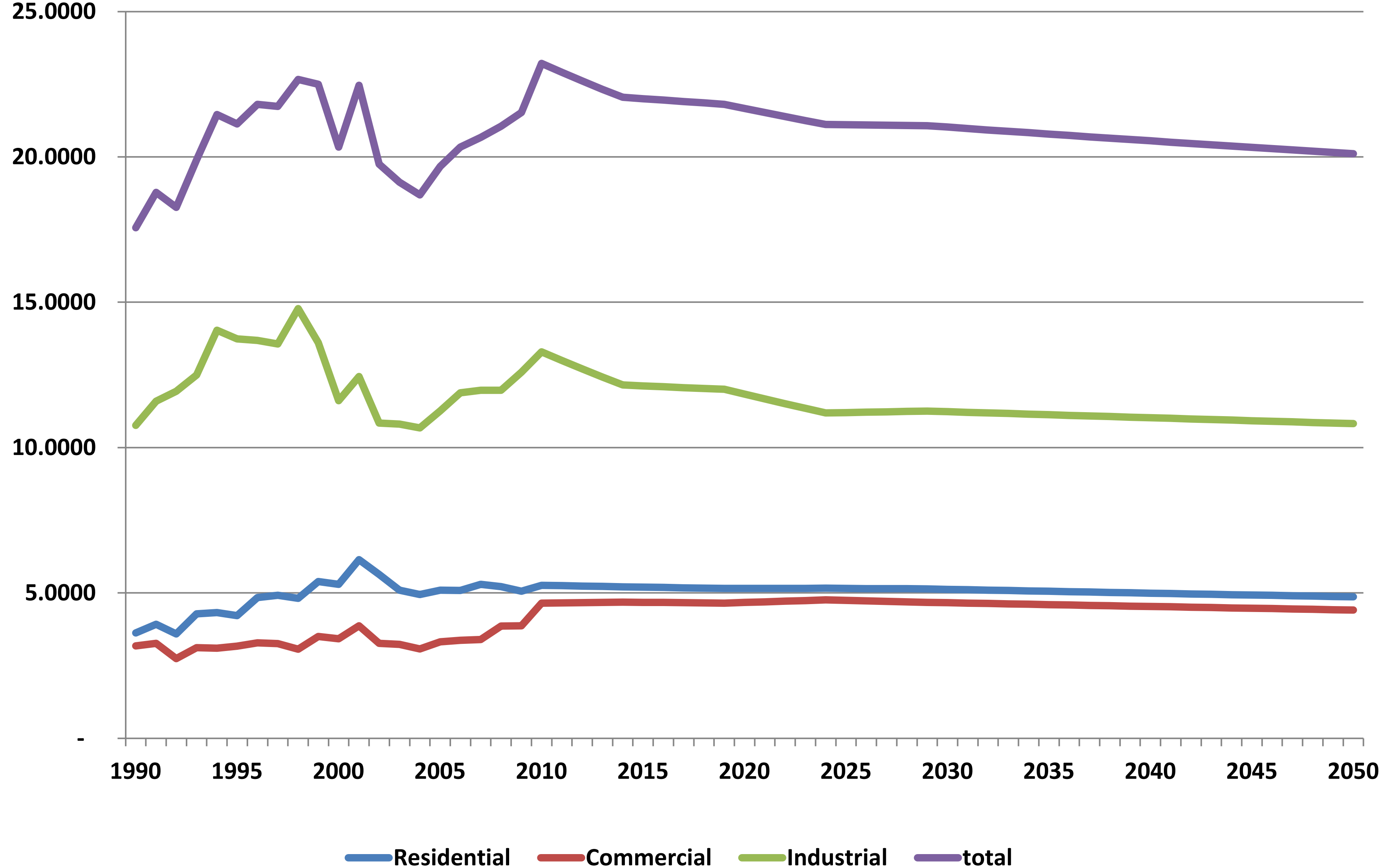
$MtCO_2e$

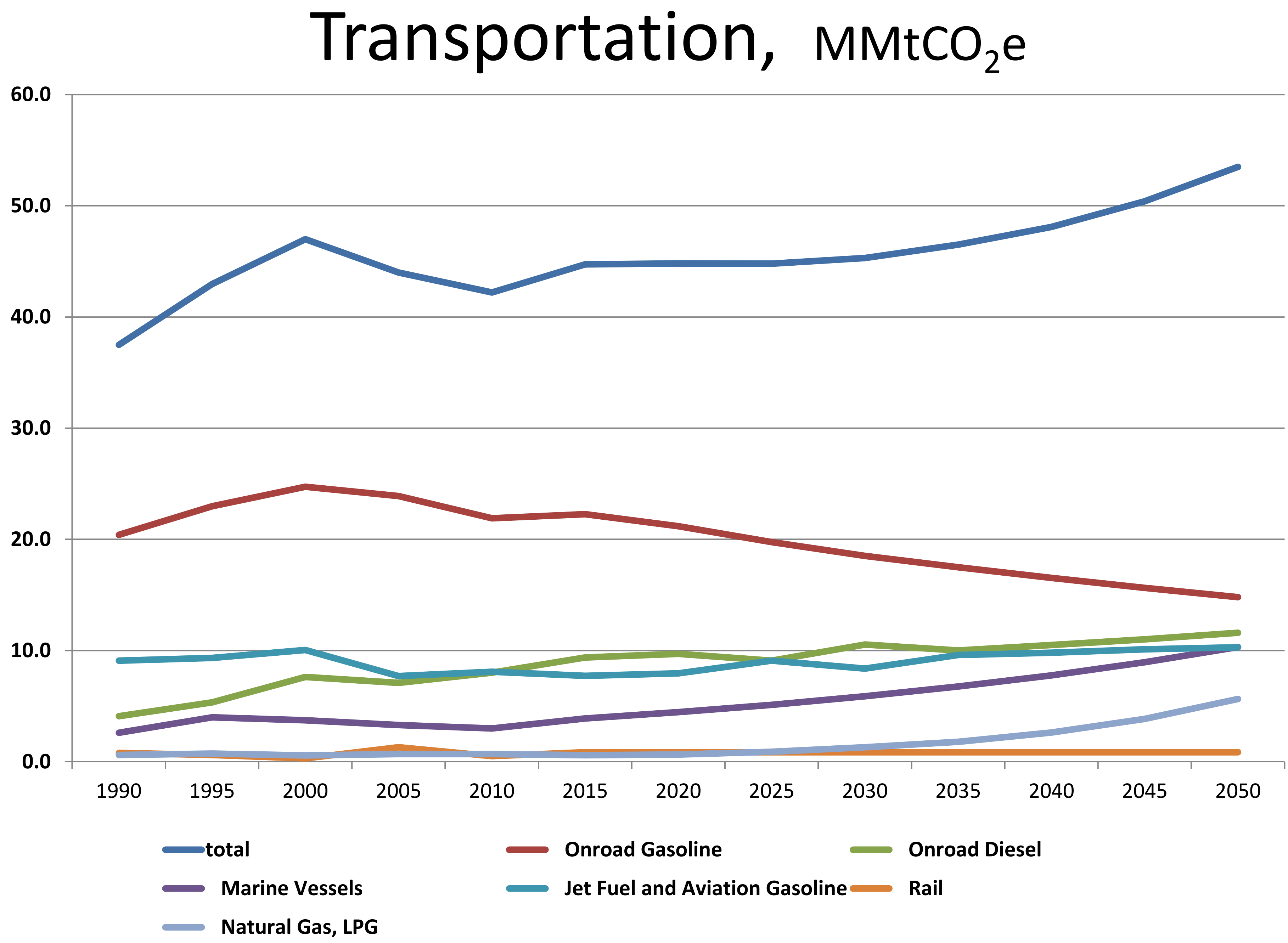


Electricity Emissions
$MtCO_2e$/per capita

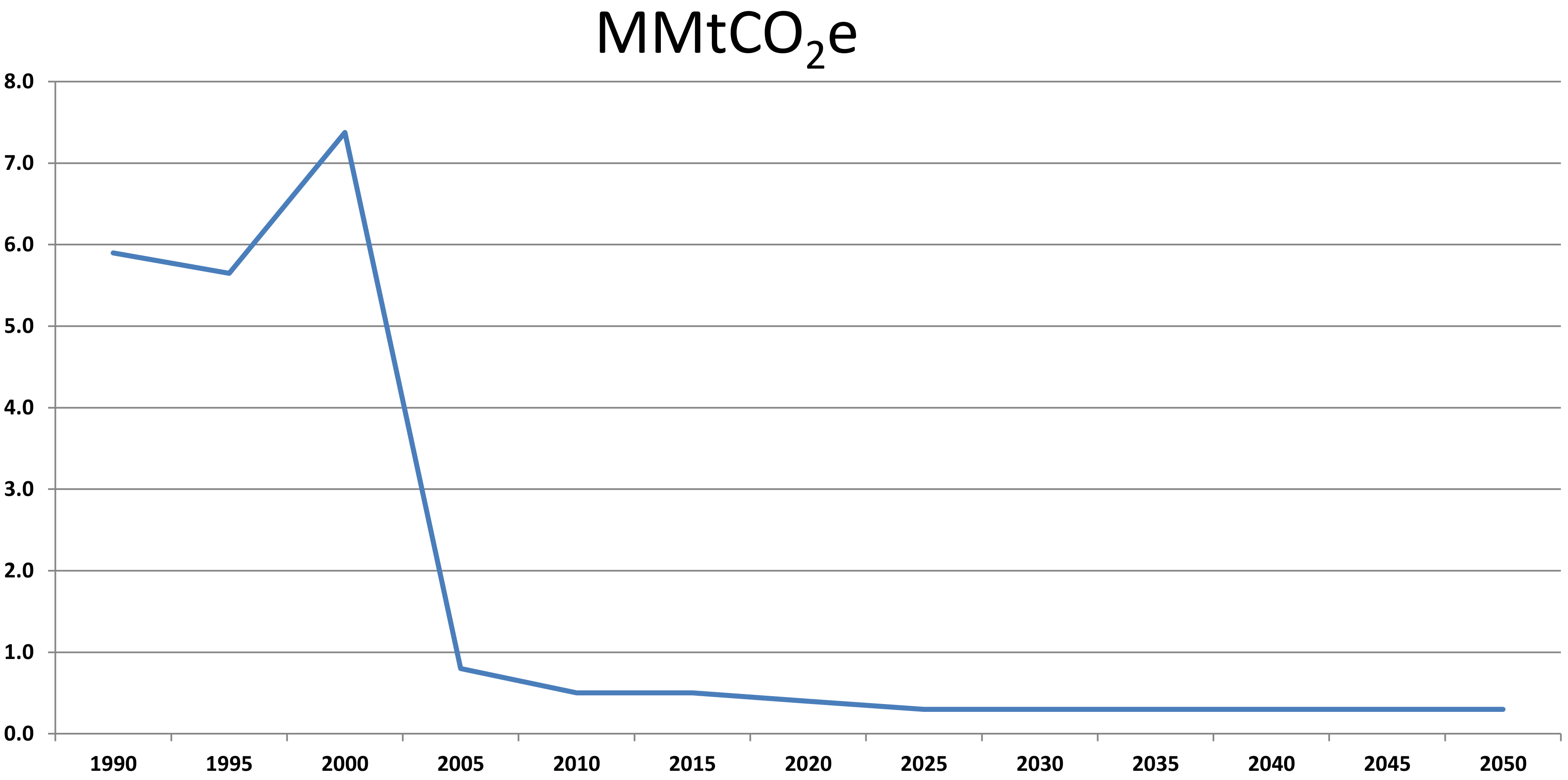


Residential, Commercial and Industrial $MMtCO_2e$




Transportation, $MMtCO_2e$
60.0
50.0
40.0
30.0
20.0
10.0
0.0
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
2050
total
Onroad Gasoline
Onroad Diesel
Marine Vessels
Jet Fuel and Aviation Gasoline
Rail
Natural Gas, LPG

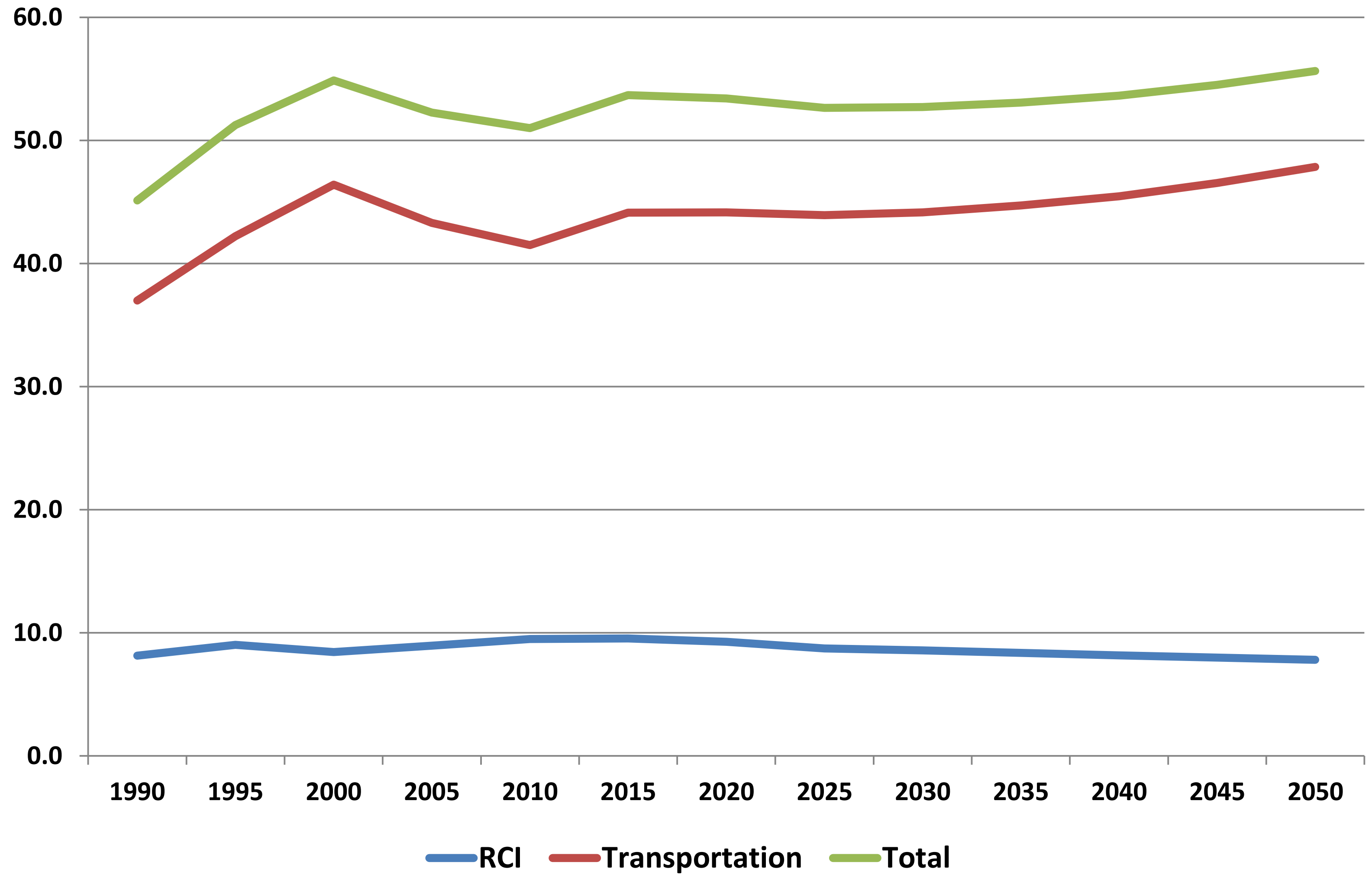
Aluminum Process, (PFC)



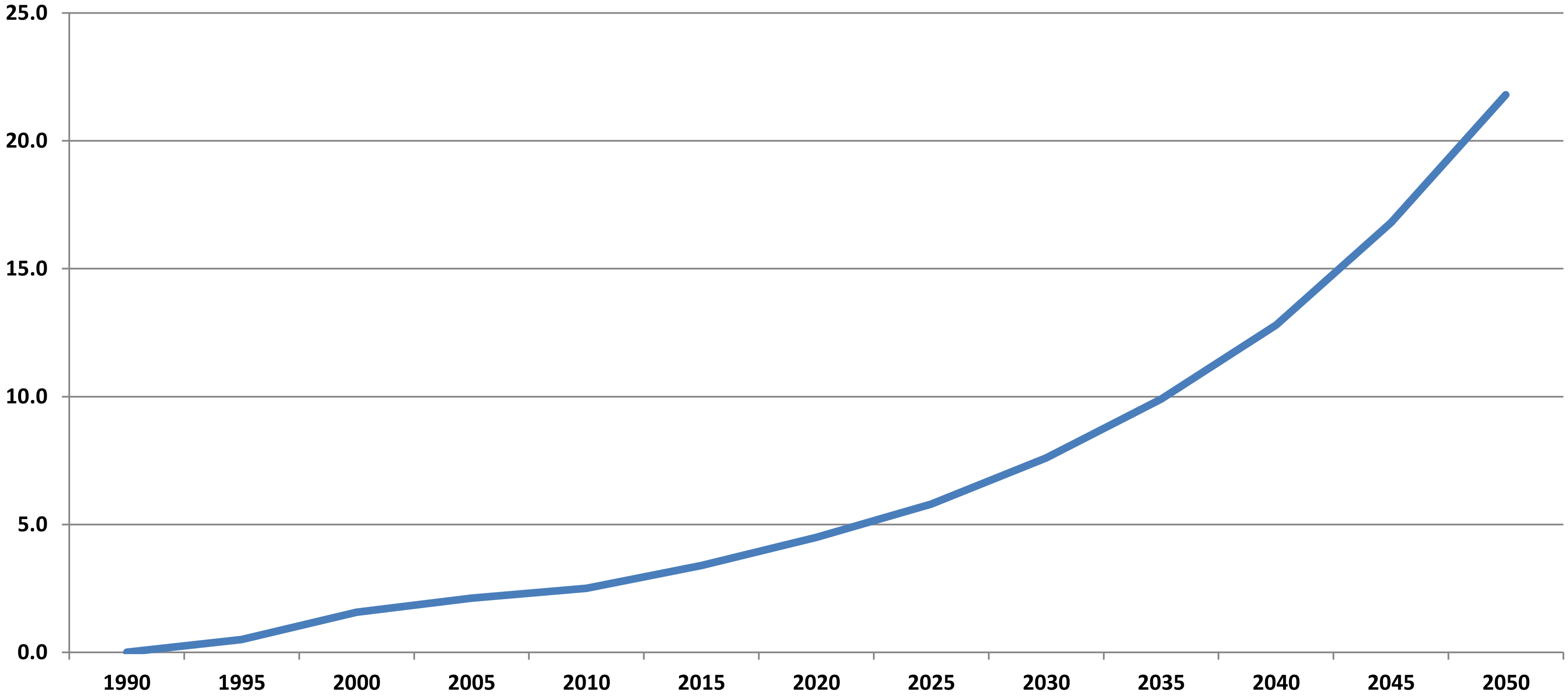
This data does not include the energy used by the Aluminum Industry. Energy use is included in the electricity sector.

According to reports submitted by Aluminum Manufacturing the GHG from the energy use is about an additional 0.6 $MtCO_2e$ in 2010 and 2011 (US EPA facility reporting data)

Petroleum – GHG emissions from RCI and Transportation Sector, $MMtCO_2e$



ODS Substitutes (HFC, PFC and SF6) $MMtCO_2e$



Hydrofluorocarbons (HFCs) and Perfluorocarbons (PFCs) are used as substitutes for ozone depleting substances (ODS). However, they are potent warming gases with high global warming potentials (GWP). The substitutes are used for refrigeration, air conditioners, and many more products. By 2020, ODS will be 80% of industrial processes emissions.

Task 2 Results

Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State

September 27, 2013

SAIC

NATIONAL SECURITY • ENERGY & ENVIRONMENT • HEALTH • CYBERSECURITY

Task 2 Scope of Work

a) Identify and summarize comprehensive GHG emission reduction programs in the Pacific Northwest, on the West Coast, in neighboring provinces in Canada, in other region of the U.S. and in other countries. The selection of other countries' programs will be based on those that have policies and circumstances directly comparable to Washington State. A list of potential programs will be run through a technical screen to determine the final list of programs to analyze.

b) Evaluate, using available information, the programs based on:
   a) The effectiveness of the program in helping the jurisdiction achieve its emission reduction goals, including cost per ton of emission reduction;
   b) The relative impact upon different sectors of the jurisdiction's economy, including power rates, agriculture, manufacturing, and transportation fuel costs;
   c) The effect on household consumption and spending, including fuel, food, and housing costs, and program measures to mitigate to low-income populations;
   d) Displacement of emission sources from the jurisdiction due to the program;
   e) Any significant co-benefits to the jurisdiction, such as reduction of potential adverse effects to public health, from implementing the program;
   f) Opportunities for new manufacturing infrastructure, investments in cleaner energy and energy efficiency, and jobs including in-state opportunities;
   g) Achievements in greater independence from fossil fuels and the economic costs and benefits;
   h) Impacts on fuel choice, if it can be determined, and
   i) The most effective implemented strategy and the trade-offs made.

c) Evaluate existing studies of the potential costs to Washington consumers and businesses of GHG emissions reduction programs or strategies being implemented in other jurisdictions.

d) Analyze options for an approach to reduce emissions that would increase spending on instate energy production relative to expenditures on imported energy sources, and effects to job growth and economic performance.

e) Evaluate opportunities for new manufacturing infrastructure and other job producing investments in Washington relating to cleaner energy and greater energy efficiency.

Task 2 in Context

How does Task 2 fit into the overall project?

- Provides a portfolio of potential actions and policies from outside WA from which CLEW may choose from in order to pursue further reductions in GHG emissions.

Next Steps?

- Task 1, Task 2, and Task 3 are complete
- First draft of Task 4 Report to be submitted for CLEW review on September 27
- CLEW Comments on Task 4 due on October 8
- SAIC will present the results of Task 4 on October 14

How Task 2 Will Feed Into Recommendations

Reviews Existing GHG Reduction Policies

- What policy tools are available?
- What has been the experience of other jurisdictions?
- How might policies affect the economy, businesses, and consumers, both positively or negatively?
- What is the potential for GHG reductions in WA?
- What is the cost of emission reductions under different policies?

Conceptual Approach

1. Screen large pool of policies based on applicability to WA GHG sources and existing policies.
2. Evaluate selected policies based on implementation in other jurisdictions.
3. Explore the GHG and economic potential of the most promising policies in WA.

SAIC®

Identify Target Sectors

- Evaluated WA's historic emissions for sectors that:
  - Contributed significantly to overall emissions
  - Have shown growth since 1990
- Primary focus:
  - Transportation (44%, 14% growth)
  - Electricity (22%, 22% growth)
  - RCI (21%, 6% growth)
  - Total: over 80% of total emissions

Million Metric Tons CO_2e	1990	2005	2010	2010 (%)	Change from 1990 Levels
Electricity, Net Consumption-based	**16.9**	**18.8**	**20.7**	**22%**	**22%**
Coal	16.8	15.2	15.8	17%	-6%
Natural Gas	0.1	3.6	4.8	5%	47%
Petroleum	0.0	0.0	0.1	0%	>100%
Biomass and Waste (CH_4 and N_2O)	0.0	0.0	0.0	0%	-
Residential/Commercial/Industrial (RCI)	**18.6**	**19.3**	**19.7**	**21%**	**6%**
Coal	0.6	0.1	0.3	0%	-50%
Natural Gas	8.6	10.3	10.8	11%	26%
Oil	9.1	8.7	8.4	9%	-8%
Wood (CH_4 and N_2O)	0.2	0.2	0.2	0%	0%
Transportation	**37.5**	**44**	**42.2**	**44%**	**13%**
Onroad Gasoline	20.4	23.9	21.9	23%	7%
Onroad Diesel	4.1	7.1	8.0	8%	95%
Marine Vessels	2.6	3.3	3.0	3%	15%
Jet Fuel and Aviation Gasoline	9.1	7.7	8.1	9%	-11%
Rail	0.8	1.3	0.5	1%	-38%
Natural Gas, LPG	0.6	0.7	0.7	1%	17%
Fossil Fuel Industry	**0.5**	**0.8**	**0.7**	**1%**	**40%**
Natural Gas Industry(CH_4)	0.4	0.7	0.7	1%	75%
Coal Mining (CH_4)	0.0	0.1	0.0	0%	-
Oil Industry (CH_4)	0.0	0.0	0.0	0%	-
Industrial Processes	**7**	**3.8**	**3.8**	**4%**	**-46%**
Cement Manufacture (CO_2)	0.2	0.4	0.3	0%	50%
Aluminum Production (CO_2, PFCs)	5.9	0.8	0.5	1%	-92%
Limestone and Dolomite Use (CO_2)	0.0	0.0	0.0	0%	-
Soda Ash	0.1	0.1	0.1	0%	0%
ODS Substitutes (HFCs, PFCs and SF_6)	0.0	2.1	2.5	3%	>100%
Semiconductor Manufacturing (HFCs, PFCs, SF_6)	0.0	0.1	0.1	0%	>100%
Electric Power T&D (SF_6)	0.8	0.3	0.3	0%	-63%
Waste Management	**1.5**	**2.5**	**2.8**	**3%**	**87%**
Solid Waste Management	1.0	1.9	2.1	2%	>100%
Wastewater Management	0.5	0.6	0.7	1%	40%
Agriculture	**6.4**	**5.7**	**5.2**	**5%**	**-19%**
Enteric Fermentation	2.0	2.1	2	2%	0%
Manure Management	0.7	1.1	1.1	1%	57%
Agriculture Soils	3.7	2.5	2.1	2%	-43%
Total Gross Emissions	**88.4**	**94.0**	**95.1**	**100%**	**8%**

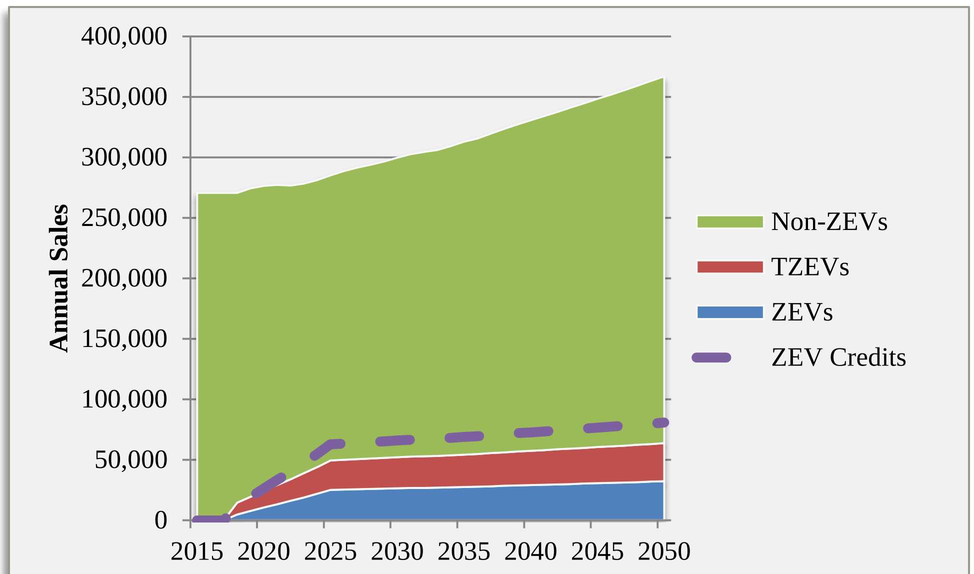
Evaluated Programs in Other Jurisdictions

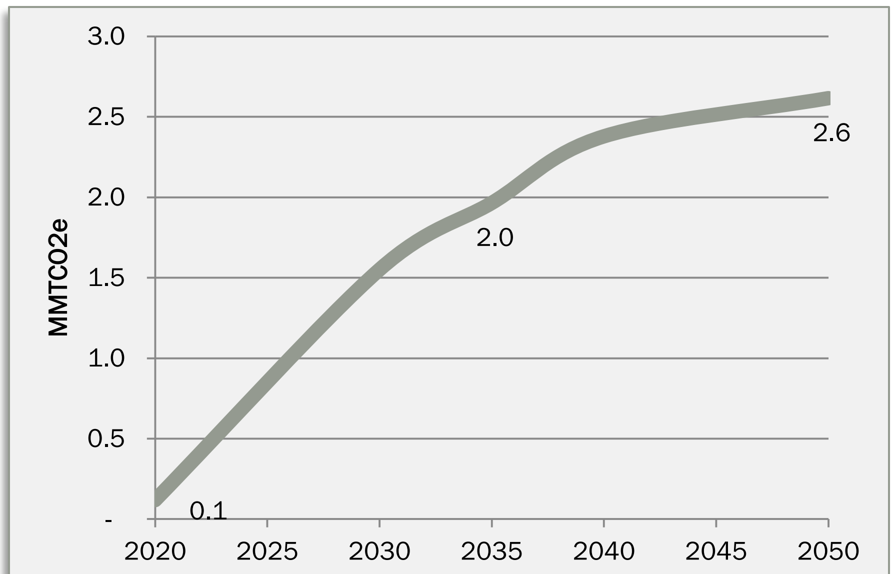
- Cross-checked sectors with existing Washington policies, focusing on areas for potential additional opportunity
- Applied screening criteria
- Identified multiple instances of each policy type, looking to multiple jurisdictions

Screening Criteria	Justification
Targets an emissions source of significant magnitude?	Policies targeting small sources of emissions will not generate the magnitude of reductions that WA requires
What are the volume and cost of GHG reductions? Has it been successful?	Unless noteworthy differences between jurisdictions exist, unsuccessful policies are unlikely to succeed in WA
Discrete and comprehensive? Bundle of related policies?	Comprehensive policies will generate more extensive GHG reductions and reduce the number of policies on which CLEW must engage
Can it be meaningfully implemented or influenced at the state level?	Some policies are best implemented and administered at the federal or local level.

Evaluated Potential in Washington

- Reviewed existing information and studies on:
  - Potential costs and benefits to WA consumers and businesses
  - Changes to spending on instate energy production relative to imported energy
  - Opportunities for manufacturing infrastructure and job producing investments
- For a subset of policies, conducted original analysis of:
  - Potential magnitude of GHG emissions reductions
  - Cost of GHG emissions reductions





Results

Overview of All Policies

Policy	Magnitude of Potential Emissions Reductions	Net Economy-Wide Financial Impact on Washington Consumers and Businesses	Opportunity to Increase in-state energy production and expenditures	Opportunity for new infra-structure and jobs in clean tech and energy efficiency
Cap and Trade	High	Uncertain	Medium	Medium
Carbon Tax	High	Uncertain	Medium	Medium
Low Carbon Fuel Standard	High	Uncertain	High	High
Zero Emissions Vehicle Mandate	Medium	Negative	Medium	High
Renewable Fuel Standard	Medium	Uncertain	Medium	Medium
Transportation Pricing – Mileage User Fee	Low	Uncertain	Low	Low
Investment in Public Transit	Low	Uncertain	Low	High
Public Benefit Fund	Medium	Positive	High	High
Property Assessed Clean Energy	Low	Positive	High	High
Marine Fuel Conservation	Low	Positive	Medium	Medium
Feed-in-Tariff	Low	Negative	High	Medium
Offshore Wind and Ocean Power	Medium	Uncertain	High	High
Landfill Methane Capture	Low	Negative	Medium	Low

Overview of Quantified Policies

Policy	GHG Reductions ($MMTCO_2e$)			Cost effectiveness ($/mtCO2e)[a]	Source of Emissions Addressed
	2020	2035	2050		
Cap and Trade	1.6	17.5	29.4	Not quantified	Electricity, RCI, Transportation
Carbon Tax	0.4 – 1.7	0.6 – 5.0	Not quantified	$5 to $23	Electricity, RCI, Transportation
Low Carbon Fuel Standard	1.0	3.9	4.0	$103 to $131	Transportation
Zero Emissions Vehicle Mandate	0.1	2.0	2.6	$70	Transportation
5% Renewable Fuel Standard	0.2	0.4	0.4	Not quantified	Transportation
Public Benefit Fund	0.6	2.9	Not quantified	$(103) to $146	Electricity, RCI
Property Assessed Clean Energy	0.02	0.05	0.6	$(171)	Electricity, RCI
Feed-in-Tariff, 375 MW Cap	0.5	0.5	0.5	$30 to $500	Electricity

Economy-wide Policies

Cap and Trade

Potential Action for Consideration

- Implement an economy-wide cap and trade program covering and reducing emissions from electricity, transportation fuels, and residential, commercial and industrial sectors

GHGs and Costs in Washington	2020	2035	2050
GHG Emissions Cap ($MMTCO_2e$)	73.6	55.2	36.8
GHG Reductions from Cap ($MMTCO_2e$)	1.6	17.5	29.4
Value of Allowance Commodity at $30/ton (billion $)	$2.2	$1.7	$1.1

Implementation Issues and Lessons Learned

- Difficult to forecast and impossible to know in advance the actual costs of compliance
- Set cap to avoid market over-supply, leading to low prices and insufficient market signal for innovation, or under-supply leading to high prices and negative econ. impacts
- Allowances convey a valuable property right; can be freely allocated, auctioned, or distributed through a combination of mechanisms
- Cost containment mechanisms such as offsets, price caps, and free allocation can be used to protect the market from unacceptably high costs or distributional inequities
- Some sectors face greater trade exposure and leakage risk than others
    - These sectors can be protected through free allocation of allowances or exemptions
- Revenue generated by the State can be invested based on State priorities

Carbon Tax

Potential Action for Consideration			
• Implement a tax on carbon emissions in WA			

GHGs and Costs in Washington	GHG Reductions ($MMTCO_2e$) 2020	GHG Reductions ($MMTCO_2e$) 2035	Cost ($\$/mtCO_2e$)
\$10 per $mtCO_2e$ tax	0.4	0.6	\$5
\$10, escalating to \$30 per $mtCO_2e$ tax	1.5	2.8	\$15
\$10, escalating to \$30 per $mtCO_2e$ tax	1.7	5.0	\$23

Implementation Issues and Lessons Learned

- Emission reductions are highly dependent on the carbon tax rate selected
- The economically efficient rate (the social cost of CO_2) is difficult to estimate
- Taxes can be imposed at various cost points, including annual escalation and caps
  - Policymakers should set these values in advance to provide market certainty, or establish a transparent mechanism to review and adjust rates periodically
- Carbon tax may be regressive
- Carbon taxes can generate significant revenue – can offset other taxes
- The decision as to which sectors should be exempted, if any, requires significant consideration
- Taxes can be collected upstream or downstream

Transportation Policies

Low Carbon Fuel Standard (LCFS)

Potential Action for Consideration
• LCFS of a 10% reduction in the carbon intensity of the fuel mix over a 10-year time period

GHGs and Costs in Washington	GHG Reductions ($MMTCO_2e$)			Cost ($/$mtCO_2e$)
	2020	2035	2050	
10% reduction in carbon intensity over 10 years	1.0	3.9	4.0	$103 to $131

Implementation Issues and Lessons Learned

- May be legal challenges to implementing at state as opposed to federal level
- Sector exemptions should be carefully considered
  - California LCFS does not cover military activity, the racing industry, the aviation industry, marine fuels, or locomotive fuels
  - Important consideration = marine fuel exemption

Zero Emissions Vehicle (ZEV) Mandate

Potential Action for Consideration

- Implement a ZEV mandate in conjunction with adopting LEV III

GHGs and Costs in Washington	GHG Reductions ($MMTCO_2e$)			Cost ($/$mtCO_2e$)
	2020	2035	2050	
22% ZEV credit requirement by 2025	0.1	2.0	2.6	$70

Implementation Issues and Lessons Learned

- Potential interactions with a LCFS
- Other states may get first offerings of ZEVs from manufacturers
  - ZEV mandate may not increase total U.S. ZEVs, but rather shift sales to Washington
- Increases in ZEV model options may increase consumer purchasing
- Customer incentives may help meet goals
  - Current sales tax exemption applies only to vehicles fueled solely by electricity, the proposed incentives may shift purchasing to a higher proportion of TZEVs
- Unknown costs to vehicle manufacturers and dealerships
- Need for additional infrastructure to support ZEVs

Renewable Fuel Standard (RFS)

Potential Action for Consideration

- Strengthen WA's existing RFS from a volumetric 2% to a universal 5% biodiesel requirement
- Extend existing incentives for alternative fuel vehicles, biofuel production and distribution, and infrastructure beyond current expiration dates

GHGs and Costs in Washington	GHG Reductions ($MMTCO_2e$)			Cost ($\$/mtCO_2e$)
	2020	2035	2050	
5% universal biodiesel requirement	0.2	0.4	0.4	Not quantified

Implementation Issues and Lessons Learned

- Volumetric RFS are difficult to enforce
  - A universal requirement would require each gallon of fuel to contain the specified percent biodiesel -- can be verified by random testing, alleviating administrative burdens
- Align policies to ensure that biofuel incentives and tax breaks are mutually supportive
- Economic studies in WA recommend implementing a carbon tax to spur the advancement and market penetration of biofuels

Reducing Vehicle Miles Traveled (VMT)

Potential Action for Consideration

- Implement a Mileage Based User Fee (MBUF) in place of the gasoline tax
- Require companies to provide a PAYD insurance offering
- *WA has long history and demonstrated progress in Trip Reduction and other existing programs, which were not evaluated in this project*

Potential Costs and Benefits to WA Consumers

- Co-benefits associated with VMT reduction
- Consumer cost savings are case-specific, and will depend on the amount of travel
- Potential to disproportionately impact low income users
- There is high uncertainty on how these policies would actually affect GHG emissions
- Could create increased cost burden on businesses with high-VMT delivery and goods transport component, if insurance offerings changes

Investments in Public Transit Infrastructure

Potential Action for Consideration

- Improve overall transportation system efficiency and reduce delay, establish an increased ridership goal, and fund proportionally expanding service miles when ridership and demand exceeds current system capabilities
- Continue to provide and potentially increase: grants, technical assistance; planning; communication and coordination
- Consider increasing the "local option" sales tax rate to allow local transit authorities to raise revenue
- Review the classification of public transit as it pertains to the 18th amendment to WA State Constitution, potentially allowing gas tax revenues to be used for transit purposes

Potential Costs and Benefits to WA Consumers

- Costs
  - Will never be self-supporting; requires subsidies
  - Increased taxes
  - Potential for fares to increase (or decrease)
- Benefits
  - Improves mobility and accessibility
  - Builds community
  - Reduces oil dependency & air emissions
  - Reduces fuel consumption costs/ transportation expenditures

Potential Costs and Benefits to WA Businesses

- Costs
  - Increased taxes
- Potential cost savings
  - Parking requirements

Energy and Residential, Commercial, and Industrial Policies

Public Benefit Fund (PBF)

Potential Action for Consideration

- Create clean energy business and economic development PBF
- Create a PBF to serve electric utilities exempt from I-937 and natural gas utilities
- Create a PBF to pursue efficiency that becomes cost-effective only when the price of carbon is included

GHGs and Costs in Washington

Three potential program designs are separately considered and quantified

Implementation Issues and Lessons Learned

- Cost recovery under I-937 functions similarly to a PBF, but a PBF can result in greater equity across citizens
- Rates must be set such that the PBF generates significant revenues without unduly impacting consumers
- PBF can target renewable energy, energy efficiency, clean energy research, development, and deployment (RD&D), or all of the above
- PBF can be used for low income assistance

Property Assessed Clean Energy (PACE)

Potential Action for Consideration
• Remove barriers to local administration of PACE programs, which support energy conservation and renewable energy

GHGs and Costs in Washington	GHG Reductions (MMTCO2e)			Cost ($/mt$CO_2$e)
	2020	2035	2050	
$10 million annual investment for 5 years	0.02	0.05	0.6	$(171)

Implementation Issues and Lessons Learned

- Must define qualifying building types and qualifying improvements
- PACE programs to date have been small because the funding mechanism is in its infancy
- Must establish the assessment lien position relative to mortgages and other tax assessments
  - Legal challenges related to this issue in the residential sector have largely stalled residential PACE implementation
- Requires seed funding for early loans, or involvement of private firms to manage debt
- There are several PACE lending models, such as warehoused, pooled bond, or owner-arranged/open market

Feed-in-Tariff

Potential Action for Consideration				
• Replace WA's existing combination of net metering and a tax incentive mechanism with a Feed-in-Tariff				

GHGs and Costs in Washington	GHG Reductions ($MMTCO_2e$)			Cost ($\$/mtCO_2e$)
	2020	2035	2050	
Program cap of 375 MW (scalable)	0.5	0.5	0.5	\$30 to \$500

Implementation Issues and Lessons Learned

- FIT success depends on existing renewable energy generation, community acceptance of renewable energy and associated costs, and interconnected codes and standards
- Need to consider whether to base rates on cost of generation or avoided cost
- Program caps serve to moderate the potential cost to ratepayers and system integration impacts of introducing a large number of FIT-funded renewable resources
    - Project caps can serve to moderate the number of large projects and/or broaden the type of technologies
- Need to consider whether to focus on small-scale or large-scale projects
- Payments need to be high enough to attract investors
- Complexities include interconnection codes, standards and practices, metering requirements, contract length, tariff revisions, payment differentiation, bonus payments, and the siting process for renewable energy systems

Additional Policies

Landfill Methane Capture

Potential Action for Consideration

- Implement a Landfill Methane Capture policy similar to CA
  - Landfills with > 450,000 tons of waste-in-place, a landfill gas heat rate > 3.0 MMBtu per hour, and which received waste after January 1, 1977 must install and operate a landfill GCCS with 99% destruction removal efficiency for methane
  - Hazardous waste landfills, construction and demolition landfills, and landfills regulated under CERCLA are exempt
  - Scaled reductions from California estimated at 0.4 MMTCO2e.

Potential Costs and Benefits to WA Consumers

- $0.09 per month per Californian
- Reduction in NMOC emissions

Potential Costs and Benefits to WA Businesses

- Capital investment of ~ $4 million
- Additional ~ $1.2-$2.6 million annually in recurring costs
- ~ $62 million total costs for technology, operation, monitoring, and maintenance
- Costs to landfill operators may translate into jobs in related sectors

Backup Slides

Table of Interactions

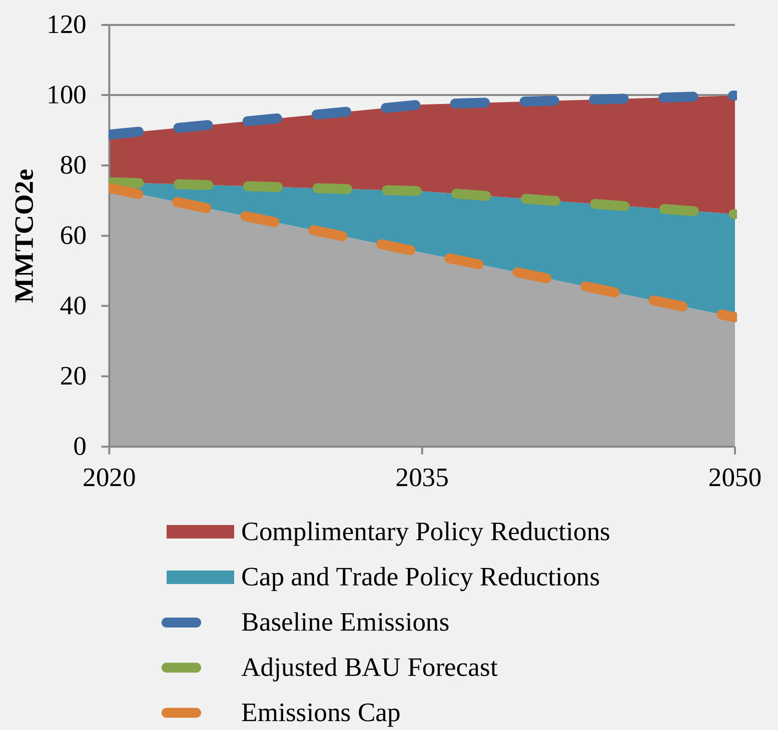
	Cap and Trade	Carbon Tax	LCFS	ZEV Mandate	PBF	PACE Programs	Feed-in-Tariff
Cap and Trade (C&T)	N/A	**Partial diminishment:** cap and trade and carbon tax are both economy-wide strategies	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T
Carbon Tax	**Partial diminishment:** cap and trade and carbon tax are both economy-wide strategies	N/A	**Partial diminishment:** carbon tax and LCFS both target transportation fuels	**Partial diminishment:** carbon tax and ZEV Mandate both target transportation emissions	**Partial diminishment:** carbon tax and PBF both encourage renewables and energy efficiency	**Partial diminishment:** carbon tax and PACE both encourage renewables and energy efficiency	**Partial diminishment:** carbon tax and FIT both encourage renewables
Low Carbon Fuel Standard (LCFS)	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Partial diminishment:** carbon tax and LCFS both target transportation fuels	N/A	**Partial diminishment:** ZEV Mandate and LCFS target vehicles and transportation fuels, respectively	No significant interaction	No significant interaction	No significant interaction
Zero Emissions Vehicles (ZEV) Mandate	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Partial diminishment:** carbon tax and ZEV Mandate both target transportation emissions	**Partial diminishment:** ZEV Mandate and LCFS target vehicles and transportation fuels, respectively	N/A	No significant interaction	No significant interaction	No significant interaction
Public Benefit Fund (PBF)	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Partial diminishment:** carbon tax and PBF both encourage renewables and energy efficiency	No significant interaction	No significant interaction	N/A	**Partial diminishment:** PBF and PACE may target same emission reductions. Both subsumed by I-937	**Partial diminishment:** PBF and FIT may target same emission reductions. Both subsumed by I-937
Property Assessed Clean Energy (PACE) Programs	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Partial diminishment:** carbon tax and PACE both encourage renewables and energy efficiency	No significant interaction	No significant interaction	**Partial diminishment:** PBF and PACE may target same emission reductions. Both subsumed by I-937	N/A	**Partial diminishment:** PACE and FIT may target same emission reductions Both subsumed by I-937
Feed-in-Tariff	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Partial diminishment:** carbon tax and FIT both encourage renewables	No significant interaction	No significant interaction	**Partial diminishment:** PBF and FIT may target same emission reductions. Both subsumed by I-937	**Partial diminishment:** PACE and FIT may target same emission reductions. Both subsumed by I-937	N/A

Table of Costs from MACCS

Policy Category	Emissions Reduction Measure	Cost Effectiveness ($2010/mt$CO_2$e)
Transportation	Low Carbon Fuel Standard	$25[e] to $129[a]
	ZEV Goal	$266[a]
	Production of Biofuels and feedstocks (RFS and AFVs)	($20)[b] to $63[a]
	Vehicle Incentives (EV, AFV, or both)	($70)[d] to $411[a]
	Diesel Engine Emissions Reductions, Fuel Efficiency, and medium to heavy duty truck hybridization (AFV Incentives)	($69)[d] to $74[e]
	Transportation Pricing	No Data
	Public Transit	$18[d]
	Shore Electrification	$61[e]
Energy Conservation (funded by PBF or PACE)	Financial Incentives and Instruments/Demand Side Management Programs	($43)[d]
	Improvements to Existing Buildings with Emphasis on Building Operations	($80)[e] to $7[b]
	Lighting	($97)[b] to $51[c]
	Electronic Equipment	($103)[b]
	HVAC Equipment	$5[c] to $50[b]
	Building Shell	($47)[b] to $21[c]
	Residential Water Heaters	$9[b]
	Conversion Efficiency	($17)[b]
Renewable Energy Generation (funded by PBF or PACE, or incentivized by FIT)	Distributed Renewable Energy Incentives	$146[a]
	Wind	$22[b] to $114[e]
	Solar Photovoltaic	$32[b] to $51[c]
	Solar Thermal	$134[e] to $142[c]
	Geothermal	($15)[c] to $102[e]
	Small Hydropower	$100[e]
	CHP	($40)[b] to $20[e]

[a] = Washington CAT
[b] = McKinsey
[c] = Bloomberg
[d] = Johns Hopkins
[e] = Sweeney and Weyant

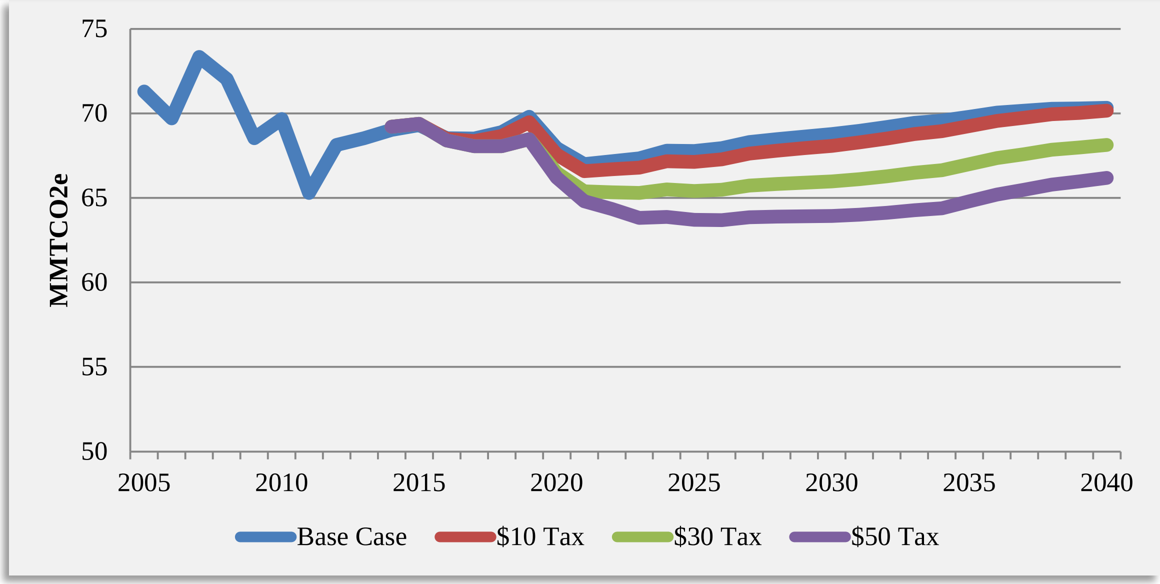
Cap and Trade



Allowance Price/Sector	(Million $USD) 2020	2035	2050
$10/MTCO$_2$e			
Electricity Generation	$169	$127	$85
Transportation Fuels	$387	$293	$195
RCI (Natural Gas and Fuel Oil)	$177	$133	$89
Total	$733	$552	$368
$30/MTCO$_2$e			
Electricity Generation	$507	$380	$254
Transportation Fuels	$1,160	$878	$585
RCI (Natural Gas and Fuel Oil)	$531	$398	$266
Total	$2,198	$1,656	$1,104
$50/MTCO$_2$e			
Electricity Generation	$845	$634	$423
Transportation Fuels	$1,934	$1,463	$975
RCI (Natural Gas and Fuel Oil)	$885	$1,991	$443
Total	$3,664	$4,088	$1,840

Carbon Tax

Change in GHG emissions, tax revenue, and energy consumption under three carbon tax rates.	2020			2035		
Tax Rate	$10	$30	$50	$10	$30	$50
Change in GHG Emissions ($MMTCO_2e$)	0.4	1.5	1.7	0.6	2.8	5.0
Change in Taxes and Tax Revenue (million US$)	$563	$1,656	$1,922	$571	$1,646	$2,635



LCFS

(million $US) with base fuel prices	2020	2035	NPV 2016-2035[a]
Low CNG Scenario	**$16**	**$135**	**$505.1**
Diesel (million $US)	$(61)	$(624)	$(2,230)
Biodiesel (million $US)	$73	$712	$2,577
CNG (million $US)	$2	$38	$120
Vehicles (million $US)	$2	$9	$38
High CNG Scenario	**$16**	**$99**	**$402.8**
Diesel (million $US)	$(61)	$(701)	$(2,448)
Biodiesel (million $US)	$73	$667	$2,452
CNG (million $US)	$2	106	$310
Vehicles (million $US)	$2	$9	$88
Low EV Scenario	**$406**	**$566**	**$4,821**
Gasoline (million $US)	$(1,423)	$(3,194)	$(20,281)
Ethanol (million $US)	$1,777	$3,567	$24,144
Electricity (million $US)	$28	$159	$671
Vehicles (million $US)	$24	$33	$41
High EV Scenario	**$406**	**191**	**$3,771.0**
Gasoline (million $US)	$(1,423)	$(2,213)	$(17,532)
Ethanol (million $US)	$1,777	$2,181	$20,260
Electricity (million $US)	$28	$184	$740
Vehicles (million $US)	$24	$39	$287
GHG Reductions ($MMTCO_2e$)	**1.0**	**3.9**	**40.5**
Cost effectiveness ($\$/mtCO_2e$)			**$103 to $131**

(million $US) with biofuel price parity	2020	2035	NPV 2016-2035[a]
Low CNG Scenario	**$0**	**$(15)**	**$(41)**
Diesel (million $US)	$(61)	$(624)	$(2,230)
Biodiesel (million $US)	$58	$561	$2,032
CNG (million $US)	$2	$38	$120
Vehicles (million $US)	$2	$9	$38
High CNG Scenario	**$0**	**$(42)**	**$(116)**
Diesel (million $US)	$(61)	$(701)	$(2,448)
Biodiesel (million $US)	$58	$526	$1,993
CNG (million $US)	$2	106	$310
Vehicles (million $US)	$2	$9	$88
Low EV Scenario	**$(19)**	**$(286)**	**$(951)**
Gasoline (million $US)	$(1,423)	$(3,194)	$(20,281)
Ethanol (million $US)	$1,352	$2,715	$18,372
Electricity (million $US)	$28	$159	$671
Vehicles (million $US)	$24	$33	$41
High EV Scenario	**$(19)**	**$(330)**	**$(1,072)**
Gasoline (million $US)	$(1,423)	$(2,213)	$(17,532)
Ethanol (million $US)	$1,352	$1,659	$15,416
Electricity (million $US)	$28	$184	$740
Vehicles (million $US)	$24	$39	$287
GHG Reductions ($MMTCO_2e$)	**1.0**	**3.9**	**40.5**
Cost effectiveness ($\$/mtCO_2e$)			**$(29) to $(24)**

Cost to LCFS Industry ($70/LCFS)	2020	2035	2050
Average of All Scenarios	$462	$867	$643

ZEV

	2020	2035	2050
Cumulative ZEV Sales (thousand)	23	383	833
Cumulative TZEV Sales (thousand)	35	393	832
Change in Annual Gasoline Consumption (million gallons)	(14)	(210)	(258)
Change in Annual Electricity Consumption (GWH)	246	2,012	2,542
GHG Emission Reductions (MMTCO$_2$e)	**0.1**	**2.0**	**2.6**

Million $US	2020	2035	NPV 2020-2035[a]
Cost to Government	**$62**	**$74**	**$1,160**
Incentives Payments	$57	$-	$489
Lost Fuel Tax Revenue	$5	$74	$671
Cost to Manufacturers	**$138**	**$155**	**$2,340**
Cost to Consumers	**$(58)**	**$(232)**	**$(2,333)**
Fuel Costs Savings[b]	$(18)	$(553)	$(4,629)
Technology Cost	$17	$321	$2,785
Incentives Received	$(57)	$-	$(489)
Total Costs	**$143**	**$(4)**	**$1,167**
Total GHG Reductions (MMTCO$_2$e)	**0.1**	**2.0**	**16.7**
Cost per mtCO$_2$e			**$70**

SAIC

PBF

Social cost of carbon

Year	Social Cost of Carbon (2013$/metric ton CO_2)	Calculated Increase to Levelized Cost of Electricity for Natural Gas CCCT (2013$/MWh)
2020	$48	$21
2035	$63	$28
2050	$79	$35

[1] U.S. EPA Website: The Social Cost of Carbon (adjusted from 2011 to 2013 dollars). Accessed August 2013 at: http://www.epa.gov/climatechange/EPAactivities/economics/scc.html

Non I-937 utilities

Calendar Year	Program Year	Projected Baseline Scenario GHGs ($MMTCO_2$)	Percent GHG Reduction Relative to Baseline	GHG Reduction ($MMTCO_2$)
2020	5	4.5	13%	0.6
2035	20	7.1	41%	2.9

Clean Energy Business and Economic Development Program

Budget and Benefits	Units	Quantity
Total Budget 2016-2020	$	100 million
Program Investments and Disbursements	$	86 million
Administrative and Operational Costs	$	14 million
Match Funding Acquired 2016-2020	$	106 million
Total Electricity Savings*	MWh	110 thousand
Total NG Savings*	MMBtu	570 thousand
Total Demand Savings*	MW	30
Total System-wide CO_2 Reduction*	**Metric Tons**	**70,000**

PACE

Hurdle Rate (%)	Loan Term (years)	Measure Life (years)	Potential Emission Reductions ($MMTCO_2$/\$50M) 2020	2035	2050
15%	15	15	0.02	0.04	0.06
15%	15	20	0.02	0.06	0.07
15%	20	20	0.02	0.05	0.05
20%	15	15	0.03	0.04	0.06
20%	15	20	0.03	0.07	0.08
20%	20	20	0.02	0.05	0.05
Estimated Range of Potential Reductions			**0.02-0.03**	**0.04-0.07**	**0.05-0.08**

Million $USD	2020	2035	NPV 2020-2035[a]
Cost to Government	**$8.90**	**$(1.00)**	**$1.70**
Loan Pool Funding	$10.00	$-	$8.20
Administrative Costs	$0.30	$0.30	$1.70
Loan Repayment Revenue	$(1.40)	$(1.20)	$(8.20)
Cost to Consumers	$(5.50)	$(19.00)	$(104.00)
Loan Repayment	$1.40	$1.20	$8.20
Energy Cost Savings	$(6.90)	$(20.00)	$(113.00)
Net Costs	**$3.40**	**$(19.60)**	**$(103.00)**
Total GHG Reductions ($MMTCO_2e$)	**0.02**	**0.05**	**0.60**
Cost per Metric Ton CO_2e ($)			**$(171.00)**

FIT

Scenario 375 MW Capacity Cap	$0.12 / kWh	$0.33 / kWh	$0.54 / kWh
Total Annual Generation (MWh)	1,207,632		
Reduction Factor (mtCO2e/MWh)	0.867		
Total Reductions (MMTCO$_2$e)	0.5		
Cost of Alternative ($/kWh)	$0.091		
FIT Incentive	$0.12	0.33	$0.54
Annual Tariff	67.5	185.6	303.8
Net Incentive (Million $)	3.4	121.5	239.6
Net Cost (Million $)	**16.0**	**134.2**	**252.3**
Cost per Metric Ton of Reductions	**$32.91**	**$275.16**	**$517.41**

Task 3 Results

Evaluation of Federal Policies

Summary of Federal Policies and Their Contributions to Washington's GHG Emission Reduction Targets

September 27, 2013

SAIC®

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Task 3 in Context

How does Task 3 fit into the overall project?

- Demonstrates federal GHG emission reduction policies effects on WA's ability to achieve its GHG reduction targets
- Will show the specific contribution of each federal policy toward WA's target goals

Next Steps?

- Task 1, Task 2, and Task 3 are complete
- First draft of Task 4 Report to be submitted for CLEW review on September 27
- CLEW Comments on Task 4 due on October 8
- SAIC will present the results of Task 4 on October 14

Task 1 Scope of Work

- The SOW identified five categories of federal policies that may contribute to meeting the state's greenhouse gas emissions target
  - Renewable fuel standards
  - Tax incentives for renewable energy
  - Tailpipe emission standards for vehicles
  - Corporate average fuel economy (CAFE) standards for cars and light trucks
  - Clean Air Act requirements for emissions from stationary sources and fossil-fueled electric generating units

Levels of Granularity of Analysis

- **National Impacts of Policies**

- **Regional Impacts of Policies**
  - Transport and Carbon Dioxide Emissions = Census Division 9
  - Electricity = Electricity Market Module 21 = Western Electricity Coordinating Council/Northwest Power Pool

- **Washington**
  - Multiply WA average historic share of fuel, energy, or emissions, as appropriate, by regional NEMS projections to estimate state-level impacts for each policy
  - Historic data for WA were obtained from the State Energy Data System (SEDS) and State CO_2 Emissions database maintained by EIA
  - Values were averaged for 2006 through 2010 to estimate WA typical share or weight in the region

Census Divisions Vs. Electricity Market Modules

Figure F1. United States Census Divisions

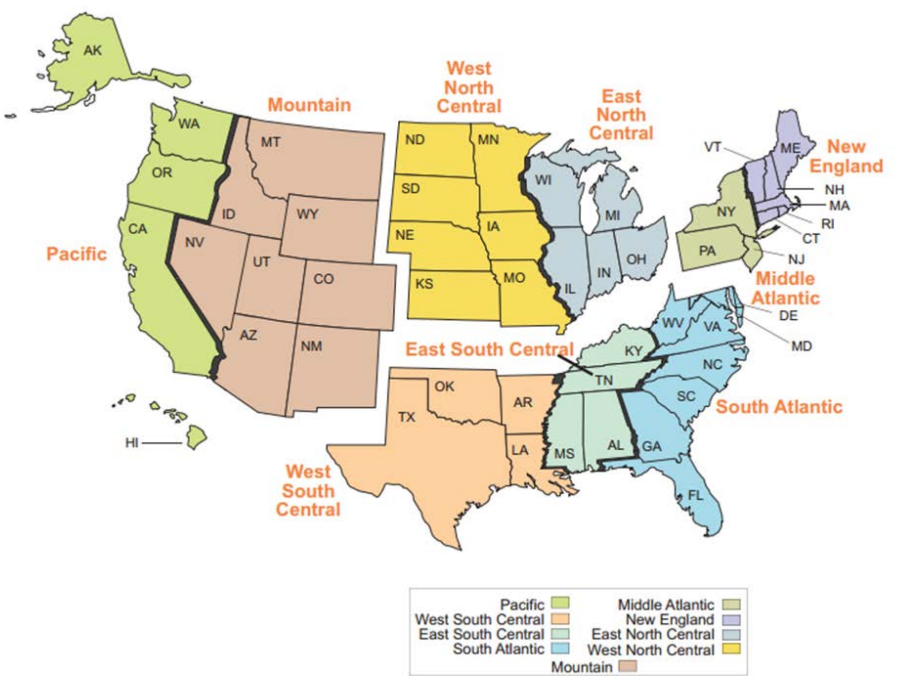
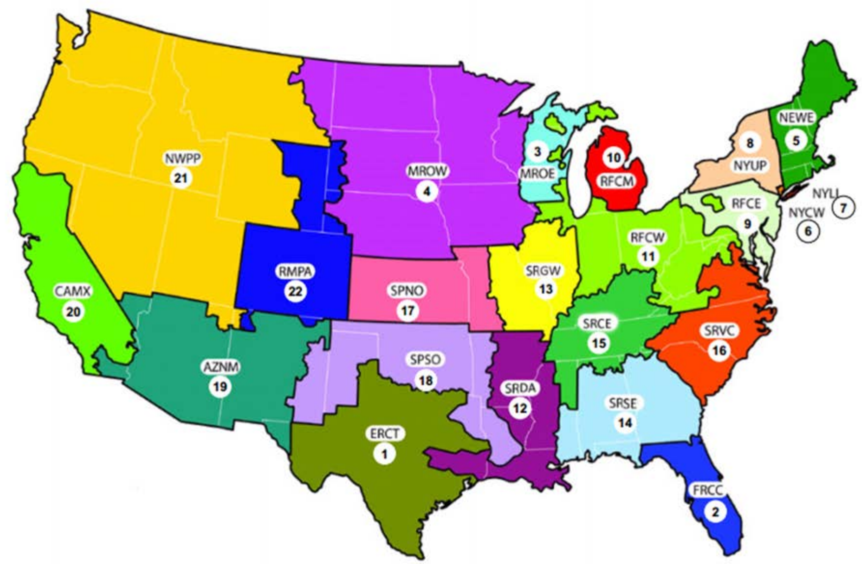


Figure F2. Electricity market module regions



1. ERCT TRE All
2. FRCC FRCC All
3. MROE MRO East
4. MROW MRO West
5. NEWE NPCC New England
6. NYCW NPCC NYC/Westchester
7. NYLI NPCC Long Island
8. NYUP NPCC Upstate NY
9. RFCE RFC East
10. RFCM RFC Michigan
11. RFCW RFC West
12. SRDA SERC Delta
13. SRGW SERC Gateway
14. SRSE SERC Southeastern
15. SRCE SERC Central
16. SRVC SERC VACAR
17. SPNO SPP North
18. SPSO SPP South
19. AZNM WECC Southwest
20. CAMX WECC California
21. NWPP WECC Northwest
22. RMPA WECC Rockies

Criteria for Policy Section

1. Requested by the CLEW as part of the SOW

2. Policy likely to significantly alter GHG emissions from the baseline in **future** years

3. Policy likely to be implemented by statute, regulation or executive action under existing authority in next several years

Policies Examined and Modeled

- **Renewable fuel standards**
  – RFS-1 and RFS-2 as required under the Energy Policy Act (EPACT) of 2005 and Energy Independence and Security Act (EISA) of 2007
- **Tax incentives for renewable energy**
  – Production Tax Credit (PTC) for Renewable Resources and its subordinate element, the Investment Tax Credit (ITC)
- **Tailpipe emission standards for vehicles**
  – Incorporated into updated CAFE Standards
- **CAFE standards for cars and light trucks**
  – More stringent requirements for 2017 - 2025 implemented subsequent to EISA 2007
- **CAA requirements for emissions from stationary sources and fossil-fueled electric generating units**
  – Mercury and Air Toxic Standards
  – Clean Air Interstate Regulations (CAIR) and Cross-state Air Pollution Rule (CSAPR)
  – Aggregate of all other CAA Regulations (includes Regional Haze Regulation)

Policies Examined and Modeled (Cont.)

- **Other Policies Considered Relevant to WA**
  - Renewable Portfolio Standards in 30 states and District of Columbia
  - Low Carbon Fuel Standard in California

Policies Examined But Not Yet Modeled

- **New CO_2 emissions standards for electric generation plants**
  - Proposal not released prior to completion of task report
  - May already be captured in Trans Alta policy
  - Possible Task 5 analysis?
- **Incentives for renewable power on federal lands**
  - Insufficient viable project opportunities in WA to justify further work
- **Elimination of oil and gas depletion allowance**
  - No measureable impact on WA GHG emissions
- **REIT and MLP Parity**
  - Potentially interesting policies with likely relatively small impact
- **Expansion of Natural Gas Exports**
  - Policy gaining momentum, may be worth Task 5 analysis

Analytical Approach and Methodology

Analytical Approach and Methodology
Modeling Tools

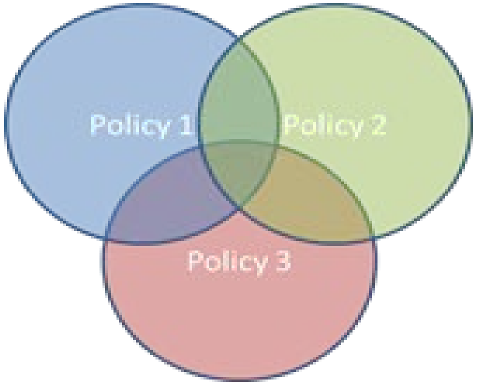
- **National Energy Modeling System (NEMS)**
  - Annual Energy Outlook 2012 Version
  - Developed by EIA, the independent statistical agency within DOE, specifically to evaluate the implications of broad federal policies
    - NEMS includes all prominent existing federal energy and environmental laws
    - Also discretely represents California's LCFS and the RPS within 30 individual states

Analytical Approach and Methodology
Individual Policy Impacts

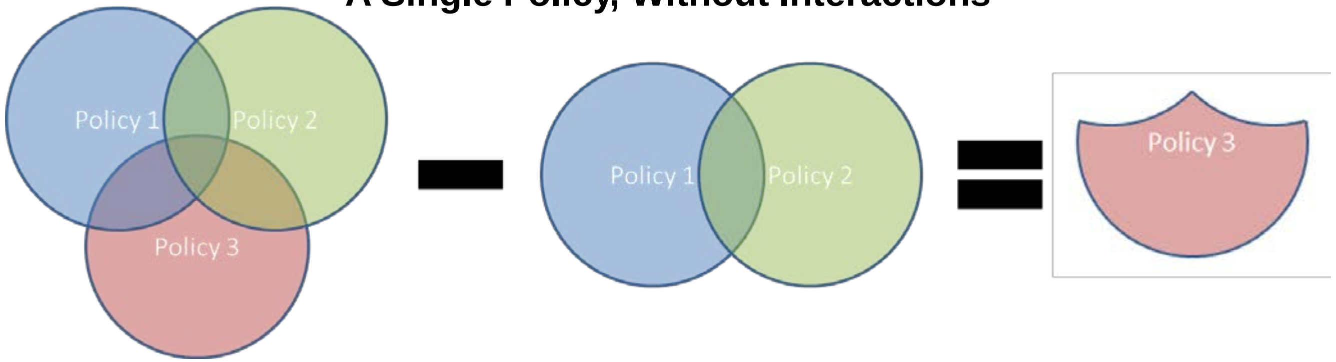
1. The reference case version of the model is considered the baseline scenario

2. Remove each policy individually, run the model comparing emissions to the baseline scenario. The difference in emissions represents the reduction due to the policy exclusive of all interactions

Reduction Due to All Federal Policies Including Interactions

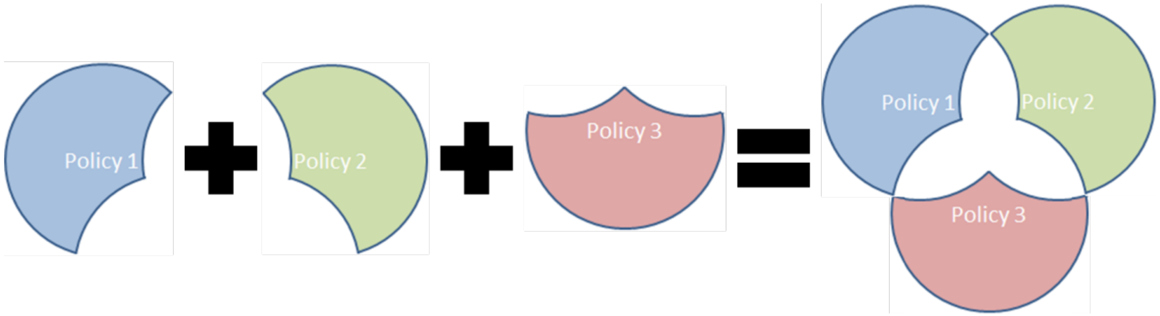


Process Used to Calculate Reduction Due to A Single Policy, Without Interactions

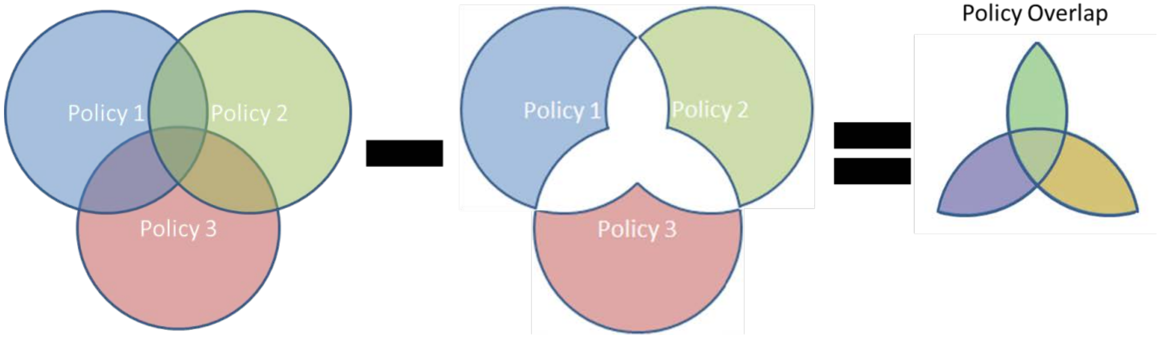


Analytical Approach and Methodology Combining Multiple Policies

Sum of Reductions Due to Individual Federal Policies Exclusive of All Interactions



Difference Between Reductions Due to the Combined Effect of Federal Policies and the Sum of Emission Reductions from Individual Policies



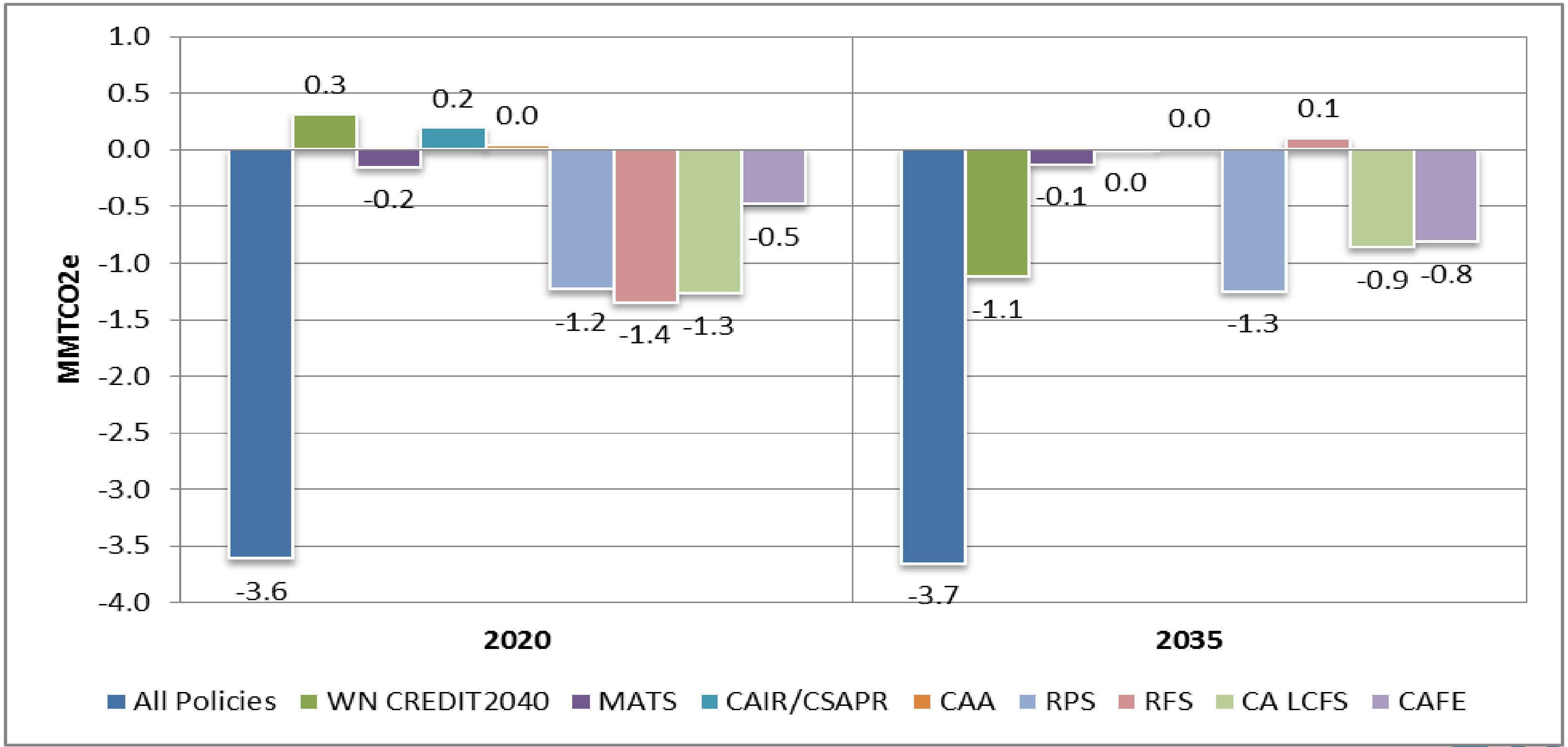
Task 3 Outcomes

Modeling Cases Run

Case ID	Case Name	Case Description
Case1	WA Baseline	AEO 2012 **Reference Case** with CA LCFS Incorporated
Case2	WN Credit 2040	AEO 2012 Reference Case with CA LCFS and **PTC Extended to 2040**
Case3	MATS Off	WA Baseline with **Mercury and Air Toxics Standard** Turned Off
Case4	CAIR/CSAPR Off	WA Baseline with **Clean Air Interstate Rule** and **Cross-state Air Pollution Rule** Turned Off
Case5	CAA Off	WA Baseline with **Clean Air Act** Turned Off
Case6	RPS Off	WA Baseline with **Renewable Portfolio Standards** Turned Off
Case7	RFS Off	WA Baseline with **Renewable Fuels Standards** Turned Off
Case8	CA LCFS Off	WA Baseline with **California Low Carbon Fuel Standard** Turned Off
Case9	CAFE Off	WA Baseline with **CAFE** Turned Off
Case10	Combined	WA Baseline with **All Policies** Turned Off

Results of Analysis
Key Takeaways

- **NEMS is a Deterministic Model that Generates Point Estimates, However:!**
  - Forecasts are more valuable for magnitude, trends and cross-comparisons
  - As demonstrated above, individual policy results cannot be summed to combined cases



Results of Analysis
Key Takeaways

- **Federal Policies Likely to Have Limited Impact on Ability of Washington to Meet GHG Emission Reduction Goals**

  - Transport
    - Benefits of CAFE largely captured in implementation of CA Clean Cars in Washington
    - Benefits of CA LCFS likely overestimated due to apportionment of savings in the region

  - Electric
    - Most of Clean Air Act rules for stationary combustion (MATS, CAIR/CSPR, New Performance Standards) likely to have little impact on Washington due to limited coal-fired generation
    - Existing appliance standards captured in baseline, proposed appliance standards unlikely to pass Congress
    - Impacts for Washington of out of state RPS in surrounding region may be overestimated fuel to apportionment of savings

Evaluation of Comprehensive GHG Emissions Reduction Programs Outside of Washington

Final Report

9/20/2013

Prepared for: Washington State Climate Legislative and Executive Workgroup (CLEW)
Prepared by: Science Applications International Corporation (SAIC)/Leidos

Table of Contents

List of Tables

List of Figures

Acronyms

AB	Assembly Bill
ACEEE	American Council for an Energy-Efficient Economy
ACP	Alternative Compliance Payments
ACSE	American Society of Civil Engineers
AEO	EIA's Annual Energy Outlook
AFV	Alternative-Fuel Vehicle
ANREU	Australian National Registry of Emissions Units
APR	Annual Percentage Rate
APTA	American Public Transportation Association
ARB	California Air Resources Board
ARFVTP	Alternative and Renewable Fuel and Vehicle Technology Program
ARRA	American Recovery and Reinvestment Act
B&O	Business and Occupation
BAU	Business-as-Usual
BC	British Columbia
BCG	Boston Consulting Group
BEV	Battery Electric Vehicle
BHI	Beacon Hill Institute
BOEM	Bureau of Ocean Energy Management
BPU	New Jersey Board of Public Utilities
Btu	British Thermal Units
C&T	Cap and Trade
CAD	Canadian Dollar
CalEPA	California Environmental Protection Agency
CAT	Washington State Climate Action Team
CBO	Congressional Budget Office
CCCT	Combined-Cycle Combustion Turbine
CCEF	Connecticut Clean Energy Fund
CCR	Cost Containment Reserve
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CEC	California Energy Commission
CEEF	Connecticut Energy Efficiency Fund
CEFIA	Connecticut Clean Energy Finance and Investment Authority
CELC	Washington Clean Energy Leadership Council
CEP	Washington Clean Energy Partnership
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CETIP	Oregon Commercial Electric Truck Incentive Program
CFI	Carbon Farming Initiative

CGE	Computable General Equilibrium
CH_4	Methane
CHP	Combined Heat and Power
CI	Carbon Intensity
CLEW	Climate Legislative Executive Workgroup
CMAQ	Congestion Mitigation and Air Quality
CMSP	Coastal and Marine Spatial Planning
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CPI	Consumer Price Index
CPM	Carbon Pricing Mechanism
CPUC	California Public Utilities Commission
CSI	California Solar Initiative
CSLP	ClimateSmart Loan Program
CTT	Clean Transportation Triangle
CVRP	California Clean Vehicle Rebate Project
DCEO	Illinois Department of Commerce and Economic Opportunity
DOE	U.S. Department of Energy
DPM	Diesel Particulate Matter
EDF	Environmental Defense Fund
EE	Energy Efficiency
EEG	Erneuebare-Energien-Gesetz
EER	Energy Economy Ratio
EERE	U.S. DOE Office of Energy Efficiency and Renewable Energy
EIA	U.S. DOE Energy Information Administration
EISA	Energy Independence and Security
EMT	Economic Modeling Team
EO	Executive Order
EPA	U.S. Environmental Protection Agency
EPIC	Electric Program Investment Charge
ETS	Emissions Trading Scheme
EU	European Union
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FCM	ISO New England Forward Capacity Market
FCV	Fuel Cell Vehicles
FERC	Federal Energy Regulatory Commission
FHFA	Federal Housing Finance Agency

FHWA	Federal Highway Administration
FIT	Feed-in Tariff
FTE	Full Time Employee
FY	Fiscal Year
GCCS	Gas Collection and Control System
gCO2e/MJ	Grams of carbon dioxide equivalent per mega joule
GDP	Gross Domestic Product
GGE	Gasoline Gallon Equivalent
GHG	Greenhouse Gas
GWh	Gigawatt hour
HFCs	Hydrofluorocarbons
HINMREC	Hawaii National Marine Renewable Energy Center
HOT	High Occupancy Toll
HOV	High Occupancy Vehicle
HTF	Federal Highway Trust Fund
ILUC	Indirect Land Use Change
IOU	Investor-Owned Utilities
IPCC	Intergovernmental Panel on Climate Change
JCP	Jobs and Competitiveness Program
JI	Joint Implementation
kWh	Kilowatt hour
LCA	Life Cycle Associates, LLC
LCFS	Low Carbon Fuel Standard
LFG	Landfill Gas
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
MACC	Marginal Abatement Cost Curve
Mg	Megagrams
MHK	Marine and Hydrokinetic
MJ	Megajoule
mmBtu	One Million British Thermal Units
$MMTCO_2e$	Million Metric Tons Carbon Dioxide Equivalent
MOU	Memorandum of Understanding
MPG	Miles Per Gallon
MPO	Metropolitan Planning Organization
MPR	Market Price Referent
MSW	Municipal Solid Waste
$mtCO_2e$	Metric Tons Carbon Dioxide Equivalent
MW	Megawatt
MWh	Megawatt hour

NAICS	North American Industry Classification System
NEMS	National Energy Modeling System
NJCEP	New Jersey's Clean Energy Program
NMOC	Non-Methane Organic Compounds
NNMREC	Northwest National Marine Renewable Energy Center
NOAA	National Oceanographic and Atmospheric Administration
NOx	Nitrogen Oxides
NPV	Net Present Value
NREL	National Renewable Energy Laboratory
NSPS	New Source Performance Standards
NYSERDA	New York State Energy Research and Development Authority
NZ ETS	New Zealand Emissions Trading Scheme
NZIER	New Zealand Institute of Economic Research
NZU	New Zealand Units
O&M	Operations and Maintenance
ODOT	Oregon Department of Transportation
ODS	Ozone-Depleting Substance
OFM	Office of Financial Management
OGV	Ocean Going Vessels
OPA	Ontario Power Authority
PACE	Property Assessed Clean Energy
PACT	Program Administrator Cost Test
PAYD	Pay-as-you-Drive
PBF	Public Benefits Fund
PCT	Participant Cost Test
PEEBA	Procurement Energy Efficiency Balancing Account
PEV	Plug-in Electric Vehicle
PFCs	Perfluorocarbons
PGC	Public Goods Charge
PHEV	Plug-In Hybrid Electric Vehicle
PIER	California Public Interest Energy Research
POLA	Port of Los Angeles
POLB	Port of Long Beach
PPA	Purchased Power Agreement
PPC	Public Purpose Charge
PSCAA	Puget Sound Clean Air Agency
PUB	Public Utility District
PV	Photovoltaic
PZEV	Partial Zero Emission Vehicle
R&D	Research and Development
RAC	Remediation Adjustment Clause

RBNZ Reserve Bank of New Zealand
RCI Residential, Commercial, and Industrial
RD&D Research, Development and Demonstration
RE Renewable Energy
REFSSA Renewable Energy Facility Site Suitability Area
ReMAT Renewable Market Adjusting Tariff
RFID Radio Frequency Identification
RFS Renewable Fuels Standard
RGGI Regional Greenhouse Gas Initiative
RIN Renewable Identification Numbers
RPS Renewable Portfolio Standards
RVO Renewable Volume Obligation
SAIC Science Applications International Corporation
SBC System Benefits Charge
SCAQMD South Coast Air Quality Management District
SCEIP Sonoma County Energy Independence Program
SEK Swedish Krona
SF_6 Sulfur Hexafluoride
SNMREC Southeast National Marine Renewable Energy Center
SO_2 Sulfur Dioxide
SOx Sulfur Oxides
STAMP State Tax Analysis Modeling Program
STIP State Transportation Improvement Plan
T&MD Technology and Market Development
TERP Texas Emissions Reduction Plan
TOTE Totem Ocean Trailer Express, Inc.
TRC Total Resource Cost
TTW Tank-to-Wheel
TWh Terawatt hour
TZEV Transitional Zero Emissions Vehicle
U.K. United Kingdom
U.S. United States
USDA U.S. Department of Agriculture
VMT Vehicle Miles Traveled
VOC Volatile Organic Compound
WA Washington
WCGA West Coast Governors Alliance
WCI Western Climate Initiative
WSDA Washington State Department of Agriculture
WSF Washington State Ferry

WSPA	Western States Petroleum Association
WSTC	Washington State Transportation Commission
WTT	Well-to-Tank
WTW	Well-to-Wheel
WWPTO	Wind and Water Power Technologies Office
ZEV	Zero Emissions Vehicle

1 Introduction

The Climate Legislative and Executive Workgroup (CLEW), as part of its Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State, has tasked Science Applications International Corporation (SAIC) through the Office of Financial Management (OFM) with identifying and evaluating comprehensive greenhouse gas (GHG) emission reduction programs in the Pacific Northwest, on the West Coast, in neighboring provinces in Canada, in other region of the U.S. and in other countries. SAIC identified and evaluated the costs and benefits of programs based on the potential of each to contribute to meeting the state's greenhouse gas (GHG) emission targets for 2020, 2035, and 2050.

On September 9 2013, SAIC submitted a draft document in fulfillment of those objectives, and received comments from the State on Friday September 13, 2013. This document provides additional response to further comments provided by the State and provides new cost effectiveness data.

This report examines potential GHG reduction policies implemented in other jurisdictions, and considers their applicability to Washington. Policies and programs targeting reductions in GHG emissions abound, and countless other policies have GHG reductions as a secondary or tertiary effect. In total, these programs are far too numerous to consider in any depth as Washington evaluates potential policies to complement its existing GHG reduction efforts. The goal of this effort is to analyze a sub-set of GHG emission reduction policies that have been implemented in other jurisdictions in order to understand their potential to contribute to Washington's GHG emission reduction goals. In addition to achieving real and significant GHG reductions, these policies would ideally shift energy production from out-of-state to in-state sources, reduce reliance on fossil fuels, and have positive impacts on job creation and infrastructure development, while minimizing any adverse impacts on household income.

Two broad categories of policies are presented: comprehensive economy-wide efforts and sector-specific or technology-specific programs. The coverage of GHG emissions regulated in comprehensive carbon pricing programs can involve virtually the entire economy of the host jurisdiction. However, these programs vary in how pricing is imposed, in some cases constraining the quantity of emissions under a cap and trade regime, and in others directly setting the price of GHG emissions with a carbon tax. Sector-specific or technology-specific programs target discrete sources of emissions, or activities that drive emissions, and can together form a portfolio that is comprehensive. These policies may target electricity generation, transportation fuels, or any other GHG-intensive sector of the economy. A list of policies that are reviewed in this report is provided in Table 1. A more detailed review of the implementation history of each policy is provided in Appendix A.

For each of the reviewed policies, this report summarizes various attributes and implementation issues, examines potential costs and benefits to Washington consumers and businesses, and reviews existing literature on the potential for the policy in Washington. For those policies with an orange check mark, original analysis of the GHG emission reduction potential was conducted. The quantification methodologies are summarized in each respective section.

Those policies with a purple check mark have also been researched and are summarized in this report, but were not subjected to original quantification. Some of these were not quantified in detail due to difficulty projecting them as a single policy as opposed to a portfolio of related policies implemented in coordination. Ultimately, the lack of original quantification is a function of resource constraints and dedicating energy towards those policies for which quantification was expected to be most useful to decision-makers. Some of the non-quantified policies, for example those related to public transit and road pricing, are already the subject of considerable energies through existing state efforts and a breadth of other resources to supplement this work exists.

Table 1. Policies with potential GHG emission reduction benefits assessed.

	Economy-wide GHG Reduction Policies
✓ (orange)	Cap and Trade
✓ (orange)	Carbon Tax
	Transportation and Land Use Policies
✓ (orange)	Low Carbon Fuel Standard
✓ (orange)	Zero Emissions Vehicle Mandate
✓ (orange)	Renewable Fuel Standard and Biofuel Support
✓ (purple)	Pricing Policies
✓ (purple)	Investment in Public Transit
	Energy Conservation Policies
✓ (orange)	Public Benefit Fund
✓ (orange)	Property Assessed Clean Energy
✓ (purple)	Marine Fuel Conservation
	Renewable Energy Policies
✓ (orange)	Feed-in-Tariff
✓ (purple)	Offshore Wind and Ocean Power
	Waste Sector Policies
✓ (purple)	Landfill Methane Capture
	Agriculture and Forestry
✓ (orange)	See Appendix[1]

✓ (orange) Reviewed, and GHG reductions quantified

[1] Washington's 2008 Climate Action Team

✓	Reviewed, but not quantified

There is also activity proposed and ongoing within and beyond the Washington State government to better understand the air emissions, health and climate change impacts of out-of-state coal transported by rail to Washington export terminals for subsequent consumption overseas.[2] Coal, or other fossil exports such as liquefied natural gas (LNG), and associated GHG emissions were not analyzed under the scope of this task, although a discussion of increased LNG exports is provided in the Task 3 Final Report on Evaluation of Federal Policies.

[2] The WA Dept. of Ecology is Washington reviews proposals and permits for coal export project proposals through the Environmental Impact Statement process. Ecology's website provides more detailed information, at http://www.ecy.wa.gov/news/2012/itn03_coal.html

2 Summary Findings

Research conducted for this effort identified myriad policies and programs with the potential to reduce emissions in Washington. This section provides an overview of findings from this research on policies summarized in the sections that follow. More detailed information on these policies can be found in Sections 4 through 15 of this report. A thorough literature review of the implementation of each policy in various jurisdictions is provided as Appendix A.

Table 2 provides a high-level overview of the policies discussed in this report. The magnitude of potential reductions and impacts on the economy, expenditures, and job creation will be highly dependent on the aggressiveness of the policy design and funding levels. As these design specifications are uncertain – and will be the subject of CLEW deliberations – Table 2 is intended to provide an order of magnitude or directional indication of the impacts of the policies to assist in understanding their qualitative impacts.

Table 2. Qualitative summary of potential GHG reduction policies

Policy	Magnitude of Potential Emissions Reductions	Net Economy-Wide Financial Impact on Washington Consumers and Businesses	Opportunity to Increase in-state energy production and expenditures	Opportunity for new infra-structure and jobs in clean tech and energy efficiency
Cap and Trade	High	Uncertain[a]	Medium	Medium[b]
Carbon Tax	High	Uncertain[a]	Medium	Medium[b]
Low Carbon Fuel Standard	High	Negative	High	High
Zero Emissions Vehicle Mandate	Medium	Uncertain[3]	Medium	High
Renewable Fuel Standard	Medium	Uncertain[4]	Medium	Medium
Transportation Pricing – Mileage User Fee[5]	Low	Uncertain	Low	Low

[3] ZEV requires significant state and individual investment. However, ZEVs provide a payback to consumers over time based on cheaper per-mile equivalent price of electricity relative to gasoline.
[4] Recent State data show that biodiesel unit cost is less than conventional diesel, however there are implementation costs and potential availability issues may have cost implications.
[5] GHG and economic impacts of MBUF policy greatly depend on design and implementation as a GHG strategy. It would presumably create the much needed revenue for transportation infrastructure as a gas-tax replacement.

Policy	Magnitude of Potential Emissions Reductions	Net Economy-Wide Financial Impact on Washington Consumers and Businesses	Opportunity to Increase in-state energy production and expenditures	Opportunity for new infra-structure and jobs in clean tech and energy efficiency
Investment in Public Transit	Low	Uncertain[6]	Low	High
Public Benefit Fund	Medium	Positive	High	High
Property Assessed Clean Energy	Low	Positive	High	High
Marine Fuel Conservation	Low	Positive	Medium	Medium
Feed-in-Tariff	Low	Negative	High	Medium
Offshore Wind and Ocean Power	Medium	Uncertain	High	High
Landfill Methane Capture	Low	Negative	Medium	Low

[a] The financial impact to consumers and businesses is dependent on how the revenues were used, and highly dependent upon revenue utilization
[b] RGGI program has demonstrated real result by applying revenues to enhance opportunity for new jobs and infrastructure in clean tech and efficiency

Understanding the cost effectiveness of emissions reductions measures is an important factor in making decisions on policy implementation. Table 3 presents a comparison of the cost per metric ton of carbon dioxide equivalent ($mtCO_2e$) of various emissions reductions measures that researchers analyzed for Washington, the entire United States, and California. The purpose of this table is to exemplify how some of the policy options analyzed in this report can result in cost effective emissions reductions measures. These data come from five reports including the Washington Climate Advisory[7] analysis and four nationally recognized marginal abatement cost curves (MACC) authored by researchers at McKinsey[8], Bloomberg[9], Johns Hopkins

[6] Major investments would increase service and lower fares, which would have a positive impact on riders; however increased subsidies would likely require raising taxes, which would negatively impact tax payers.
[7] Washington Climate Advisory Team. 2008. Leading the Way: A Comprehensive Approach to Reducing Greenhouse Gases in Washington State. 72pp. Online at: https://fortress.wa.gov/ecy/publications/publications/0801008b.pdf
[8] Creyts, J., Derkach, A., Nyquist, S., Ostrowski, K., and J. Stephenson. 2007. Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost? U.S. Green House Gas Abatement Mapping Initiative Executive Report. 107pp. Online at: http://www.mckinsey.com/client_service/sustainability/latest_thinking/reducing_us_greenhouse_gas_emissions

University[10], and Stanford University[11]. Ranges are provided representing the high- and low-cost estimates in the literature, with intermediate results omitted for simplicity. Although not all numbers are Washington-specific, and methodologies and assumptions vary by study, these data paint a picture of the potential costs of certain emissions reduction measures under the policies analyzed here.

Table 3. Cost effectiveness (2010 dollars per metric ton of CO_2e) comparison of emissions reduction measures taken from nationally-recognized MACCs. Parentheses indicate negative numbers that should be interpreted as cost savings.

Policy Category	Emissions Reduction Measure	Cost Effectiveness ($2010/mt$CO_2$e)
Transportation	Low Carbon Fuel Standard	$25[e] to $129[a]
	ZEV Goal	$266[a]
	Production of Biofuels and feedstocks (RFS and AFVs)	($20)[b] to $63[a]
	Vehicle Incentives (EV, AFV, or both)	($70)[d] to $411[a]
	Diesel Engine Emissions Reductions, Fuel Efficiency, and medium to heavy duty truck hybridization (AFV Incentives)	($69)[d] to $74[e]
	Transportation Pricing	No Data
	Public Transit	$18[d]
	Shore Electrification	$61[e]
Energy Conservation (funded by PBF or PACE)	Financial Incentives and Instruments/Demand Side Management Programs	($43)[d]
	Improvements to Existing Buildings with Emphasis on Building Operations	($80)[e] to $7[b]
	Lighting	($97)[b] to $51[c]
	Electronic Equipment	($103)[b]
	HVAC Equipment	$5[c] to $50[b]
	Building Shell	($47)[b] to $21[c]
	Residential Water Heaters	$9[b]

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[9] Bloomberg New Energy Finance. 2010. A Fresh Look at the Costs of Reducing US Carbon Emissions. 33pp. Online at: http://about.bnef.com/white-papers/us-mac-curve-a-fresh-look-at-the-costs-of-reducing-us-carbon-emissions/

[10] Johns Hopkins University and The Center for Climate Strategies. 2010. Impacts of Comprehensive Climate and Energy Policy Options on the U.S. Economy. 76pp. Online at: http://www.climatestrategies.us/library/library/download/105

[11] Sweeney J., and J. Weyant. 2008. Analysis of Measures to Meet the Requirements of California's Assembly Bill 32 (DRAFT September 27, 2008). Precourt Institute of Energy Efficiency, Stanford University. 108pp.

	Conversion Efficiency	($17)[b]
Renewable Energy Generation (funded by PBF or PACE, or incentivized by FIT)	Distributed Renewable Energy Incentives	$146[a]
	Wind	$22[b] to $114[e]
	Solar Photovoltaic	$32[b] to $51[c]
	Solar Thermal	$134[e] to $142[c]
	Geothermal	($15)[c] to $102[e]
	Small Hydropower	$100[e]
	CHP	($40)[b] to $20[e]

[a] = Washington CAT
[b] = McKinsey
[c] = Bloomberg
[d] = Johns Hopkins
[e] = Sweeney and Weyant

To tailor results more specifically to Washington, this report performed original analysis and calculations on a sub-set of promising policies to understand the emissions reduction opportunities and costs in Washington. Table 4 summarizes this analysis for the eight policies for which quantification was performed. These estimates are the results of specific policy assumptions documented in each policy's respective section. Changing the assumptions, for example the magnitude of a carbon tax, stringency of the cap, or investment in a PACE program, will change the estimated emissions reductions. Therefore, these should be considered as estimates within the context of the assumptions documented in later chapters. Tailored calculations can be conducted based on specified inputs.

Table 4. Estimated GHG emission reduction potential of policies when independently implemented. Interactions may decrease emissions when policies are implemented together.

Policy	GHG Reductions (MMTCO$_2$e)			Cost effectiveness ($/mtCO2e)[a]	Source of Emissions Addressed
	2020	2035	2050		
Cap and Trade	1.6	17.5	29.4	Not quantified	Electricity, RCI, Transportation
Carbon Tax	0.4 – 1.7	0.6 – 5.0	Not quantified	$5 to $23	Electricity, RCI, Transportation
Low Carbon Fuel Standard	1.0	3.9	4.0	$103 to $131	Transportation
Zero Emissions Vehicle Mandate	0.1	2.0	2.6	$70	Transportation
5% Renewable Fuel Standard[b]	0.2	0.4	0.4	Not quantified	Transportation
Public Benefit Fund[c]	0.6	2.9	Not quantified	$(103) to $146	Electricity, RCI

Property Assessed Clean Energy[d]	0.02	0.05	0.6	$(171)	Electricity, RCI
Feed-in-Tariff, 375 MW Cap[e]	0.5	0.5	0.5	$30 to $500	Electricity

[a] NPV 2013 of emission reductions through 2035, 5 percent discount rate

[b] Represents the net gain in emission reductions of a 5 percent RFS relative to Washington's current 0.5 percent RFS attainment

[c] Assumes extending I-937 utility requirements to utilities under 25,000 customers. Two additional options were considered in the analysis as well. Results are highly dependent on funding levels.

[d] Based on assumed PACE funding of $50 million over 5 years. Results are scalable.

[e] All Feed-in-Tariff reductions would contribute to I-937 goals.

The estimates in Table 4 assume that each policy would be implemented independently from all of the others. However, if multiple policies were implemented either simultaneously or in succession, there would likely be significant interactions that would decrease the overall quantity of emissions reductions achieved. Quantitatively estimating that interaction in conjunction with existing Washington policies and federal policies will be performed in the Task 4 report for this effort. Table 5 provides a qualitative summary of the interactions that would be expected between policies. Three types of interactions are indicated.

- Complement: indicates that the emissions reductions of the policy occur in a capped sector and will contribute to meeting a cap. These policies do not reduce the total amount of emissions reductions required within the capped sector, but the portion of reductions that must be achieved via the cap and trade mechanism is diminished by the portion achieved by the complementary policy

- Partial diminishment: occurs when two policies target the same source of emissions for reductions, or when emission reductions in one sector reduce the efficacy of a strategy in another.

- No significant interaction: there is no expected interaction that would decrease the overall quantity of emissions reductions achieved.

Table 5. Qualitative summary of interactions between seven policies evaluated in greatest depth. Table can be read vertically or horizontally, as entries to the right of grey cells are the same as those to the left.

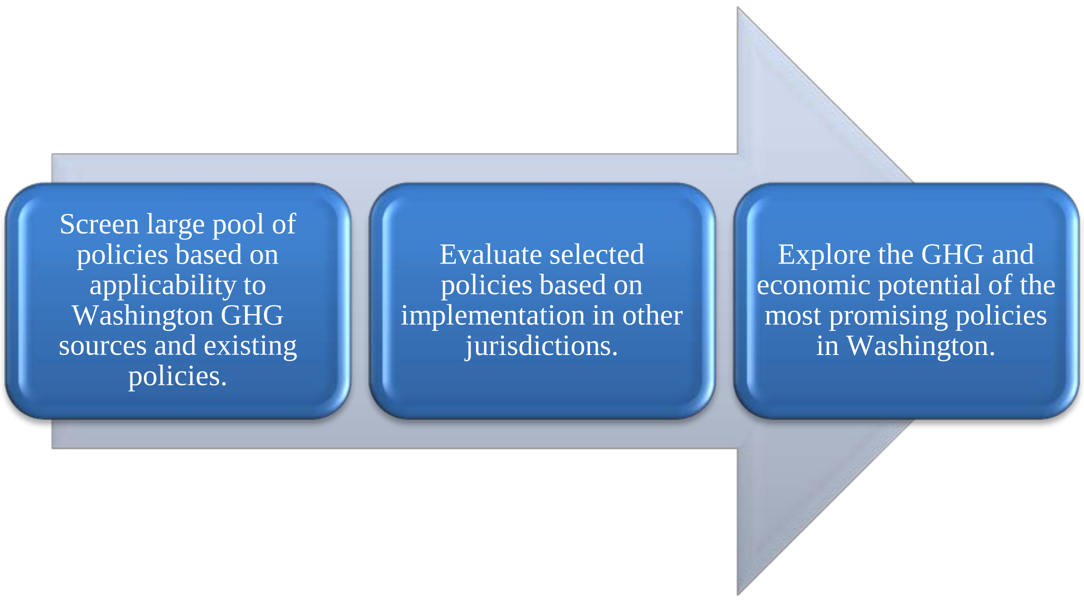
	Cap and Trade	Carbon Tax	LCFS	ZEV Mandate	PBF	PACE Programs	Feed-in-Tariff
Cap and Trade (C&T)	N/A	**Partial diminishment:** cap and trade and carbon tax are both economy-wide strategies	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T
Carbon Tax	**Partial diminishment:** cap and trade and carbon tax are both economy-wide strategies	N/A	**Partial diminishment:** carbon tax and LCFS both target transportation fuels	**Partial diminishment:** carbon tax and ZEV Mandate both target transportation emissions	**Partial diminishment:** carbon tax and PBF both encourage renewables and energy efficiency	**Partial diminishment:** carbon tax and PACE both encourage renewables and energy efficiency	**Partial diminishment:** carbon tax and FIT both encourage renewables
Low Carbon Fuel Standard (LCFS)	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Partial diminishment:** carbon tax and LCFS both target transportation fuels	N/A	**Partial diminishment:** ZEV Mandate and LCFS target vehicles and transportation fuels, respectively	No significant interaction	No significant interaction	No significant interaction
Zero Emissions Vehicles (ZEV) Mandate	**Complement:** policy will reduce capped sector emissions, contributing to	**Partial diminishment:** carbon tax and ZEV Mandate both target transportation	**Partial diminishment:** ZEV Mandate and LCFS target vehicles and	N/A	No significant interaction	No significant interaction	No significant interaction

	Cap and Trade	Carbon Tax	LCFS	ZEV Mandate	PBF	PACE Programs	Feed-in-Tariff
	meeting C&T	emissions	transportation fuels, respectively				
Public Benefit Fund (PBF)	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Partial diminishment:** carbon tax and PBF both encourage renewables and energy efficiency	No significant interaction	No significant interaction	N/A	**Partial diminishment:** PBF and PACE may target same emission reductions. Both subsumed by I-937	**Partial diminishment:** PBF and FIT may target same emission reductions. Both subsumed by I-937
Property Assessed Clean Energy (PACE) Programs	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Partial diminishment:** carbon tax and PACE both encourage renewables and energy efficiency	No significant interaction	No significant interaction	**Partial diminishment:** PBF and PACE may target same emission reductions. Both subsumed by I-937	N/A	**Partial diminishment:** PACE and FIT may target same emission reductions Both subsumed by I-937
Feed-in-Tariff	**Complement:** policy will reduce capped sector emissions, contributing to meeting C&T	**Partial diminishment:** carbon tax and FIT both encourage renewables	No significant interaction	No significant interaction	**Partial diminishment:** PBF and FIT may target same emission reductions. Both subsumed by I-937	**Partial diminishment:** PACE and FIT may target same emission reductions. Both subsumed by I-937	N/A

3 Policy Screening and Evaluation Process Overview

Virtually unlimited policies exist that either directly or indirectly, positively or negatively, intentionally or unintentionally, impact GHG emissions. It is neither feasible nor beneficial to evaluate all of these policies. It is not feasible due to the budget and scope of this effort; it is not beneficial because it would dilute the attention focused on the policies of greatest potential. Therefore, this effort applied an iterative screening process to identify the programs with greatest potential as GHG mitigation policies. A graphical representation and summary is provided in Figure 1.

Figure 1. Policy screening and evaluation process



To begin the policy screening and evaluation process, various types of policies were qualitatively considered in the context of Washington's GHG emission profile and major sources. From a pool of virtually limitless policies with the potential to affect GHG emissions, a list of approximately 20 policies was established for further analysis.

Potential targeted programs were identified through several channels. First, policies and sectors recommended by members of the Washington State Climate Legislative and Executive Workgroup (CLEW) were considered to ensure that topics of interest to Washington State stakeholders were studied. Second, the breakdown of emissions in Washington State's 2010 GHG inventory were reviewed, and all sources were considered on the combined basis of their magnitude in 2010, and their growth since 1990, as shown in Table 6. For these flagged sources, Washington State's actions to date and initiatives taken in other states and local governments targeting reductions in emissions from these sources were reviewed. Broadly, three categories of emissions dominate Washington's profile, have grown considerably from 1990 levels, and provide the greatest opportunity for reductions:

- Transportation
- Electricity
- Residential, commercial, and industrial sector (RCI)

Industrial processes, waste, and agriculture also contribute to Washington's GHG emissions. The agricultural sector is the most significant of these, but is not included for further analysis because of its diverse emission sources, the complexity of managing livestock and soil emissions, and the potential for impacting productivity. Additionally, emissions from agriculture have fallen from 1990 levels. Finally, although emissions from the waste sector have grown from 1990 to 2010, in absolute terms they are still relatively small. Table 6 summarizes Washington State's GHG emissions profile in 2010.

Table 6: Washington State 2010 GHG Inventory

Million Metric Tons CO_2e	1990[12]	2005	2010	2010 (%)	Change from 1990 Levels
Electricity, Net Consumption-based	**16.9**	**18.8**	**20.7**	**22%**	**22%**
Coal	16.8	15.2	15.8	17%	-6%
Natural Gas	0.1	3.6	4.8	5%	47%
Petroleum	0.0	0.0	0.1	0%	>100%
Biomass and Waste (CH_4 and N_2O)	0.0	0.0	0.0	0%	-
Residential/Commercial/Industrial (RCI)	**18.6**	**19.3**	**19.7**	**21%**	**6%**
Coal	0.6	0.1	0.3	0%	-50%
Natural Gas	8.6	10.3	10.8	11%	26%
Oil	9.1	8.7	8.4	9%	-8%
Wood (CH_4 and N_2O)	0.2	0.2	0.2	0%	0%
Transportation	**37.5**	**44**	**42.2**	**44%**	**13%**
Onroad Gasoline	20.4	23.9	21.9	23%	7%
Onroad Diesel	4.1	7.1	8.0	8%	95%
Marine Vessels	2.6	3.3	3.0	3%	15%
Jet Fuel and Aviation Gasoline	9.1	7.7	8.1	9%	-11%
Rail	0.8	1.3	0.5	1%	-38%
Natural Gas, LPG	0.6	0.7	0.7	1%	17%

[12] Washington State Department of Ecology. 2007. Washington State 1990 Greenhouse Gas Emissions Inventory. Accessed September 2013 at: www.ecy.wa.gov/climatechange/docs/1990GHGBaseline_Legislators.pdf

Million Metric Tons CO_2e	1990[12]	2005	2010	2010 (%)	Change from 1990 Levels
Fossil Fuel Industry	**0.5**	**0.8**	**0.7**	**1%**	**40%**
Natural Gas Industry(CH_4)	0.4	0.7	0.7	1%	75%
Coal Mining (CH_4)	0.0	0.1	0.0	0%	-
Oil Industry (CH_4)	0.0	0.0	0.0	0%	-
Industrial Processes	**7**	**3.8**	**3.8**	**4%**	**-46%**
Cement Manufacture (CO_2)	0.2	0.4	0.3	0%	50%
Aluminum Production (CO_2, PFCs)	5.9	0.8	0.5	1%	-92%
Limestone and Dolomite Use (CO_2)	0.0	0.0	0.0	0%	-
Soda Ash	0.1	0.1	0.1	0%	0%
ODS Substitutes (HFCs, PFCs and SF_6)	0.0	2.1	2.5	3%	-
Semiconductor Manufacturing (HFCs, PFCs, SF_6)	0.0	0.1	0.1	0%	>100%
Electric Power T&D (SF_6)	0.8	0.3	0.3	0%	-63%
Waste Management	**1.5**	**2.5**	**2.8**	**3%**	**87%**
Solid Waste Management	1.0	1.9	2.1	2%	>100%
Wastewater Management	0.5	0.6	0.7	1%	40%
Agriculture	**6.4**	**5.7**	**5.2**	**5%**	**-19%**
Enteric Fermentation	2.0	2.1	2	2%	0%
Manure Management	0.7	1.1	1.1	1%	57%
Agriculture Soils	3.7	2.5	2.1	2%	-43%
Total Gross Emissions	**88.4**	**94.9**	**95.1**	**100%**	**8%**

The initial list of policies was further refined based on additional research and feedback from the CLEW. Next, each remaining policy was evaluated in greater depth to understand their successes and lessons learned in jurisdictions where they have been implemented, across a variety of metrics including cost, impact on fuel choice and consumption, household and economic impacts, and co-benefits. A literature review was conducted on each policy for a selection of implementation instances (i.e., jurisdictions that have already instituted that policy). To the extent permitted by the available resources, the following issues were addressed:

- Quantity of GHG emissions reductions achieved
- Cost of GHG emissions reductions, or costs associated with the program
- Potential to cause GHG or economic leakage, shifting emissions or economic activity out-of-state
- The effectiveness of the program in helping the jurisdiction achieve its emissions reduction goals, including cost per ton of emissions reduction

- The relative impact upon different sectors of the jurisdiction's economy, including power rates, agriculture, manufacturing, and transportation fuel costs
- The effect on household consumption and spending, including fuel, food, and housing costs, and program measures to mitigate to low-income populations
- Displacement of emission sources from the jurisdiction due to the program
- Any significant co-benefits to the jurisdiction, such as reduction of potential adverse effects to public health, from implementing the program
- Opportunities for new manufacturing infrastructure, investments in cleaner energy and energy efficiency, and jobs including in-state opportunities
- Achievements in greater independence from fossil fuels and the economic costs and benefits
- Impacts on fuel choice

Results from this research are provided in Appendix A.

Based on additional feedback from the CLEW, the implementation history reviewed, and a set of screening criteria, the most promising policies were selected and reviewed using exiting literature exploring their potential costs and benefits in Washington, including impact on consumers and businesses, and potential to generate infrastructure investment and create jobs. In addition to those noted already, the primary screening criteria and their justification are shown in Table 7.

Table 7: Primary Screening Criteria for Promising Policies in Washington State

Screening Criteria	Justification
Does the policy target an emissions source of significant magnitude in Washington?	Policies targeting small sources of emissions will not generate the magnitude of reductions that Washington requires.
What have been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?	Policies that have not succeeded or have not generated significant reductions in other jurisdictions are unlikely to succeed in Washington, unless there are noteworthy differences between the jurisdictions.
Is the policy discrete and comprehensive, or is it instead a bundle of related policies?	Comprehensive policies will generate more extensive GHG reductions, and do not require a multitude of individual policies targeting the same source. This reduces the number of policies on which CLEW must engage.
Can the policy be meaningfully implemented or influenced at the state level?	Some policies are best implemented and administered at the federal or local level. The goal of this exercise is to identify policies that the CLEW can pursue and implement for the State.

Finally, tailored analyses of GHG reduction potential and investment potential in Washington are provided for the seven policies described in the Introduction. It is important to note that the quantifications provided in this report do not include all possible variables and interactions, particularly in regard to economic impacts. While it would be ideal to understand all of the policies on a cost per metric ton CO_2e basis, such a metric was not possible given the budgetary and time constraints of this effort. In order to arrive at a cost per metric ton CO_2e value, all other economic factors must be considered. These include both direct impacts on regulated industries and consumers, as well as indirect impacts resulting from revenue or consumption changes that result from the policy. Undertaking that level of analysis requires comprehensive and integrated economy-wide economic modeling.

4 Cap and Trade

Table 8: Potential Costs and Benefits of a Cap and Trade System to Washington Consumers and Businesses

Potential Action for Consideration			
• Implement an economy-wide cap and trade program covering and reduction gemissions from electricity, transportation fuels, and residential, commercial and industrial sectors.			
GHGs and Costs in Washington	**2020**	**2035**	**2050**
GHG Emissions Cap ($MMTCO_2e$)	73.6	55.2	36.8
GHG Reductions from Cap ($MMTCO_2e$)	1.6	17.5	29.4
Value of Allowance Commodity at $30/ton (billion $)	$2.2	$1.7	$1.1

Implementation Issues and Lessons Learned

- Although the quantity of emissions is known under cap and trade, it is difficult to forecast and impossible to know in advance the actual costs of compliance.
- The emissions cap must be set appropriately to avoid market over-supply, leading to low prices and insufficient market signal for innovation, or under-supply leading to high prices and negative economic impacts. Historically, markets including the EU ETS and RGGI have suffered from over-allocation due to events such as the economic recession and the drop in natural gas prices. California has not had an over-allocation issue thus far, though current signs suggest a long market through 2020.
- Allowances convey a valuable property right; they can be freely allocated, auctioned, or distributed through a combination of mechanisms.
- Cost containment mechanisms such as offsets, price caps, and free allocation can be used to protect the market from unacceptably high costs or distributional inequities.
- Some sectors face greater trade exposure and leakage risk than others. These sectors can be protected through free allocation of allowances or exemptions.
- Revenue generated by the State can be invested based on State priorities. Safeguards to ensure borrowing of revenue, as occurred in California, can protect these funds.

Potential Costs and Benefits to WA Consumers	**Potential Costs and Benefits to WA Businesses**
• There is no consensus among studies as to whether cap and trade would increase or decrease personal income. • Some studies suggest that cap and trade will result in significant net savings; others suggest that it will diminish disposable income.	• Regulated industries will face increased costs of compliance; however, many of these costs can be passed to customers. • With sufficient scarcity, cap and trade should foster innovation and support clean tech.

Summary of Screening Criteria

Does the policy target an emissions source of significant magnitude in Washington?
Cap and trade could cover emissions from the electricity, residential, commercial, and industrial, and transportation sectors, which comprise over 90 percent of Washington GHG emissions.

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?
The EU ETS and RGGI cap and trade programs have both achieved GHG reduction goals. However, it is unclear what portion of these GHG reductions are attributable to cap and trade, and what portion is attributable to the economic downturn. Both programs have suffered from over-supply of allowances and low costs, which diminish the incentive for innovation.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?
Cap and trade is a comprehensive policy that can be implemented economy-wide.

Can the policy be meaningfully implemented or influenced at the State level?
Cap and trade would ideally be implemented on as large a scale as possible. Some critics argue that implementation at the State level may lead to leakage and diminished effectiveness, and suggest that it should be implemented only at the federal or international level. However, jurisdictions including California and Quebec have implemented state/provincial programs and begun linking to create a larger, more economically efficient cap and trade system, demonstrating a leadership role.

4.1 Introduction

A cap and trade program is a market-based mechanism used to achieve reductions in the emissions of a particular pollutant or group of pollutants (in this case, greenhouse gases). Conceived largely as an alternative to address concerns raised by traditional command-and-control environmental regulation, cap and trade does not prescribe the methods that firms must use to reduce emissions, nor does it dictate the ultimate level of emissions for any individual firm. Instead, cap and trade sets an overall cap on emissions for a geographic boundary, or an individual sector, or group of sectors within that boundary and requires companies to hold rights (typically referred to as allowances) for any emissions that fall under the cap. Generally, program sponsors will reduce the number of allowances available over time, effectively lowering the cap and reducing emissions. In its most basic form, the cap and trade program offers the advantage of a known maximum quantity of emissions for a given pollutant.

After an initial distribution of allowances, companies are free to buy and sell them in accordance with their compliance needs or as an investment vehicle like any other commodity. This trading component allows those participants with the lowest cost of abatement to reduce emissions at a price below the prevailing trading price, and those with higher cost of abatement to purchase allowances at a price below their own costs of abatement.

While the trade component of cap and trade drives overall compliance costs down, the ultimate level of those costs is impossible to know and difficult to forecast. This is a major disadvantage of a cap and trade program, particularly as it relates to a carbon tax, where the cost per ton is generally known in advance. Some of the greatest opposition to cap and trade programs is driven by a fear of out of control allowance costs and their impact on energy prices and the economy in general. Policymakers have a number of tools to mitigate this risk when implementing cap and trade, but they each, in their own way diminish the advantage of certainty around total emission levels. Most programs have multi-year compliance periods and many programs allow banking of allowances for use in subsequent years within the compliance period. This allows companies to build up reserves of allowances when they perceive costs are low, or their need to use allowances for compliance is low. However, this may result in lower emissions than projected in initial years and higher emissions in subsequent years. Similarly, some programs allow borrowing of allowances from future years, which will shift emissions forward and reduce the cap in later years. This is potentially more problematic as a tighter cap in the future years will likely raise allowance prices and increase political pressure to raise or loosen the cap.

Another common cost containment mechanism is offsets. Offsets are reductions that occur outside of the regulated sectors or the regulated boundary that may be purchased by companies that are subject to the cap. Because GHGs are typically well-mixed global constituents this appears logical, as the radiative impact of given amount of GHG is no higher or lower based on the location of its release. Although most cap and trade programs have limits on the use of offsets and rigorous protocols for their accounting, it remains difficult to ensure that offsets do not raise the overall level of global emissions. This can happen when reductions from offset projects are not additional to business as usual, "leak" to other sectors, or are not estimated properly. This can lead to offset projects that actually don't provide any real reductions being used as compliance mechanism for cap and trade covered sectors to continuing emitting at high levels. Important issues related to offsets include additionality, project accounting boundaries, and leakage.

The most blunt cost containment mechanism is a price cap. A price ceiling may come in the form of a hard cap, which establishes a maximum price in the market. California's cap and trade program has a soft cap, whereby additional allowances may be made available from future compliance years to mitigate price shocks in early years. Often, a price floor is also employed, partially as a mechanism for raising funds to be used by the program sponsor and also to ensure that regulated entities have an incentive to control emissions, even in oversupplied markets. In either case, either a price floor or a price ceiling distorts markets, and diminishes the information available to market participants on the scarcity or abundance of allowances.

When developing a cap and trade program, the regulating entity must determine the coverage of the program, including the pollutants capped, the geography of the coverage and the sectors covered. The method for the initial distribution of allowances must also be determined. Initially, allowances may be allocated freely or they may be auctioned. Ultimately, the distribution method will have little effect on the value of allowances, which is determined by their incremental scarcity relative to emission levels and the marginal cost of reducing emissions to eliminate that scarcity; however, the allocation of allowances confers valuable property rights with the potential for important distributional impacts. There are those who point out that forcing regulated entities to purchase allowances through auctions consumes valuable capital that could otherwise be spent on emission reductions. Further, these entities are likely to pass on a substantial portion of auction costs to consumers. Others suggest that rewarding the polluting community with this valuable property right is unjust. Some go on to argue that because these allowances have value, their "cost" is passed on to consumers anyway, even though the initial holders of allowances did not have to pay for them.

The following section, Section 4.2, discusses previous work analyzing the potential for a cap and trade program in Washington State, generally within the context of the Western Climate Initiative (WCI). Section 4.3 offers an analysis of the potential reductions that could be generated from a Washington cap and trade program, end estimates the value of the allowance commodity created under such a regime. Finally, Section 4.4 offers an overview of cap and trade programs implemented in California, the European Union, RGGI, and elsewhere. Further implementation history is available in Appendix A.

4.2 Literature Review of Washington Potential

In February 2007, the Governors of Arizona, California, New Mexico, Oregon, and Washington signed an agreement to develop a regional target for GHG emission reductions and develop a market-based program to achieve the target, establishing the WCI.[13] The Governors of Montana and Utah and the Premiers of British Columbia, Manitoba, Ontario, and Quebec joined the WCI during 2007 and 2008. However, the shifting political landscape in the region, along with economic concerns from the financial crisis, led several states to pull out of the WCI. Arizona, Montana, New Mexico, Oregon, Utah and Washington formally withdrew from the WCI in 2011. California, British Columbia, Ontario, Quebec and Manitoba are continuing to work together through Western Climate Initiative, Inc. (WCI, Inc.) to develop a cap-and-trade program.[14]

Washington was an original partner in the WCI, which aimed to implement a cap-and-trade program for Western states and Canadian provinces. The program set a goal of reducing GHG emissions 15 percent below 2005 levels by 2020.[15] The program was designed to cover emissions of carbon dioxide, methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride. Industries that would be covered include electricity generation (including emissions from electricity generated outside the WCI jurisdictions), combustion at industrial and commercial facilities, industrial processes, residential, commercial and industrial fuel combustion facilities, and transportation fuel combustion. The WCI design also includes the implementation of complementary policies.[16]

California has moved forward with its own cap and trade program, with its first auction of allowances occurring in November 2012 and three additional auctions occurring subsequently.

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[13] Western Climate Initiative. Archived site. http://www.westernclimateinitiative.org/index.php

[14] Western Climate Initiative, Inc. (WCI, Inc.) is a non-profit corporation formed to provide administrative and technical services to support the implementation of state and provincial greenhouse gas emissions trading programs. WCI Inc. http://www.wci-inc.org/index.php

[15] The Western Climate Initiative. Archived site. http://www.westernclimateinitiative.org/the-wci-cap-and-trade-program

[16] Design Recommendations for the WCI Regional Cap-and-Trade Program. March 2009. http://www.westernclimateinitiative.org/the-wci-cap-and-trade-program/design-recommendations

Quebec has also established a cap and trade program. These programs are poised to be linked beginning in 2014, and staff in California and Quebec are working to establish necessary policy frameworks.[17] Should Washington pursue a cap and trade program, alignment and linkage with California and Quebec would create a larger and more economically efficient cap and trade program.

The following sections provide a review of three studies conducted between 2009 and 2010 that analyze the potential economic impacts to Washington and the region of the proposed cap-and-trade program designed as part of the Western Climate Initiative (WCI). [18] The following three studies are reviewed:

- Updated Economic Analysis of the WCI Regional Cap-and-Trade Program. July 2010. (WCI Economic Modeling Team)[19]
- Washington Western Climate Initiative Economic Impact Analysis. ECONorthwest. February 2010. (ECONorthwest)[20]
- The Economic Analysis of the Western Climate Initiative's Regional Cap-and-Trade Program. The Beacon Hill Institute. March 2009. (Beacon Hill Institute) [21]

The first two studies found that implementing cap and trade in the WCI jurisdictions including Washington would have a positive impact on economic factors including job creation and economic output. The third study by the Beacon Hill Institute contradicts these findings, showing job losses and decreases to investment, personal income, and disposable income. Each study and its findings are summarized below.

4.2.1 WCI Economic Modeling Team Analysis

In September 2008, the WCI Partner jurisdictions released their Design Recommendations for the WCI Regional Cap-and-Trade Program.[22] An analysis of the economic impacts of the cap-

[17] California Environmental Protection Agency, Air Resources Board. April 2013. Air Resources Board sets date for linking cap-and-trade program with Quebec. Accessed July 2013 at: http://www.arb.ca.gov/newsrel/newsrelease.php?id=430

[18] Western Climate Initiative. March 2009. Design Recommendations for the WCI Regional Cap-and-Trade Program. Accessed August 2013 at: http://www.westernclimateinitiative.org/document-archives/wci-design-recommendations

[19] Updated Economic Analysis of the WCI Regional Cap-and-Trade Program. July 2010. (WCI Economic Modeling Team). http://www.westernclimateinitiative.org/document-archives/func-download/265/chk,2eaaf81e0b154d203d8f64fa595cbf76/no_html,1/

[20] Washington Western Climate Initiative Economic Impact Analysis. ECONorthwest. February 2010. (ECONorthwest). http://www.ecy.wa.gov/climatechange/docs/20100707_wci_econanalysis.pdf

[21] The Economic Analysis of the Western Climate Initiative's Regional Cap-and-Trade Program. The Beacon Hill Institute. March 2009. (Beacon Hill Institute) http://www.washingtonpolicy.org/sites/default/files/WesternClimateInitiative.pdf

and-trade program to the region was completed by the WCI Economic Modeling Team (EMT), along with support contractors, in September 2008 as part of the design process. The analysis was updated in 2010 to account for expansion of the WCI (to include Manitoba, Québec, and Ontario) and the economic downturn of 2008–2009. The updated analysis also includes various model improvements identified by the EMT and stakeholders. The analysis used ENERGY 2020, a well-established energy model, to simulate energy demand, energy supply, energy costs, and GHG emissions under user-defined scenarios across multiple regions and sectors.[23] The model was run under a main policy scenario along with several sensitivity scenarios. The main policy scenario modeled the cap-and-trade program as designed and included the impact of complementary policies and the use of offsets and banking of allowances.[24] The analysis assumed that all reductions came from sectors covered by the cap. Emissions from electricity imported into the WCI Partner Jurisdictions from outside jurisdictions are included in the analysis. The sensitivity scenarios modeled situations where the complementary policies achieve only half of their anticipated GHG reductions, there is a faster rate of economic growth and lower fuel prices, higher fuel and electricity generation costs, and alternative carbon prices. The complementary policies included energy efficiency targets and standards, emissions performance standards for electric power, renewable energy standards, renewable fuels standards, transportation planning, mass transit, government procurement policies, and direct government funding and investment in key technologies.

The analysis resulted in the following conclusions:

- The WCI emissions reduction goal for 2020 can be achieved with a net cost savings of approximately $100 billion in the WCI region over the 2012 to 2020 period. The cost savings, although significant, are less than 0.2 percent of the total economic size of the 11 WCI Partner jurisdictions.
- The allowance price would be $33 per metric ton carbon dioxide equivalent in 2020, which is comparable to the results of other independent studies.
- Complementary policies produce cost savings and have the potential to significantly reduce emissions. With complementary policies modeled at roughly half as effective as assumed in the main policy case, the allowance price would need to exceed $50 per meticmetric ton to achieve the regional reduction goal.

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[22] Design Recommendations for the WCI Regional Cap-and-Trade Program. March 2009. http://www.westernclimateinitiative.org/document-archives/func-download/14/chk,4fd4d111cfca96e0dcb0223b1f210c0c/no_html,1/

[23] Additional information about the ENERGY 2020 model can be found at the following link: http://www.energy2020.com/ENERGY%202020%20Model%20Overview.htm.

[24] The model enabled allowances to be banked when allowance prices are low and for banked allowances to be used when allowance prices are high.

Table 9 shows the cost savings and allowance prices expected under the main policy case and the sensitivity cases.

Table 9. Cost Savings and Allowance Prices from Economic Modeling Scenarios

Economic Modeling Scenarios	Cost Savings 2012–2020 (2007 US$)	Emissions Allowance Price in 2020 (2007 US$)
Main Policy Case	**$102 billion**	**$33 per metric ton**
Sensitivity Cases		
Complementary policies only half as effective as in main case	At least $38 billion	At least $50 per metric ton
Faster economic growth and lower primary energy prices	At least $202 billion	At least $50 per metric ton
Higher energy prices and power plant construction costs	$106 billion	$13 per metric ton

4.2.2 ECONorthwest Analysis

In 2010, the Washington State Department of Ecology contracted with economic consulting firm ECONorthwest to estimate the potential economic impacts to Washington if the cap-and-trade strategy proposed by the WCI was implemented.[25,26] The analysis builds on previous WCI modeling conducted by the WCI Economic Modeling Team that used the ENERGY 2020 model.[27] The ENERGY 2020 model was used to forecast changes in energy prices and energy demand that would result from a cap-and-trade system as part of the process of developing WCI design recommendations.

The results of the ECONorthwest analysis indicate that that the WCI cap-and-trade strategy, if implemented as designed, would result in a net increase of 19,300 jobs and increased economic output of $3.3 billion in Washington State by 2020. The ECONorthwest analysis assumed that member jurisdictions enacted four complementary policy measures in addition to the cap-and-

[25] Washington Western Climate Initiative Economic Impact Analysis. ECONorthwest. February 2010. http://www.ecy.wa.gov/climatechange/docs/20100707_wci_econanalysis.pdf

[26] The study was funded through a grant from the Energy Foundation, http://www.ef.org/

[27] ENERGY 2020 is an integrated multi-sector energy model that estimates energy demand and supply. The model also simulates energy-related decisions and their impacts on GHG emissions. It is not a macroeconomic model such as REMI, which simulates the behavioral response of the aggregate economy in terms of changes in GDP, employment and other macroeconomic variables. Energy 2020 simulates detailed end uses for three residential categories, 40 NAICS commercial and industrial categories, and three transportation service categories. The stock and turnover of equipment and buildings is explicitly modeled as are investments in energy efficiencies and expenditures on energy consumption.

trade framework. These complementary measures were also modeled in the ENERGY 2020 analysis and include:

- **Energy Efficiency**. Energy efficiency for electricity and natural gas increases 0.5 percent per year starting in 2012. The previous ENERGY 2020 analysis captured the fuel savings, changes to annualized device and process investments, and changes in operations and maintenance (O&M). The modeling effort also included program administration cost, which was forecast to be $0.6 billion by 2020.
- **Clean Car Standards**. By 2020, per-mile GHG emissions from vehicles decrease by 17 percent.[28] ENERGY 2020 captured the fuel savings, increase in device investment, and increase in O&M. This is equivalent to California's Pavley II (LEV-II) and the policy starts in 2017.
- **VMT Reduction**. Vehicle Miles Traveled (VMT) are lower by 2 percent from the reference case by 2020, beginning in 2008. ENERGY 2020 modeled the fuel savings and decrease in device investment and O&M due to less wear and tear on the vehicles. ENERGY 2020 did not capture the cost of bringing about the VMT reduction but the implementation costs were assumed to be small.
- **Ontario Coal Phase-out**. Ontario phases out all of its coal generation over the 2009 – 2015 time period.[29]

The analysis modeled three policy scenarios. The primary scenario modeled the impact of the WCI cap-and-trade strategy as designed, called the WCI Policy scenario. This scenario used the following key assumptions:

- The complementary policies are included;
- Banking of allowances is allowed;
- Offsets are allowed for up to 49 percent of emissions reductions; and
- Allowance costs are capped at $30.

Two additional scenarios were modeled to address a range of possible market conditions. The two additional scenarios included:

- **Less Effective Complementary Policies Scenario**. This scenario assumed that the complementary policies are only half as effective as in the WCI Policy scenario and that the allowance price is capped at $50 instead of $30.

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[28] The reference runs, main policy case, and sensitivity cases in the previous WCI modeling all include Clean Car Standards through 2016. This includes Federal GHG emissions and CAFÉ standards which align with the GHG emission standards previously proposed by California. Efficiency improvements beyond 2016 (Pavely II) are included the complementary policies runs.
[29] The WCI was a regional program and included the Canadian provinces of Manitoba, Québec, and Ontario.

- **High Energy Cost Scenario**. This scenario assumes fuel prices and generation costs are higher than expected in the WCI Policy scenario. This scenario assumes that energy prices start at 2008 prices and increase in real terms by 50 percent by 2020. The high power generation cost case assumes that capital and O&M costs are 30 percent higher than in the WCI Policy case. Allowance prices capped at $10 in this scenario.

All the scenarios showed increases in jobs and economic output. However, the "less effective complementary policies" scenario showed less job growth and economic output than the "WCI policy" scenario. The "high energy cost" scenario showed higher job growth and economic output. Table 10 shows the increase in jobs and economic output from each of the three scenarios modeled.[30]

Table 10. Summary of Job and Economic Output from Modeled Scenarios in 2020

Scenario	Jobs	Economic Output (Million $)
WCI Policy	19,300	$3,309
Less Effective Complementary Policies	845	$695
High Energy Cost	25,358	$4,361

The analysis examined how potential economic benefits and costs would be distributed across Washington industries and found that the major sources of spending would occur in the following areas:[31]

- All commercial and industrial customers will have an increase in economic output over time if they have made investments in energy efficient equipment. Similarly, households that have purchased energy efficient equipment will have lower energy bills and consequently more money to spend on other goods and services.
- Suppliers of energy efficient equipment (contractors, construction, retail trade sectors) will benefit from increased spending on energy efficient equipment.
- Residential and commercial sector customers will have an increase in costs due to greater investments in energy efficiency equipment relative to the Reference Scenario. These higher costs are mitigated by energy cost savings for these same customers in future years after the initial investment is made.

[30] The analysis did not provide details on the specific mechanisms for job growth for each scenario.
[31] Washington Western Climate Initiative Economic Impact Analysis. ECONorthwest. February 2010. http://www.ecy.wa.gov/climatechange/docs/20100707_wci_econanalysis.pdf

The analysis finds that, given the nature of the spending that is likely to occur due to the WCI Policy, most of the job increases will occur in established industries. Much of the expected job growth would come from contractors supplying and installing energy efficient equipment such as windows, insulation, commercial lighting, air conditioners, and heat pumps. These types of contractors, although not traditionally considered green jobs, will likely see economic benefits as spending on these types of measures increases in response to the WCI Policy.[32]

4.2.3 Beacon Hill Institute Analysis

The Beacon Hill Institute at Suffolk University (BHI) analyzed projections of cost savings conducted by the WCI during the design of the cap-and-trade system and conducted an independent economic impact estimate based on the policy scenarios in the WCI analysis.[33] The WCI analysis included three cap-and-trade policy scenarios that represent broad and narrow scopes for the program. The narrow scope scenario covers stationary sources (both combustion and process) and the electric sector. The broad scope adds transportation fuels and residential and commercial fuels. The WCI analyzed the following three cases:

- Broad Scope, with complementary policies and without offsets
- Broad Scope, with complementary policies and with offsets
- Narrow Scope, with complementary policies and with offsets

BHI modeled the impact on the economies of the then seven U.S. member states under the three policy scenarios. The WCI design recommends that member states auction at least 25% of the GHG permits by 2020, with a goal of auctioning 100% of permits. BHI modeled the three scenarios under both a 25 percent and 100 percent auction. The analysis used the STAMP® (State Tax Analysis Modeling Program) to model the impact on employment, wages and income on the member state economies. STAMP is a five-year dynamic computable general equilibrium (CGE) model that simulates changes in taxes, costs (general and sector specific) and other economic inputs.[34] The analysis assumed that the auctioning of permits would create revenue for the states and modeled revenue from the auctions as a change in state tax policy. The percentage of permits not auctioned was treated as a price increase. The analysis utilized the weighted change of fuel costs (increases) for energy and transportation fuels as estimated in the three cap-and-trade cases from the WCI report and modeled these changes in STAMP as a state tax or price increase on fuel to measure the dynamic effects on the state economies.

[32] Ibid.
[33] The Economic Analysis of the Western Climate Initiative's Regional Cap-and-Trade Program. The Beacon Hill Institute. March 2009. http://www.washingtonpolicy.org/sites/default/files/WesternClimateInitiative.pdf
[34] For more information about the STAMP modeling program see the Beacon Hill website: http://www.beaconhill.org/STAMP_Web_Brochure/STAMP_EconofSTAMP.html

The BHI analysis found that a cap-and-trade policy, as recommended by the WCI, would have substantial negative effects on member states by 2020. The analysis showed a decrease in employment, investment, personal income, and disposable income in every member state. The results of the analysis contrast with the positive results of the original WCI assessment, which showed total cost savings for the region.[35] The "narrow with offsets" scenario with a 100 percent permit auction resulted in the least amount of job losses and personal income reductions. BHI found that under this scenario Washington could lose 2,800 jobs and see personal income reduced by over $760 million. The "broad with no offsets" scenario with a 25 percent auction showed the highest job losses and income reductions. BHI found that under this scenario Washington could lose over 18,000 jobs and see personal income decrease by over $5 billion.[36]

Table 11 shows a summary of the total impact on employment, private investment, personal income, and disposable income for all member states for each of the scenarios modeled. Table 12 shows the range of potential impacts on employment and personal income for each of the member states individually.

Table 11. Summary of BHI Estimates in 2020

Policy Scenario	Employment		Gross Private Investment ($ million)	Personal Income ($ million)	Disposable Income ($ million)	Disposable Income ($ per Capita)
	Private	Public				
Auction 100% of Allowances						
Broad, No Offsets	-251,674	142,241	-1,448.41	-18,308.56	-17,420.86	-172.6
Broad, Offsets	-113,558	57,269	-712.57	-10,451.68	-7,838.56	-78.35
Narrow, Offsets	-103,931	83,519	-547.75	-6,344.97	-5,138.98	-59.23
Auction 25% of Allowances						
Broad, No Offsets	-165,397	19,710	-4,539.55	-47,706.88	-30,316.49	-272.34
Broad, Offsets	-59,240	6,920	-989.22	-13,094.59	-6,302.83	-62.65
Narrow, Offsets	-35,177	-354	-1,620.21	-10,195.15	-6,341.78	-63.47

Table 12. Range of Impact on Jobs and Personal Income by State in 2020

State	Net Employment jobs	Personal Income ($ million)	Per Capita Disposable Income ($)
Arizona	-4,801to -20,496	-722.27 to -5,397.10	-47.60 to -224.98
California	-7,886 to -78,694	-4,038.18 to -30,398.72	-62.72 to -287.63

[35] The WCI analysis did not model impact on employment.
[36] It is unclear whether the analysis specifically modeled the impacts of increased investment in energy efficiency which has been shown in other analyses to potentially lead to job growth.

Montana	-548 to -2,869	-91.77 to -689.21	-54.77 to -250.79
New Mexico	-8 to -4,689	-165.16 to -1,242.23	-47.84 to -219.41
Oregon	-1,823 to -10,748	-320.60 to -2,419.17	-46.42 to -213.65
Utah	-2,546 to -9,899	-246.34 to -1,846.52	-40.38 to -185.83
Washington	**-2,800 to -18,292**	**-760.64 to -5,713.92**	**-66.02 to -302.54**

4.3 Quantification

This section builds on previous analysis of the potential GHG emission reductions that could be generated from implementation of a cap and trade program in Washington. This analysis is much more limited in scope than the work previously conducted and is intended to provide an analysis consistent with the others produced that can be used for high-level policy evaluation, and which attempts to separate the contribution of the cap and trade policy as distinct from other complementary policies. While emission reductions in the capped sectors may be significant, many of these reductions are actually attributable to other policy mechanisms. This analysis considers the effect of the cap and trade policy as only the emission reductions required in excess of complementary policies.

Importantly, this analysis projects beyond the initial reduction assessments for 2020, out to 2035 and 2050 to provide a picture of the long-term outcomes that could be expected from the cap and trade policy. This is important as many of the complementary policies currently in effect diminish the impact of cap and trade in the near term.

The cap and trade policy examined in this section assumes the emission cap in the years 2020, 2035 and 2050 match the Washington State GHG reduction goals which were based on the initial WCI target of 1990 levels by 2020, 25% below 1990 levels by 2035 and 50% below 1990 levels by 2050. Annual reductions were estimated for each of these years, assuming that the caps were met.

Reductions from existing complementary policies were incorporated into the analysis. It was assumed that the cap and trade policy would work as a safety net to ensure reduction goal achievement, by reducing emissions beyond what the complimentary policies were able to achieve. The cap and trade policy was not given credit for reductions estimated for each of the existing complementary policies, which include:

- Energy Independence Act (I-937)
- Purchase of Clean Cars
- Washington's Renewable Fuel Standard (RFS)
- Public Fleet Conversion to Clean Fuels
- Appliance Standards
- Energy Code Policies

- Energy Efficiency and Energy Consumption Programs for Public Buildings

4.3.1 Methodology

The sectors included in the analysis and assumed to be covered by a cap and trade policy are Electric Power Generation, Transportation Fuels (on road gasoline and diesel, aviation fuels, rail, and marine vessels), and RCI natural gas and fuel oil only, as electric power generation is already covered on the generation side and emissions from direct coal combustion in these sectors are very small and have already been reduced to 50% below 1990 levels. These sectors represent about 85% of total emissions in Washington State. The sectors were chosen based on WCI and California policy designs, as well as Washington's specific emissions inventory profile. Industrial process emissions were not included for several reasons, even though certain industrial sectors are included by California and WCI. First the overall contribution of industrial process emissions to Washington's total emissions is just 4 percent. Each individual industrial sector is showing reductions or no growth in GHG emissions except Ozone Depleting Substance (ODS) Substitutes which did not exist in 1990. The ODS Substitute sector is expected to be addressed by federal policy. Finally overall industrial sector process emissions have almost reached the 2050 target, currently 47 percent below 1990 levels, even with the addition of ODSs.

Emissions from the covered sectors were equal to 73.6 MMTCO2e in 1990. A compliance pathway was constructed using the targets of 1990 emission levels by 2020, 25 percent below 1990 levels by 2035, and 50 percent below 1990 levels by 2050. These were the targets outlined by WCI and used in previous analyses of cap and trade impacts on emissions in Washington. The emission cap levels for each sector were based on the 1990 emissions estimate from the Washington State Greenhouse Gas Emissions Inventory 1990-2010 report and are provided in Table 13.

Table 13: Emission Caps (Million Metric Tons)

		Emissions Cap		
Cap and Trade Covered Sector	**1990 level**	**2020**	**2035**	**2050**
Electricity Generation	16.9	**73.60**	**55.20**	**36.80**
Transportation Fuels	39.0			
RCI (Natural Gas and Fuel Oil)	17.7			
Total Emission Cap (All Covered Sectors)	**73.60**			

There are no caps set for individual sectors in 2020, 2035, and 2050, but only total emissions across all sectors. It is not expected that each sector will meet the cap independently or proportionately but that all the sectors as a whole will meet the cap, depending on where emissions can be reduced the most cost effectively. Sectors with higher cost to reduce emissions will likely continue to emit at higher rates and purchase allowances from sectors that can most cost effectively reduce, even far below their 1990 levels.

To quantify the emission reductions from the cap and trade policy, baseline emissions forecasts were created for each of the covered sectors independently. All baseline emission forecast estimates used the 2010 emission estimates from Washington State Greenhouse Gas Emissions Inventory 1990-2010 report as a starting point, and were forecasted out using emission forecasts and consumption growth rates from Washington's emission inventory report Appendix 3: Washington GHG Emissions Projection 2009-2035.

Table 14: Baseline Emission Forecasts by Sector

Cap and Trade Covered Sector	2020 (1990 level)	2035	2050
Electricity Generation	24.94	35.18	38.71
Transportation Fuels	43.97	44.22	46.05
RCI (Natural Gas and Fuel Oil)	19.87	17.92	15.10
Total Emissions (All Covered Sectors)	**88.78**	**97.32**	**99.86**

These baseline emission forecasts were then adjusted based on the emission reductions expected from the applicable complementary policies to develop a business as usual (BAU) forecast. Table 12 below provides the expected annual reductions from each of the existing complementary policies in the target years. I-937 was the only policy estimated to impact the electricity generation sector because the I-937 conservation targets were assumed to overlap with the electricity savings from the appliance standards, energy code improvements, and programs for public buildings complementary policies. In order to avoid any double counting, emission reductions from electricity savings from these three complementary policies were not included, only emission reductions from natural gas and fuel oil savings.

Table 15: Complimentary Policy Reductions ($MMTCO_2e$)

Complimentary Policy	Sector Impacted	2020	2035	2050
Energy Independence Act (I-937)	Electricity	7.9	12.7	19.71
Appliance Standards (includes expected reductions from new federal standards on top of WA state standards)	RCI (Natural Gas and Fuel Oil)	0.1	0.3	0.5
Energy Efficiency and Energy Consumption Programs for Public Buildings (ESSB 5509 - RCW 39.35D)	RCI (Natural Gas and Fuel Oil)	0.01	0.01	0.01
Energy Code Policies (based on linear adoption estimates, more conservative versus early adoption estimates)	RCI (Natural Gas and Fuel Oil)	0.30	1.27	1.27
Purchasing of Clean Cars (Pavley standards and LEV III reductions as calculated in task 1b)	Transportation Fuels	5.00	10.00	11.70
Emission Reduction Related to Washington's RFS (as estimated with 5% biodiesel mandate)	Transportation Fuels	0.265	0.385	0.49
Conversion of Public Fleet to Clean Fuels	Transportation	0.03	0.041	0.05

	Fuels			
Total Reductions		**13.54**	**24.64**	**33.71**

*Details on reduction estimate methodologies for all complimentary policies can be found in DRAFT Task 1B - Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State.

The adjusted BAU forecast for all sectors was compared to the compliance pathway based on the target year emission caps. The difference between these two estimates across all sectors was assumed to be the emission reductions that the cap and trade policy was responsible for.

4.3.2 Assumptions, Exclusions, and Data Sources

The following assumptions about the structure of the Cap and Trade policy, the path towards attainment, associated data parameters, and exclusions are included in this analysis.

- The emissions cap matches the initial Washington State reduction goals and the WCI targets of 1990 emission levels by 2020, 25% below 1990 levels by 2035, and 50% below 1990 levels by 2050.
- The total emission cap will be met in each target year.
- The cap and trade policy was not given credit for reductions estimated from each of the existing complementary policies.
- The sectors included in the analysis and assumed to be covered by a cap and trade policy are Electric Power Generation, Transportation Fuels (on road gasoline and diesel, Aviation fuels, Rail, and Marine Vessels), and RCI Stationary Combustion (natural gas and fuel oil).
- Electricity generation sector emission forecasts were based on the 2010 emission estimate and growth rates for the I-937 emission estimate completed previously.
- Transportation fuel sector emission forecasts were based on the emission growth rates as outlined in Appendix 3: Washington GHG Emissions Projection 2009-2035.
- RCI sector emission forecasts were based on emissions from each target year as given in Appendix 3: Washington GHG Emissions Projection 2009-2035.
- Emission and consumption growth rates were assumed to remain constant from 2035 to 2050 in each sector.
- Emission reductions associated with electricity savings from the appliance standards, energy code improvements, and programs for public buildings complementary policies were not incorporated into the BAU forecast to avoid double counting with I-937 due to assumed overlaps.

The primary data sources used in this analysis include:

Data	Source

GHG Forecasts	Washington State GHG Inventory, Appendix 3: Washington GHG Emissions Projection 2009-2035. http://www.ecy.wa.gov/climatechange/docs/ccp_appendix3.pdf
1990-2010 Washington State GHG Emission Estimates	Washington State Greenhouse Gas Emissions Inventory 1990-2010. https://fortress.wa.gov/ecy/publications/publications/1202034.pdf
Allowance Price Options	• Updated Economic Analysis of the WCI Regional Cap-and-Trade Program. July 2010. (WCI Economic Modeling Team). http://www.westernclimateinitiative.org/document-archives/func-download/265/chk,2eaaf81e0b154d203d8f64fa595cbf76/no_html,1/ • Washington Western Climate Initiative Economic Impact Analysis. ECONorthwest. February 2010. (ECONorthwest). http://www.ecy.wa.gov/climatechange/docs/20100707_wci_econanalysis.pdf • The Economic Analysis of the Western Climate Initiative's Regional Cap-and-Trade Program. The Beacon Hill Institute. March 2009. (Beacon Hill Institute) http://www.washingtonpolicy.org/sites/default/files/WesternClimateInitiative.pdf
Complementary Policy Reduction Estimates	DRAFT Task 1B - Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State

4.3.3 Results

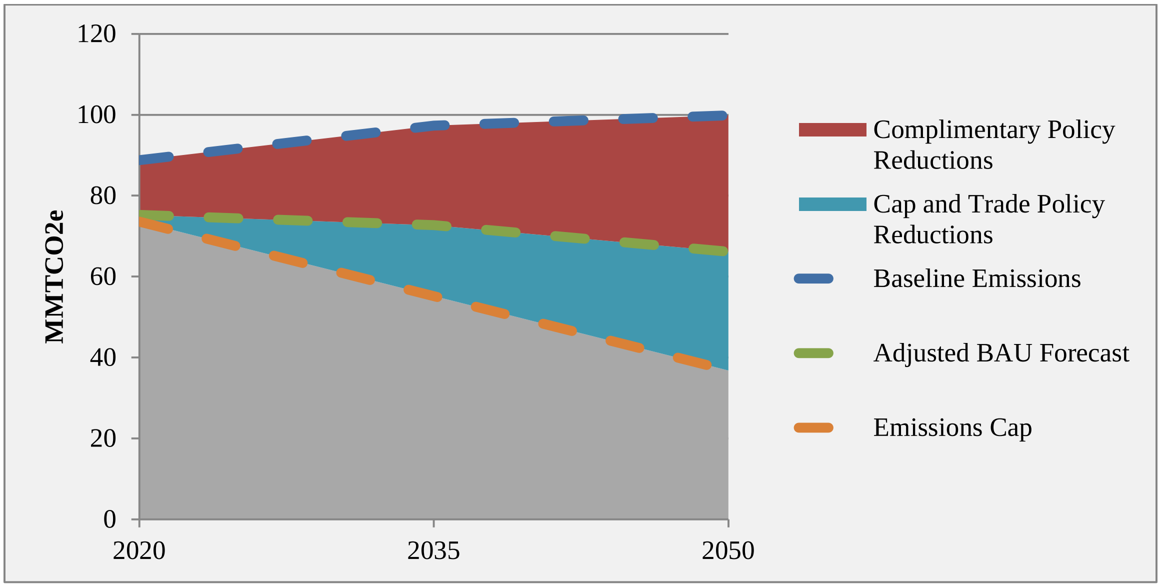
Results for the emission reduction estimates calculated based on the methodology described above are provided in Table 16.

Table 16: Washington State Cap and Trade Program Results

Results	2020 ($MMTCO_2e$)	2035 ($MMTCO_2e$)	2050 ($MMTCO_2e$)
Covered Sector Baseline Emissions	88.78	97.32	99.86
Complimentary Policy Reductions in Covered Sectors	13.54	24.64	33.71
BAU Forecast (Adjusted Baseline)	75.24	72.69	66.16
Emissions Cap	73.60	55.20	36.80
Cap and Trade Policy Reductions	**1.64**	**17.49**	**29.36**

The results indicate that the sectors in Washington State assumed to be covered by a cap and trade program in this analysis are on track to just miss the emission reduction goal of 1990 levels by 2020, without a cap and trade program. However, over time the difference between the emissions cap and Washington's projected BAU emissions widens significantly, by 2035 over 17 million metric tons separate the target of 25% below 1990 levels and the projected emissions of the covered sectors, and that figure grows to almost 30 million metric tons by 2050. Assuming that all sectors comply with the policy, cap and trade would be responsible for closing the gap between the BAU forecasted emissions and the emissions cap.

Figure 2: GHG Emissions Impact of Cap and Trade Policies



The broader economic impacts that would result from a Washington State cap and trade program are most appropriately modeled using techniques similar to those described in section 4.2. These analyses give State level impacts on jobs, cost savings, economic output, personal income, and disposable income. This requires modeling the complex relationships between the program, energy prices, commercial and industrial energy use, investment, and many other variables. A simplified look at cap and trade costs can be estimated by looking at a range of allowance prices in any given year and the number of allowances allocated to each sector. Depending on the method of distribution of these allowances, either through free allocation or auction, the total value of the allowance is either borne as a cost to the covered sectors (and revenue for the state that can be reinvested) or provided as a valued commodity that can generate revenue for the covered sectors. In either case the basic costs of the cap and trade are more accurately viewed as a transfer, either from covered sectors to each other, from the covered sectors to the state, or from consumers to the state or covered sectors. The allowance prices used in the studies reviewed in section 4.2 ranged from $10 to $30 to $50 per metric ton CO_2e. These three prices will be used to provide a range of potential value/costs. However, it is important to note that these prices are not a forecasted expectation of price, but simply a range of possible scenarios. As discussed in Section 4.3, allowance prices in both the RGGI and the EU ETS are currently below $5 per metric ton, while prices in the CA ETS are between $10-$15 per metric ton.

Using the same assumptions as described in the methodology above and these three allowance price options, it is possible to estimate the total value of the allowance commodity created by the cap and trade program. Total emission allowance value was determined individually for sectors based purely on their emission contribution to the overall cap, however depending on a number of variables, including competitive risks and leakage potential, these allowances and values may be distributed differently.

Table 17: Emission Allowance Commodity Value (potential cost to covered sectors/consumers and potential revenue to the State if 100% allocated through auctions)

	(Million $USD)		
Allowance Price/Sector	**2020**	**2035**	**2050**
$10/MTCO$_2$e			
Electricity Generation	$169	$127	$85
Transportation Fuels	$387	$293	$195
RCI (Natural Gas and Fuel Oil)	$177	$133	$89
Total	$733	$552	$368
$30/MTCO$_2$e			
Electricity Generation	$507	$380	$254
Transportation Fuels	$1,160	$878	$585
RCI (Natural Gas and Fuel Oil)	$531	$398	$266
Total	$2,198	$1,656	$1,104
$50/MTCO$_2$e			
Electricity Generation	$845	$634	$423
Transportation Fuels	$1,934	$1,463	$975
RCI (Natural Gas and Fuel Oil)	$885	$1,991	$443
Total	$3,664	$4,088	$1,840

The estimated costs to covered sectors and or their consumers and the state revenues of cap and trade program with 100% allocation through auction, based on the assumptions outlined above, range from $732M if allowances are set at $10/ton, to $3.6B if allowances are set at $50 a ton in 2020. It is also important to note that as the cap is reduced overtime so is the total value of allowance commodity.

4.4 Implementation History

The notion of market-based mechanisms for addressing environmental pollution was first explored by the British economist, Arthur Pigou, in the early 20th century. Pigou observed that the social costs of some industrial activities were not captured in the price of the products being exchanged.[37] In order to internalize these externalities (unacknowledged costs), Pigou suggested that taxes or fees equal to the social costs be imposed on the goods.[38] In 1960 Ronald Coase argued that by making property rights explicit and transferable, the market could play an important role in valuing these rights and ensuring that they gravitated to their highest value use. In 1968, John Dales applied these theories to water pollution control using tradable permits or allowances.[39] In the late 1980's, the administration of President George H.W. Bush proposed the most ambitious emission trading program in history, the Acid Rain Allowance Trading Program to cut emissions of sulfur dioxide. The Program became part of the Clean Air Act Amendments of 1990, and by most accounts is perceived as wildly successful. Between 1990 and 2010, U.S. sulfur dioxide emissions declined from 15.9 million tons annually to 5.1 million tons. Annual net benefits are estimated at between $59 billion and $116 billion,[40] compared with annual costs between $0.5 and $2.0 billion.[41] Costs of compliance are estimated to be anywhere from 15 to 90 percent below a more traditional command and control approach. [42]

As concerns grew about the impact of greenhouse gases on the global ecosystem, policymakers pursued multilateral agreements to slow or reverse the growth of greenhouse gas emissions, and they sought regulatory approaches that minimize economic costs. In 2005, looking at the successful U.S. experience with the Acid Rain Allowance Program, the European Union launched its Emissions Trading Scheme (ETS) to reduce greenhouse gas emissions. Several cap and trade programs have been subsequently launched in New Zealand, the Northeast of the United States, and in California. Each of these programs differs in some respects but they all provide valuable lessons learned when contemplating a program for Washington.

California Cap and Trade Program. As a potential linking partner and the regional pioneer in this space, the California Cap and Trade Program provides particularly relevant lessons for Washington. The California Global Warming Solutions Act of 2006 (AB 32) set targets for GHG reductions in California relative to an anticipated business as usual trajectory. By 2020, the bill calls for California emissions to return to the 1990 level of 427 million metric tons of carbon dioxide equivalent ($MMTCO_2e$), a reduction of approximately 77 $MMTCO_2e$. To reach this goal,

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[37]Richard Coniff, *The Political History of Cap and Trade*, Smithsonian Magazine, August 2009, http://www.smithsonianmag.com/science-nature/Presence-of-Mind-Blue-Sky-Thinking.html

[38] Please see accompanying discussion of carbon taxes.

[39] Tom Tietenberg, *The Evolution of Emissions Trading*, Colby College, http://www.aeaweb.org/annual_mtg_papers/2008/2008_90.pdf

[40] Most of the benefits are associated with improved human health rather than ecological health as originally anticipated.

[41]R. Schmalensee and R. Stavins, *The SO_2 Allowance Trading System: The Ironic History of a Grand Policy Experiment*, Resources for the Future Discussion Paper, August 2012. http://www.rff.org/RFF/Documents/RFF-DP-12-44.pdf

[42] Though a substantial portion of these savings (perhaps on the order of one-third) can be attributed to the deregulation of the railroad industry that permitted low-sulfur western coal to be brought to utilities in the East and Midwest.

the AB 32 Climate Change Scoping Plan Document established a suite of policy mechanisms with a cap-and trade program as the centerpiece.[43]

The California Cap and Trade Program will regulate approximately 35 percent of California's GHG emissions in the first compliance period (2013-2014) by covering the electricity sector and certain industrial sectors. The program will expand to cover 85 percent of California emissions in the second and third compliance periods (2015-2017 and 2018-2020) when transportation fuels and natural gas suppliers are included. In addition to emissions from in-state sources, electricity imported to California is also subject to a compliance obligation corresponding to its emissions. This compliance obligation is the responsibility of the electricity importer, and not the out-of-state entity generating the power.[44]

Allowances are distributed through a variety of mechanisms including free allocation to industry, free allocation to electricity distributors (for the benefit of ratepayers), and auctions. The percent of freely allocated allowances will decline over time. For vintage 2013, over 90 percent of allowances were freely allocated. Auctions are held on a quarterly basis and include both current vintage allowances and an advance auction of future vintage allowances. The auction mechanism utilizes a settlement price corresponding to the minimum price – working downwards from the highest bid – at which all available allowances are sold. There is also a price floor below which allowances will not be sold. The price floor was $10.00 in 2012, increasing five percent plus inflation each year thereafter. There have been three auctions conducted to date, with prices for current vintages ranging from $10.09 to $14.00 per $mtCO_2e$.[45] The California program allows the use of GHG offsets to meet up to 8 percent of each regulated entity's compliance obligation.

As the California Cap and Trade Program is in its first year of its first compliance period, it is too early to assess programmatic success or costs. The California Air Resources Board (ARB) has attempted to make forecasts of key performance metrics:

- Market forces associated with cap and trade are expected to generate the additional 34.4 $MMTCO_2e$ reductions necessary to meet the 2020 cap, and to facilitate the complementary measures.[46]

[43] California Air Resources Board. December 2008. Climate Change Scoping Plan: a framework for change. Accessed August 2013 at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf
[44] California Environmental Protection Agency, Air Resources Board. April 2013. Article 5: California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms. Accessed July 2013 at: http://www.arb.ca.gov/cc/capandtrade/ct_rf_april2013.pdf
[45] California Air Resources Board. July 2013. Auction Information. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/auction/auction.htm
[46] California Air Resources Board. December 2008. Climate Change Scoping Plan: a framework for change. Accessed August 2013 at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

- ARB modeling predicts a decrease in fuel use of 2 to 4 percent in 2020 relative to a business-as-usual projection.[47]
- ARB estimates minimal, if any, impact on household income (0 to 0.1 percent decrease).
- A modest decrease in labor demand (0.3 to 0.6 percent) is expected given forecast allowance prices.
- Overall, ARB modeling indicates that the Cap and Trade program will reduce total economic output by a 0.1 percent annually.

California Cap and Trade auctions are already generating significant revenues, with the late 2012 auction and the 2013 auctions expected to generate on the order of $500 million. The California Department of Finance (Finance) and ARB drafted, through a public consultation process, a three-year investment plan to identify "investments to help achieve greenhouse gas reduction goals and yield valuable co-benefits."[48] The intent was that the plan would be submitted to the California Legislature, which would in turn appropriate cap and trade revenue to State agencies for implementation of programs to further the objectives of AB 32. The California Legislature passed a $96.3 billion budget for the fiscal year 2013-2014 on Friday June 13, 2013. Although the Investment Plan recommended allocating cap and trade revenue to a variety of pre-existing programs that could begin to use the funds immediately, the approved FY 2013-2014 budget instead borrowed the expected $500 million in auction proceeds to meet other budgetary needs. Governor Brown has stated that he borrowed the $500 million to provide more time to set up programs that will use the funding effectively. No timetable for repayment has yet been issued.[49]

European Union Emissions Trading Scheme. The EUETS was not only the first cap and trade program to address greenhouse gases but it might also be the most complex and ambitious. The EU ETS operates in all 28 EU countries as well as Iceland, Liechtenstein and Norway, covering sectors that are responsible for approximately 45 percent of total GHG emissions in those countries. The first phase was set up to be experimental to help develop the market and lasted from 2005 through 2007. The second phase went from 2008 through 2012. The third phase of the EU ETS runs from 2013-2020, and aims to lower emissions from covered sectors by 21 percent from 2005 levels by 2020.[50] The third phase includes some significant program changes. The scope of the EU ETS will be expanded to include additional sectors and gases, and an

[47] California Air Resources Board. October 2010. Staff Report: Initial Statement of Reasons. Accessed August 2013 at: ihttp://www.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm
[48] California Department of Finance. May 2013. Cap and Trade Auction Proceeds Investment Plan: Fiscal Years 2013-14 through 2015-16, page 1. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/final_investment_plan.pdf
[49] Mulkern, Anne C. *Gov. Brown proposes to borrow $500M from cap-and-trade revenue*. ClimateWire. May 15, 2013
[50] European Commission. July 2013. The EU Emissions Trading System (EU ETS). Accessed July 2013 at: http://ec.europa.eu/clima/policies/ets/index_en.htm

overall EU cap will be used instead of individual member state set caps.[51] The default allocation method in the third phase will be auctions, though there will continue to be free allocation to manufacturing[52] and industries identified as at risk of leakage.[53] The EU ETS market has historically utilized the Clean Development Mechanism (CDM) and Joint Implementation (JI) elements of the Kyoto Protocol to generate and obtain international offsets from developing and developed nations respectively. In addition, the EU is pursuing sector-based offset crediting through a new market mechanism.[54] Finally, the EU ETS is pursuing linkage with the Australian cap and trade system, beginning in 2015.[55]

Given its relatively long history, the EU ETS is the most studied GHG cap and trade system and has faced significant challenges and criticisms over time. Some important lessons learned include:

- Over-allocation of allowances has posed challenges in assessing the program's long-term economic impacts. Key questions still remain as a result, (i) how tight a cap should be set in going forward to deliver a price point on emission allowances that will provide the desired level of emission abatement, and (ii) what consequences does this cap have for economic growth and competitiveness?[56] In its haste to establish a program, the EU ETS set caps based on inaccurate forecasts of future emissions. Accurate current and historical emissions data are essential to setting the right emissions cap.
- The over-allocation of the market, meaning that the allowances available in the market exceed emissions, has led to very low prices over time. Allowances on the EU market have traded at a high of €32 in 2006 and at prices near zero when the price crashed during in 2007, but rebounded to trade back over €30 in 2008.[57] Currently prices are trading slightly above €4.

[51] http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf
[52] European Commission. January 2013. Free allocation based on benchmarks. Accessed July 2013 at: http://ec.europa.eu/clima/policies/ets/cap/allocation/index_en.htm
[53] European Commission. January 2013. Carbon leakage. Accessed July 2013 at:: http://ec.europa.eu/clima/policies/ets/cap/leakage/index_en.htm
[54] European Commission. January 2013. International carbon market. Accessed July 2013 at: http://ec.europa.eu/clima/policies/ets/linking/index_en.htm
[55] European Commission. August 2012. Australia and European Commission agree on pathway towards fully linking emissions trading systems. Accessed July 2013 at: http://ec.europa.eu/clima/news/articles/news_2012082801_en.htm
[56] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf
[57] http://www.theguardian.com/environment/2013/jan/24/eu-carbon-price-crash-record-low

- There has been a lack of innovation as a result of the EU ETS, likely attributable to an insufficient price signal from allowance prices. A higher carbon price is likely required for inducing innovation.[58]
- The EU ETS program has undergone significant revisions over time. A trading program should provide enough certainty and should cover a long enough time period to influence technology investment decisions.[59]
- If allowance banking from year-to-year is allowed to help firms minimize cost and increase flexibility over time, the program must provide a predictable long-term policy environment that allows for this to occur and be incorporated into planning.[12]
- The EU ETS has been criticized for the windfall profits of companies who passed on the price of carbon to customers even though their allowances were obtained for free.[60] Several studies summarized by the U.K. Department of Energy and Climate Change concluded that free allocation may have a negative effect on both the environmental and cost effectiveness of the EU ETS. If using free allocations, there should be appropriate regulatory oversight of public utilities, and auction of most or all allowances.[12]

Despite these substantial challenges associated with the EU ETS, the results have been generally encouraging:

- Even with much higher carbon price expectations than the market delivered, only a small fraction of businesses expected downsizing or relocation due to these climate based policies, showing that negative impacts to employment and competition might not be significant, even with prices up to €40.[8]
- A recent report by the European Commission estimated that the EU would save an average of US$26 billion (€20 billion) in fuel costs each year from 2016 to 2020.[61]
- Most estimates place the total cost at less than 1 percent of the European Union's GDP and potentially as low as 0.01 percent of the EU's GDP[14]. Several studies claim that if all allowances were auctioned, rather than freely allocated, there would be no economic cost and could potentially see significant economic gains.[62]

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[58] Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

[59] U.S. Government Accountability Office (GAO), 2008 report - Lessons Learned from the European Union's Emissions Trading Scheme and the Kyoto Protocol's Clean Development Mechanism; http://www.gao.gov/new.items/d09151.pdf

[60] Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

[61] Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

[62] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf

- A recent report by the European Commission estimated that the health benefits of improved air quality if the EU ETS tightened its 2020 cap would be in the range of $4.3 billion to $10.4 billion.

Regional Greenhouse Gas Initiative. The Regional Greenhouse Gas Initiative (RGGI) is a highly focused, cooperative effort among nine northeast states in the U.S. to regulate and reduce GHG emissions from the power sector only. RGGI is composed of individually-operating emission trading programs within each state that together have created a regional market for emission allowances. Development of RGGI began in 2003, with the first memorandum of understanding (MOU) being released in 2005. The first auction of emission allowances occurred in 2008, with the first three-year compliance period starting in January 2009. RGGI currently operates in Connecticut, Delaware, Maine, Massachusetts, Maryland, New Hampshire, New York, Rhode Island, and Vermont (New Jersey participated through 2011). Each State program was developed based on the agreed upon RGGI Model Rule, which includes capping emissions from the electric power plants and requiring that a certain percentage of emission allowances are provided through participation in regional auctions rather than free allocation. Currently, around 90 percent of all allowances are provided through auction, with the remaining sold directly to qualified sectors.[63] RGGI allows for the use of offsets from certain project types to substitute for emission allowances, up to 3.3 percent of a utility's reported emissions, encouraging investment in particular project types identified as high priority by the states. Although more narrowly focused than the EU ETS, the experience of RGGI has had some important similarities:

- There was a significant excess supply of allowances relative to actual emission levels in the region. Emissions have never approached the cap, peaking at 135 million tons in 2010 and dropping to 118 million tons in 2011. In 2012, with NJ dropping from the program, RGGI-covered emission levels hit a low of about 92 million[64].
- A New York State Energy Research and Development Authority analysis concluded that *"…three categories of factors are the primary drivers of the decreased CO_2... : 1) lower electricity load (due to weather; energy efficiency programs and customer-sited generation; and the economy); 2) fuel-switching from petroleum and coal to natural gas (due to relatively low natural gas prices); and 3) changes in available capacity mix (due to increased nuclear capacity availability and uprates; reduced available coal capacity;*

[63] Environmental Defense Fund – "RGGI: The World's Carbon Markets: A Case Study Guide to Emissions Trading"; http://www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_rggi_case_study_may_2013.pdf
[64] RGGI CO2 Allowance Tracking System; https://rggi-coats.org/eats/rggi/index.cfm?fuseaction=home.home&clearfuseattribs=true

increased wind capacity; and increased use of hydro capacity)".[65] RGGI is credited with helping reduce electric load and increasing renewable capacity through its funding of renewable energy and energy efficiency programs.

- As a result of the oversupply of allowances, auction prices have remained very low. From September 2008 to June 2013, auction clearing prices have ranged from a low of $1.86 to a high of $3.51, with an average of $2.35/mt$CO_2$e and cumulative proceeds totaling $1.35 billion.[66]
- Even at the very low levels of auction prices the program has raised significant revenues, totaling $825.5 million over the initial 3-year compliance period.[67]
- Of the revenues raised, 66 percent have been reinvested in energy efficiency, 5 percent in renewable energy and 4.5 percent in administrative costs.
- In response to the very low auction prices, the 2014 regional cap has been reduced from 165 million (already adjusted down from 188 million due to NJ's dropping out) to 91 million tons – roughly equivalent to 2012 emissions levels and a reduction of 45 percent of the previous cap. The cap will decline 2.5 percent each year from 2015 to 2020.
- Given the tighter cap, there are concerns that current cost control mechanisms will be insufficient. Thus, the participating states will establish a cost containment reserve (CCR), which is a reserved quantity of allowances, in addition to the cap, that would only be available if defined allowance price triggers were exceeded ($4 in 2014, $6 in 2015, $8 in 2016, and $10 in 2017, rising by 2.5 percent, to account for inflation, each year thereafter).
- Households in the RGGI region recognized a nearly $1.1 billion net gain due to improvements in energy efficiency resulting from RGGI revenues.[68]

New Zealand Emissions Trading Scheme. Like RGGI, the New Zealand Emissions Trading Scheme (NZ ETS) was launched in 2008, covering only a single sector (Forestry). It was designed to cover more sectors progressively over time, with the aim of including all sectors by 2015. The liquid fossil fuels, stationary energy, and industrial processes sectors joined in July 2010 and the waste and synthetic GHG sectors joined in January 2013. The agriculture sector was originally scheduled to enter the scheme in January 2015. This date has been pushed back until the New Zealand Parliament determines that sufficient technologies are available to reduce emissions in the sector and that international competitors are taking sufficient action on their

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[65] Environmental Defense Fund – "RGGI: The World's Carbon Markets: A Case Study Guide to Emissions Trading";
http://www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_rggi_case_study_may_2013.pdf

[66] http://www.rggi.org/market/co2_auctions/results

[67] Note: The author of this study, SAIC was a member of the team conducting allowance auctions on behalf of RGGI Inc.

[68] Analysis Group's November 2011 Report;
http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Economic_Impact_RGGI_Report.pdf

agriculture emissions.[69] Participants in the agriculture sector are still required to report their emissions.

Under the NZ ETS, compliance entities are required to obtain and surrender New Zealand Units (NZUs), or other eligible units including international emission units, to account for their direct GHG emissions or the emissions associated with their products. The NZ ETS provides for the transitional free allocation of NZUs to the agriculture sector and certain trade-exposed emission intensive industrial sectors.[70] The original aim of the NZ ETS was to have full auctioning by all sectors in 2013; however, the allocation of a limited number of free NZUs was extended through amendments in 2012. There are a host of cost control mechanisms in the NZ ETS that have resulted in low prices for NZUs. Most were initially designed to be temporary (or transitional) but have been extended through amendments to the scheme in 2012.[71]:

- Compliance entities can continue to purchase NZUs at a fixed price of NZ$25, which effectively serves as a price ceiling, and free allocations of NZUs are given to businesses with emissions-intensive, trade-exposed activities.
- The scheme has extended the measure that allows non-forestry participants to surrender one allowance for every two tonnes of CO_2e (the "one-for-two" surrender obligation), which effectively halves the price of allowances.
- The forestry sector has been given the flexibility to convert land for other use while avoiding NZ ETS deforestation costs by planting a carbon-equivalent area of forest elsewhere, known as "offsetting".[72]
- And perhaps most importantly entities can continue to use an unlimited number of international emission units, which has been a main driver in reducing the cost of compliance.[73]

The revised legislation does not specify an end date for the extended transition measures; however, they are expected to be in place at least until the next NZ ETS review which is scheduled for 2015. The result of these measures is that the price of NZUs have dropped from about NZ$20 (US$16) in 2011 to about NZ$2 (US$1.61) in early 2013. Despite these low prices, the NZETS has made electricity generated from renewable energy a more profitable option for

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[69] New Zealand Ministry of the Environment. April 2013. Agriculture in the Emissions Trading Scheme. http://www.climatechange.govt.nz/emissions-trading-scheme/participating/agriculture/

[70] New Zealand Ministry of the Environment. Allocation in the New Zealand Emissions Trading Scheme. http://www.mfe.govt.nz/publications/climate/allocation-nz-ets-dec07/allocation-nz-ets-dec07.html

[71] New Zealand Ministry of the Environment. November 2012. 2012 Amendments to the New Zealand Emissions Trading Scheme (NZ ETS): Questions and answers. http://www.climatechange.govt.nz/emissions-trading-scheme/ets-amendments/questions-answers.html

[72] New Zealand Ministry of the Environment. Forestry allocation: NZUs for pre-1990 forest. December 2012. http://www.climatechange.govt.nz/emissions-trading-scheme/participating/forestry/allocation/

[73] ECOFYS. May 2013.

electricity companies in New Zealand. Eleven new renewable power stations totaling 1,340 MW of capacity were constructed in 2010 and 2011. Of those, 59 percent were wind power, 26 percent geothermal, 13 percent hydro, and 2 percent were tidal.[74] Meanwhile, low NZU prices have limited the expected impact on GDP to between 0.1 and 1.0 percent between now and 2020, depending on the scenario modeled.[75]

[74] Climate Spectator. August 2011. http://www.businessspectator.com.au/article/2011/8/1/carbon-markets/smooth-trading-so-far-so-good-nz-ets#ixzz2bUkaBANi

[75] New Zealand Institute of Economic Research. Macroeconomic impacts of the New Zealand Emissions Trading Scheme: A Computable General Equilibrium analysis. March 2011. http://nzier.org.nz/system/files/07.03_BusinessNZ_%20Emissions-2.pdf

5 Carbon Tax

Table 18: Potential Costs and Benefits of a Carbon Tax Policy to Washington Consumers and Businesses

Potential Action for Consideration			
• Implement a tax on carbon emissions in the state of Washington			
GHGs and Costs in Washington[76]	**GHG Reductions ($MMTCO_2e$)**		**Cost**
	2020	**2035**	**($/mtCO_2e$)[77]**
$10 per $mtCO_2e$ tax	0.4	0.6	$5
$10, escalating to $30 per $mtCO_2e$ tax	1.5	2.8	$15
$10, escalating to $30 per $mtCO_2e$ tax	1.7	5.0	$23

Implementation Issues and Lessons Learned

- Emission reductions are highly dependent on the carbon tax rate selected, and the economically efficient rate (the social cost of CO_2) is difficult to estimate.
- Taxes can be imposed at various cost points, including annual escalation and caps. Policymakers should set these values in advance to provide market certainty, or establish a transparent mechanism to review and adjust rates periodically.
- Without protections to low-income households, a carbon tax may be regressive.
- Carbon taxes can generate significant revenue; there are many options for how to use that revenue, including offsetting other taxes or funding additional GHG programs.
- The decision as to which sectors should be exempted, if any, requires consideration of trade-exposure (ability for sectors to move out-of-state or be out-competed by out-of-state firms), potential for cost impacts to be inequitably distributed, and political practicalities.
- Taxes can be collected upstream or downstream, e.g., from fuel producers or fuel consumers

Potential Costs and Benefits to WA Consumers	**Potential Costs and Benefits to WA Businesses**
• Potential increase in gasoline, residential natural gas, electricity prices • Carbon tax revenue could be used to reduce or offset other types of taxes, including the state property tax, state retail sales tax	• Potential increase in diesel, commercial natural gas price, electricity prices, industrial coal price • Commercial and industrial sector revenue generated from the tax • Carbon tax revenue could be used to reduce business and occupation (B&O) tax

Summary of Screening Criteria

***Does the policy target an emissions source of significant magnitude in Washington*?**

Yes. A carbon tax policy would cover all emissions from regulated sectors, economy-wide. While some sectors, such as maritime and aviation fuel consumption for out-of-state and international travel, may be exempt, this provides an opportunity to reduce emissions across the entire economy.

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[76] The modeled Carbon Tax considers the impact of a British Columbia-styled carbon tax which applies to the electricity, residential commercial and industrial (RCI), and transportation sectors only. The model assumes that taxes are not applied to industrial process emissions. The model further assumes that aviation and marine fuels are exempt from the carbon tax. Several different carbon tax rates are presented, providing a range of potential GHG impacts and estimates for tax increases and tax revenue generation, as presented in the Quantification section of this report.

[77] 5 percent discount rate, NPV 2013

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?
From 2008 to 2011, BC's per capita GHG emissions associated with carbon-taxed fuels declined by 10 percent. During this period, BC's reductions outpaced those in the rest of Canada by 8.9 percent. [78] Quantitative volumes were not noted. In absence of all other GHG reduction strategies, the carbon tax alone is estimated to cause reduction in BC's emissions in 2020 by up to 3 $MMTCO_2e$ annually. [79]

In July 2013, one year after the start of the Australia Carbon Pricing Mechanism (CPM), emissions from electricity generation were down over 12 $MMTCO_2e$, or 6.9 percent.[80] The Australian CPM has received mixed reviews of success, most recently from the Institute for Energy Research, which claimed in a recent study that the policy caused increases in electricity prices (15 percent), increases in unemployment (10 percent), increased income tax rates for taxpayers, and have actually increased CO_2 levels.[81]

A May 2013 CBO report on the effects of a carbon tax in the United States did not directly quantify expected revenue from a carbon tax, but rather referred to analyses on cap-and-trade programs to suggest that a carbon tax that covered the bulk of CO_2 emissions in United States could generate a substantial amount of revenue. The report cited a 2011, CBO study of a nationwide cap-and-trade program that would have set a price of $20 in 2012 to emit a ton of CO_2 (and increased that price by 5.6 percent each year thereafter), which estimated revenues from the program to be $1.2 trillion during its first decade. The 2011 report cited also estimated that this cap-and-trade policy would reduce U.S. emissions of CO_2 by about 8 percent over that period than they would be without the policy.[82]

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?
The policy is discrete and comprehensive.

Can the policy be meaningfully implemented or influenced at the State level?
In the absence of a Federal carbon tax, the state can meaningfully implement a policy to charge units of emissions.

5.1 Introduction

Like a cap and trade system, a carbon tax is a market-based mechanism that aims to reduce GHG emissions in a covered geography, sector, or both without prescribing specific methods to

[78] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685
[79] British Columbia Ministry of Finance: How the Carbon Tax Works. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm
[80] Ibid.
[81] Robson, A. Australia's Carbon Tax: An Economic Evaluation. Institute for Energy Research. September 2013. Accessed September 2013 at: http://www.instituteforenergyresearch.org/wp-content/uploads/2013/09/IER_AustraliaCarbonTaxStudy.pdf and associated press release accessed September 2013 here: http://www.instituteforenergyresearch.org/2013/09/05/deadweight-down-under-australias-carbon-tax/.
[82] Congress of the United States. Congressional Budget Office. Effects of a Carbon Tax on the Economy and the Environment. May 2013. Page 1. Accessed September 2013 at: http://www.cbo.gov/sites/default/files/cbofiles/attachments/44223_Carbon_0.pdf

achieve those reductions or the ultimate level of emissions for any individual firm. Further, a carbon tax does not provide certainty as to a specific overall level of GHG emissions during any given year or over time. This uncertainty is seen as a principal disadvantage of a carbon tax approach. Conversely, the principal advantage of a carbon tax is that it provides price certainty to the market. This certainty helps policymakers predict economic impacts and helps individuals and firms make the investments necessary and adjust budgets accordingly to prepare for the increased costs of GHG emitting activities.

The most economically efficient carbon tax would be set at an amount equal to the social cost of GHG emissions that are currently not captured in the market and lead to an oversupply of GHG emitting fossil fuels. However, it is very difficult to estimate the social costs of GHG emissions and studies to date have found a wide range of potential costs, even when excluding the tail-end of the distribution of outcomes that would represent an existential threat to humanity.

A more practical approach is to set the tax at an amount that is forecast to yield a particular desired emissions level, as would be achieved under a cap and trade system. However, it is very difficult to predict the magnitude of emission reductions due to the price signals provided by a carbon tax. One of the advantages of the tax, after all, is the flexibility of firms to adjust their emissions to market conditions; reducing emissions when abatement costs are low, and allowing emissions to persist while paying additional taxes when abatement costs are high (e.g., when the price of natural gas compared to coal is peaking).[83] This can be addressed by adjusting the tax periodically (annually or biannually) to achieve the desired level of emission reductions in an iterative process. Unfortunately this approach mitigates the price certainty benefit of carbon taxes and subjects the program to the full range of political uncertainties on an ongoing basis.

The economic efficiency of a carbon tax is not only a function of the price at which it is set, but also the manner in which it is collected. A carbon tax may be collected upstream at petroleum refineries, coal suppliers and gas distribution companies. This has the benefit of a limited number of regulated entities, most with the capacity and experience required for the necessary data collection and administrative activities. Alternatively, the tax may be collected at the end use consumer; when purchasing goods and services, at the gas station, or via utility bills. While this results in a logarithmically larger number of regulated entities, increases administrative costs, and enhances the opportunities for waste and fraud, it offers the substantial benefit of visibility to the consumer that may alter behavior and consumption choices. The costs of a tax collected upstream will naturally filter down to the end-use customer, but may not be visible at all, unless specifically called out on bills or in pricing.

[83] Center for Climate and Energy Solutions, *Options and Considerations for a Federal Carbon Tax*, February 2013, http://www.c2es.org/publications/options-considerations-federal-carbon-tax

In addition to efficiency concerns, there are distributional impacts to consider when implementing a carbon tax. In their simplest form, carbon taxes are regressive. They will represent a much larger portion of resources available to low income individuals than high income individuals. There are also geographic and sectoral distributional impacts. A carbon tax is likely to create greater burdens in rural areas where miles travel by personal vehicles are considerably higher than in a metropolitan area and much greater burdens in localities dependent on coal-fired electric generation than areas dependent on nuclear or renewable fuels. Similarly, while a carbon tax may benefit the natural gas industry, it will create hardship for coal production companies.

A carbon tax can generate significant revenues. Those revenues can be used to ameliorate some of the negative distributional impacts. This can be accomplished through tax exemptions or refunds for low income individuals and disproportionately affected sectors. In general, the use of carbon revenues to reduce taxes on labor and capital - things we want more of, in contrast to GHG emissions – can help lower the overall economic costs of the program.[84] There will, of course, be many competing desires for the use of carbon tax revenues. Among these are funds for low-carbon investments in renewable energy and energy efficiency, investments in adaptation to climate change and a virtually limitless list of credible expenditures dependent on political priorities.

The use of revenues is far from the only political consideration associated with the implementation of a carbon tax. As with cap and trade, carbon taxes may be applied to all GHG emitting sectors, or may exempt certain sectors. The decision as to which sectors should be exempted, if any, requires consideration of trade-exposure (ability for sectors to move out-of-state or be out-competed by out-of-state firms), potential for cost impacts to be inequitably distributed, and political practicalities. One challenge to the success of a carbon tax program is the inexorable pressure to expand exemptions, reducing both the tax base and the share of emissions subject to abatement.

The majority of work conducted to assess economy-wide GHG policies in Washington has been directed towards cap and trade. However, at both the federal and sub-national levels, carbon taxes have been gaining momentum. Most relevant perhaps, Washington's neighbor to the north – British Columbia – established a carbon tax that has enabled sweeping changes to its tax structure, including significant modifications to reduce income taxes. While income tax is not collected in Washington, the strategy of recycling carbon tax revenue to decrease less popular taxes could be replicated. Section 5.2 below provides a summary of the most comprehensive modeling exercise identified of the impacts of a carbon tax on the Washington economy, which

[84]Goulder, Lawrence, Environmental Policy Making in a Second-best Setting, Economics of the Environment, Selected Readings, 5th ed. Editor R. Stavins, New York, 2005

includes a discussion of exempt industries. Next, Section 5.2 summarizes modeling conducted by SAIC using the same model, but considering sensitivity to a number of variables. Finally, section 5.3 ? provides a brief history of carbon tax implementation in other jurisdictions.

5.2 Literature Review of Washington Potential

In 2011, the Washington State Department of Commerce commissioned a study by University of Washington graduate student Keibun Mori titled "*Washington State Carbon Tax: Fiscal and Environmental Impact*". The results, methodology, and model were later presented in the article *"Modeling the impact of a carbon tax: A trial analysis for Washington State"* published in the journal *Energy Policy.*[85] The study used British Columbia's (BC) Carbon Tax policy parameters to quantify the environmental and fiscal impacts of a potential carbon tax in Washington. The primary parameters used in the analysis included:

- A default carbon tax rate of \$10/mtCO_2e increasing at \$5/mtCO_2e per year and capped at \$30/mtCO_2e.[86] [Based on his findings, Mori recommended that the cap for Washington State be \$70/ mtCO_2e].
- All carbon tax revenues are cycled back into the economy in the form of income and business tax credits.
- Exemptions included for aviation and maritime fuel for interstate and international trips.
- The study pulled elasticity estimates for various fuel types, and provided a weighted average value for various fuels, as summarized in Table 19.[87] The price elasticity of demand estimates the effect of price changes on demand for fuels.

Table 19: Weighted Price Elasticities of Demand for Various Fuel Types [from Mori, 2011]

Sector	Fuel Type	Price Elasticity of Demand
Transportation	Gasoline	-0.62
	Diesel Fuel	-0.44
	Jet Fuel	-0.23
	Residual Fuel	-0.37
Residential	Electricity	-0.43
	Natural Gas	-0.38
Commercial	Electricity	-0.47
	Natural Gas	-0.35
Industrial	Electricity	-0.49

[85] Mori. 2012. Modeling the impact of a carbon tax: A trial analysis for Washington State. Energy Policy. (June 28, 2012). Accessed August 2013 at: http://www.sciencedirect.com/science/article/pii/S0301421512004806
[86] Mori. 2011. *Washington State Carbon Tax: Fiscal and Environmental Impacts.* Page 6. Accessed August 2013 at: http://www.commerce.wa.gov/Documents/Washington-State-Carbon-Tax.pdf
[87] Mori, 2011. Table 6, Page 24.

Sector	Fuel Type	Price Elasticity of Demand
	Natural Gas	None estimated

The study concluded that implementing a carbon tax could help Washington meet the revised goals of the State Energy Strategy that include maintaining competitive energy prices, fostering a clean energy economy and jobs, and meeting obligations to reduce GHG emissions.[88] In order to work toward reducing emissions to 1990 levels by 2035, the study concluded that a carbon tax would need to start at $\$10/mtCO_2e$ in year one, increase by $\$5/mtCO_2e$ per year, and be capped at $\$70/mtCO_2e$ ($0.70 per gallon of gasoline).[89] The tax rate of $\$70/mtCO_2e$ assumes the State would also implement other policies to reduce emissions to reach its 2035 goal of 25 percent below 1990 levels by 2035. Based on his findings, Mori offered the following recommendations for implementing a carbon tax in Washington:[90]

- Identify a carbon tax rate that provides explicit price information on future energy costs.
- Coordinate complementary policies, such as policies that target non-point source emissions.
- Duplicate the British Columbia exemptions for jet and marine fuel to ease oppositions from the freight industry and mitigate the potential leakage of demand for air and marine travel.
- Design a fair and reliable revenue recycling mechanism to maintain economic competitiveness by offsetting the financial burden of the carbon tax.

Critics of a carbon tax in other jurisdictions, particularly British Columbia, have voiced concerns that the tax creates incentives for some businesses to reduce output or shift production and investment to other locations where energy taxes are lower. In British Columbia, the carbon tax paid by all businesses exceeds the revenues they save from the lower business tax rates. Additionally, critics charge that consumers, along with truckers and commercial vehicles, purchase fuels across the U.S. border where fuel prices are cheaper.[91]

In his analysis, Mori modeled the Washington carbon tax after BC's carbon tax, such that it would be implemented at $\$10/mtCO_2e$ in year one and increased annually by $\$5/mtCO_2e$ per year until reaching a maximum of $\$30/mtCO_2e$. Based on these rates, Mori estimated that the $\$30/mtCO_2e$ tax would generate roughly $2.1 billion in revenues for the state, and would reduce GHG emissions by 8.4 percent, or 7 $MMTCO_2e$, from a business as usual approach by 2035.[92] In

[88] Mori. 2011. Pages 8 and 43.
[89] Mori. 2011. Page 6.
[90] Mori. 2011. Pages 43-44.
[91] The Vancouver Sun. 2013. *B.C.'s carbon tax hurting businesses.* Accessed at 2013: http://www.vancouversun.com/business/bc2035/carbon+hurting+businesses/8739247/story.html
[92] Mori. 2011. Table 1, Page 5.

order to meet Washington's GHG target, Mori recommended a tax rate of \$70/mtCO_2e to reduce GHG emissions by 16 percent, or 13.3 MMTCO_2e.

In British Columbia, tax revenue was used to offset income tax. However, as Washington does not have an income tax, the analysis instead assumed that the carbon tax revenues would be used to offset Washington's major tax revenue sources – retail sales tax and property tax for individuals and the business and occupation (B&O) taxes for businesses.[93] According to Mori, consumers eventually bear all the increased costs from the carbon tax through increased costs of final products from manufacturers. This cost could be partially offset by returning the carbon tax revenues to consumers in the form of tax credits.[94]

Modeling showed that a carbon tax would slow the growth of industries that emit large amounts of CO_2, but boost other industries in clean energy. Additionally, implementation of a carbon tax has the potential to slightly reduce economy-wide employment due to the lower demand for workers in carbon-intensive industries and weakened incentives for labor force participation.[95]

Mori found that many of the costs and benefits of a Washington revenue-neutral carbon tax policy would be similar to those observed in the BC Carbon Tax policy. British Columbia and Washington are geographically contiguous and share many socioeconomic characteristics, including fuel mix of electricity generation, land use patterns, economic structure, and dependence on international trade. These similarities enable a relevant comparison of forecasted and actual effects of the British Columbia carbon tax, to forecasted effects in Washington.[96]

The majority of Washington's energy production comes from hydropower. In 2012, hydropower made up 69.5 percent of Washington's aggregate fuel mix, where coal power made up 13.4 percent and natural gas made up 11.0 percent of the aggregate fuel mix.[97] No cost increase is expected for hydropower. At a cost of \$30/mtCO_2e, the carbon tax is expected to increase the cost of industrial natural gas by 16.9 percent and coal by 79.4 percent.[98] The increase in the cost of electricity production from emissions-intensive generation facilities has the potential to be passed down to consumers. If the carbon tax is set at too high a rate, energy production in these sectors has the potential to move out of state, though this would likely have minimal impact on Washington's predominantly hydro-powered generation.

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93 Mori, 2011.
94 Mori, 2011.
95 Resources for the Future. *Considering a Carbon Tax.* Accessed August 2013 at: http://www.rff.org/centers/climate_and_electricity_policy/Documents/carbon-tax-FAQs.pdf
96 Ibid.
97 Washington State Department of Commerce. 2013. *Washington State Electric Utility Fuel Mix Disclosure Reports for Calendar Year 2012.* Accessed August 2013 at: http://www.commerce.wa.gov/Documents/Utility-Fuel-Mix-Reports-Data-CY2012.pdf
98 Mori. 2012. Modeling the impact of a carbon tax: A trial analysis for Washington State. Energy Policy. (June 28, 2012). Accessed August 2013 at: http://www.sciencedirect.com/science/article/pii/S0301421512004806

One strategy to mitigate future impacts is to provide explicit information on future energy costs, as it is likely to prompt consumers and businesses to invest in energy-saving technologies and therefore maximize the effect of the carbon tax.[99] In British Columbia, analysts determined the carbon tax is still too low in terms of price to drive a shift to new low-carbon practices and technologies. [100]

A carbon tax has the potential to cause leakage, or a shift of Washington's GHG emissions to other jurisdictions. This would occur as the carbon tax alters the relative price of fuels, and with it alters the economics of operating in Washington. Depending on the interaction between these costs and tax adjustments resulting from carbon tax revenue, this could cause adverse impacts on overall production activities, particularly on energy-intensive industries such as refining and metal manufacturing. Mori cites a report by Morgenstern et al (2007) that found a carbon tax at \$10/mtCO_2e would reduce output by less than 1 percent for most industries near-term in the US, but will be greater for industries such as vehicle manufacturing (1 percent), chemicals and plastics (1 percent), and primary metals (1.5 pecentpercent).[101] A revenue recycling scheme to offset tax revenues with the emphasis on low-income households and energy-intensive industries can mitigate the concerns on income equity and leakage problems.[102]

5.3 Quantification

This section presents updated analytical results on the impact of a potential carbon tax on Washington's GHG emissions and revenue potential. It builds on the analysis performed by Mori in 2011, utilizing an updated version of the model provided by the author and Washington State. The model considers the impact of a British Columbia-styled carbon tax which applies to the electricity, residential commercial and industrial (RCI), and transportation sectors only. The model assumes that taxes are not applied to industrial process emissions. The model further assumes that aviation and marine fuels are exempt from the carbon tax.

Several different carbon tax rates are presented, providing a range of potential GHG impacts and estimates for tax increases and tax revenue generation. This analysis does not engage the political question of how those revenues might be used. Options include alterations to the tax code, as done in British Columbia, use of revenue as seed funding for a PACE program

[99] Mori. 2011. *Washington State Carbon Tax: Fiscal and Environmental Impacts.* Accessed August 2013 at: http://www.commerce.wa.gov/Documents/Washington-State-Carbon-Tax.pdf
[100] Sustainable Prosperity. *British Columbia Carbon Tax Review.* September 2012. Accessed August 2013 at: http://www.sustainableprosperity.ca/dl891&display
[101] Morgenstern, et. al. Competitiveness Impacts of Carbon Dioxide Pricing Policies on Manufacturing. Assessing US Climate Policy Options. November 2007. Resources for the Future. Pages 96-105. Accessed September 2013 at: http://rff.org/RFF/Documents/CPF_COMPLETE_REPORT.pdf
[102] Sustainable Prosperity. September 2012.

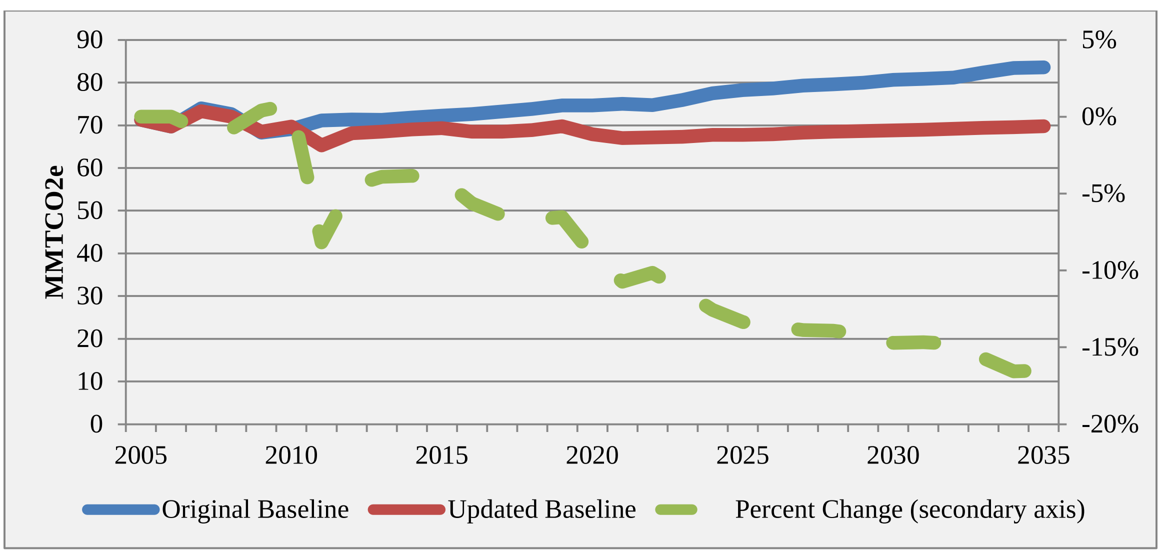
(discussed in Section 10 of this report), use as a PBF-type fund (discussed in Section 10 of this report) as done with RGGI auction revenues, or myriad other options.

5.3.1 Methodology

As the most robust, Washington-specific carbon tax model available, this analysis utilizes the C-TAM model created by Mori and staff at the Washington Department of Commerce. The original model, documented in Section 5.2, utilized then-current data to project baseline fuel consumption and costs. For this analysis, an updated model was obtained, version 2.2, which incorporates important changes to these baseline data. The version of the model used here utilizes reference case data from the EIA's Annual Energy Outlook 2013. Importantly, use of the AEO 2013 data means that the baseline case against which the model quantifies emission reductions, already includes emission reductions from existing federal policies including those evaluated in Task 3.

The general impact of the update to the model was to decrease projected baseline emissions. As shown in Figure 3, the update to AEO input data causes a reduction in 2035 baseline emissions of almost 14 MMTCO$_2$e, or over 16 percent. This is due to the inclusion of additional federal policies enacted since C-TAM's original issuance, including the new light-duty vehicle GHG and CAFE standards for model years 2017-2025, among others. This update is important to recognize, because while the results generated from the updated model will generally show lower overall magnitude emission reductions, absolute emissions will be lower than in previous modeling.

Figure 3. Change in baseline projection between C-TAM base model and update including AEO 2013.



C-TAM is an elasticity-based model which projects GHG emission changes based on changes in fuel consumption across various sectors. In response to the change in price of these fuels that results from inclusion of a carbon premium equal to the per unit GHG emissions multiplied by the carbon tax, the model applies an elasticity factor to calculate emission changes. Essentially, this means that as total prices (base fuel price plus carbon tax) go up, consumption and with it GHG emissions will go down. The magnitude of this change is different for each fuel, based on a fuel-specific elasticity value which roughly corresponds to price sensitivity.

The model also includes an option, utilized in this analysis, which enables the electricity sector to choose alternate fuels in response to the imposition of a carbon tax. In essence, this means that rather than simply reducing the use of fuels and therefore consumption, the fuel mix itself may adjust to the new relative expense of feedstocks resulting from a carbon tax.

In addition to estimating changes in GHG emissions, this analysis also provides a summary of tax generation by sector, and in total. These taxes come as a cost to businesses and individuals, but as revenue to the State. Therefore, two different approaches were pursued to estimate the cost effectiveness of the carbon tax under each tax rate.

Cost of Tax Method: The cost of tax method treats all taxes as costs. Total tax generation from the program's modeled inception in 2015 through 2035 are summed to a net present value in 2013. This value is then divided by the total number of emissions reductions achieved over this same period from 2015 to 2035. The cost of tax method will result in a higher estimated cost effectiveness because it assumes all taxes are net costs and does not account for the subsequent spending of that tax revenue by the State.

Marginal Abatement Method: The marginal abatement method follows the economic principle that emitters whose costs of reducing emissions are above the tax rate will elect to pay the tax, and that those whose emissions are below the tax rate will choose to reduce their emissions. Accordingly, the marginal, most expensive GHG reduction that should occur under this system is a reduction equal to the tax rate. To estimate cost effectiveness, annual costs were calculated as the product of the tax rate and total emissions, then summed from 2015 to 2035 to a net present value in 2013. As with the previous method, this cost was then divided by the total number of emissions reductions achieved over the same period from 2015 to 2035.

Although the cost of tax method is a seemingly more intuitive approach, the marginal abatement method should more accurately reflect the impact to the State's economy as a whole.

5.3.2 Assumptions, Exclusions, and Data Sources

Most notably, this analysis relies on the C-TAM model and its various assumptions, elasticities, and methods documented in Mori 2011. In addition, this analysis applies the following assumptions:

- All assumptions implicit in C-TAM version 2.2
- The carbon tax is first imposed in 2015

- The first-year carbon tax rate is $10 per metric ton CO_2e, and escalates to various levels by $5 annually in each model run
- A carbon tax results in a change to the electric fuel mix as relative prices of fuels change
- The tax is applied to the electricity, RCI, and transportation sectors
- All aviation fuel and marine fuels are exempted
- Baseline fuel consumption and cost are derived from the AEO 2013, and prorated for Washington from the Pacific region
- Base costs of fuels do not change as a result of the carbon tax. It is possible that producers and distributors of fossil fuels would reduce operating margins and costs to maintain market share

The primary data sources used in this analysis include:

Data	Source
Energy forecasts	AEO 2013
Energy prices	AEO 2013
Additional model data including GHG emission factors, WA tax rates and revenues, and price elasticity of demand.	C-TAM version 2.2

5.3.3 Results

Three carbon tax rates of $10, $30, and $50 per metric ton CO_2e were analyzed. The tax rate in all three scenarios began at $10 per metric ton CO_2e and escalated $5 per year to reach these levels. C-TAM modeling with these parameters estimated emission reductions ranging from 0.9 to 5.4 $MMTCO_2e$ in 2020, and 1.1 to 8.1 $MMTCO_2e$ in 2035, depending on the tax rate specified. These reductions are the result of decreased energy use ranging from 20.4 to 85.72 billion Btus in 2020, and 30.2 to 135.9 billion Btus in 2035. Summary results are provided in Table 20.

Table 20. Change in GHG emissions, tax revenue, and energy consumption under three carbon tax rates.

	2020			2035		
Tax Rate	$10	$30	$50	$10	$30	$50
Change in GHG Emissions ($MMTCO_2e$)	0.4	1.5	1.7	0.6	2.8	5.0
Change in Taxes and Tax Revenue (million US$)	$563	$1,656	$1,922	$571	$1,646	$2,635

As shown in Figure 4, emission reductions are proportional to the magnitude of the carbon tax applied due to linear price elasticities. In the base case, emissions are the greatest, and in each model run reflecting higher carbon tax rates, emissions decrease. Emissions are lowest under a modeled $50 carbon tax; yet higher tax rates would generate even deeper GHG reductions.

Figure 4. Washington emissions from the energy sector in the base case and three carbon tax rates.

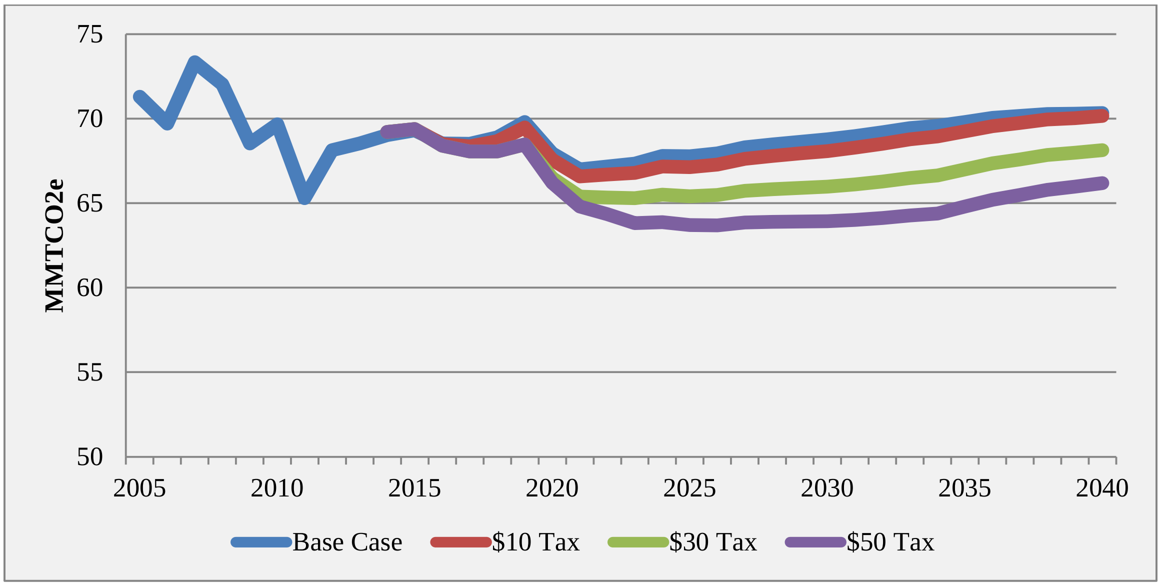


Table 21, Table 22, and Table 23 provide summary information on the three modeled carbon tax rates of $10, $30, and $50 per metric ton CO_2e in 2020 and 2035. The GHG emission reductions are the result of increased prices to carbon-intensive fossil fuels, and the GHG reductions generally correspond to a decrease in fossil fuel energy consumption. In addition to the impact on GHG reductions, these figures also provide results on the taxes generated from the residential, commercial, industrial, and transportation sectors. In all three carbon tax rates modeled, the largest share of tax was generated from the transportation sector, though GHG emission reductions from this sector are proportionally smaller. This is a result of a relatively low price elasticity of demand in the transportation sector compared to the residential, commercial, and industrial sectors.

Table 21, Table 22, and Table 23 also provide total tax revenues collected in each target year for each tax rate. A carbon tax of $10 per metric ton CO_2e could generate $563 million, and a carbon tax of $50 per metric ton CO_2e could generate 1.9 billion in 2020. With 2012 taxes totaling $17.6 billion, this translates to enough revenue to offset between 3 and 11 percent of Washington's existing tax collection.

In addition to the annual tax revenue and GHG reductions, Table 21, Table 22, and Table 23 provide cumulative tax revenue and GHG reductions from inception in 2015 through 2035.

Cumulative GHG reductions range from 10.4 MMTCO2e with a $10 per metric ton CO_2e tax, to 69.2 MMTCO2e when the tax is allowed to rise to $50 per metric ton CO_2e. Finally, each table provides an estimate of the cost effectiveness of the carbon tax using both the cost of tax method and the marginal abatement method. Cost effectiveness using the cost of tax method ranges from $341 to $634 per metric ton CO_2e. Cost effectiveness according to the marginal abatement method is $5 to $23 per metric ton CO_2e. Based on the cost of tax method, cost effectiveness increases as the maximum carbon tax rate rises. This is due to the fact that higher taxes incentivize greater abatement and result in fewer taxed emissions. Conversely the cost effectiveness according to the marginal abatement method decreases as the tax rate increases. This occurs because each reduction that occurs is assumed to have a cost equal to the higher tax rate. Although both methods are presented for completeness, the marginal abatement method more appropriately reflects the true cost effectiveness of a carbon tax.

Table 21. GHG emission reductions and taxes resulting from a constant $10 per metric ton CO_2e tax, by sector

	2020		2035		2015-2035	
Sector	**GHG Emission Reductions ($MMTCO_2e$)**	**Tax Revenue (million $USD)**	**GHG Emission Reductions ($MMTCO_2e$)**	**Tax Revenue (million $USD)**	**GHG Emission Reduction s ($MMTCO_2e$)**	**NPV Tax Revenue (million $USD)[a]**
Residential	0.1	$76	0.2	$78	2.7	903
Commercial	0.1	$72	0.3	$82	3.2	923
Industrial	0.4	$104	0.6	$105	10.2	1,213
Transportation	0.3	$312	0.3	$306	6.3	3,583
Totals	**0.4**	**$563**	**0.6**	**$571**	**10.4**	**6,577**
Cost per ton CO_2e (cost of tax method)					**$634**	
Cost per ton CO_2e (marginal abatement method)					**$5**	

[a] 5 percent discount rate, NPV in 2013

Table 22. GHG emission reductions and taxes resulting from a $10 per metric ton CO_2e tax which escalates by $5 annually to a $30 carbon tax, by sector

	2020		2035		2015-2035	
Sector	**GHG Emission Reductions ($MMTCO_2e$)**	**Tax Revenue (million $USD)**	**GHG Emission Reductions ($MMTCO_2e$)**	**Tax Revenue (million $USD)**	**GHG Emission Reduction s ($MMTCO_2e$)**	**NPV Tax Revenue (million $USD)[a]**
Residential	0.2	$222	0.6	$223	7.7	2,301
Commercial	0.3	$210	0.8	$231	9.1	2,345
Industrial	0.7	$304	1.3	$296	18.6	3,088
Transportation	0.8	$920	1.0	$897	18.6	9,284
Totals	**1.5**	**$1,656**	**2.8**	**$1,646**	**42.0**	**16,907**
Cost per ton CO_2e (cost of tax method)					**$403**	

Cost per ton CO_2e (marginal abatement method)	$15

[a] 5 percent discount rate, NPV in 2013

Table 23. GHG emission reductions and taxes resulting from a $10 per metric ton CO_2e tax which escalates by $5 annually to a $50 carbon tax, by sector

Sector	2020		2035		2020-2035	
	GHG Emission Reductions ($MMTCO_2e$)	Tax Revenue (million $USD)	GHG Emission Reductions ($MMTCO_2e$)	Tax Revenue (million $USD)	GHG Emission Reduction s ($MMTCO_2e$)	NPV Tax Revenue (million $USD)[a]
Residential	0.3	$258	1.0	$352	12.0	3,189
Commercial	0.3	$243	1.2	$362	14.2	3,245
Industrial	0.7	$352	1.9	$461	25.9	4,255
Transportation	0.9	$1,069	1.7	$1,460	29.1	13,049
Totals	**1.7**	**$1,922**	**5.0**	**$2,635**	**69.2**	**23,582**
Cost per ton CO_2e (cost of tax method)					**$341**	
Cost per ton CO_2e (marginal abatement method)					**$23**	

[a] 5 percent discount rate, NPV in 2013

5.4 Implementation History

British Columbia, Canada: On July 1, 2008, British Columbia (BC) implemented the BC Carbon Tax Act, the first carbon tax policy in North America. The BC carbon tax imposes a price on the use of carbon-based fuels, including gasoline, diesel, jet fuel, natural gas, propane, and coal. BC's carbon tax was designed to be "revenue neutral," as all revenue generated by the tax is used to reduce other taxes – mainly through cuts to income taxes (personal and corporate), as well as targeted tax relief for vulnerable households and communities, resulting in no overall increase in taxation. The tax covers three quarters (77 percent) of the province's GHG emissions from residential, commercial, and industrial sources. The measure is a central component of BC's climate change strategy that aims to reduce GHG emissions by 33 percent below 2007 levels by 2020.[103]

When introduced in 2008, the BC carbon tax was set at CAD$10 (US$9.68) per $mtCO_2e$. It was designed to rise by CAD$5 (US$4.84) per year thereafter until it reached CAD$30 (US$29.04) per $mtCO_2e$ in 2012. Since different fuels generate different amounts of GHGs when burned, the CAD$30 (US$29.04) per $mtCO_2e$ is translated into tax rates for specific fuel types. For example,

[103] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685

the current rate for a liter of gasoline is CAD$0.0667 (US$0.227/gallon) and the current rate for a liter of diesel is CAD$0.0767 (US$0.265/gallon).[104]

According to the BC Ministry of Finance, the revenue-neutral carbon tax is based on the following principles[105]:

- **All carbon tax revenue is recycled through tax reductions.** The government has a legal requirement to present an annual plan to the legislature demonstrating how all the carbon tax revenue will be returned to taxpayers through tax reductions. The money will not be used to fund government programs.
- **Allow time to adjust.** The tax rate started low and increased gradually to allow individuals and businesses time to adjust.
- **Protect low-income individuals and families.** Low-income individuals and families are protected through a refundable Low Income Climate Action Tax Credit designed to offset the carbon tax.
- **The tax has the broadest possible base.** Virtually all emissions from fuel combustion in BC captured by Environment Canada's National Inventory Report are taxed, with no exceptions except those required for integration with other climate action policies in the future and for efficient administration.
- **The tax will be integrated with other measures.** The carbon tax will not, on its own, meet BC's emission-reduction targets, but it is a key element in the strategy. The carbon tax and complementary measures such as "cap and trade" system will be integrated as other measures are designed and implemented.

The tax puts a price on carbon to encourage individuals, businesses, industry, and others to use less fossil fuel and reduce their GHG emissions. In addition, it sends a consistent price signal, ensuring that those who produce emissions pay for them, and makes clean energy alternatives more competitive.[106] According to Sustainable Prosperity, the majority of energy and carbon intensive industries in Canada are overwhelmingly in favor of a price on carbon, but there is no consensus on the pricing mechanism.[107]

From 2008 to 2011, BC's per capita GHG emissions associated with carbon-taxed fuels declined by 10 percent. During this period, BC's reductions outpaced those in the rest of Canada by 8.9

[104] British Columbia Ministry of Finance: What is the Carbon Tax?. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/A1.htm
[105] British Columbia Ministry of Finance. Tax Cuts Funded by the Carbon Tax. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/A2.htm
[106] British Columbia Ministry of Finance: Carbon Tax Review, and Carbon Tax Overview. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/carbon_tax.htm
[107] Sustainable Prosperity. Canadian Business Preference on Carbon Pricing. January 2011. Accessed August 2013 at: http://www.sustainableprosperity.ca/dl329&display

percent.[108] Quantitative volumes were not noted. In absence of all other GHG reduction strategies, the carbon tax alone is estimated to cause reduction in BC's emissions in 2020 by up to 3 $MMTCO_2e$ annually. [109]

Australia: Under Australia's Carbon Pricing Mechanism (CPM), which took effect in July 2012, liable entities must surrender one carbon unit for every metric ton of CO_2e they emit in each subject year. The CPM covers approximately 60 percent of Australia's emissions and includes emissions from electricity generation, stationary energy, landfills, wastewater, industrial processes, and fugitive emissions, but does not cover agricultural or transportation emissions.[110] Entities in regulated sectors are subject to the CPM if they operate subject facilities with direct (scope 1) emissions that exceed 25,000 $mtCO_2e$ per year.[111] Although households, businesses use of light-duty vehicles and the agriculture, forestry and fishery industries do not pay a carbon price for transport fuel under the CPM, these sectors will continue to pay a transport fuel excise tax. Emissions from certain business transport fuels, such as rail and shipping, are also subject to an effective carbon price through changes to the tax structure that result in a price equivalent to a carbon price on these emissions.[112]

The CPM was structured to begin effectively as a carbon tax (fixed price) and transition later to a cap and trade system (flexible price). Initial designs called for a gradually increasing fixed price for carbon for each of the first three years of implementation (July 2012 to July 2015), then a transition to a flexible-price scheme in July 2015, when the price of carbon units would be set by the market. However, the Australian Government announced in July 2013 that it has planned to move up the start date of the flexible-price scheme to July 2014, one year earlier than expected. The limit on emissions, known as the "pollution cap", in the first year of the flexible-price period will be set once the relevant legislation is amended to make 2014-2015 the first flexible-price year. Until then, the existing default pollution cap will be extended to 2014-2015.

The Australian Government estimated that Australia's per capita emissions were around 25 $mtCO_2e$ in 2012, and were projected to increase to 27 $mtCO_2e$ in 2030 without the CPM. With the CPM, per capita emissions are projected to be 21 $mtCO_2e$ in 2030 with domestic abatement only, and 13 $mtCO_2e$ with domestic and international abatement included.[113] In July 2013, one year after the start of the CPM, emissions from electricity generation were down over 12

[108] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685
[109] British Columbia Ministry of Finance: How the Carbon Tax Works. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm
[110] Australian Government Clean Energy Regulator: About the carbon pricing mechanism. Accessed July 2013 at: http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/About-the-Mechanism/Pages/default.aspx
[111] Ibid.
[112] Australian Government. Transport Fuels. http://www.cleanenergyfuture.gov.au/transport-fuels/
[113] Australian Government. How Australia's Carbon Price is Working One Year On. July 2013. http://www.cleanenergyfuture.gov.au/wp-content/uploads/2013/08/carbon-price-one-year-on.pdf

MMTCO$_2$e, or 6.9 percent.[114] The Australian CPM has received mixed review of success, most recently from the Institute for Energy Research, which claimed in a recent study that the policy caused increases in electricity prices (15 percent), increases in unemployment (10 percent), increased income tax rates for taxpayers, and have actually increased CO_2 levels.[115]

In July 2013, one year after the start of the program, emissions from electricity generation were down over 12 MMTCO$_2$e, or 6.9 percent.[116] The Australian CPM has received mixed reviews of success, most recently from the Institute for Energy Research, which claimed in a recent study that the policy caused increases in electricity prices (15 percent), increases in unemployment (10 percent), increased income tax rates for taxpayers, and have actually increased CO_2 levels.[117]

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[114] Ibid.

[115] Robson, A. Australia's Carbon Tax: An Economic Evaluation. Institute for Energy Research. September 2013. Accessed September 2013 at: http://www.instituteforenergyresearch.org/wp-content/uploads/2013/09/IER_AustraliaCarbonTaxStudy.pdf and associated press release accessed September 2013 here: http://www.instituteforenergyresearch.org/2013/09/05/deadweight-down-under-australias-carbon-tax/.

[116] Ibid.

[117] Robson, A. Australia's Carbon Tax: An Economic Evaluation. Institute for Energy Research. September 2013. Accessed September 2013 at: http://www.instituteforenergyresearch.org/wp-content/uploads/2013/09/IER_AustraliaCarbonTaxStudy.pdf and associated press release accessed September 2013 here: http://www.instituteforenergyresearch.org/2013/09/05/deadweight-down-under-australias-carbon-tax/.

6 Reducing Vehicle Miles Traveled (VMT)

Transportation sources generate more GHG emissions than any other sector in the State. This is not the result of an abnormally inefficient transportation system; nor is the car culture more pervasive among Washington residents than the rest of Americans. The transportation sector's lead ranking in statewide GHG emissions has the most to do with the abundance of hydropower, which provides a large share of the state's electricity and results in a relatively low-GHG profile for the electric power and RCI sectors. In fact, on a per-capita basis, on-road gasoline and diesel fuel consumption has been consistently among the lowest in the region for at least the past decade, as Washington drivers consume less than their counterparts in Oregon, Idaho, and Montana, although more than Californians.[118] Still, given that transportation sector accounts for nearly half of the State's GHG emissions, specifically 44 percent of total GHG emissions in 2010, the State is unlikely to achieve the GHG emissions reductions it has targeted in its statute without a significant decrease in transportation emissions.

There are many transportation emission-reduction strategies, which can be grouped into the four categories of vehicle improvements, fuel switching, system efficiency, and demand reduction. For this project, several policies that require or incentivize next-generation technologies in vehicles and fuels were analyzed in depth, including ZEV, LCFS, and RFS and biofuels support. Some indicate technology-based strategies are more cost-effective than VMT strategies.[119]

In addition to policies targeting vehicles and fuels, there are a large number of policy approaches and program strategies that seek improvements in overall transportation system efficiency and VMT reductions. Many VMT-reduction strategies have been evolving in practice around the world in various forms and for a variety of purposes, for decades. Examples include carpooling, public transportation options, roadway pricing, and comprehensive land-use planning requirements. This is one reason that more VMT policies were not analyzed in greater depth under Task 2 of this project – in general, the most successful and essential VMT-reduction strategies are already in place in Washington, and thus not the focus of the Task 2 scope. Transportation and environmental professionals recognize that there is no 'silver bullet' for the transportation sector, and thus the State already has a host of effective programs that continue to generate benefits, whatever their primary objective might be. For as long as there has been traffic congestion, communities and governments have sought congestion relief – because congestion contributes more than GHG emissions, but also air quality pollutants, fuel costs, foreign oil dependency, and delays in time which causes frustration, lost revenue, and a

[118] U.S. Energy Information Administration, State Energy Data System (SEDS), as summarized by SAIC in Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State, Task 1.a – Analyze Washington State's total consumption and expenditures for energy, 2013.

[119] American Association of State Highway and Transportation Officials (AASHTO) Primer on Transportation and Climate Change, April 2008, accessed September 2013 at http://downloads.transportation.org/ClimateChange.pdf

disruption of goods movements to markets. The programs have fallen under categories mirroring the most pressing problems of the time – from air quality attainment under the Clean Air Act, to congestion relief. The flip side highlights the many co-benefits of transportation GHG emission-reduction strategies to reduce VMT: saving time and money, enhancing livability, reducing energy use and foreign oil dependence, and improving air quality, which provides health benefits.

The challenge with policies that target demand reduction is that they often require a behavioral shift, for example to telework rather than commuting into work, or to take a bus or bike instead. People make daily choices about whether and how to make a trip, considering cultural, economic, environmental, and social factors. Elasticity data have long shown that Americans' demand for travel is relatively inelastic. As gasoline prices rise, people are more likely to change cars than change driving habits – price affects vehicle choice more than VMT.[120] Historically, VMT closely tracks the economy and personal income, and has grown at roughly 2.5 percent per year.[121] American Association of State Highway and Transportation Officials (AASHTO) asserts that some VMT growth is in fact necessary to accommodate population and economic growth, including freight transport, although recommends the nation work toward an overall reduction in the *rate of growth* in nationwide VMT down to about one percent per year,[122] which will require a reduction in per capita VMT.

New research suggests that the many varied VMT-targeting policies, many of which have demonstrated successes at a program level (e.g., Washington State's Commute Trip Reduction Program)[123], may be having a strong macro effect, actually changing the trajectory of the VMT trendline. "Per person, per driver, and per household—we now have fewer light-duty vehicles and we drive each of them less than a decade ago." The peak occurred several years prior to the start of the economic rescession; therefore the author attributes the reduction to "other societal changes that influence the need for vehicles (e.g., increases in telecommuting and in the use of public transportation)."[124] Driving in Oregon also *may* have peaked in 2004 – a traffic data analysis by *the Oregonian* demonstrates a changing trend that mirrors the national numbers.[125]

[120] Moving Cooler*: Transportation Strategies to Reduce Greenhouse Gas Emissions, June 2009.*
[121] American Association of State Highway and Transportation Officials (AASHTO) Primer on Transportation and Climate Change, April 2008, accessed September 2013 at http://downloads.transportation.org/ClimateChange.pdf
[122] American Association of State Highway and Transportation Officials (AASHTO) Primer on Transportation and Climate Change, April 2008, accessed September 2013 at http://downloads.transportation.org/ClimateChange.pdf
[123] State of Washington Department of Commerce, Energy Strategy, 2012 Washington State Energy Strategy, 2011, accessed September 2013 at http://www.commerce.wa.gov/Documents/2012WAStateEnergyStrategy.pdf.
[124] Michael Sivak, Has Motorization in the U.S. Peaked? Part 2: Use of Light-Duty Vehicles. University of Michigan, Transportation Research Institute, UMTRI-2013-20. July 2013. Accessed September 2013 at http://deepblue.lib.umich.edu/bitstream/handle/2027.42/98982/102950.pdf
[125] Joseph Rose, Drivers ease off the gas in cultural shift, the Sunday Oregonian, September 15, 2013.

These historical patterns, which are reflected in Washington as well,[126] likely would not have occurred if it were not for the effective implementation of bundles of travel demand management programs and investments, including pricing strategies, trip reduction programs, and transportation alternatives.

Dozens of potential policies targeting system efficiency and VMT reductions could have been identified for further consideration under Task 2 of this project, but the list of all possible policy approaches was narrowed to the following based on the criteria established in Section 3, and given that many policies and programs already exist and are being successfully implemented in Washington currently.

- Mileage Based User Fee (MBUF)
- Pay-As-You-Drive Insurance (PAYD)
- Significant New Investment in Public Transit

A discussion of MBUF and PAYD are included in this final report. Although quantification was not prepared based on the limited information available on these approaches as a GHG reduction strategy, the MBUF policy, which is gaining traction around the country for revenue generation as a gas tax replacement, could have strong potential as a GHG strategy given thoughtful design and implementation. The CLEW may consider whether further evaluation is desired under Task 5. Public transit also provides an important role within the overall efficiency of the transportation system, and synergistic effects when new investments are implemented in coordination with other transportation and land-use strategies. However, current research and communications with State agency staff resulted in the determination not to conduct additional quantitative evaluation, because given foreseeable funding levels even if moderate increases are approved, the magnitude of emissions reductions achievable for changes to transit policy are small relataive to other policies evaluated in depth under Task 2. Related to transit invesntments, Compact Transit-Oriented Development (CTOD) land-use patterns are reportedly associated with significant GHG emission reductions. CTOD is discussed and its potential GHG reductions quantified under Task 1, within the evaluation of the Growth Management Act (GMA).

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[126] Data show a short-term peak and decline through the available data series (appears to be through 2010), but projections through 2050 show annual increase in per capita VMT in BAU scenario. Same chart indicates per-capita and total VMT reductions will be reduced if VMT benchmarks are achieved in future years. Source: Kathy Leotta, WSDOT, VMT Targets, Strategies, and Challenges, May 5, 2010, American Association of State Highway and Transportation Officials (AASHTO), Reducing GHG through VMT Strategies, Webinar, May 2010.

6.1 Pricing Strategy to Reduce VMT – MBUF and PAYD

Table 24: Potential Costs and Benefits and Additional Screening Criteria for Implementation of Pricing Strategies to Reduce VMT to Washington Consumers and Businesses

<table>
<tr><th colspan="2">Potential Action for Consideration</th></tr>
<tr><td colspan="2">• Implement a Mileage Based User Fee (MBUF) in place of the gasoline tax
• Require companies to provide a PAYD insurance offering</td></tr>
<tr><th>Potential Costs and Benefits to WA Consumers</th><th>Potential Costs and Benefits to WA Businesses</th></tr>
<tr><td>• All the co-benefits associated with VMT reduction, if effective
• Consumer cost savings are case-specific, and will depend on the amount of travel, among other factors
• Depending on pricing implementation, potential to disproportionately impact low income users; mitigation for impacts should be considered
• In general, there is high uncertainty on how these policies would actually affect GHG emissions; the results would largely be dependent on design and implementation, and if the approach provides enough signal, economic or otherwise, to incent behavior.</td><td>• Could create increased cost burden on businesses with high-VMT delivery and goods transport component, if insurance offerings changes</td></tr>
<tr><th colspan="2">Summary of Screening Criteria</th></tr>
<tr><td colspan="2">Does the policy target an emissions source of significant magnitude in Washington?
The transportation sector in the state of Washington accounted for 44 percent of total emissions in 2010. To the extent the policies effectively reduce VMT, it would reduce associated transportation emissions.

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful? Many states are investigating a MBUF as a revenue option to replace the insufficient gas tax. Data from MBUF program pilots have shown that VMT charges can be implemented to replace the gas tax as the principal revenue source for road funding,[127] but no studies of MBUF as a GHG policy have been reviewed.

No comprehensive studies of PAYD program implementation have been identified.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?
PAYD would be discrete and could be comprehensive of a subsector or transportation, depending on implementation. MBUF would be more comprehensive, depending on how it would be structured.

Can the policy be meaningfully implemented or influenced at the State level?
For MBUF, yes, it would be implemented by the State.

For PAYD, the state has a limited role. The Washington legislature already removed barriers to insurance</td></tr>
</table>

[127] Whitty, J. 2013. Page 45. Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUCPilotPrelimFind_Feb13.pdf

companies' allowing PAYD. The State could consider requiring companies to offer it.

Pricing strategies to reduce VMT impose direct charges for the use of a roadway or roadways, with various goals. Goals may include revenue generation, as in the MBUF, or incentivizing behavioral changes such as driving less to reduce risk of accidents and associated costs to insurance companies, as in PAYD. The policies are defined as follows:

MBUF: implemented in the place of the gasoline tax, charges are assessed based on mileage traveled rather than fuel consumed, to directly tie charges to use of the system in order to account for highly fuel efficient vehicles, or vehicles that require no fuel.

PAYD insurance or Usage-Based insurance: the cost of insuring a motor vehicle is contingent on the type of vehicle, time, distance traveled, location, and behavior

MBUF and PAYD policies are grouped in this section even though they are very different in how they are implemented and to whom they apply. However as a GHG policy, both are targeting reduced VMT by putting a price on total vehicle trips per individual, family, or business, so the effectiveness of either is based on the elasticity of demand from this mechanism of cost. As such, a key policy design element for GHG reductions would be to maximize the information feedback to the driver on how much each mile costs. Once the VMT tax or PAYD insurance policy is implemented, drivers consider the cost of each mile, and adjust their driving patterns accordingly. As far as policy implementation, the policies are quite different, as one applies to private insurance companies, whereas the other applies to all drivers and is administered through an overseeing government entity or third-party government supported entity. Both of these two unique policy examples are grouped in this document because of their similarities in how they might affect GHG emissions, as discussed further below.

VMT charging policies charge drivers according to the number of miles traveled. Such policies may be implemented by the State government for revenue generation and/or congestion relief, with GHG reduction as a co-benefit.

Government road usage fees, MBUF: As cars increasingly become more fuel efficient, state and local governments receive less revenue from the traditional fossil fuel taxes to spend on road infrastructure maintenance and development. A MBUF can be used to generate revenue based on mileage traveled rather than fuel consumed, to account for highly fuel efficient vehicles, or vehicles that require no fuel. Under government VMT programs, a fee is assessed based on the number of vehicle miles that are traveled. Often, this fee replaces the gasoline tax to generate revenue for road infrastructure maintenance and development in response to increasing fuel efficiency in vehicles which is causing declining revenues. Under this system, users are paying for their actual use of the transportation system, rather than paying based on the quantity of fuel that their vehicles consume. These programs can be as simple as a flat fee charged per mile based on odometer readings, or tiered fees based on distance, location, and other factors. Implementation can be done through various mechanisms, including pay-at-the-pump and onboard vehicle monitoring devices.

As part of the 2012 Supplemental Transportation Budget to the Washington State Transportation Commission (WSTC), the State of Washington provided funding to investigate the potential for VMT charges as an alternative to gasoline taxes and submitted a Work Plan and budget to the Legislature for further investigating the use of a VMT charge.[128] As part of the process, there was a series of four Steering Committee meetings from September 2012 to January 2013, ultimately finding that there were numerous viable implementation mechanisms for the use of a VMT-based charge in Washington. In developing the proposed Work Plan, a phased approach has been adopted to allow for evaluation of the project at various stages. Currently, the project is undergoing approval for Phase I, an estimated $1.6 million in-depth research and development phase to refine the policy framework and operational concepts of the program.[129]Important policy issues raised for consideration during further investigation in Phase I of the project (if implemented) include:[130]

- Relationship to the gas tax
- Social objectives (reduce energy, GHG, congestion or encourage transit)
- Rate setting and use of revenue
- Equity (income and urban/rural)
- Privacy
- Accounting for out-of-state motorists
- Accounting for out-of-state travel by residents

Washington's 2012 tax revenue from motor fuel sales tax was $1.18 billion,[131] and Washington's 2011 VMTs totaled 56.97 billion.[132] Based on these values, an average VMT fee of approximately $0.021 per mile, or $210 per year for an individual driving an annual average of

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[128] Washington State Transportation Commission. *Road Usage Charge Assessment*. Accessed July 2013 http://www.wstc.wa.gov/StudiesSurveys/RUC2012/default.htm

[129] Washington State Transportation Commission. Washington State Road Usage Charge Feasibility Assessment. Accessed September 2013 at: http://waroadusagecharge.files.wordpress.com/2012/08/wastate_flyer_vfinal_screen2.pdf

[130] Transportation Committees of Washington State Senate and House of Representatives. Washington State Road Usage Charge Assessment. (PowerPoint Presentation). Slide 15. Accessed September 2013 at: http://www.wstc.wa.gov/StudiesSurveys/RUC2012/documents/2013_02_RUCSummary.pdf

[131] United States Census Bureau, American Fact Finder. Accessed September 2013 at: http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=bkmk

[132] Washington State Department of Transportation. Measuring Delay and Congestion Annual Report: Congestion Report Dashboard of Indicators. Accessed September 2013 at: http://wsdot.wa.gov/publications/fulltext/graynotebook/DB_CR12.pdf

10,000 miles, could generate enough revenue to replace the motor fuel sales tax. As previously stated, these policies are most often implemented as revenue generation mechanisms rather than GHG reduction policies. Implemented at this level, this cost is unlikely to influence driving behavior to substantially affect GHG emissions. On the other hand, some reports provide extremely optimistic results from the implementation of a MBUF. For example, the Rocky Mountain Institute estimates that there is a nationwide potential for between a 12 and 15 percent reduction in VMT with the implementation of a VMT tax, at a present value cost (in 2009 dollars) of $168 billion for the entire country.[133]

The Texas Transportation Institute offers archives of MBUF studies, symposium materials, and news through 2012.[134]

Pay-As-You-Drive Insurance, or Usage-Based Insurance: Under PAYD insurance, the cost of insuring a motor vehicle is contingent on the type of vehicle, time, distance traveled, location, and behavior.[135,136] Pay-as-you-drive insurance is currently offered in over 35 states, including Washington, in a variety of forms, through a variety of providers. "Low mileage discounts" are available in Washington State through several providers.[137]

A 2008 Brookings study found that upon implementing nationwide pay-as-you-go insurance policies for all drivers, "[…] driving would decline by 8 percent nationwide, netting society the equivalent of about $50 billion to $60 billion a year by reducing driving-related harms. This driving reduction would reduce carbon dioxide emissions by 2 percent and oil consumption by about 4 percent. To put it in perspective, it would take a $1-per-gallon increase in the gasoline tax to achieve the same reduction in driving."[138]

Beginning in 2012, pay-as-you-go became available in Oregon.[139] Progressive Universal Insurance Co. was the pilot company in Oregon[140], with seven companies now offering it in the

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[133] Rocky Mountain Institute. *Summary of U.S. VMT Reduction Strategies*. (2011). Accessed July 2013 at: http://www.rmi.org/RFGraph-Summary_of_US_VMT_reduction_strategies
[134] http://utcm.tamu.edu/mbuf/
[135] Orenstein, B. *Who's doing what? The rise of usage-based auto insurance*. Insure. (September 4, 2012). Accessed July 2013 at: http://www.insure.com/car-insurance/usage-based-insurance-update.html
[136] National Association of Insurance Commissioners and the Center for Insurance Policy and Research. *Usage-Based Insurance and Telematics*. (last updated May 29, 2013). Accessed July 2013 at: http://www.naic.org/cipr_topics/topic_usage_based_insurance.htm
[137] Pay-As-You-Go Insurance from Onstar/National General Insurance -- Low-Mileage Discount Offered in 35 States. Accessed July 2013 at: http://www.lowmileagediscount.com/what-is-payg/lmd-states.asp
[138] Bordoff, J. and P. Noel. *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity*. The Brookings Institution. (July 2008). Accessed July 2013 at: http://www.brookings.edu/research/papers/2008/07/payd-bordoffnoel
[139] The Sightline Institute. *Pay-As-You-Drive Car Insurance*. Accessed July 2013 at: http://www.sightline.org/research/payd/

State.[141] The policy is voluntary, and offers the benefit of reduced insurance cost to safe or infrequent drivers (up to a 45 percent reduction, depending on driving patterns), with the tradeoff of reduced privacy (mileage and location are tracked via a GPS-enabled device that also detects erratic braking and high speeds for some insurance companies).

In March 2012, with the passage of HB 2361 into law, there are no more known remaining legal barriers to PAYD insurance in Washington. The bill exempts certain information on usage-based insurers (including the usage-based component of the insurance rate) and users (including names and individual identification data of the insured) from public inspection during state filings. The bill also protects the insured from having data on their location collected by the insurance company without disclosure to and consent from the insured.[142] A potential action the State may consider is to require companies to provide a PAYD insurance offering. An AASHTO webinar indicted estimates of GHG reduction potential in 2030 of 1.1 to 3.5 percent, ranging from whether states simply allow, or require companies to offer a PAYD option.[143]

6.2 Investments in Public Transit Infrastructure

Table 25: Potential Costs and Benefits of Public Transit to Washington Consumers and Businesses

Potential Action for Consideration
• Emphasizing an overarching goal of improving overall transportation system efficiency and reducing delay, establish an increased ridership goal, and fund proportionally - expanding service miles when ridership and demand exceeds current system capabilities. A doubling of ridership goal is reportedly unrealistic even assuming moderate increases in funding levels over most recent budget requests. It would more likely require a doubling of associated funding,[144] which would presume a major political and public opinion shift toward much greater subsidies to allow new capital investments and service, and lower fares to encourage maximum use. • Through WSDOT, continue to provide and potentially increase: o grants and technical assistance to aid local, and regional transit authorities o planning assistance and direction on the types of projects in which investments should be made o Communication and coordination with local and regional transit authorities to ensure that state-level goals and federal-level direction for transit development are implemented, providing a centralized view of the transportation system as a whole (including cross-jurisdictional travel between transit authorities, freeway travel, and other modes of travel)

[140] Oregon Environmental Council. *Pay-As-You-Drive Insurance*. Accessed July 2013 at: http://www.oeconline.org/our-work/climate-protection/transportation/other-transportation-solutions/payd

[141] Hunsberger, B. *Pay-as-you-drive car insurance: Trade your privacy for a price break?* The Oregonian. (March 2, 2013). Accessed July 2013 at: http://www.oregonlive.com/finance/index.ssf/2013/03/pay-as-you-go_car_insurance_tr.html

[142] Engrossed Substitute House Bill 2361. http://apps.leg.wa.gov/documents/billdocs/2011-12/Pdf/Bills/House%20Passed%20Legislature/2361-S.PL.pdf

[143] AASHTO, Reducing GHG through VMT Strategies, Webinar, May 2010.

[144] WSDOT Public Transportation Division staff, personal communication, September 18, 2013.

- Consider increasing the "local option" sales tax rate in cases where there is political will in order to allow local transit authorities to raise additional revenue
- Review the classification of public transit as it pertains to the 18th amendment to the Washington State Constitution, potentially allowing gas tax revenues to be used for transit purposes

Potential Costs and Benefits to WA Consumers	Potential Costs and Benefits to WA Businesses
• Public transportation will never be self-supporting and will always require subsidies. In addition to Federal and State Government contributions of capital costs, funding for state-sponsored public transit improvements would likely come from an increase in taxes (fuel, motor vehicle excise) • Funding from local transit authorities would come from an increase in fares (ferries and transit) or local sales taxes • Benefits include improved mobility and accessibility for not only choice riders, but also captive riders that include elderly, poor, and disabled populations ; improved community and environment[145] • For consumers using public transit, reduced fuel consumption costs transportation expenditures (for example, some households may be able to reduce the total number of cars or save money on maintenance for vehicles used less frequently).	• Increasing public transit service may reduce the need for businesses to offer parking for employees, and reduce developers' parking requirements at new facilities • Funding for operating budgets for state-sponsored public transit improvements would likely come from an increase in taxes (e.g., fuel, motor vehicle excise)

Summary of Screening Criteria

Does the policy target an emissions source of significant magnitude in Washington?

Yes. The transportation sector in the state of Washington accounts for 44 percent of total emissions in Washington (in 2010). A policy that targets mode-shifting from low-occupancy vehicles to transit and increases public transit ridership as a component of a larger strategy to increase overall transportation system efficiency and reduce delay associated with congestion would reduce VMT and associated emissions from transportation fuel combustion.

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?

Fehr and Peers, for the State of Washington Department of Commerce in 2009 estimated that transit system enhancements and expansion could achieve two to ten percent reduction in mobile source GHG emissions, based on a doubling of transit revenue miles.[146] If a doubling of revenue miles is unrealistic given any forseeable near- or medium-term scenario, then it can be deduced that the emission reduction

[145] Connecting Washington Task Force. January 6, 2012. Page 2.

[146] Fehr and Peers, prepared for the State of Washington Department of Commerce, Assessment of
Greenhouse Gas Analysis Tools, 2009, accessed September 2013 at
http://www.commerce.wa.gov/Documents/GMS-Climate-Greehouse-Gas-Tool-Assess.pdf

potential of lesser transit system enhancement and expansion policy than the 'doubling' assessed by Fehr and Peers would be relatively small compared to other transportation policy options.

In July of 2010, Johns Hopkins University and the Center for Climate Strategies estimated that transit expansion would result in 27.05 $MMTCO_2e$ annual reduction in GHG emissions nationwide by 2020, at an expected $16.72/$mtCO_2e$ cost.[147] The analysis of expected reductions considered actions at the federal, state and local levels to implement transit programs, which included additional federal funding, additional state funding and "fast tracking" capital investment, and increased development of transit capacity and maintenance level of effort at the local level.[148]

In 2008, the Washington State Climate Advisory Team quantified expected cumulative GHG savings of development and expansion of "Transit, Ridesharing, and Commuter Choice Programs" to be 23.6 $MMTCO_2e$ for the State of Washington from 2008-2020 (cost was not quantified). This policy included reducing statewide per capita VMT and working with local governments and regional planning organizations to achieve state targets.[149]

Of note, GHG reductions from expansion of public transit systems are achievable only when riders are taken off of the road at high enough levels to offset the GHG emissions from the operation of the transit system itself. Optimal reductions are achieved when systems are operating at or near ridership capacity. Therefore, it is important to increase ridership on existing infrastructure (which can be done by increasing frequency and reliability of service, among other alternatives) in addition to planning for system expansion.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?
This policy is a bundle of related policies and guidance, and would govern an extensive network of 31 public transit authorities in the state.

Can the policy be meaningfully implemented or influenced at the State level?
Public transit is primarily a local activity in Washington, with the the 31 transit authorities in Washington function at the local or regional level. The state can take a variety of actions to support transit activities, which alone would not generate significant GHG emissions reductions:

- Providing grants and technical assistance to aid local, and regional transit authorities
- Providing planning assistance and direction on the types of projects in which investments should be made
- Communicating and coordinating with local and regional transit authorities to ensure that state-level goals and federal-level direction for transit development are implemented, providing a centralized view of the transportation system as a whole (including cross-jurisdictional travel between transit authorities, freeway travel, and other modes of travel)

The State has less influence over the following options that could allow for greater transit funding:

- Increasing the "local option" sales tax rate in cases where there is political will in order to allow local transit authorities to raise additional revenue

[147] Johns Hopkins University and Center for Climate Strategies. Impacts of Comprehensive Climate and Energy Policy Options on the U.S. Economy. July 2010. Table 2-2. Page 22.
[148] Johns Hopkins University and Center for Climate Strategies. July 2010. Table 4-1. Page 61.
[149] Washington Climate Advisory Team. Leading the Way: A Comprehensive Approach to Reducing Greenhouse Gases in Washington State. January 25, 2008. Table 4.1. Page 76. Accessed September 2013 at: https://fortress.wa.gov/ecy/publications/publications/0801008b.pdf

- Reviewing the classification of public transit as it pertains to the 18th amendment to the Washington State Constitution, potentially allowing gas tax revenues to be used for transit purposes

Public transit serves purposes other than GHG reduction, including increased mobility of the population and accessibility to transportation, and reduced congestion. GHG reduction benefits from public transit come from moving a larger number of people on less fuel, and often cleaner fuel, than traditional passenger motor vehicle travel, reducing fossil fuel consumption, and therefore GHG emissions. In Washington as elsewhere, public transit is primarily a local activity serving the specific needs of each community. Within Washington, there are 31 transit authorities operating at the local or regional level, and the Washington State Department of Transportation's (WSDOT) role falls more to oversight and coordination with and among the transit authorities. As such, at the state level, Washington provides funding to aid local, and regional transit authorities, provide direction on the types of projects in which investments should be made, and communicate and coordinate with local and regional transit authorities to ensure that state-level goals for transit development are implemented. These types of activities while important will not generate significant gains in GHG reductions relative to the State's goals without a dramatic increase in funding levels.

The following section summarizes public transit investments in Washington. The WSDOT publishes an annual report summarizing the status of public transportation systems in the state. The most current report, updated in December 2012, summarizes the system's 2011 operations.[150] The State of Washington currently has 31 local public transit authorities, including 20 public transportation benefit areas (PTBAs), two unincorporated transportation benefit areas (UTBAs), five city and three county authorities, and one regional district authority.[151] These transit systems had a total service area population of 5,847,118 people in 2011, covering 86 percent of the total state resident population.[152] In 2011, the total operating investment in the state was $1.9 billion, with 93 percent raised from local taxes, five percent from federal investment, and one percent from state support. The total capital investment in public transit in 2011 was $353 million, with 90 percent from federal investment, six percent from local tax revenue, and four percent from state investment.[153] Public transit infrastructure in Washington State was given a "D+" (poor) grade by the Seattle Section of the American Society of Civil Engineers (ASCE) in their 2013 Report Card for Washington's Infrastructure, largely due to lack of maintenance, funding, and public transit options not keeping pace with population

[150] Washington State Department of Transportation. 2011 Summary of Public Transportation. Updated December 2012. Accessed August 2013 at: http://www.wsdot.wa.gov/publications/manuals/fulltext/m0000/TransitSummary/PTSummary.pdf
[151] Washington State Department of Transportation. Updated December 2012. Page 1.
[152] Washington State Department of Transportation. Updated December 2012. Page 8 and page 14.
[153] Washington State Department of Transportation. Updated December 2012. Pages 11-12.

expansion.[154] While Washington has made investments in public transit and the State's grade is higher than the national average for transit (a "D"), this still indicates an area for improvement that would contribute to emission reductions, with the co-benefit of increased options for mobility and potentially quality-of-life for Washington residents.

Generally, the WSDOT and the State of Washington can affect public transit in the following ways:

- WSDOT:
    - Setting state-level goals for transit and communicating and coordinating with transit authorities to ensure implementation of goals (for example, WSDOT's mobility objective of expanding and improving the effectiveness of existing planning and grant programs that support intercity, rural and special needs transportation)[155]
    - Providing grants and technical assistance to transit authorities
    - Providing planning assistance and direction on the types of projects in which investments should be made
    - Providing a centralized view of the transportation system as a whole (including cross-jurisdictional travel between transit authorities, freeway travel, and other modes of travel)

- State of Washington Legislative authority:
    - Approve "local option" sales tax rate that allows transit authorities to raise revenue
    - Review the classification of public transit as it pertains to the 18th amendment to the Washington State Constitution, potentially allowing gas tax revenues to be used for transit purposes

6.3 Literature Review of Washington Potential

Washington has released several reports in the past few years examining the role of the state in public transportation. In January 2011, the Washington State Legislature Joint Transportation Committee released a report on the State Role in Public Transportation, which was

[154] American Society of Civil Engineers (ASCE) Seattle Section. 2013 Report Card for Washington's Infrastructure. Page 65. Accessed July 2013 at: http://www.seattleasce.org/reportcard/2013ReportCardWA.pdf; and ACSE 2013 Report Card for America's Infrastructure State Facts: Washington. Accessed July 2013 at: http://www.infrastructurereportcard.org/a/#p/state-facts/washington

[155] Hammond, P. WSDOT Strategic Plan 2011-2017. Strategic Goal: Mobility (Congestion Relief). September 2010. Objective 3.9. Page 26. Accessed September 2013 at: http://www.wsdot.wa.gov/NR/rdonlyres/533F8188-9F2B-4DAD-BF91-7590086A7904/0/StrategicPlan1117.pdf

commissioned by the Washington State Legislature during the 2010 legislative session.[156] The report provided a general framework for state transportation efforts, and identified the following key areas for the state:

- Integrating transportation systems at the regional level
- Refining policies to encourage the use of public transportation
- Evaluating and refocusing funding sources and outlays in the immediate and long term
- Aligning reporting with federal systems
- Focusing on performance to meet basic mobility needs of constituents.

The key finding of the effort was that public transportation needs to be integrated into transportation planning as a whole.

In 2008, the Washington State Climate Advisory Team quantified expected cumulative GHG savings of development and expansion of "Transit, Ridesharing, and Commuter Choice Programs" to be 23.6 $MMTCO_2e$ for the State of Washington from 2008-2020 (cost was not quantified). This policy, which includes a bundle of synergistic policies beyond just transit, included reducing statewide per capita VMT and working with local governments and regional planning organizations to achieve state targets.[157]

In July 2011, Governor Christine Gregoire convened the 31 member Connecting Washington Task Force to develop a ten-year strategy for maintaining and improving Washington's transportation system. The findings of the effort were summarized in a report released in January 2012, and broadly recommended that the state strategically invest $21 billion in system preservation, strategic improvements, system efficiency and safety; portions of which would go to public transit investments (the amount allocated to public transit would be determined during design and implementation of the strategy).[158] The key theme of the Task Force's work was that the investments in infrastructure should strengthen Washington's economy and create in-state jobs.

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[156] Washington State Legislature Joint Transportation Committee. Identifying the State Role in Public Transportation: Final Report. January 2011. Accessed August 2013 at: http://wstc.wa.gov/Meetings/AgendasMinutes/agendas/2011/January18/documents/011811_BP5_StateRolePublicTransportation.pdf

[157] Washington Climate Advisory Team. Leading the Way: A Comprehensive Approach to Reducing Greenhouse Gases in Washington State. January 25, 2008. Table 4.1. Page 76. Accessed September 2013 at: https://fortress.wa.gov/ecy/publications/publications/0801008b.pdf

[158] Connecting Washington Task Force. Connecting Washington: Strategic Transportation Investments to Strengthen Washington's Economy and Create Jobs. January 6, 2012. Accessed August 2013 at: http://www.wsdot.wa.gov/NR/rdonlyres/0DD6F466-6D52-4495-AAC6-78F2AA5B2332/0/ConnectingWashingtonfinal_report.pdf

Based on the Connecting Washington Task Force report, it is expected to cost $2 billion over the next ten years to restore Washington's public transit system to pre-recession levels.[159] These are estimates of maintenance costs, and do not account for the cost of infrastructure improvements. The task force estimated that over $50 billion dollars would be needed over the next ten years to maintain *and improve* existing infrastructure, which includes roads, bridges, freight mobility enhancements, ferry terminals, transit vehicles and increased transit services.[160] From that $50 billion estimate, the task force recommended a ten year plan that includes $21 billion of investment, to include $2.5 billion for public transportation, $1.3 billion in grants to cities and counties for improving mobility in key economic corridors, and $11 billion for state-funded improvements to mobility in key economic corridors.[161] The task force recommended that most of the funding for these expenditures be raised through tolling, taxes and fees on motor vehicles and through bond proceeds.

The Connecting Washington Task Force included members from various Washington State entities, including state senators and representatives, city council members, associations including Washington AAA, the Washington Transit Association, the Washington State Labor Council, and members representing various commercial interests. Despite the broad representation of interests on the Task Force, there was some response to the report and findings, notably from the Washington Policy Center. In May 2012, the Center released a policy brief which recommended that the state not create a state-level tax to fund local transit agencies, and that money raised through vehicle taxes (fuel, excise and other) only be used for highway maintenance and improvements, rather than for public transit improvements, citing the 18th amendment to the Washington State constitution. The foundation of the argument was that public transit is a local function with its own tax base and revenue generation, and that the state role should be limited to granting tax authority to local jurisdictions. The brief also argued that public transit is sufficiently funded in the state, and that taxes on drivers should go to much-needed infrastructure improvements.[162]

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[159] Connecting Washington Task Force. January 6, 2012. Page 13.
[160] Connecting Washington Task Force. January 6, 2012. Page 13.
[161] Connecting Washington Task Force. January 6, 2012. Allocation of funding was not final, and was included for illustrative purposes. Pulled from Figure 8, Page 21.
[162] Ennis, M. A Roadmap for Mobility: Recommendations on a Responsible Transportation Funding Plan for Washington State. Washington Policy Center, Center for Transportation. May 2012. Accessed August 2013 at: http://www.washingtonpolicy.org/sites/default/files/A-Roadmap-For-Mobility.pdf

7 Low Carbon Fuel Standard

Table 26: Potential Costs and Benefits of an LCFS Policy to Washington Consumers and Businesses

Potential Action for Consideration				
• Implement a Low Carbon Fuel Standard of a 10 percent reduction in the carbon intensity of the fuel mix over a 10 year time period in the State of Washington				
GHGs and Costs in Washington	**GHG Reductions ($MMTCO_2e$)**			**Cost ($\$/mtCO_2e$)[163]**
	2020	**2035**	**2050**	
10 % reduction in carbon intensity over 10 years	1.0	3.9	4.0	\$103 to \$131

Implementation Issues and Lessons Learned

- There may be legal challenges to implementing an LCFS at state as opposed to federal level, as evidenced by the current litigation surrounding California's LCFS.
- Sector exemptions should be carefully considered, such as those included in the California LCFS program. The California LCFS does not cover military activity, the racing industry, the aviation industry, marine fuels, or locomotive fuels.[164] Of important consideration to Washington will be the marine fuel exemption, which will affect the Washington State Ferries.

Potential Costs and Benefits to WA Consumers	**Potential Costs and Benefits to WA Businesses**
• Fuel prices for consumers may fluctuate, based on the cost of alternative fuels and feedstock, development of refining capacity for in-state biofuel production or purchase out-of-state alternative fuels, among other factors • EVs and AFVs are more expensive upfront than traditionally fueled base vehicles. These costs can be largely made up through Federal and state tax credits and over the term of ownership through lower fuel prices.[165]	• Shifts away from petroleum-based fuels (gasoline and diesel) will have negative impacts on businesses involved in oil production, refining and transportation, along with ancillary business supporting those businesses • Significant increases in biofuel production will positively impact the farming and agricultural sectors of the economy, with additional demand for fuel feedstock. In addition, significant increases in biofuel production with positively impact companies involved in biofuel production, refining, and transportation. The impact to WA will depend on the proportion of the feedstock produced in-state. • Shifts toward natural gas or electricity produced in-state will have positive impacts on businesses involved in those industries

Summary of Screening Criteria

***Does the policy target an emissions source of significant magnitude in Washington*?**
Yes. The transportation sector in the state of Washington accounts for 44 percent of total emissions in

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163 5 percent discount rate, NPV 2013
164 California Air Resources Board (CARB). Final Regulation Order. Subchapter 10. Climate Change. Article 4. Regulations to Achieve Greenhouse Gas Emission Reductions. Subartible 7. Low Carbon Fuel Standard. Section 95480.1(d) Exemption for Specific Applications (Page 3). http://www.arb.ca.gov/fuels/lcfs/CleanFinalRegOrder112612.pdf
165 Mello, T. B. Ownership costs of traditional versus alternative fuel vehicles: Department of Energy calculator breaks down pricing. Autoweek. February 4, 2013. Accessed September 2013 at: http://www.autoweek.com/article/20130204/carnews/130209970

Washington (in 2010). These emissions are the result of combustion of transportation fuels, so the implementation of a LCFS to reduce the carbon intensity of the fuel mix would have a corresponding effect on emissions from transportation fuel combustion.

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?

The costs and volume of reductions in other jurisdictions are discussed in further detail under Appendix A. Summary information for the California and Oregon LCFS is as follows:

- California: In advance of program implementation, ARB estimated total costs, including production, storage, transport and dispensing for various alternative fuels to range from $1.4/GGE (cellulosic ethanol) to $7.2/GGE (hydrogen).[166] California ARB estimates GHG reductions in 2020 of 15,800,000 from direct combustion of transportation fuels (in 2020) and 22,900,000 from the full fuel lifecycle (in 2020).[167]
- Oregon: While costs were not estimated for the Oregon LCFS program, the volume of reductions from the program was expected to range from 2,189,000 to 2,285,000 (in 2022).[168] Note: The Oregon Department of Environmental Quality never moved to implement the standards because of the program's sunset date.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

An LCFS policy is discrete and comprehensive, covering a large source of emissions through a single policy mechanism. The policy examined in the Department of Ecology study was a 10 percent reduction in the carbon intensity of fuels from 2013 to 2023, which is a similar design to policies that were examined in other jurisdictions, including California, Oregon, British Columbia and the European Union.

Can the policy be meaningfully implemented or influenced at the State level?

There may be legal challenges to implementing an LCFS at state as opposed to federal level, as evidenced by the current litigation surrounding California's LCFS. Several court cases have challenged the California LCFS regarding the potential impact of the regulation on agricultural and ethanol production practices in other states. Plaintiffs assert that the regulation unfairly impacts out-of-state producers and therefore regulates conduct outside of California in violation of the Interstate Commerce Clause of the U.S. Constitution. On September 18, 2013, the 9th U.S. Circuit Court of Appeals ruled 2-1 that the California LCFS did not violate the Interstate Commerce Clause of the U.S. Constitution.[169] Challenges facing the California LCFS could be indicative of those that may face a proposed LCFS in Washington.

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[166] Baral, A. International Council on Clean Transportation. *Summary Report on Low Carbon Fuel-Related Standards*. (October 2009). Page 11. Accessed July 2013 at: http://www.theicct.org/sites/default/files/publications/ICCT_LCFS_workingpaper_Oct09.pdf (page 11)

[167] California Air Resources Board (CARB). *Proposed Regulation to Implement the Low Carbon Fuel Standard: Volume I: Staff Report: Initial Statement of Reasons*. (March 2009). Page VII-5. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf

[168] Oregon Department of Environmental Quality. *HB 2186: Oregon Low Carbon Fuel Standards and Truck Efficiency*. (March 2013). Page 234. Accessed July 2013 at: http://www.deq.state.or.us/pubs/legislativepubs/2013/HB2186LegRpt2013.pdf

[169] Jacobs, J. Appeals court rejects industry challenge to Calif. low-carbon fuel standard. E&E News PM. September 18, 2013. Accessed September 2013 at: http://www.eenews.net/eenewspm/2013/09/18/stories/1059987472

7.1 Introduction

The transportation sector in the state of Washington accounts for 44 percent of total emissions in Washington (in 2010), the result of combustion of transportation fuels. A low carbon fuel standard (LCFS) requires a reduction in the carbon intensity of the transportation fuel mix, on average, over time, considering the entire lifecycle of the fuels. The lifecycle of petroleum-based fuels includes the GHG emissions associated with crude recovery, crude transportation, fuel production, fuel transportation, and end-use of the fuel in motor vehicles. A parallel analysis would apply to non-petroleum motor fuels. The regulated entities tend to be fuel producers and importers who sell motor gasoline and diesel fuel. Today, the most common method for generating the credits required for compliance is the use of ethanol, followed by, to a lesser extent, natural gas and bio-based gases, biodiesel, and electricity.[170]

At a national level, Congress has adopted a renewable fuels standard (RFS) under the Energy Independence and Security Act (EISA), which requires fuel providers to gradually increase the amount of biofuel in their products through 2022 (both cellulosic and biomass-based, though there are separate targets for each). The goals of an RFS and an LCFS are interrelated, but different, as are their structures. An RFS is explicitly targeted at increasing the supply of renewable fuels, and is generally prescriptive about the fuels that can be used for compliance. An LCFS on the other hand, provides a market mechanism that may be met through the use of renewable fuels, but is not prescriptive about which fuels must be used or to what extent. GHG reductions associated with improved fossil fuel production pathways are as equally legitimate in the context of an LCFS as GHG reductions associated with the use of renewable or alternative fuels. Currently, there is no national LCFS, and studies have returned conflicting results on the potential impacts of implementing such a policy. Further discussion of a federal LCFS policy is discussed in the Task 3 report on Federal policies. Several states have implemented LCFS, including Washington's western neighbors, California, Oregon and British Columbia.

While the costs and volume of reductions in other jurisdictions are discussed in further detail later in this document, it is worth noting that in California total costs, including production, storage, transport and dispensing for various alternative fuels range from $1.4/GGE (cellulosic ethanol) to $7.2/GGE (hydrogen),[171] and California ARB estimates GHG reductions in 2020 of 15,800,000 mtCO_2e from direct combustion of transportation fuels (in 2020) and 22,900,000

[170] UC Davis Institute of Transportation Studies, *Status Review of California's Low Carbon Fuel Standard*, S.Yeh, J. Witcover, J. Kessler, Spring 2013, p. 1

[171] Baral, A. International Council on Clean Transportation. *Summary Report on Low Carbon Fuel-Related Standards*. (October 2009). Page 11. Accessed July 2013 at: http://www.theicct.org/sites/default/files/publications/ICCT_LCFS_workingpaper_Oct09.pdf (page 11)

$mtCO_2e$ from the full fuel lifecycle (in 2020).[172] Although no costs were estimated for the Oregon LCFS program, the volume of reductions from the program is expected to range from 2,189,000 $mtCO_2e$ to 2,285,000 $mtCO_2e$ (in 2022).[173]

There may be legal challenges to implementing an LCFS at state as opposed to federal level, as evidenced by the current litigation surrounding California's LCFS. There has been a series of court challenges to the LCFS centered on the potential impact of the regulation on agricultural and ethanol production practices in other states. In December 2011, the U.S. District Court for the Eastern Division of California found that the regulation violated the Interstate Commerce Clause of the U.S. Constitution because it: 1) discriminates against the use of out-of-state corn-based ethanol; and 2) seeks to control farming and transportation practices outside of its own borders. In April 2012, the U.S. Ninth District Court of Appeals granted a stay of injunction while CARB appeals the injunction. The stay allows the program to be enforced until the appeal is resolved. On September 18, 2013, the 9th U.S. Circuit Court of Appeals ruled 2-1 that the California LCFS did not violate the Interstate Commerce Clause of the U.S. Constitution.[174] On June 6, 2013 California's Fifth Court of Appeals handed down a provisional ruling in a case that argued that the LCFS was implemented without adequate study of general environmental impacts as required by the California Environmental Quality Act (CEQA) and specifically improperly deferred development of mitigation measures for potential increases in NOx emissions that may occur due to the LCFS. The court has allowed CARB to proceed with the existing regulation but has provided formal direction for addressing the concerns raised by the lawsuit. Challenges facing the California LCFS could be indicative of those that may face a proposed LCFS in Washington.

Subsequent to the implementation of the California LCFS, there has been a series of dueling studies on the economic impacts of the regulation. The first, released in June 2012, was prepared by the Boston Consulting Group (BCG) on behalf of the Western States Petroleum Association (WSPA). Using proprietary models, the BCG forecast potentially dire economic consequences from the California LCFS including a loss of 28,000 to 51,000 jobs, a loss of $4.4 billion in tax revenue and between $0.33 and $1.06 in costs per gallon.[175] A review of the BCG report by the UC Davis Policy Institute for Energy, Environment and the Economy identified seven critical

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[172] California Air Resources Board (CARB). *Proposed Regulation to Implement the Low Carbon Fuel Standard: Volume I: Staff Report: Initial Statement of Reasons*. (March 2009). Page VII-5. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf

[173] Oregon Department of Environmental Quality. *HB 2186: Oregon Low Carbon Fuel Standards and Truck Efficiency*. (March 2013). Page 234. Accessed July 2013 at: http://www.deq.state.or.us/pubs/legislativepubs/2013/HB2186LegRpt2013.pdf

[174] Jacobs, J. Appeals court rejects industry challenge to Calif. low-carbon fuel standard. E&E News PM. September 18, 2013. Accessed September 2013 at: http://www.eenews.net/eenewspm/2013/09/18/stories/1059987472

[175] Boston Consulting Group, *Understanding the Impacts of AB 32*, Prepared for the Western State Petroleum Association, June 19, 2012, pp.3-4. http://www.cafuelfacts.com/wp-content/uploads/2012/07/BCG_report.pdf

assumptions and five intermediate conclusions that made significant contributions to the negative outcomes in the BCG study. These include no response in fuels demand to increased price, a limited availability of "bankable" compliance credits and a small number of advanced technology vehicles in the fleet by 2020.[176] In June 2013, ICF International released the first phase of a two-phase study of the California LCFS to be completed for the California Electric Transportation Coalition. The results of macroeconomic modeling will be contained in the yet-to-be-released second phase of the study, but the first phase sought to develop plausible compliance scenarios. Key findings that differ from the BCG assumptions include that there will be significant over-compliance and banking in the early years of the regulation, the LCFS is driving investment in low-carbon fuels, and natural gas consumption in the transportation sector is poised to expand rapidly.[177]

A summary of existing LCFS policies and their relative successes is provided in Appendix A. Section 7.2 is a Literature Review summarizing existing work that has been done to evaluate the potential for, and impacts of, an LCFS in Washington. Section 7.3 presents original analysis conducted for this report, which evaluates the potential emission reductions and some of the associated costs and benefits of an LCFS in Washington in the target years 2020, 2035, and 2050.

7.2 Literature Review of Washington Potential

In May 2009, Washington State Governor Christine Gregoire issued an Executive Order (EO) directing the Washington State Department of Ecology to investigate the potential for a Low Carbon Fuel Standard in Washington in order to … "assess whether the California low-carbon fuel standards; standards developed or proposed in other states, provinces or for the nation; or modified standards or alternative requirements to reduce carbon in transportation fuels would best meet Washington's greenhouse gas emissions reduction targets."[178] The Washington State Department of Ecology worked with the Departments of Commerce and Transportation and used consultant assistance to respond to the EO, assessing several scenarios for development and implementation of an LCFS in Washington.

For the analysis, the consultant, TIAX, constructed model runs around a hypothetical LCFS aimed at achieving a 10 percent reduction in fuel carbon intensity over a 10-year period. The

[176] University of California, Davis, *Expert Evaluation of the Report: Understanding the Impacts of AB 32*, May 2013, pp. 9-10, http://policyinstitute.ucdavis.edu/files/general/pdf/2013-05-09_Expert-Evaluation-of-BCG-Report.pdf
[177] ICF International, *California's Low Carbon Fuel Standard: Compliance Outlook for 2020*, prepared for the California Electric Transportation Coalition, June 2013, pp.2-3., http://www.caletc.com/wp-content/downloads/LCFSReportJune.pdf
[178] Office of the Governor. Executive Order 09-05: Washington's Leadership on Climate Change. May 21, 2009, Section (1)(f). Accessed August 2013 at: http://www.governor.wa.gov/office/execorders/eoarchive/eo_09-05.pdf

study assumed that the LCFS would have a 2013 start year, with 2023 being the target for achieving the desired fuel standard. The baseline carbon intensity, projected to 2013 based on 2007 data, was 92.2 gCO_2e/MJ, meaning that an LCFS of 10 percent reduction in carbon intensity would yield an 83 gCO_2e/MJ carbon intensity in 2026.[179]

The TIAX study consisted of three main components. First, the study analyzed available in-state fuel supplies and found ample feedstock volumes for alternative fuel production in the state of Washington. Next, the study evaluated the carbon intensity of each fuel pathway, estimating a well-to-tank (WTT), a tank-to-wheel (TTW) and a well-to-wheel (WTW) emission reduction for the various scenarios being examined.[180] Emissions from indirect land use change (ILUC) were also examined.

Finally, the consultant constructed six compliance scenarios to capture the range of possibilities and performed economic analyses on the various scenarios. The compliance scenarios, intended to gauge the impacts of various pathways to achieving the desired LCFS treated gasoline and diesel "pools" separately in all but one scenario. The scenarios are summarized below:

- Scenario A: Compliance through cellulosic ethanol and diesel fuels produced in-state
- Scenario B: Compliance through cellulosic ethanol and diesel fuels produced out-of-state
- Scenario C: Compliance through mixed sources of biofuels: conventional, cellulosic, imported and in-state.
- Scenario D: Compliance through high electric vehicle (EV) sales and in-state cellulosic biofuels.
- Scenario E: Compliance through high electric vehicle (EV) sales and mixed sources of biofuels.
- Scenario F: One-Pool: a ""middle-of-the-road" scenario combining a mixture of biofuel and electrical vehicles, and increased use of light duty diesels

Following the completion of the TIAX study, one of the primary authors, Jennifer Pont, prepared an analysis of the impact of updated assumptions on the non-economic conclusions of the TIAX study. The report, released by Life Cycle Associates, LLC (LCA) identified several key assumptions upon which the TIAX study was based, and which Pont/LCA found should be

[179] Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. A Low Carbon Fuel Standard in Washington: Informing the Decision. February 18, 2011. Page 3. Accessed August 2013 at: http://www.ecy.wa.gov/climatechange/docs/fuelstandards_finalreport_02182011.pdf

[180] Well-to-wheel (WTW) emissions are the fuel lifecycle emissions, which can be broken into two parts: well-to-tank (WTT), which refers to fuel production and tank-to-wheel (TTW), which refers to vehicle tailpipe emissions.

updated. While several key assumptions should be updated, Pont/LCA note that the impact on the non-economic conclusions of the original study are likely minimal.[181]

The TIAX study estimated both a tank-to-wheel (TTW) and a well-to-wheel (WTW) emission reduction for the various scenarios being examined. The TTW estimated emission reduction from the policy ranged from 1.5 $MMTCO_2e$ to 3.5 $MMTCO_2e$, while the WTW estimated emission reduction from the policy ranged from 1.5 $MMTCO_2e$ to 4 $MMTCO_2e$. The range in emissions is attributable to the variety of fuels and technologies applied in each scenario.[182] These estimates were generated using the carbon intensity values generated by the consultant for the various fuel pathways. Carbon intensity measures the amount of CO_2e per unit output, in this case, grams of CO_2e per MJ. The results of the carbon intensity evaluation that fed this analysis are summarizes in Table 27, below.

Table 27: Summary of Estimated Carbon Intensity Values for Fuel Pathways Considered [Reproduced from Pont, J. and J. Rosenfeld (TIAX)]

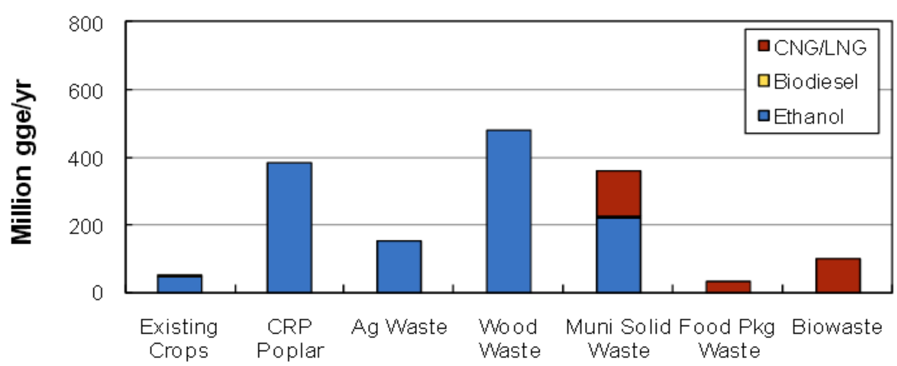
Carbon Intensity (g CO_2e/MJ)	WTT			TTW				ILUC	WTW
	Feedstock & Transport	Production & Transport	WTT Total	Vehicle CO_2	Vehicle CH_4	Vehicle N_2O	TTW Total		
Gasoline Blendstock	7	11	18	73	0.1	1.4	74	0	92
Gasoline (10% Corn Ethanol)	8	13	21	68	0	1.4	69	2	92
Ultra Low S Diesel	7	10	16	75	0.02	0.05	75	0	91
Ethanol, MW Corn Average	21	44	65	0	0.25	0.58	0.83	28	94
Ethanol, NW Prod., MW Corn	22	35	57	0	0	0.6	1	28	86
Ethanol, Farmed Trees	12	-2	10	0	0	1	1	4	15
Ethanol, Wheat Straw	15	2	17	0	0	1	1	0	18
Ethanol, Forest Residue	11	8	19	0	0	1	1	0	20
Ethanol, Mill Waste	4	8	11	0	0	1	1	0	12
Ethanol, Brazil Sugarcane	20	0	20	0	0	1	1	26	46
Biodiesel, MW Soybeans	6	11	17	3.04	0.01	0.65	4	47	68
Biodiesel, NW Canola	15	7	23	3	0	1	4	0	26

[181] Pont, J. Life Cycle Associates, LLC. WA LCFS Analysis: Implication of Updated Assumptions. July 3, 2013. LCA.8047.84.2013.
[182] Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Pages 85-86

Carbon Intensity ($g\ CO_2e/MJ$)	WTT			TTW				ILUC	WTW
	Feedstock & Transport	Production & Transport	WTT Total	Vehicle CO_2	Vehicle CH_4	Vehicle N_2O	TTW Total		
Biodiesel, Yellow Grease Average	3	6	9	3	0	1	4	0	13
Biodiesel, Tallow Average	17	6	23	3	0	1	4	0	27
RD II, NW Prod., MW Soy Oil	6	14	19	0	0	1	1	47	67
Electricity, WA Grid Mix + RPS	1	21	23	0	0	0	0	0	23
CNG, pipeline NG	8	2	10	56	0	2	59	0	69

In addition to calculating the carbon intensity of fuels, TIAX concluded that there were ample feedstock volumes for alternative fuel production in the state of Washington. The feedstocks considered ranged from cultivated feedstocks (starches, cellulose, oils) to utility-based feedstocks (natural gas and renewable electricity) to waste derived feedstocks (agricultural, wood and food packaging waste, MSW and biowaste).[183] In total, the study estimated that alternative fuels produced from these feedstocks have the potential to displace up to 40 percent of Washington's 2007 petroleum consumption.[184] Figure 5, pulled from the TIAX report, summarizes the types and quantities of alternative fuel production potential in the state.

Figure 5: Summary of Types and Quantities of Alternative Fuel Production Potential in Washington [Figure from Pont, J. and J. Rosenfeld (TIAX)]



[183] Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. A Low Carbon Fuel Standard in Washington: Informing the Decision. February 18, 2011. Page 3. Accessed August 2013 at: http://www.ecy.wa.gov/climatechange/docs/fuelstandards_finalreport_02182011.pdf

[184] Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Page 7.

While feedstock volumes are available, TIAX identified processing infrastructure as a potential limiting factor. They note that there is a lack of commercial-scale cellulosic ethanol production capacity in Washington, despite existing State policy and incentives[185] and considerable cellulosic ethanol feedstock available in-state (this impacts Scenarios A, C, D, E and F of the analyses run in the study). There are no commercial-scale cellulosic ethanol production plants planned in the state of Washington, though there are two pilot projects in Oregon: Pacific Ethanol and ZeaChem, that may provide a means for expansion of production into Washington if they prove successful. In contrast to cellulosic ethanol production, the study notes significant conventional biodiesel production capacity in the state, with over 130 million gallons per year of capacity among four firms.[186]

The 2011 economic modeling considered a variety of impact categories, including fuel consumption and expenditures, vehicle expenditures and infrastructure costs, and found that there would be a range of impacts on the Washington State economy as a result of the implementation of the LCFS. Overall, the study found that the economic impacts would be a primarily positive as the result of the LCFS in all scenarios, with the exception of Scenario B (compliance through cellulosic ethanol and diesel fuels produced out-of-state), which was the only scenario to have negative results in employment, personal income, and gross state product. While all impacts were relatively small (less than 0.5 percent), scenarios that saw net growth were positive due to increases in economic activity within the state, as increased in-state investments have direct impacts on expenditures on intermediate goods. Scenario B saw net negative impacts due to the sourcing of cellulosic ethanol from out-of-state, which means that investments were not on in-state sources, and therefore did not have the positive impact on the Washington state economy. The primary findings are as follows:[187]

Employment — Depending on the scenario, employment relative to the BAU case was expected to be impacted by a range of negative 0.01 percent to positive 0.32 percent on average per year. This range represents a change in employment in Washington as a result of the policy between a net loss of 200 jobs to a gain of 12,000 jobs on average per year in the Washington State economy between 2014 and 2023.

Personal Income — Depending on the scenario, total personal income relative to the BAU case was expected to range from a decline of 0.01 percent to an increase of 0.20

[185] Existing state policies and incentives include loans, grants, tax exemptions and deductions. A list of current initiatives is available through EERE AFDC here: http://www.afdc.energy.gov/laws/laws/WA/tech/3252
[186] Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Page 8.
[187] Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Table 8-2. Page 121.

	percent on average per year. This range would mean between a total net loss of $13.8 million dollars to a total net gain of $526.4 million dollars of personal income on average per year for Washington State residents between 2014 and 2023 (US$ 2008).
Gross State Product	Depending on the scenario, effects on gross state product ranged from an expected decrease of 0.01 percent to an increase of 0.29 percent on average per year.[188] This range represents a change in gross state product as a result of the policy between a total net loss of $36.5 million to a total net gain of 741.3 million (US $2000) on average per year.

These findings show that potential for in-state economic growth is highly dependent on the pathway to compliance with the LCFS. Using the scenarios modeled in the TIAX study as an example, there may be net positive impacts on job growth, personal income and gross state product if aggressive in-state production and refining of biofuels are pursued to achieve the desired LCFS (as in Scenarios A, C, D, E and F, to varying extents). Alternatively, if out-of-state biofuels are purchased and imported to achieve the LCFS (as in Scenario B), this would have a net negative impact on jobs, personal income and gross state product.

Further, the implementation of an LCFS policy in Washington State may require significant investments in alternative fuel capacity in the state, including additional refining capacity for ethanol and biodiesel, labor, utilities and feedstock for new refinery operations, infrastructure investments for natural gas and biodiesel distribution, and additional vehicle costs for natural gas-powered heavy duty vehicles.[189] The economic impact numbers of each of the modeled scenarios in the TIAX study are summarized in Table 28.

Table 28: The Washington LCFS Scenarios Average Annual Economic Impact 2014-2023 [Reproduced from Pont, J. and J. Rosenfeld (TIAX)]

Reference Case	Employment (1,000s)	Total Personal Income ($2008, Millions)	Gross State Product ($2000, Millions)
Scenario A	12	526.4	741.3
Scenario B	(0.2)	(13.8)	(36.5)
Scenario C	3.9	177.7	225.3
Scenario D	8.2	341.7	454.2
Scenario E	3.6	147.6	164.4

[188] Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Table E-3. Page ix, Table E-3.
[189] Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Page 119.

Scenario F	6	281.6	389.3
Business-as-Usual, 2009 Level	3,727.4	263,524.4	259,603.0

7.3 Quantification

This section builds on previous analysis, including the consultant work performed in by TIAX for the Department of Ecology in 2011, which estimated the carbon intensity of various fuel pathways. This section analyzes the potential GHG emission reductions that could be generated from implementation of a low carbon fuel standard in Washington. This analysis is much more limited in scope than the work previously conducted for the State, and is intended to provide an analysis consistent with the others produced for this effort, to be used for high-level policy evaluation. Importantly, this analysis projects beyond the initial LCFS compliance period to 2035 and 2050, to provide a picture of the long-term outcomes that could be expected from an LCFS policy. In particular, this analysis considers how an LCFS might result in increased demand of alternative fuels and decreased demand for traditional gasoline and diesel fuel, and associated fuel expenditures.

The LCFS policy examined in this section assumes a start year of 2016, and a 10 percent reduction in the GHG carbon intensity of the fuel mix by the year 2025, consistent with LCFS implemented in other states and modeled by TIAX in 2011 (start date adjusted to reflect evaluation in 2013). This analysis further stipulates, however, that the LCFS policy is maintained at a 10 percent reduction in 2035 and 2050.

7.3.1 Methodology

To quantify the emission reductions from an LCFS in Washington, a compliance pathway was constructed which increases the reduction in GHG intensity from zero to 10 percent over the course of a 10-year period ending in 2025, then increasing more gradually to 20 percent in 2035 and 30 percent in 2050. The compliance schedule to 10 percent was derived from the work completed for the Department of Ecology in 2011, which defined percentage reductions for each year. The schedule was shifted to a 2025 attainment date to reflect a potential start date of 2016. In addition to a compliance schedule for achieving carbon intensity reductions, the analysis also applies the baseline carbon intensity of the Washington fuel mix from the 2011 consultant report. The compliance schedule is shown in Table 29.

Table 29: Compliance schedule modeled in hypothetical LCFS policy calculations. Intermediate years 2026-2034 and 2036 to 2049 not shown.

Year	Percentage Reduction	LCFS Carbon Intensity (gCO_2e/MJ)
2015	Baseline (0.0%)	92.20

2016	0.25%	91.97
2017	0.50%	91.74
2018	1.00%	91.28
2019	1.50%	90.82
2020	2.50%	89.90
2021	3.50%	88.97
2022	5.00%	87.59
2023	6.50%	86.21
2024	8.00%	84.82
2025	10.00%	82.98
2035	10.00%	82.98
2050	10.00%	82.98

GHG emission reductions from the LCFS were calculated based on gasoline and diesel fuel consumption projections in Washington State by the Office of Financial Management (OFM) Transportation Revenue Forecast Council.[190] Projections were provided to 2040, and the 2050 projection used in this analysis was calculated based on the linear trend to 2040. Gasoline and diesel pools were treated separately in the analysis, consistent with prior consultant work. However, in reality, the LCFS would not necessarily require equal reductions from gasoline and diesel, and instead can be constructed to enable trading of credits and reductions across fuels and suppliers, which would likely reduce overall costs.

In addition to GHG reductions resulting from an LCFS, several compliance scenarios were constructed to illustrate a range of shifts in fuel use. These scenarios are intended to demonstrate that an LCFS does not dictate the precise replacement fuels, and that the volumes of fuels and associated costs are highly dependent on the ways in which the market responds, technologies mature, and on consumer preference. As noted, gasoline and diesel pools were modeled separately. Rather than attempt to project specific fuels that will be available and dominant in the future, this analysis defines several biofuel pathways representing various carbon intensities. Although there is significant uncertainty regarding the specific fuel pathways that will be available in the future, these carbon intensities were selected in order to reflect an expected decrease in carbon intensity of biofuels through time due to technological and market advances. The percentages presented in the tables below represent the percent of the non-gasoline or non-diesel fuel mix that will be met by each fuel.[191] Table 30 summarizes the two gasoline scenarios, one of which assumes that electricity will fill only 25 percent of the gasoline replacement market by 2050, and the other assuming that electricity reaches 50 percent.

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[190] OFM Transportation Revenue Forecast Council, Washington State Motor Vehicle Fuel Tax Extended Forecast, June 2013

[191] This methodology and the assumptions were developed with assistance from Washington Department of Ecology and Washington Department of Commerce.

Table 30: Compliance scenarios modeled for the gasoline pool. Percentages represent the portion of decreased gasoline consumption that is met by each fuel

Fuel	Lifecycle Carbon Intensity (gCO_2e/MJ)	Percent of Gasoline Replacement (Low Electric Vehicle Scenario)			Percent of Gasoline Replacement (High Electric Vehicle Scenario)		
		2020	2035	2050	2020	2035	2050
Ultra Low Carbon Ethanol	15	5%	10%	15%	5%	15%	15%
Low Carbon Ethanol	20	0%	5%	10%	0%	10%	15%
Moderate Carbon Ethanol	46	15%	15%	15%	15%	10%	5%
High Carbon Ethanol	86	5%	5%	5%	5%	5%	5%
Ultra High Carbon Ethanol	94	70%	50%	30%	70%	35%	10%
Electricity	23*	5%	15%	25%	5%	25%	50%

*Reflects an EER of 3.0

Table 31 summarizes the two diesel scenarios modeled, one of which assumes that compressed natural gas (CNG) will fill only 15 percent of the diesel replacement market, and the other assuming that CNG reaches 50 percent. These scenarios were used to calculate the potential changes in volumes and fuel costs resulting from an LCFS.

Table 31: Compliance scenarios modeled for the diesel pool. Percentages represent the portion of decreased diesel consumption that is met by each fuel

Fuel	Lifecycle Carbon Intensity (gCO_2e/MJ)	Percent of Diesel Replacement (Low CNG Vehicle Scenario)			Percent of Diesel Replacement (High CNG Vehicle Scenario)		
		2020	2035	2050	2020	2035	2050
Ultra Low Carbon Biodiesel	4	5%	10%	15%	5%	10%	10%
Low Carbon Biodiesel	13	25%	30%	30%	25%	25%	25%
Moderate Carbon Biodiesel	26	25%	25%	25%	25%	20%	15%
High Carbon Biodiesel	68	40%	25%	15%	40%	20%	0%
Pipeline CNG	77*	5%	10%	15%	5%	25%	50%

*Reflects an EER of 0.9

The gasoline and diesel replacement percentages in Table 30 and Table 31 above were used to calculate a weighted carbon intensity of the replacement fuel mix. Based on this weighted carbon intensity, the amount of gasoline and diesel that would need to be replaced to meet the LCFS carbon intensity was calculated. Because of different energy densities and energy economy ratios (EER), the quantity of replacement fuel is not simply equal to the reduction in gasoline and diesel. Therefore, the appropriate EER and energy densities were applied to calculate how many units of each alternative fuel would be required based on the percentage of diesel or gasoline energy replaced by each source.

To demonstrate how an LCFS would result in a shift of fuel expenditures, base price forecasts were used to estimate the change in cost associated with each fuel type in the target years. In analyzing the costs and benefits of its LCFS policy, California ARB assumed that future fossil fuel costs would be unchanged. However, a study by Boston Consulting Group estimated that implementation of California LCFS would result in increased costs to industry requiring cost recovery of $0.33 to $1.06 per gallon. [192] A subsequent analysis by the UC Davis Policy Institute, however, concluded that the BCG report was too narrow in scope (looked solely at the refining sector), and included a variety of problematic assumptions.[193] Additionally, BCG's cost estimates reflect a compliance pathway where fossil fuel providers are forced to purchase LCFS credits from producers of low carbon fuels. As such, these costs represent a wealth transfer within the economy, and not a net cost to the State. Based on this characterization of industry costs as a transfer, and the fact that any increase in fossil fuel cost would correspond to a decrease in costs to alternative fuel providers, the price of fuel is assumed not to change as the result of LCFS.

However, total expenditures on fuel will change as a result of changes in consumption patterns. These changes are calculated in order to demonstrate shifts in spending among fuels – some of which may be generated in-state – but are not intended to represent overall economic impact. For example, although total fuel costs may increase, some of that spending may be more likely to stay in state if biofuel refining capacity is increased, partially or entirely offsetting the change. Alternatively, increased spending on electricity or CNG relative to gasoline will have differential impacts on those sectors of the economy.

The incremental cost of new vehicles was calculated using incremental cost data for the gasoline pool from the Department of Energy's VISION model produced by Argonne National Laboratory. Volumes of biodiesel and ethanol in all projected scenarios were low enough that it was assumed these fuels could be accommodated without any significant change to fleet dynamics. However, for electricity in the gasoline pool and CNG in the diesel pool, additional vehicles will be required to utilize these fuels. Data for vehicle miles traveled (VMT) for each vehicle type as well as fuel economy of each vehicle type were extracted from VISION in order to calculate the number of additional medium-duty CNG and electric vehicles required. The costs

[192] Boston Consulting Group. 2012. Understanding the impact of AB 32. Accessed September 2013 at: http://cafuelfacts.com/wp-content/uploads/2012/07/BCG_report.pdf

[193] UC Davis Policy Institute for Energy, Environment and the Economy. 2013. Expert Evaluation of the Report: "Understanding the Impacts of AB32". Accessed September 2013 at: http://policyinstitute.ucdavis.edu/files/general/pdf/2013-05-09_Expert-Evaluation-of-BCG-Report.pdf May 2013

associated with these additional vehicles were calculated as the incremental cost relative to the baseline technology. For electric vehicles, this value was extracted for the appropriate year for VISION. Because comparable cost data are not available for medium-duty CNG vehicles, this analysis relies on the incremental cost for medium-duty CNG vehicles estimated in the 2011 TIAX consultant report.

Lastly, the potential distributional impact of LCFS on the oil industry and alternative fuels industry is estimated based on previous work by BCG. The per gallon increase in cost to the oil industry calculated by BCG is multiplied by the total volume of gasoline and diesel consumed in Washington in the analyzed scenarios.

7.3.2 Assumptions, Exclusions, and Data Sources

The following assumptions about the structure of the LCFS policy, the path toward attainment, associated data parameters, and exclusions are included in this analysis:

- The LCFS begins in 2016
- The baseline carbon intensity of the fuel mix is 92.2 gCO_2e/MJ for all fuels combined.
- The carbon intensity compliance requirements are applied separately to gasoline and diesel fuel pools
- The target carbon intensity of a 10 percent reduction is met in 2025, 2035, and 2050. The carbon intensity in 2020 represents a 2.5 percent reduction, on the path to the 2025 goal.
- Energy (MJ) consumed by the transportation sector is unaffected by the LCFS; however quantities of fuels are affected
- Fuel prices are not affected by the LCFS. Although there may be some shifts in prices due to trading in LCFS credits, these represent transfers within the economy. Additional costs to fossil fuel consumers would correspond to decreased costs to alternative fuel consumers.
- Biodiesel is 19 percent more expensive in the forecast years than diesel, consistent with Washington State Department of Transportation[194]
- There is a general trend towards lower carbon biofuels, and away from higher carbon biofuels due to anticipated technology improvement and market maturity.
- The business-as-usual fleet is able to accommodate the volumes of ethanol and biodiesel projected. However, additional medium-duty CNG trucks and electric vehicles are required to utilize the increased volumes of CNG and electricity resulting from the LCFS.
- Costs quantified include changes in fuel costs and technology costs. Additionally, decreases in fuel tax collections are quantified as an economic transfer.

[194] Washington State Department of Transportation. 2013. Annual Fuel Price Forecast

This analysis relies on the data sources summarized in Table 32.

Table 32: Primary data sources used to quantify GHG impacts of a Washington State LCFS

Data	Source
Gasoline and diesel consumption forecasts	OFM Transportation Revenue Forecast Council, Washington State Motor Vehicle Fuel Tax Extended Forecast, June 2013
Price of diesel and price differential to biodiesel	Washington State Department of Transportation. 2013. Annual Fuel Price Forecast
Price of gasoline, ethanol, natural gas, and electricity	EIA, Annual Energy Outlook 2013. Table 3.9. Energy Prices by Sector and Source – Pacific.
Carbon intensities, EERs, and energy densities of the fuels	Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. A Low Carbon Fuel Standard in Washington: Informing the Decision. February 18, 2011
Fuels and fuel ratios replacing gasoline and diesel	Personal communication: Washington Department of Ecology, Washington Department of Commerce
Incremental Cost of alternative fuel vehicles	DOE, VISION model; Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. A Low Carbon Fuel Standard in Washington: Informing the Decision. February 18, 2011

7.3.3 Results

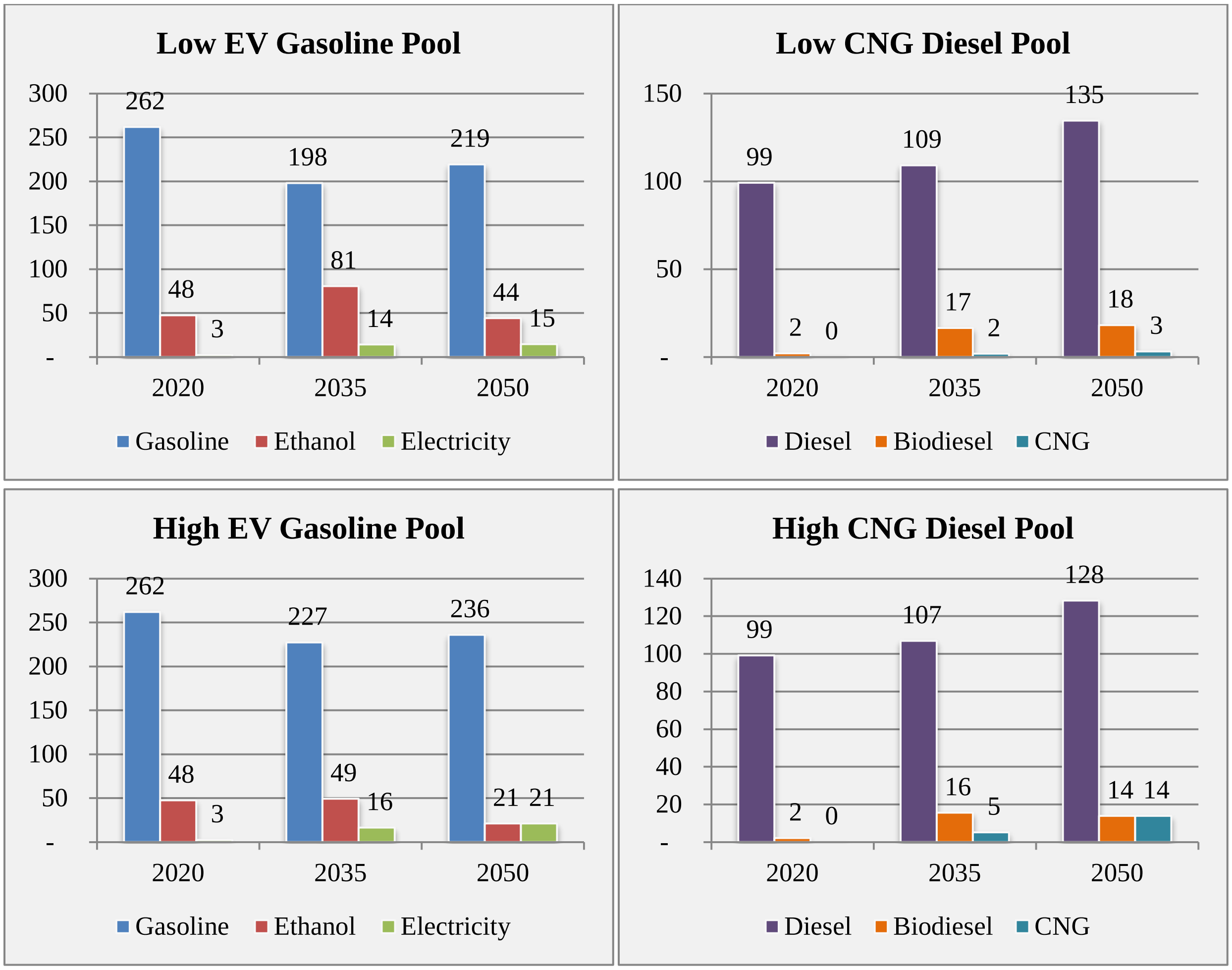
Based on an LCFS that achieves a decreased carbon intensity of 10 percent by 2025, and maintains that level through 2050, estimated GHG emission reductions are 1.0 $MMTCO_2e$, 3.9 $MMTCO_2e$, and 4.0 $MMTCO_2e$ annually in 2020, 2035, and 2050, respectively. Table 33 summarizes the baseline emissions forecast for gasoline and diesel pools, as well as the emissions forecast for these pools under the assumed LCFS. Emissions in the LCFS scenario include emissions from alternative fuels in addition to the base fossil fuels.

Table 33: GHG reductions from a Washington State LCFS

	2020 ($MMTCO_2e$)	2035 ($MMTCO_2e$)	2050 ($MMTCO_2e$)
LCFS Target	**2.5 percent**	**10 percent**	**10 percent**
Baseline Emissions	**38.1**	**38.8**	**40.1**
Gasoline Pool	28.8	27.0	25.7
Diesel Pool	9.4	11.8	14.4
Emissions Under LCFS	**37.2**	**34.9**	**36.1**
Gasoline Pool	28.1	24.3	23.1
Diesel Pool	9.1	10.6	13.0
Emission Reductions	**1.0**	**3.9**	**4.0**
Gasoline Pool	0.7	2.7	2.6
Diesel Pool	0.2	1.2	1.4

In addition to the GHG reductions, calculations were performed to examine different scenarios by which the LCFS might be met. These scenarios, constructed with input from State officials, model different levels of penetration for CNG vehicles into the diesel market, and EVs into the gasoline market. The remainder of the carbon reductions are met through the mixes of ethanol and biodiesel described in Table 30 and Table 31, above. Figure 6 illustrates how the different fuels in the gasoline and diesel pools enter the Washington market. Each figure shows the MJ of diesel or gasoline that is replaced with alternative fuels in order to meet the LCFS. Ultimately, more or less MJ of the alternative fuel may be required to meet the decreased gasoline or diesel fuel due to the EERs. For example, with an EER of 3.0, only one MJ of delivered electricity is required to meet the demand previously satisfied by 3 MJ of gasoline. What is noteworthy about Figure 6 is that the impact on traditional fuels of meeting the LCFS is highly dependent on the alternative fuels available. In the low CNG vehicle scenario, diesel consumption decreases by 21 billion MJ (160 million gallons) in 2050. However, because CNG has a higher carbon intensity than the modeled biodiesel fuels, a scenario in which CNG plays a larger role requires greater reductions in diesel fuel. In the high CNG vehicle scenario, a reduction of 28 billion MJ (206 million gallons) of diesel is required to meet the 10 percent LCFS in 2050.

Figure 6: Fuel use under an LCFS in gasoline (left) and diesel (right) scenarios. (Billion MJ)[195]



Based on these scenarios, estimated changes in energy expenditures by source are shown in Table 34, along with the incremental vehicle spending for CNG and electric vehicles to accommodate these fuels. All biodiesel pathways have been aggregated, as have all ethanol pathways for simplicity of presentation. All scenarios result in a net increase in total costs, primarily due to the higher projected price of ethanol and biodiesel on an energy basis relative to gasoline and diesel.[196] Current prices for these biofuels are at parity or lower than their fossil fuel counterparts on a volumetric basis, but due to their lower energy content they track closely with, or cost somewhat more than gasoline and diesel, which is reflected in price forecasts used for

[195] All MJ values are presented as the MJ required for gasoline or diesel (depending on pool). Actual MJ delivered to meet the LCFS may vary. For example, with an EER of 3.0, electricity will only actually supply one third of the MJ presented for the gasoline scenarios.
[196] Through 2035, ethanol is projected to be less expensive than gasoline per gallon. However, due to its lower energy content and the requirement to meet the energy demand of the replaced gasoline, ethanol is more expensive on an energy basis.

this analysis. As a result, the cost-effectiveness of the LCFS from potential inception in 2016 through 2035 is $103 to $131 per mt$CO_2$e reduced.

Table 34: Changes in fuel consumption and expenditures for scenarios in the gasoline pool. Positive values represent increased costs, and negative values represent cost savings

(million $US)	2020	2035	NPV 2016-2035[a]
Low CNG Scenario	**$16**	**$135**	**$505.1**
Diesel (million $US)	$(61)	$(624)	$(2,230)
Biodiesel (million $US)	$73	$712	$2,577
CNG (million $US)	$2	$38	$120
Vehicles (million $US)	$2	$9	$38
High CNG Scenario	**$16**	**$99**	**$402.8**
Diesel (million $US)	$(61)	$(701)	$(2,448)
Biodiesel (million $US)	$73	$667	$2,452
CNG (million $US)	$2	106	$310
Vehicles (million $US)	$2	$9	$88
Low EV Scenario	**$406**	**$566**	**$4,821**
Gasoline (million $US)	$(1,423)	$(3,194)	$(20,281)
Ethanol (million $US)	$1,777	$3,567	$24,144
Electricity (million $US)	$28	$159	$671
Vehicles (million $US)	$24	$33	$41
High EV Scenario	**$406**	**191**	**$3,771.0**
Gasoline (million $US)	$(1,423)	$(2,213)	$(17,532)
Ethanol (million $US)	$1,777	$2,181	$20,260
Electricity (million $US)	$28	$184	$740
Vehicles (million $US)	$24	$39	$287
GHG Reductions (MMTCO_2e)	**1.0**	**3.9**	**40.5**
Cost effectiveness ($/mt$CO_2$e)			**$103 to $131**

[a] 5 percent discount rate, NPV 2013

However, if biofuel prices continue to track with fossil fuel prices on an energy basis, overall costs may be cost negative. Table 35 illustrates a scenario in which biodiesel achieves and maintains price parity with diesel on an energy basis, and in which ethanol maintains price parity with gasoline on an energy basis. These scenarios all show cost savings, indicating the sensitivity of the cost impact of an LCFS on the future prices of biofuels. Were biofuels able to achieve and maintain price parity with fossil fuels on an energy basis, the cost effectiveness of the LCFS is estimated to be between -$29 and -$24 per mtCO_2e.

Table 35: Changes in fuel and vehicle expenditures associated with potential Washington LCFS. Positive values represent increased costs, and negative values represent cost savings

(million $US)	2020	2035	NPV 2016-2035[a]
Low CNG Scenario	**$0**	**$(15)**	**$(41)**
Diesel (million $US)	$(61)	$(624)	$(2,230)
Biodiesel (million $US)	$58	$561	$2,032
CNG (million $US)	$2	$38	$120
Vehicles (million $US)	$2	$9	$38
High CNG Scenario	**$0**	**$(42)**	**$(116)**
Diesel (million $US)	$(61)	$(701)	$(2,448)
Biodiesel (million $US)	$58	$526	$1,993
CNG (million $US)	$2	106	$310
Vehicles (million $US)	$2	$9	$88
Low EV Scenario	**$(19)**	**$(286)**	**$(951)**
Gasoline (million $US)	$(1,423)	$(3,194)	$(20,281)
Ethanol (million $US)	$1,352	$2,715	$18,372
Electricity (million $US)	$28	$159	$671
Vehicles (million $US)	$24	$33	$41
High EV Scenario	**$(19)**	**$(330)**	**$(1,072)**
Gasoline (million $US)	$(1,423)	$(2,213)	$(17,532)
Ethanol (million $US)	$1,352	$1,659	$15,416
Electricity (million $US)	$28	$184	$740
Vehicles (million $US)	$24	$39	$287
GHG Reductions (MMTCO$_2$e)	**1.0**	**3.9**	**40.5**
Cost effectiveness ($/mtCO$_2$e)			**$(29) to $(24)**

[a] 5 percent discount rate, NPV 2013

It is also worth noting the types of fuels being purchased. In particular, the decreases all come in the form of gasoline or diesel fuels. Increased expenditures go towards ethanol and electricity in the gasoline pool, both of which can potentially be generated within Washington. For the diesel pool, it is possible based on prior TIAX assessments that a significant portion of the biodiesel requirement could be met from in-state resources; however, natural gas would still be imported. Finally, the scenarios illustrate that by increasing the demand for low carbon biofuels, an LCFS would create an opportunity for in-state feedstocks and growth of the in-state biofuel processing sector. By 2050, modeling indicates that there will be a potential demand for 792 million to 1.65 billion gallons of ethanol, and 363 to 477 million gallons of biodiesel as a result of the LCFS. However, demand and availability of feedstocks are not a guarantee that in-state production will expand to keep pace with LCFS requirements.

Finally, compliance with the LCFS will place a varied burden on different industries. One potential scenario for compliance outlined by the Boston Consulting Group (BCG) is that fossil fuel suppliers will comply by purchasing LCFS credits from alternative fuel suppliers. BCG places this cost at \$0.33 to \$1.06 per gallon.[197] Although the assumptions underlying the BCG analysis have been questioned,[198] Table 36 provides an estimate of the potential distributional impact that could occur as a result of LCFS if the oil industry were to comply through the purchase of LCFS credits valued at up to \$70 per metric ton CO_2e. These high-end estimates based on a per gallon compliance cost of \$1.06 reflect a potential transfer from the oil industry to alternative fuel suppliers.

Table 36. Potential cost of LCFS to oil industry, and benefit to alternative fuel suppliers, if oil industry compliance is met through purchase of LCFS credits at \$70 per ton CO_2e. (million \$USD)

Scenario	2020	2035	2050
Average of All Scenarios	\$462	\$867	\$643

7.4 Implementation History

This section summarizes low carbon fuel standards implemented in other jurisdictions. The following programs are included:

The California Air Resources Board Low Carbon Fuel Standard Program: Established under California Assembly Bill (AB) 32 and Governor Schwarzenegger's 2007 Executive Order S-01-07, the California LCFS is a performance-based measure that aims to cut the carbon intensity of transportation fuels by at least 10 percent by 2020.[199] Under the standard, which ARB began implementing in 2010, carbon intensity is measured in grams of CO_2 equivalent per mega-Joule (gCO_2e/MJ), and fuel providers must demonstrate that their fuel mix meets the LCFS standards for each annual compliance period through a system of "credits" and "deficits" whereby the carbon intensity of a particular fuel in the portfolio is either lower than or higher than the standard for gasoline or diesel, respectively.[200] These intermediate targets are set from a baseline carbon intensity for the fuel mix supplied to the state, with a declining average carbon intensity over time. The performance-based nature in the California LCFS allows for flexibility, as regulated entities can incorporate new or improved technologies into existing production pathways, or develop new production pathways to reduce the carbon intensity of their fuel mix. In addition, credits may be banked and traded on the LCFS market to realize compliance. The

[197]

[198]

[199] California Assembly Bill 32, Chapter 488. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/ab32.pdf, and California Office of the Governor, Executive Order EO S-01-07. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/eos0107.pdf

[200] California Air Resources Board. *Low Carbon Fuel Standard 2011 Program Review Report*. (December 8, 2011). Page 23. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/workgroups/advisorypanel/20111208_LCFS%20program%20review%20report_final.pdf

California LCFS accounts for emissions associated with both direct and indirect land use change in its development of lifecycle carbon intensities.

There have been several court challenges to the California LCFS surrounding the Constitutionality of the regulation, specifically as it pertains to the Commerce Clause. In the latest action as of the drafting of this document, the 9th U.S. Circuit Court of Appeals had ruled 2-1 that the California LCFS did not violate the Interstate Commerce Clause of the U.S. Constitution on September 18, 2013.[201]

Oregon Low Carbon Fuel Standard Program: The Oregon LCFS was authorized in 2009 under House Bill 2186, and includes a mandate to cut carbon intensity in cars and trucks by 10 percent per gallon by 2025. During the program design process, safeguards such as exemptions, deferrals, and periodic program reviews to protect producers, consumers and regulated parties from unintended negative consequences, such as increased prices were included as important topics to address.[202]

HB 1286 contains a sunset provision that would effectively end the LCFS in 2015 unless the legislature votes to override the provision. As of a state Senate vote on July 8, 2013, the LCFS will be allowed to expire in 2015, but the topic may be heard for reconsideration at a short session of the Senate in February 2014.[203] The Oregon Department of Environmental Quality never moved to implement the standards because of the sunset date.

British Columbia Renewable and Low Carbon Fuel Requirements Regulation: British Columbia's LCFS, which was established under the province's Greenhouse Gas Reduction Act (SBC 2008, Chapter 16), applies to all fuels used for transportation in British Columbia, and includes a target of a 10 percent reduction in carbon intensity in those fuels by 2020.[204] Transportation fuel suppliers calculate a weighted average carbon intensity for their fuel mix, and there is currently no credit/deficit trading system for trading allowances, though the regulation allows for 'notional transfers' of emissions among suppliers.[205] British Columbia's

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[201] Jacobs, J. Appeals court rejects industry challenge to Calif. low-carbon fuel standard. E&E News PM. September 18, 2013. Accessed September 2013 at: http://www.eenews.net/eenewspm/2013/09/18/stories/1059987472

[202] Oregon Department of Environmental Quality. Oregon Low Carbon Fuel Standards Advisory Committee Process and Program Design. (January 25, 2011). Pages 101-104. Accessed July 2013 at: http://www.deq.state.or.us/aq/committees/docs/lcfs/reportFinal.pdf

[203] Zheng, Y. The Oregonian. *Oregon Senate rejects 'clean fuels' bill, a top priority for environmental lobby*. (July 6, 2013). Accessed July 2013 at: http://www.oregonlive.com/politics/index.ssf/2013/07/oregon_senate_rejects_clean_fu.html#incart_river; and Greenwire. E&E Publishing. *State Senate rejects clean fuels bill*. (July 8, 2013). Accessed July 2013 at: http://www.eenews.net/greenwire/2013/07/08/stories/1059983987

[204] British Columbia Ministry of Energy and Mines. *Renewable & Low Carbon Fuel Requirements Regulation*. Accessed July 2013 at: http://www.empr.gov.bc.ca/RET/RLCFRR/Pages/default.aspx

[205] Natural Resources Defense Council. *A Comparison of California and British Columbia's Low Carbon Fuel Standards*. (March 2010). Page 4. Accessed July 2013 at: http://climateactionnetwork.ca/archive/webyep-

LCFS includes only emissions from direct land use change in its development of lifecycle carbon intensities.

Because of regulatory structure, there is a concern that the policy may reduce the use of crudes (such as Canadian oil sands) within the LCFS jurisdiction, but these crudes may still be used elsewhere to produce fuel (with added emissions from additional transportation).[206]

European Union Fuel Quality Directive: The European Union's Fuel Quality Directive was established in 2009 under Directive 2009/30/EC, and requires the GHG intensity of transportation fuels, specifically petroleum, diesel and biodiesel, to be reduced by up to 10 percent by 2020. The policy includes a binding 6 percent reduction in the GHG intensity of these fuels by 2020 for fuel suppliers, with intermediate targets of 2 percent by 2014 and 4 percent by 2017; the remaining 4 percent of the 10 percent target is non-binding, and contingent upon the development of new technologies such as carbon capture and storage (additional 2 percent reduction on the 10 percent target), and the purchase of credits through the Clean Development Mechanism (CDM) (additional 2 percent reduction on the 10 percent target).[207] The EU is currently reviewing the potential to include indirect land use change from biofuels in its Directive.

system/program/download.php?FILENAME=53-31-at-PDF_File_Upload_1.pdf&ORG_FILENAME=BC_and_CA_fuel_standard_comparison_FINAL.pdf

[206] Natural Resources Defense Council. March 2010.

[207] European Commission. *Fuel Quality*. Accessed July 2013 at: http://ec.europa.eu/clima/policies/transport/fuel/index_en.htm

8 Zero Emissions Vehicle Goal

Table 37: Potential Costs and Benefits of a Zero Emissions Vehicle Goal to Washington Consumers and Businesses

Potential Action for Consideration				
• Consider implementing a ZEV mandate in conjunction with adopting the California Low Emissions Vehicle III Standard (LEV III) to realize benefits from a coordinated package of transportation policies.				
GHGs and Costs in Washington	**GHG Reductions ($MMTCO_2e$)**			**Cost ($/mt$CO_2$e)[208]**
	2020	**2035**	**2050**	
22 percent ZEV credit requirement by 2025	0.1	2.0	2.6	$70
Implementation Issues and Lessons Learned				
• Potential interactions with a low carbon fuel standard. • Other states have implemented ZEV mandates and may get first offerings of ZEVs from manufacturers, including ZEV models not distributed to non-ZEV states; conversely, a ZEV mandate may not increase total U.S. ZEVs, but rather shift sales to Washington. • Increases in ZEV model options may increase consumer purchasing. • Customer incentives may help meet goals. Since the current sales tax exemption applies only to vehicles fueled solely by electricity, the proposed incentives may shift purchasing to a higher proportion of TZEVs. • Unknown costs to vehicle manufacturers and dealerships. • Need for additional infrastructure to support ZEVs.				
Potential Costs and Benefits to WA Consumers	**Potential Costs and Benefits to WA Businesses**			
• Public health benefits from reduced emissions. • Increase in vehicle prices as a result of incremental vehicle technology prices. California has estimated that the average new vehicle purchase costs will increase by about $1,900.[209] • Increased purchase costs are expected to be offset by reduced operating costs, ultimately resulting in a net savings of up to $4,000 over the lifetime of the vehicles.[210] • Replacing single occupancy gasoline vehicles with single occupancy ZEV/TZEVs will reduce emissions overall, but does nothing to address congestion, which by itself can increase emissions and create tremendous costs to both consumers and businesses.	• Opportunities for engineering and manufacturing jobs within the State of Washington.[211] • Shifts away from petroleum-based fuels (gasoline and diesel) will have negative impacts on businesses involved in oil production, refining and transportation. • Shifts toward electricity produced in-state will have positive impacts on businesses involved in those industries as there will likely be increases in electricity demand from electric vehicle charging. • Replacing single occupancy gasoline vehicles with single occupancy ZEV/TZEVs will reduce emissions overall, but does nothing to address congestion, which by itself can increase emissions and create tremendous costs to both			

[208] 5 percent discount rate, NPV 2013
[209] (p.147 of the CARB study: http://www.arb.ca.gov/regact/2012/leviiighg2012/levisor.pdf).
[210] (CARB Study page 209).
[211] (governor's plan page 5: http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf)

	consumers and businesses.

Screening Criteria

Does the policy target an emissions source of significant magnitude in Washington?
A ZEV mandate targets emissions from the transportation sector. In 2010, the transportation sector in the state of Washington accounted for 44 percent of total GHG emissions.[212]

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?
ZEVs provide an opportunity to reduce transportation emissions without decreasing vehicle usage. Twelve other states have also adopted California's ZEV mandates, but California provides a particularly good example of developing a market and increasing market penetration of ZEVs through the ZEV mandate.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?
The ZEV mandate is a discrete and comprehensive policy. California, however, has included the ZEV mandate in a bundle of policies under the Advanced Clean Cars Program, a coordinated policy package that combines standards for smog, GHG emissions, and ZEV adoption.[213]

Can the policy be meaningfully implemented or influenced at the State level?
Yes, California is currently implementing a ZEV mandate at the state level as a part of the Advanced Clean Cars Program.

8.1 Introduction

In 2010, the transportation sector in the state of Washington accounted for 44 percent of total GHG emissions, the result of combustion of carbon intensive transportation fuels. Zero emissions vehicles (ZEVs) provide an opportunity to reduce transportation emissions without decreasing vehicle usage. The primary ZEVs available today are electric vehicles and plug-in hybrid electric vehicles, both of which utilize electricity in place of gasoline. Despite their name, ZEVs however do cause emissions of GHGs and other pollutants. Whereas traditional vehicles emit GHGs and pollutants out of the tailpipe, the emissions associated with ZEVs are upstream at, for example, electricity generating facilities. Due to scale and regulation, these facilities more effectively manage emissions on a net energy basis. Additionally, less energy is required to operate an electric motor than a gasoline engine. Even when accounting for upstream emissions from electricity generation, the use of ZEVs results in GHG reductions and reductions in smog forming criteria pollutants.

[212] Department of Ecology. 2012. Washington State Greenhouse Gas Emissions Inventory 1990-2010. Accessed July 2013 online at: https://fortress.wa.gov/ecy/publications/SummaryPages/1202034.html
[213] California Air Resources Board. 2011. Advanced Clean Cars Summary (page 1). Accessed August 2013 online at: http://www.arb.ca.gov/msprog/clean_cars/acc%20summary-final.pdf

This benefit can be compounded, however, due to Washington's clean energy mix and low GHG emissions in the electricity sector. Because of the relatively clean electricity fuel mix in Washington State due to the large presence of hydropower, transferring transportation energy generation from the vehicle to the power plant has the added benefit of moving the transportation sector away from fossil fuels.

A ZEV mandate is a policy mechanism designed to incentivize ZEVs in the marketplace. Originally adopted in 1990 by California, the ZEV regulation requires automakers to produce and sell a certain number or percentage of passenger and light duty truck ZEVs each year the regulation is in effect. The purpose of this regulation is to encourage the development and commercialization of ZEVs, improve air quality, and reduce GHG emissions. California currently has two ZEV policies in place, one which provides rules up through model year 2017, and a second that covers model years 2018 to 2025. Both of the California rules acknowledge the current challenges in getting true ZEVs onto the road, and provide a mechanism by which automakers can receive partial credits for various advanced vehicles (e.g., partial ZEVs and transitional ZEVs) including ultra clean gasoline, natural gas, hybrids and plug-in hybrids. It is important to note that there is a difference in vehicles that qualify for these credits, namely partial ZEVs (PZEV) and transitional ZEVs. A PZEV is 90% cleaner than the average new model year car, has a 15-year / 150,000 mile warranty, has zero evaporative emissions, and can use non-ZEV fuels (e.g., hybrid electric or gas vehicles).[214] A TZEV has the same first three qualities as a PZEV, but a TZEV has to use a ZEV fuel such as electricity or hydrogen (e.g., plug-in hybrid electric vehicle or a hydrogen fuel cell vehicle).[215] This credit arrangement allows automakers to fulfill their obligation with a combination of true ZEVs and other low emitting vehicles. However, this arrangement also means that automakers do not necessarily put the prescribed number of ZEVs on the road, but rather generate a quantity of ZEV credits equal to their obligation.

Section 8.2 provides an overview of work completed to date that analyzes the potential for a ZEV policy in Washington. Section 8.3 provides original estimates of the potential GHG reductions that could be generated through implementation of a ZEV program in Washington based on the most current California standard. Additional background on the California program, its structure, and implementation history is provided in Section 8.4.

[214] Drive Clean California. California Vehicle Emissions Ratings: PZEV Definition. Accessed August 2013 online at: http://www.arb.ca.gov/msprog/zevprog/factsheets/driveclean.pdf
[215] California Air Resources Board. November 2010. ZEV Regulation 2010: Staff Proposal. Accessed September 2013 online at: http://www.arb.ca.gov/msprog/levprog/leviii/meetings/111610/zev_workshop_presentation_final.pdf

8.2 Literature Review of Washington Potential

In 2008, Washington State's Climate Action Team (CAT) Transportation Implementation Working Group conducted a brief analysis of how implementation of California's 2009-2017 ZEV regulation might impact Washington. The analysis separately projected results for the years 2012-2014, and 2015-2017. The following table provides the results from the 2008 CAT analysis.

Table 38: Number of ZEVs as a result of implementing the 2009-2017 California ZEV standards in Washington.[216]

Vehicle Types	2012-2014 ZEV Requirement	2012-2014 Number of Vehicles	2015-2017 ZEV Requirement	2015-2017 Number of Vehicles
Ultra Clean Gasoline	6%	16,800	6%	16,800
Hybrids and Natural Gas	3%	8,400	2%	5,600
Plug-in Hybrids and Neighborhood Electric Vehicles	2.19%	6,132	3%	8,400
ZEV (full electric or fuel cell)	0.81%	2,268*	3%	4,200*
Total ZEV Obligation	12%	33,600	14%	35,000
Total WA new vehicle sales (2002-2006)		280,000		280,000

*In 2012-2014, ZEVs are not required to be sold in Washington, but some may be voluntarily sold in the state. After 2014, regulations would require some true ZEVs to be placed in Washington, but numbers depend on how manufacturers comply with California.

This analysis projected there to be 33,600 ZEVs sold in Washington from 2012-2014 and 35,000 from 2015-2017. The number of ZEVs registered in Washington in 2012 totaled 2,669.[217] Furthermore, the CAT suggested that there could be approximately 400,000 mtCO_2e reduced by 2035 as a result of this policy.[218] The CAT study also estimated costs of a Washington ZEV program to be approximately $180 million by 2017. Costs will generally be lower as the ZEV technology gets better. Furthermore, the study found that the addition of PZEVs[219] to the annual targets lowers costs because PZEV technology is more commercialized than ZEV technology such as battery electric vehicles (BEVs) or fuel cell vehicles (FCVs).[220] After considering these results, however, the 2008 Transportation Implementation Working Group chose not to provide a

[216] Table adapted from: Washington Climate Action Team: Transportation Implementation Working Group. November 2008. Reducing Greenhouse Gas Emissions and Increasing Transportation Choices for the Future Accessed August 2013 online at: http://www.ecy.wa.gov/climatechange/2008CAT_iwg_tran.htm
[217] 2012 Vehicle registration data provided by WA Department of Ecology
[218] Washington CAT 2008, page 55.
[219] PZEVs can include ultra clean gasoline vehicles, hybrid electric vehicles, and neighborhood electric vehicles (NEVs) with limited speed and range.
[220] Washington CAT 2008, page 58-59.

recommendation to Washington on the ZEV standard because there was still uncertainty and mixed opinion over multiple points of the policy.[221] Table 39 summarizes some of the main arguments presented in the CAT study as Pros and Cons for a ZEV mandate.

Table 39. Summary of arguments for and against a ZEV mandate, put forth by the 2008 CAT.[222]

Pros	Cons
ZEVs can reduce GHGs, and fewer plug-in hybrids will be delivered to Washington without ZEV requirement.	A ZEV or plug-in hybrid sold in another state has the same effect on global emissions as a ZEV sold in Washington.
Delaying implementation may cause later challenges to manufacturers meeting a future mandate	The market has a greater effect than regulations
The mandate will encourage recharging infrastructure that will enable additional future ZEVs	The infrastructure does not exist, and utilities, businesses, and local governments do not appear willing to build before demonstration of demand.[223]
Initial ZEV requirements create a pathway speeding arrival of true ZEVs	The market has a greater effect than regulations
Costs are lower than previous estimates	Costs are still very high
Manufacturers will subsidize sales in order to move vehicles from dealers.	Dealers are forced to assume risk of high priced inventory that may not sell

Since the time of the CAT's work in 2008, California has passed additional ZEV standards for 2018-2025. In considering implementing the 2018-2025 ZEV standards, Washington can look to California as an example of the potential economic benefits provided by the ZEV regulation. California attributes their ZEV regulations with increased job creation as a result of automakers such as Tesla targeting the California ZEV market. In 2011, ARB projected a Tesla manufacturing facility in Fremont, California, to create 1,000 jobs alone. Furthermore, California has become a strong job and economic center for the plug-in electric vehicle charging sector, allowing companies to foster an early market for ZEVs with new financing and charging options. According to the state, this innovation and technology advancement spurs consumer costs savings, allowing consumers to spend money to boost local economies and further job creation.[224] These economic benefits could translate to Washington with the implementation of a ZEV standard from 2018-2025. Washington is already benefitting with 80 jobs at the SGL/BMW Automotive Carbon Fiber plant at Port of Moses Lake. This plant is helping to produce, the new BMW i3, an all-electric vehicle.

[221] Washington CAT 2008, page 56.
[222] Washington CAT 2008, pages 56-59.
[223] Note that this was an argument presented at the time of the Washington CAT analysis in 2008. Currently, there is progress in infrastructure penetration into the market as exemplified by the West Coast Green Highway. Details about this highway can be found at: http://www.westcoastgreenhighway.com/
[224] CARB Advanced Clean Cars Summary 2011, page 2.

The following section provides an estimate of the potential GHG reductions and selected costs and benefits associated with a ZEV mandate following California's 2018-2025 model.

8.3 Quantification

This section analyzes the potential GHG emission reductions that could be generated from a zero emissions vehicle (ZEV) mandate with supporting purchase incentives. The potential policy is modeled on California's ZEV mandate which extended manufacturer ZEV sales requirements to 2025.[225] Previously, California's ZEV program goals extended only to a level of 16 percent of light duty vehicle sales in 2018, and included a variety of trading mechanisms for meeting this goal through the use of transitional technologies including hybrid vehicles. The 2012 amendments created new requirements for the years 2018 to 2025, and limits the program to ZEVs and transitional zero emissions vehicles (TZEVs). The program sets a total ZEV requirement equal to a percent of passenger cars and light duty trucks sold in the state. Of this percentage, there is a minimum floor that must be met through true ZEVs, with an option to generate credits to fill the remainder through TZEVs. The credit requirements for the ZEV program are shown in Table 40. These credit requirements, however, may not represent the actual number of vehicles may generate more or less than one credit depending upon their characteristics.

Table 40. ZEV Requirements for Large Volume Manufacturers.[226]

Model Years	Total ZEV Percent Requirement	Minimum ZEV floor	TZEVs
2018	4.5%	2.0%	2.5%
2019	7.0%	4.0%	3.0%
2020	9.5%	6.0%	3.5%
2021	12.0%	8.0%	4.0%
2022	14.5%	10.0%	4.5%
2023	17.0%	12.0%	5.0%
2024	19.5%	14.0%	5.5%
2025 and subsequent	22.0%	16.0%	6.0%

To help incentivize ZEVs, California also offers incentives for ZEVs equal to $2,500, and for TZEVs equal to $1,500. This analysis assumes that Washington would offer these same

[225] CARB, Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.
[226] Ibid.

incentive levels through 2025, and that incentives would not extend beyond that date. Given Washington's current sales tax exemptions due to sunset in 2015, Washington may wish to fill the 2016-2017 gap by either beginning to offer incentives or extending the tax breaks in order to ensure that ZEVs remain attractive, and that sales are not delayed.

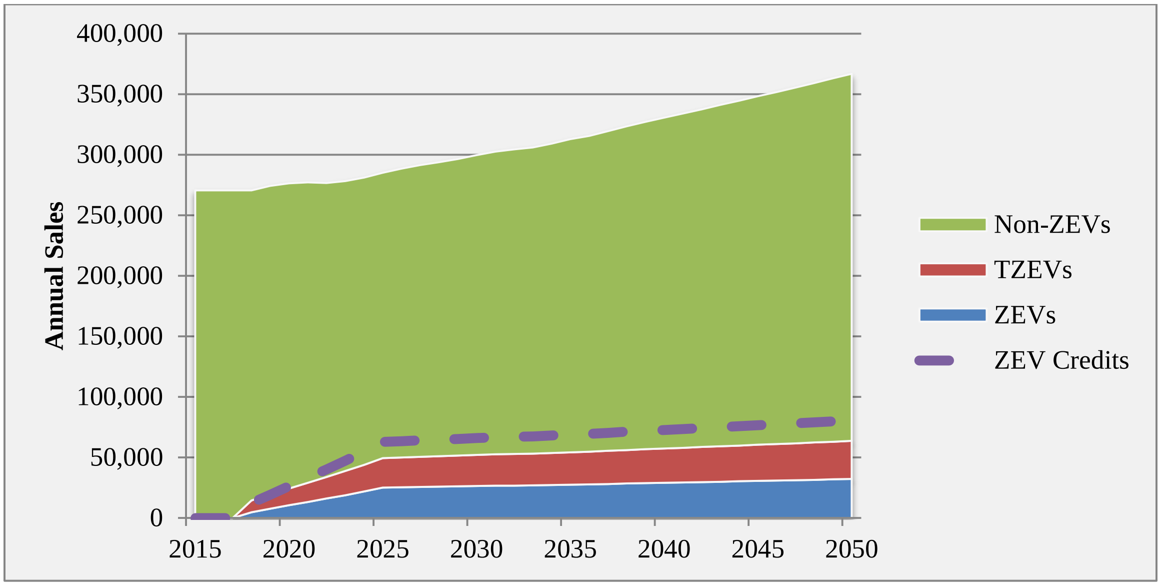
8.3.1 Methodology

To estimate ZEV sales, this analysis utilized the VISION model created by the Department of Energy's (DOE) Argonne National Laboratory. The model has been created to estimate impacts on energy use, carbon emissions, and vehicle deployment in the U.S. through the year 2050. The model's base case scenario incorporates the Annual Energy Outlook 2012 report for vehicle and fuel forecasts. VISION is the model that DOE uses to estimate potential impacts of various vehicle technologies ranging from light- to heavy-duty vehicles, and traditional and alternative fuels. The model relies on vehicle stock projections to track changes in the fuel or vehicle mix through time. In addition to estimating fuel consumption, emissions, and vehicles, the model can be used to estimate the incremental cost increases associated with alternative fuel vehicles.

To begin, the total number of ZEV credits generated by ZEVs and TZEVs were calculated in order to run VISION under baseline assumptions and assumptions reflecting increased ZEV and TZEVs. The structure of the ZEV mandate does not require a 1:1 ratio of actual vehicles to ZEV credits. Instead, depending on vehicle characteristics, a ZEV or TZEV may generate more or less than 1.0 credits. For example, a ZEV with an electric range of 350 miles or above would generate 4 credits, whereas a ZEV with a range of only 50 miles generates a single credit. Similarly, depending on the all-electric range of a TZEV, it may generate anywhere from 0.4 to 1.3 ZEV credits.

This analysis applies a credit of 2.5 to all ZEVs, representing a battery electric vehicle with a 150 mile range. TZEVs generate 0.7 credits each, which is based on the VISION plug-in hybrid vehicle with a greater than 40 mile range. Based on projected vehicle sales figures, and applying these credit values to reach the ZEV requirement in Table 40, total ZEVs and TZEVs sold per year were calculated. Figure 7 shows the number of ZEV credits required to meet the mandate, and the number of TZEV and ZEVs used to generate these credits. As shown in Figure 7, the number of actual vehicles sold will be considerably lower than the number of credits generated as a result of ZEVs which generate greater than one credit on average.

Figure 7. ZEV credits, ZEVs, and TZEVs required to meet ZEV mandate.



Fleet projections in the VISION model were modified to reflect the increased market share of ZEVs and TZEVs as a result of a ZEV mandate, and the results were compared to the VISION default. This provided an estimate of the changes in fuel consumption resulting from increased market penetration of ZEVs. VISION outputs reflect the entire U.S., and therefore these outputs were scaled to Washington and emissions calculated using Washington-specific emission factors. The scaling factor was calculated as the number of projected passenger cars and light-duty trucks sold in Washington as a portion of these sales for the U.S. in VISION. This was used to create an annual scaling factor representing Washington's approximate share of the market. This scaling factor was then multiplied by total changes in energy across a variety of fuels to estimate anticipated changes in fuel consumption in Washington. This same scaling factor was also applied to the cost of vehicles to estimate the incremental cost of buying ZEVs to meet the ZEV mandate.

Changes in GHG emissions were estimated on a lifecycle basis using carbon intensity values generated by TIAX in their 2011 review of a potential LCFS in Washington. These values for electricity, gasoline, diesel, and various biodiesel and ethanol pathways are provided in Section 6, and are tailored to Washington's electric mix and potential feedstocks. Similarly, changes in energy consumption by fuel were used to estimate the change in fuel costs using Washington-specific price forecasts provided by the State. Calculating GHG emission reductions and costs external to the VISION model allowed the results to be tailored to Washington circumstances representing energy markets and fuel emissions characteristics.

Following California ARB's assumptions in evaluating its 2018-2025 ZEV mandate, this quantification assumes that all incremental technology costs are passed along to the consumer as increased vehicle costs. These costs were calculated by scaling the incremental cost increases generated in VISION to Washington State by applying the aforementioned scaling factor. Manufacturer compliance costs were estimated at $500 per vehicle based on California ARB estimates. This value represents the additional compliance cost beyond that required to comply with LEV III. Both vehicle costs and manufacturer costs were annualized across the vehicle life in order to more appropriately align overall costs and benefits.

Incentive payments were calculated by applying a $2,500 incentive to each ZEV, and a $1,500 incentive to each TZEV. Incentives are included as a cost on the government side of the ledger, but a benefit to the consumers. As a result of decreased gasoline consumption, Washington would also lose revenue from its fuel tax.[227]

8.3.2 Assumptions, Exclusions, and Data Sources

The following assumptions about the structure of the ZEV mandate policy, the path towards attainment, associated data parameters, and exclusions are included in this analysis:

- The ZEV mandate begins in 2018, increases to 2025, and remains level at 2025 levels through 2050.
- Automakers meet the ZEV mandate using the maximum number of TZEVs allowed.
- ZEVs generate an average 2.5 credits, and TZEVs generate 0.7 credits each
- No FCV credits are traveled
- Incentives are offered beginning in 2018, and are provided for each vehicle purchased through 2025. No incentive is offered after 2025.
- Baseline fuel economy increases consistent with LEV III and federal standards, as reflected in VISION
- Vehicle VMT is calculated on an annual basis based on vehicle age in VISION, including rebound effects
- Incremental technology costs calculated within VISION associated with TZEVs and ZEVs are passed to consumers
- Compliance costs to manufacturers above those related to LEV III are $500 per vehicle, based on California ARB estimates[228]
- All one-time costs are annualized over the vehicle lifetime
- All costs are discounted to 2013 using a 5 percent discount rate

This analysis relies on the data sources summarized in Table 41.

[227] The price forecasts used to calculate savings to consumers include taxes; therefore, tax losses to the government are quantified based on current rates and assessed as a cost.
[228] ARB, Initial Statement of Reasons

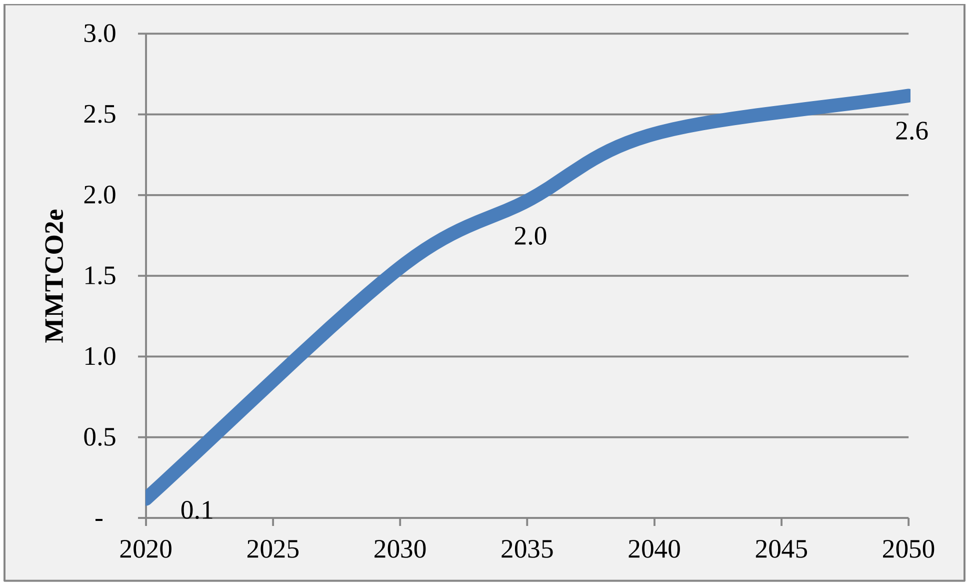
Table 41. Data sources used in estimating the impact of a ZEV mandate in Washington.

Data	Source
Model	DOE Argonne National Laboratory. 2012. VISION.
Washington Vehicle sales forecasts	Light-duty vehicle sales growth factors from U.S. EIA. "AEO 2013: Light-Duty Vehicle Sales by Technology Type, Pacific Region, Reference Case" applied to new vehicle registration data from National Auto Dealers' Association. "2013 NADA Data, State of the Industry Report."
Baseline Gasoline consumption forecast	OFM Transportation Revenue Forecast Council, Washington State Motor Vehicle Fuel Tax Extended Forecast, June 2013
ZEV mandate requirements	CARB, Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.
ZEV and TZEV credit generation rates	CARB, Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles.
Lifecycle carbon intensity values	Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. A Low Carbon Fuel Standard in Washington: Informing the Decision. February 18, 2011
Incentive payments	CARB. 2013. Implementation Manual for the FY 2012-2013 Clean Vehicle Rebate Project (CVRP). http://energycenter.org/sites/default/files/docs/nav/transportation/cvrp/FY%2012-13%20Implementation%20Manual_FINAL.pdf
Fuel Costs	Personal communication: Washington Department of Ecology, Washington Department of Commerce

8.3.3 Results

Based on the modeled ZEV mandate and supporting incentives, we calculate that Washington could achieve significant GHG reductions while decreasing expenditures on out of state energy sources, and gasoline in particular, with an increase in electricity consumption. Figure 8 shows emissions reductions resulting from the ZEV mandate, which increase over the study horizon, and begin to level out as they approach 2050. Emission reductions are estimated to be 0.1 $MMTCO_2e$ in 2020, 2.0 $MMTCO_2e$ in 2035, and 2.6 $MMTCO_2e$ in 2050.

Figure 8. GHG emission reductions from ZEV Mandate.



As shown in Table 42, the ZEV Mandate is estimated to cumulatively place a combined 58 thousand ZEVs and TZEVs on the road from 2018 to 2020. By 2035 and 2050, the mandate would cumulatively lead to a combined total of 776 thousand and 1.6 million vehicles, respectively. As a result of these vehicles, Washington emission reductions are estimated to be 0.1 $MMTCO_2e$ in 2020, 2.0 $MMTCO_2e$ in 2035, and 2.6 $MMTCO_2e$ in 2050. These emission reductions are the result of decreases in gasoline consumption, which are significantly greater than the GHG emissions incurred as a result of increased electricity use. To accommodate the ZEVs and TZEVs that would result from a ZEV mandate, Washington would need to deliver 2,542 GWH of additional electricity by 2050.

Table 42. Summary of ZEV Mandate impacts on sales of ZEVs, fuel consumption and GHG emissions.

	2020	2035	2050
Cumulative ZEV Sales (thousand)	23	383	833
Cumulative TZEV Sales (thousand)	35	393	832
Change in Annual Gasoline Consumption (million gallons)	(14)	(210)	(258)
Change in Annual Electricity Consumption (GWH)	246	2,012	2,542
GHG Emission Reductions ($MMTCO_2e$)	**0.1**	**2.0**	**2.6**

Costs of the ZEV Mandate were calculated across a variety of categories including manufacturer compliance costs, consumer technology costs (incrementally more expensive vehicles), and fuel costs. In addition, Table 43 quantifies the incentive payments resulting from a $2,500 incentive for ZEVs and a $1,500 incentive for TZEVs, and the decrease change in tax revenue that results from decreased gasoline consumption. The cumulative 2020-2035 costs reflect net present value in 2013, applying a 5 percent discount rate.

Table 43. Costs of a ZEV Mandate. Positive values represent costs, and negative values represent savings.

Million $US	2020	2035	NPV 2020-2035[a]
Cost to Government	**$62**	**$74**	**$1,160**
Incentives Payments	$57	$-	$489
Lost Fuel Tax Revenue	$5	$74	$671
Cost to Manufacturers	**$138**	**$155**	**$2,340**
Cost to Consumers	**$(58)**	**$(232)**	**$(2,333)**
Fuel Costs Savings[b]	$(18)	$(553)	$(4,629)
Technology Cost	$17	$321	$2,785
Incentives Received	$(57)	$-	$(489)
Total Costs	**$143**	**$(4)**	**$1,167**
Total GHG Reductions (MMTCO_2e)	**0.1**	**2.0**	**16.7**
Cost per mtCO_2e			**$70**

[a] 5 percent discount rate, NPV in 2013
[b] Includes fuel tax

Finally, a cost per metric ton CO_2e was calculated for each target year using the estimated emission reductions and cumulative costs, excluding transfers, in Table 43. Costs in 2020 are relatively high with a NPV of $3555 per metric ton CO_2e. This is a result of high upfront costs for vehicle purchases and a relatively small fleet of vehicles generating emission reductions. However, as the fleet turns over and stabilizes with a relatively constant proportion of ZEVs and TZEVs, overall costs are outweighed by overall benefits. The result is that the ZEV Mandate in 2035 and 2050 is estimated to have a negative NPV of ($19) and $(12) per metric ton CO_2e, respectively.

8.4 Implementation History

There are currently two ZEV policies in California that regulate the standards for ZEVs from 2009-2017[229] and from 2018-2025[230]. The ZEV program for 2018-2025 acts as the focused technology of the Advanced Clean Cars program, a coordinated policy package that combines

[229] California Code of Regulations. Section 1962.1: Zero-Emission Vehicle Standards for 2009 through 2017 Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles. Accessed August 2013 online at: http://www.arb.ca.gov/msprog/zevprog/zevregs/zevregs.htm
[230] California Code of Regulations. Section 1962.2: Zero-Emission Vehicle Standards for 2018 through Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles. Accessed August 2013 online at: http://www.arb.ca.gov/msprog/zevprog/zevregs/zevregs.htm

standards for smog, GHG emissions, and ZEV adoption.[231] The following paragraphs briefly discuss the ZEV standards for 2009-2017 and 2018-2025.

The California ZEV requirement for 2009-2017 mandates that particular number/percentage of vehicles that produce no air emissions are delivered and sold in the state. The following table shows the minimum ZEV requirement standards for car manufacturer sales levels for 2009-2017 in California.

Table 44: Minimum ZEV requirement standards as a percentage of car manufacturer sales levels for 2009-2017.[232]

Model Year	Minimum ZEV Requirement
2009-2011	11%
2012-2014	12%
2015-2017	14%

This regulation defines ZEV fuel to include electricity, hydrogen, or compressed air.[233] Due to the fact that there is a limited market for ZEVs[234] and the fact that more efficient ZEV technology continues to develop, California set the ZEV requirements with the caveat that manufacturers could incorporate PZEVs to meet their targets up until 2018.[235] PZEVs include ultra clean gasoline vehicles, hybrid electric vehicles, and neighborhood electric vehicles (NEVs) with limited speed and range. From 1996-2010, the cumulative vehicle placement from this ZEV regulation resulted in 180 fuel cell vehicles (FCVs), 5,200 battery electric vehicles (BEVs), 28,800 neighborhood electric vehicles (NEVs), 380,000 hybrid or compressed natural gas vehicles, and 1.75 million conventional gas vehicles.[236]

The ZEV program for 2018-2025 is part of California's Advanced Clean Cars (ACC) program, a coordinated policy package that combines standards for smog, GHG emissions, and ZEV adoption. The following table shows the minimum ZEV requirement standards for car manufacturer sales levels for 2018-2025.

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[231] California Air Resources Board. 2011. Advanced Clean Cars Summary (page 1). Accessed August 2013 online at: http://www.arb.ca.gov/msprog/clean_cars/acc%20summary-final.pdf
[232] Table adapted from: California Code of Regulations Section 1962.1, page 1.
[233] Table adapted from: California Code of Regulations Section 1962.1, page 31.
[234] Limited market here means that ZEVs do not compare to standard gasoline and diesel vehicles in terms of affordable vehicles with customary range, speed, and refueling capability.
[235] Table adapted from: California Code of Regulations Section 1962.1, page 5.
[236] CARB Advanced Clean Cars Summary 2011, page 11.

Table 45: Minimum ZEV requirement standards as a percentage of car manufacturer sales levels for 2018-2025.[237]

Model Year	Minimum ZEV Requirement
2018	4.5%
2019	7.0%
2020	9.5%
2021	12.0%
2022	14.5%
2023	17.0%
2024	19.5%
2025 and after	22.0%

There are progress and challenges as California has seen and encountered over its time of implementing the ZEV regulations. California represents 40 percent of the U.S. market for plug-in electric vehicles, and automakers are hoping to integrate FCVs into California starting in 2015. The ZEV mandate and funding through programs such as purchase and infrastructure incentives have spurred growth and technological advances in the ZEV market through California companies. Communication between utilities, local governments and communities has strengthened private-public partnerships to create strategies to overcome challenges to ZEV adoption.[238] Challenges include investing in easily-accessible and cost effective ZEV infrastructure, ZEV performance, commercialization of ZEVs across all vehicle categories, reducing the high up-front costs to purchase ZEVs, and raising consumer awareness.[239]

In the 2013 California Governor's ZEV Action Plan, California has set a goal to have 1.5 million ZEVs on the road by 2025. This plan outlines steps on a five year basis from 2015-2025 to implement and streamline infrastructure plans and permitting, encourage private investment and manufacturer production of ZEVs, keep ZEV costs competitive with conventional combustion vehicles, and ensure that there will be mainstream access of ZEVs to consumers.[240] With the ZEV regulations and this action plan, California has set a practical example that Washington could build upon if the State chooses to adopt the 2018-2025 ZEV standards.

[237] Table adapted from: California Code of Regulations Section 1962.2, page 1.
[238] California Governor's Interagency Working Group on Zero-emission Vehicles. February 2013. ZEV Action Plan: A roadmap toward 1.5 million zero-emission vehicles on California roadways by 2025. Accessed September 2013 online at: http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf, page 3.
[239] California Governor's Interagency Working Group on Zero-emission Vehicles 2013, page 6.
[240] California Governor's Interagency Working Group on Zero-emission Vehicles 2013, page 2.

9 Renewable Fuel Standard and Supporting Policies

Potential Action for Consideration				
Strengthen Washington's existing RFS from a volumetric 2 percent to a universal 5 percent biodiesel requirement. To support this goal, extend existing incentives (or their equivalent) for alternative fuel vehicles, biofuel production and distribution, and infrastructure beyond current expiration dates.				
GHGs and Costs in Washington	**GHG Reductions ($MMTCO_2e$)**			**Cost ($\$/mtCO_2e$)**
	2020	**2035**	**2050**	
5 percent universal biodiesel requirement	0.2	0.4	0.4	Not quantified

Implementation Issues and Lessons Learned

- Volumetric renewable fuel standard requirements are difficult to enforce. Changing from a volumetric requirement to a universal requirement for each gallon of diesel fuel sold would require each gallon of fuel to contain the specified percent biodiesel. This can be verified by random testing, alleviating the administrative burden of a volumetric requirement and simplify enforcement.
- Align policies to ensure that biofuel incentives and tax breaks are mutually supportive.
- Economic studies in Washington recommend implementing a carbon tax to spur the advancement and market penetration of biofuels. Results indicated that GHG-based price incentives can provide a foundation for the diversification of motor fuels, encourage advanced research and development of biofuel technology and infrastructure, and incentivize the state energy industry to invest further in biofuel production and fueling support.

Potential Costs and Benefits to WA Consumers	Potential Costs and Benefits to WA Businesses
• Public health benefits from reduced emissions.[241,242] • Consumers receive incentives for their purchase and use of AFVs, generally reducing the up-front cost of the vehicle. Consumers may incur the cost of interest on loans received to purchase an AFV.	• Opportunities for engineering and manufacturing jobs within the State of Washington associated with biofuel infrastructure. • Shifts away from petroleum-based fuels (e.g., gasoline and diesel) will have negative impacts on businesses involved in oil refining and transportation.

Summary of Screening Criteria

Does the policy target an emissions source of significant magnitude in Washington?
The transportation sector in the state of Washington accounted for 44 percent of total emissions in Washington in 2010. These emissions are the result of combustion of transportation fuels, so the implementation of a progressive RFS along with AFV incentives to purchase vehicles and increase infrastructure would have a corresponding effect on emissions from transportation fuel combustion.

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?
Several AFV incentive programs in other states (e.g., California, Illinois, and New York) have reduced

[241] NYSERDA/New York City Clean-Fueled Bus Program Case Study: Hybrid-electric and Natural Gas Buses. Online at: http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx
[242] Illinois Green Fleets: Green Jobs, Clean Diesel, Clean Air. 2009. *A Grant Application submitted to the U.S. Environmental Protection Agency-Region 5 by the Illinois Environmental Protection Agency, the American Lung Association of Illinois, and the Respiratory Health Association of Metropolitan Chicago on behalf of the Illinois Clean Diesel Workgroup*, (page 10). Online at: http://www.recovery.illinois.gov/documents/Applications/IEPA%2066.039%20National%20Clean%20Diesel.pdf

emissions and been considered successful. Most notably, the California Energy Commission's (CEC) Alternative and Renewable Fuel and Vehicle Technology Program has awarded $64 million to biofuels through the first two investment plans, and an additional $76 million is being allocated to biofuels and alternative fuel production in the 3rd and 4th investment plans as of December 2011. The CEC estimates annual carbon emission reductions from biofuel production projects by 2020 to be between 1.3 $MMTCO_2e$ and 6.8 $MMTCO_2e$.[243] A detailed analysis of other jurisdictional incentives can be found in Appendix A.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?
A RFS is a discrete policy targeting the State's fuel mix. Supporting AFV, biofuel production, and infrastructure support policies represent a bundle of policies to support the RFS. Incentives target different sectors of the AFV market in an effort to commercialize alternative fuel production and increase use of renewable fuels.

Can the policy be meaningfully implemented or influenced at the State level?
Washington has already implemented an RFS and several AFV and biofuel-associated tax exemptions, loans, and grants at the state level.

9.1 Introduction

Fuel consumption in the transportation sector is the largest source of emissions in the State of Washington. Transportation activities resulted in 42.2 $MMTCO_2e$ of emissions, or 44 percent of total emissions in Washington in 2010. The largest share of emissions from this source resulted from consumption of on-road gasoline and diesel (21.9 and 8 $MMTCO_2e$, respectively), making incentives to purchase alternative-fuel vehicles (AFVs) and increase fueling and support infrastructure important steps to reducing on-road GHG emissions.

Renewable fuels generally have lower lifecycle emissions than their fossil fuel counterparts, and present an opportunity to reduce on-road emissions. While some ethanol pathways have higher lifecycle emissions than gasoline, biodiesel is consistently a lower-carbon alternative to diesel. Washington's existing RFS rules impose a 2 percent volumetric requirement for biodiesel as a portion of total diesel sales. To date, Washington's compliance is well below this level, and strengthening the RFS to increase compliance, as well as increasing the requirement to 5 percent, represents an opportunity to decrease diesel emissions in the State.

In addition to the Washington RFS, ancillary policies that encourage production of alternative fuels and create support infrastructure can ease the path to RFS compliance. Many of these programs encourage alternative fuels such as electricity or hydrogen in addition to biodiesel..

[243] California Energy Commission. Benefits report for the Alternative and Renewable Fuel and Vehicle Technology Program (December 2011). Online at: http://www.energy.ca.gov/2011publications/CEC-600-2011-008/CEC-600-2011-008-SD.pdf (page 26)

Electric vehicles were considered previously in the context of the ZEV mandate, and are not included in this discussion.

9.2 Literature Review of Washington Potential

Currently, the State of Washington has an RFS requiring 2 percent biodiesel as a portion of overall diesel sales, provides certain tax exemptions for AFVs, and provides loans and grants for research and development in the production of alternative fuels.[244,245] Biofuel and its supporting infrastructure must be cost-effective in order for widespread use of biofuels to thrive. The following list provides brief descriptions of the major State policies currently in place for renewable fuel production, market integration, and infrastructure:

Renewable Fuel Standard: Washington has a statewide Renewable Fuels Standard (RFS) that sets minimum sales percentages of ethanol and biodiesel.[246] The standard requires that by November 30, 2008, biodiesel must represent 2 percent of all diesel fuel sold in the State. The share rises to 5 percent when Washington's feedstock production and processing capacities can satisfy a 3 percent requirement. The state ethanol standard has already been met as a result of the fuel quantities required by the Federal RFS2 program. However, the state requirement for biodiesel has not been met, as biodiesel represents less than 1 percent of all diesel sold in the state.[247] To meet a 5 percent goal, the rule could be changed from a volumetric requirement to a universal requirement for each gallon of diesel fuel sold. This would require each gallon of fuel to contain the specified percent biodiesel. This can be verified by random testing which would alleviate the administrative burden of a volumetric requirement and simplify enforcement. The change would also mirror Oregon's RFS, which moved to a 5 percent universal biodiesel requirement in 2011, and create a uniform regional policy framework and fuel distribution system as Oregon relies on Washington for the bulk of its fuel supply.[248]

Alternative Fuel Loans and Grants: Administered by Washington's Department of Commerce in consultation with other state agencies, the Energy Freedom Program offers loans through the Energy Freedom Account that provide financial and technical assistance for bioenergy research, production, and market development. Loans allow for the conversion of farm products, organic

[244]U.S. DOE EERE. Alternative Fuels Data Center (AFDC) (Washington- and policy- specific database query). Accessed July 2013 at: http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y

[245] For a complete summary of Washington's biofuels incentives, see: BioEnergy Washington. 2009. Washington State Bioenergy Policy Framework. Accessed July 2013 online at: http://www.bioenergy.wa.gov/BiofuelIncentives.aspx

[246] Codified as RCW 19.112

[247] Washington State Department of Ecology, 2010 Comprehensive Plan, Appendix 2: Washington Policies to Reduce Greenhouse Gas Emissions, Accessed September 2013 at http://www.ecy.wa.gov/climatechange/docs/ccp_appendix2.pdf

[248] Washington State Department of Commerce. 2013 Biennial Energy Report. http://www.commerce.wa.gov/Documents/2013-biennial-energy-report.pdf

wastes, cellulose and biogas to electricity, biofuel, and other products. The Green Energy Incentive Account through this program also provides financial assistance for alternative fueling infrastructure along interstates. The programs will expire June 30, 2016.[249]

Biofuels Distribution Tax Exemption and Deduction: Expiring July 1, 2015, the retail sales and use tax exemption applies to fuel delivery vehicles, machinery, equipment, and related services that are used for the retail sale or distribution of blends of 20 percent biodiesel or greater or E85 motor fuel.[250] Washington also implements a business and occupation tax deduction for the sale or distribution of biodiesel or E85 motor fuel also expiring July 1, 2015.[251]

Biofuels Production Tax Exemption: Washington exempts qualifying buildings, equipment, and land used for the manufacture of alcohol fuel, biodiesel, or biodiesel feedstocks from state and local property and leasehold excise taxes. This exemption lasts for six years from the date the facility or addition to the existing facility becomes operation. This incentive expires December 31, 2015.[252]

Biodiesel Feedstock Tax Exemption: Washington exempts waste vegetable oil (i.e., cooking oil gathered from restaurants or commercial food processors) used to produce biodiesel for personal use from state sales and use taxes.[253]

Based on the incentives already in place, Washington has made strides towards increasing the adoption of alternative fuels in the state and being a leader in this space. However, many of these incentivizing policies are slated to expire in the next several years. Extending these policies or their equivalent could help maintain Washington's momentum, and provide certainty over the future economic landscape to consumers and businesses.

The 2012 Washington State Energy Strategy outlines the current biofuels production incentives and recommends that a comprehensive biofuel incentives study be completed to rationalize Washington's biofuel policy.[254] Understanding the economic and environmental impacts of biofuel incentives will allow Washington to deploy a harmonized set of policies to reduce GHG

[249] RCW 43.325. Description adapted from the U.S. DOE EERE Alternative Fuels Data Center. Accessed July 2013 at: http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y
[250] RCW 82.08.955 and 82.12.955. Description adapted from the U.S. DOE EERE Alternative Fuels Data Center. Accessed July 2013 at: http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y
[251] RCW 82.04.4334. Description adapted from the U.S. DOE EERE Alternative Fuels Data Center. Accessed July 2013 at: http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y
[252] RCW 82.29A.135, 84.36.635 and 84.36.640. Description adapted from the U.S. DOE EERE Alternative Fuels Data Center. Accessed July 2013 at: http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y
[253] RCW 82.08.0205 and 82.12.0205. Description adapted from the U.S. DOE EERE Alternative Fuels Data Center. Accessed July 2013 at: http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y
[254] 2012 Washington State Energy Strategy (page 37).

emissions and increase biofuel use. A 2011 study published in the Journal of Agricultural and Resource Economics modeled the economic and environmental effects of Washington State biofuel policy alternatives.[255] Results indicated that blend mandates and carbon-based fuel taxes were the only policy options that yielded net CO_2e emissions as a result of decreased fossil fuel consumption and the substitution of biofuel into the transportation fuel mix. The model results suggested that biofuel subsidies may reduce the overall price of fuel to make it more competitive in the marketplace such that there will be an increase the quantity demanded for fuel and, subsequently, increases GHG emissions. With regards to economic impacts, results showed that subsidies would increase household income while fuel taxes decrease household income and increase state revenue.[256] A recurrent theme in this study is that policy implementation will depend on the priorities of the State. For example, if reducing carbon emissions is the top priority, blend mandates such as the RFS and carbon-based fuel taxes such as those discussed in previous sections, would be particularly cost effective. Furthermore, results indicated that blend mandates, feedstock subsidies, and a revenue-neutral subsidy policy would be important for prioritizing production of biofuels and feedstocks.[257]

A 2010 study completed by Washington State University on Biofuel Economics and Policy in Washington State did a similar analysis as presented above, and recommended targeting GHGs through a carbon tax[258] as the most effective method to address biofuel issues in Washington. GHG-based price incentives can provide a foundation for the diversification of motor fuels, encourage advanced research and development of biofuel technology and infrastructure, and incentivize the state energy industry to invest further in biofuel production and fueling support. The study urges the state to focus on the demand side of biofuel markets by targeting consumer incentives that promote increased consumption of biofuels in place of petroleum-based fuels.[259] Washington has made productive progress with the existing RFS, tax exemptions and loan and grant programs. However, in addition to strengthening the RFS, a comprehensive biofuel incentives evaluation study could be completed to better understand and rationalize the impacts of Washington's biofuel policies and incentives and bring about a harmonized suite of policies.[260]

[255] McCullough, M., Holland, D., Painter, K., Stodick, L., and J. Yoder. 2011. Economic and Environmental Impacts of Washington State Biofuel Policy Alternatives. *Journal of Agricultural and Resource Economics* 36(3), pages 615-629.
[256] McCullough et al. 2011 (page 617, 628).
[257] McCullough et al. 2011 (page 628)
[258] This Task 2 report provides a detailed analysis of a carbon tax.
[259] Yoder, J., Shumway, R., Wandschneider, P., and D. Young. 2010. Biofuels Economics and Policy for Washington State. Washington State University School of Economic Sciences, p. 117. Accessed July 2013 online at: http://cru.cahe.wsu.edu/CEPublications/XB1047E/XB1047E.pdf
[260] 2012 Washington State Energy Strategy (page 37).

9.3 Quantification

This section analyzes the potential GHG emission reductions from the implementation of a viable RFS for biodiesel in Washington. The current RFS policy has proven difficult to implement and enforce. The standard requires that the minimum fraction of total annual sales of diesel fuel consist of biodiesel or renewable diesel. This volumetric requirement necessitates tracking of all blendstocks entering into the fuel supply throughout the year which has resulted in an administrative challenge. In addition, there is no requirement for any individual company to comply which has resulted in the standard being difficult to enforce.[261] As of 2012 the requirement has not been met and biodiesel levels were less than 1 percent of total sales.[262] The GHG reductions associated with the current levels of biodiesel are quantified in Task 1 (modeled as biodiesel representing one half of one percent of all diesel fuel). This section quantifies the additional emissions reductions from the RFS assuming that it is amended to a universal 5 percent biodiesel requirement and is modeled as biodiesel representing an additional 4.5 percent in addition to the half percent already in the supply.

9.3.1 Methodology

Emissions reductions were estimated using projections of diesel consumption and projections of biodiesel consumption in the transportation sector in Washington. Most diesel fuel is consumed in the transportation sector which accounted for almost 80 percent of diesel consumption in the state in 2010. Projections of diesel consumption to 2040 were provided by the Office of Financial Management Transportation Revenue Forecast Council. These projections were extrapolated to 2050 using the average growth rate for the last five years of the forecast period. This analysis assumes that the RFS is amended to a universal 5 percent biodiesel requirement.

Consumption of biodiesel was projected to 2020, 2035, and 2050 using the assumption that a requirement of 5 percent biodiesel will be met, but not exceeded, in the target years. This analysis accounts for an additional 4.5 percent of biodiesel consumption to reach the 5 percent requirement. GHG emissions reductions were calculated by multiplying the gallons of diesel avoided by the carbon intensity for diesel fuel and adjusting for the carbon intensity of biodiesel. The energy density of biodiesel is lower than that of diesel and therefore more biodiesel is needed to meet the original demand, also referred to as the energy economy ratio (EER). However, this difference is negligible at low-level biodiesel blends up to B5. For the purposes of this analysis B5 is assumed to have an EER of 1.0 compared to diesel.

[261] Washington State Department of Commerce. 2012 Washington State Energy Strategy.
[262] Email correspondence with Mary Beth Lang, Bioenergy and Special Projects Coordinator., Washington State Department of Agriculture. July 29, 2013.

The principal feedstocks used to produce biodiesel consumed in Washington are Midwest soybeans, Northwest canola oil, and waste grease.[263] A small percentage of biodiesel produced from corn oil is also expected to enter the market in the future.[264] Carbon intensities for regular diesel and biodiesel were adapted from the report *A Low Carbon Fuel Standard in Washington: Informing the Decision* prepared by TIAX LLC in February 2011.[265] The carbon intensity for corn oil was taken from the California Low Carbon Fuel Standard (LCFS)[266] as the TIAX report did not provide a specific carbon intensity for this pathway.[267] Table 46 below shows the carbon intensities used for fuels in this analysis.

Table 46. Carbon Intensity Values for Diesel and Biodiesel Fuels

Fuel	Carbon Intensity (gCO_2e/MJ)
Baseline Diesel	92
Biodiesel, MW Soybeans	68
Biodiesel, NW Canola	26
Biodiesel, Waste Grease	20
Biodiesel, Corn Oil	4

Source: TIAX LLC. A Low Carbon Fuel Standard in Washington: Informing the Decision. Adapted from Table 5-6. Corn oil carbon intensity from California LCFS.

There may be GHG emissions associated with land use when new land is brought into cultivation to replace crops used in biofuel production. These emissions are referred to as indirect land use change (ILUC) and can occur with increased biofuel production. The carbon intensities used in this analysis include ILUC where applicable.[268]

Table 47 shows the assumed share of biodiesel produced from each feedstock in Washington in the target years.[269] The share of each biodiesel feedstock was used to determine the average biodiesel carbon intensity for each target year. It is likely that advanced biofuels, including renewable biodiesel and other advanced conversion pathways, will be available to the Washington market in increasing quantities in the future, particularly in 2035 and 2050.

[263] Washington State Department of Commerce. 2012 State Energy Strategy. Phone conversation with Department of Commerce, Peter Moulton.
[264] Phone conversation with Peter Moulton, Department of Commerce.
[265] TIAX LLC. A Low Carbon Fuel Standard in Washington: Informing the Decision. Adapted from Table 5-6. http://www.ecy.wa.gov/climatechange/docs/fuelstandards_finalreport_02182011.pdf.
[266] California Air Resources Board (ARB), Low Carbon Fuel Standard. http://www.arb.ca.gov/fuels/lcfs/CleanFinalRegOrder112612.pdf
[267] Note that CARB is planning revise the carbon intensity for corn oil in the near future and it is expected to increase, however, the magnitude of the increase is unclear until the revised intensity is published.
[268] MW soybeans is the only biodiesel pathway that includes ILUC in the TIAX report.
[269] Email correspondence with Peter Moulton, Department of Commerce, August 22, 2013.

Advanced biofuels will most likely have lower carbon intensities, which would reduce the average carbon intensity of biodiesel and help to increase GHG reductions. However, assumptions regarding the availability and level of adoption of these fuels are highly uncertain. To approximate the decreasing carbon intensity of biodiesel this analysis assumes an increase in the target years of biodiesel produced from canola oil, waste grease, and corn oil, and a reduction in biodiesel produced from MW soybeans. Biodiesel fuels produced from canola, waste grease, and corn oil all have lower carbon intensities than biodiesel produced from MW soybeans as shown in Table 47.

Table 47. Share of Biodiesel Fuel Consumed in Target Years

	Ratio of Biodiesel Fuel in Target Years			
Fuel	**2013**	**2020**	**2035**	**2050**
Biodiesel, MW Soybeans	0.50	0.35	0.20	0.15
Biodiesel, NW Canola	0.25	0.30	0.35	0.40
Biodiesel, Waste Grease	0.25	0.30	0.35	0.35
Biodiesel, Corn Oil	0.00	0.05	0.10	0.10
Average Biodiesel CI (gCO_2e/MJ)		**37.8**	**30.1**	**28.0**

9.3.2 Assumptions, Exclusions, and Data Sources

The GHG emission reductions associated with the RFS for biodiesel were projected for the target years utilizing the following assumptions:

- Legislative action is taken to modify the RFS from the existing volume-based standard to a universal 5 percent biodiesel standard that is enforceable and practicable.
- A 5 percent biodiesel requirement is met, but not exceeded, in the target years.
- Primary feedstocks for biodiesel consumed in Washington are Midwest soybeans, Northwest canola, and waste grease. Canola and waste grease quantities increase through the target years and small amount of corn oil is included in 2035 and 2050.

This analysis relies on the data sources summarized in Table 48.

Table 48. Data Sources Used to Estimate Emission Reductions from an RFS in Washington

Data	Source
Diesel consumption projections 2014-2040	Transportation Revenue Forecast Council. Email correspondence with Office of Financial Management, Transportation Revenue Forecast Council, August 22, 2013.
Carbon intensities for	TIAX LLC. A Low Carbon Fuel Standard in Washington: Informing the Decision. Adapted from Table 5-6.

fuels	http://www.ecy.wa.gov/climatechange/docs/fuelstandards_finalreport_02182011.pdf. The carbon intensity for corn oil is from the California LCFS: California Air Resources Board (ARB), Low Carbon Fuel Standard.
Energy density for diesel	California Air Resources Board (ARB), Low Carbon Fuel Standard. Look up Tables. (http://www.arb.ca.gov/fuels/lcfs/lu_tables_11282012.pdf, and http://www.arb.ca.gov/fuels/lcfs/CleanFinalRegOrder112612.pdf)

9.3.3 Results

Based on the method outlined above, total projected diesel consumption and biodiesel consumption and the estimated GHG emission reductions associated with an additional 4.5 percent biodiesel consumption to reach a 5 percent biodiesel requirement in 2020, 2035, and 2050 are shown in Table 49.

Table 49. Emissions Reductions Associated with an RFS for Biodiesel, achieving a net increase of 4.5 percent biodiesel relative to current attainment.

Target Year	2020	2035	2050
Diesel avoided (million gallons)	34	43	52
Emissions from Diesel (MMTCO$_2$e)	0.4	0.5	0.6
Biodiesel required (million gallons)	34	43	52
Emissions from Biodiesel (MMTCO$_2$e)	0.2	0.2	0.2
Net Reduction in CO2e (MMTCO$_2$e)	**0.2**	**0.4**	**0.4**

9.4 Implementation History

9.4.1 Renewable Fuels Standards

Washington Renewable Fuel Standards: The Washington Legislature passed a RFS in 2006. The standard requires that, starting in 2008, at least 2 percent of total gasoline sold in the state must be denatured ethanol and at least 2 percent of total diesel fuel sold in the state must be biodiesel or renewable diesel.[270]

The ethanol requirement has effectively been superseded by the introduction of ethanol content requirements under the Federal renewable fuel standard. The Federal standards have led to a current average ethanol content of just over 9 percent in Washington, 7 percent over the state's 2 percent requirement. Washington consumed over 2.5 billion gallons of motor gasoline in

[270] Note that this standard was designed to increase to 5% 180 days after the Washington State Department of Agriculture (WSDA) determines that in-state feedstocks and oil-seed crushing capacity can meet a 3% requirement.

2011.[271] With a 9 percent average ethanol content, annual motor gasoline reductions resulting from the ethanol component of RFS2 can be approximated at about 230 million gallons. Further analysis of the Federal RFS is included in the Federal Policy Analysis conducted in Task 3 of this project.

The biodiesel portion of the requirement has proven difficult to implement and enforce. The standard requires that the minimum fraction of total annual sales of diesel fuel consist of biodiesel or renewable diesel. This volumetric requirement necessitates tracking of all blendstocks entering into the fuel supply throughout the year which has resulted in an administrative challenge. In addition, there is no requirement for any individual company to comply which has resulted in the standard being difficult to enforce.[272] As of 2012 the requirement has not been met and biodiesel levels were less than 1 percent of total sales.[273]

The RFS legislation as written is designed to increase the biodiesel requirement to 5 percent of total annual diesel fuel sales when the state determines that both in-state oil seed crushing capacity and feedstock grown in Washington State can satisfy a 3 percent requirement.[274] Diesel that contains 5 percent biodiesel, known as B5, is already sold in certain markets in Washington and petroleum fuel distributors are continuing to add biodiesel storage and blending infrastructure to support biodiesel requirements in Oregon and British Columbia, which are largely dependent on Washington refineries and distributors for their fuel supply.[275] Prices for B5 have become cost competitive and in some cases have been less expensive than regular diesel. In April 2013, B5 was $0.62 per gallon less than the average diesel price.[276]

Efforts have been made to modify the existing biodiesel standard from a 2 percent volumetric requirement to a 5 percent universal requirement, similar to the RFS implemented in Oregon. A universal standard requires all diesel fuel sold at the pump to contain the minimum fraction of biodiesel. This can be verified by random testing which would alleviate the administrative burden of a volumetric requirement and simplify enforcement. However, recent attempts to implement this change during the 2012 legislative session were unsuccessful.[277]

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[271] Data provided by Department of Commerce in comment on draft version.
[272] Washington State Department of Commerce. 2012 Washington State Energy Strategy.
[273] Email correspondence with Mary Beth Lang, Bioenergy and Special Projects Coordinator., Washington State Department of Agriculture. July 29, 2013.
[274] RCW 19.112.110. http://apps.leg.wa.gov/RCW/default.aspx?cite=19.112.110
[275] Washington State Department of Commerce. 2012 State Energy Strategy. http://www.commerce.wa.gov/Documents/2012WAStateEnergyStrategy.pdf
[276] Washington State Department of Transportation. The Fuel and Vehicle Trends Report. April 30, 2013. http://www.wsdot.wa.gov/NR/rdonlyres/5EDEBF3D-4617-4A51-ADB7-61842F1ABC02/0/FuelandVehicleTrendsApr2013.pdf
[277] House Bill 2740. http://apps.leg.wa.gov/billinfo/summary.aspx?bill=2740&year=2011

Federal Renewable Fuels Standard (RFS-1 and RFS-2): The Renewable Fuels Standard (RFS) was created under EPACT 2005. EPACT required that 7.5 billion gallons of renewable fuels be blended into motor gasoline by 2012. Administered by EPA, the original RFS is often referred to as RFS-1. The Program was expanded under EISA 2007. In addition to motor gasoline, it now includes diesel fuels. The target for renewable fuel to be blended into transportation fuels was raised to 36 billion gallons by 2022. EISA established new categories of renewable fuels including biomass-based diesel, non-cellulosic advanced and cellulosic biofuel, each with its own target within the larger overall target. Together, these advanced biofuels were equal to 21 billion of the overall 36 billion gallons targeted in 2022. EISA also set thresholds for the life-cycle GHG emissions of each of these fuels. To qualify under the program, traditional renewable fuels would need to have life-cycle emissions that are 20 percent lower than the fuel being displaced, advanced biofuel and biomass-based diesel would need to have lifecycle emissions 50 percent below the fuel being displaced, and cellulosic biofuel would need to have life-cycle GHG emissions 60 percent below the gasoline or diesel fuel it displaces. Under this Program (now referred to as RFS-2) the EPA assigns refiners and importers of petroleum-based transportation fuels a Renewable Volume Obligation (RVO). These regulated entities may meet these obligations with Renewable Identification Numbers (RIN), an alphanumeric code assigned to each gallon of renewable fuel either produced or imported into the United States. RINs may be traded so that obligations can be met at least cost.

The EPA estimated that RFS-2 will displace approximately 13.6 billion gallons of motor gasoline and diesel fuel in 2022, reducing greenhouse gas emissions by 138 million metric tons, and decreasing the cost of oil imports by $41.5 billion. At the same time, the program will increase farm income by $13 billion dollars in 2022, but will also increase the annual cost of food by $10 per person in the U.S.[278] In 2011 and 2012, the American Petroleum Institute commissioned a two-phase study to look at the economic impacts of RFS-2. In phase one, Charles River Associates used the NEMS version from *Annual Energy Outlook 2011* to evaluate the market's ability to absorb ethanol into petroleum based fuels. They estimated that by 2013 the U.S. market would no longer be able to absorb the requisite volume of ethanol and would have to begin either reducing production of petroleum based fuels or increasing the portion of production that was exported.[279] Further, Charles River found that by 2015, implementation of the rule would be impossible. In phase two, NERA economic consulting looked at the economic

[278]U.S. EPA Office of Transportation and Air Quality. February 2010. EPA Finalizes Regulation for the National Renewable Fuel Standard Program for 2010 and Beyond. EPA-420-F-10-007.
[279] Foster, H., Bron, R., and P. Bernstein at Charles River Associates. November 2, 2011. Impact of the Blend Wall Constraint in Complying with the Renewable Fuel Standard. H. Foster, R. Baron, P. Bernstein,. Accessed August 2013 online at: http://www.api.org/news-and-media/news/newsitems/2013/march-2013/~/media/Files/Policy/Alternatives/13-March-RFS/CRA_RSF2_BlendwallConstraints_Final_Report.pdf

effects of hitting this "blend wall," and concluded that it would result in a $770 billion decline in GDP in 2015, and a diminution of household consumption of $2,700.[280]

What these studies fail to emphasize is that under EISA, the EPA has considerable discretion to alter the individual standards or provide waivers to fuel producers and exporters. In his June 26, 2013 testimony to the House Committee on Energy and Commerce, Subcommittee on Energy and Power, EIA Administrator Adam Sieminski stated that "the RFS program is not projected to come close to the achievement of the legislative target that calls for 36 billion gallons of renewable motor fuels use by 2022." He went on to state, "EPA will need to decide how to apply its regulatory discretion regarding the advanced and total RFS targets as allowed by law." The U.S. EPA did reduce compliance levels for cellulosic ethanol in 2012 and 2013, setting the 2013 target at 6 million gallons, less than half of the level in February 2013 proposed rulemaking and well below the one billion gallons foreseen in EISA. The final 2013 rulemaking did maintain the advanced biofuel target at statutory levels, with the total renewable fuels target at 16.55 billion gallons. The final rulemaking does project, however, that EPA will need to adjust the total target below the 18.15 billion gallons contained in EISA.[281] The EIA points out that the expectation that cellulosic and advance biofuels could be available in significant volumes at reasonable costs has not been realized and that the general reduction in fuel volumes consumed places additional pressure on biofuel volumes targets.[282]

9.4.2 AFV Purchase and Fueling Infrastructure Support Incentives

The USDA Advanced Biofuel Payment Program: This program, within the USDA's Rural Development Office, provides payments[283] to biofuel producers to support and expand production of advanced biofuels.[284] Under this program, payments are made to eligible producers based on the amount of advanced biofuels produced from renewable biomass, other than corn kernel starch. Biofuel can be made from a variety of non-food sources, including waste products. Examples of eligible feedstocks include, but are not limited to, crop residue, animal, food and yard waste material, vegetable oil, and animal fat. To be eligible, producers must enter into a contract with USDA Rural Development for advanced biofuels production and submit records to

280 NERA Economic Consulting. October 2012. Economic Impacts Resulting from Implementation of RFS2 Program. Accessed August 2013 online at: http://www.api.org/~/media/Files/Policy/Alternatives/13-March-RFS/NERA_EconomicImpactsResultingfromRFS2Implementation.pdf

281 U.S. Energy Information Administration. August 14, 2013. EPA Finalizes Renewable Standard for 2013; Additional Adjustments Expected in 2014. Accessed August 2013 online at: http://www.eia.gov/todayinenergy/detail.cfm?id=12531

282 Energy Information Administration, U.S. Department of Energy, statement of Adam Sieminski, Administrator, before the Subcommittee on Energy and Power, Committee on Energy and Commerce, U.S. House of Representatives, June 26, 2013, http://www.eia.gov/pressroom/testimonies/sieminski_06262013.pdf

283 One payment is based on actual production and another payment is based on incremental production.

284 U.S. Department of Agriculture Advanced Biofuel Payment Program. Online at: http://www.rurdev.usda.gov/BCP_Biofuels.html

document their production.[285] Through this and other programs, USDA is working to support the research, investment and infrastructure necessary to build a strong biofuels industry that creates jobs and broadens the range of feedstocks used to produce renewable fuel.

California Alternative and Renewable Fuel and Vehicle Technology Program (ARFVT)[286]: This program provides funding of up to $100 million annually, leveraging public and private investment to develop and deploy clean, efficient, and low-carbon alternative fuels and technologies.[287] California's objective is to produce 20 percent of biofuels used in state by 2010, 40 percent by 2020, and 75 percent by 2050. The CEC developed and adopted three investment plans since 2008 that guide more than $361 million in total awards for the first four fiscal years of the ARFVT Program, of which $114.9 million was allocated to biofuels. Using funds from this first investment plan (fiscal years 2008-09 and 2009-10), plus a portion of funds from the second investment plan (fiscal year 2010-2011), the Energy Commission funded 86 projects totaling $197.4 million to date, of which $64 million was awarded to biofuels.[288] The most recent investment plan, covering fiscal years 2012-2013, allocates $20 million and $21.5 million to alternative fuel production and alternative fuel infrastructure, respectively[289].

[285] U.S. Department of Agriculture Rural Development Energy Programs Fact Sheet. Online at: http://www.rurdev.usda.gov/SupportDocuments/RD_energy_factsheet_1928_2009_final.pdf

[286] California Energy Commission. California's Alternative & Renewable Fuel & Vehicle Technology Program. Online at: http://www.energy.ca.gov/drive/

[287] California Energy Commission. Background Information: 2013-2014 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program. Online at: http://www.energy.ca.gov/2012-ALT-2/background.html

[288] California Energy Commission. Benefits report for the Alternative and Renewable Fuel and Vehicle Technology Program (December 2011). Online at: http://www.energy.ca.gov/2011publications/CEC-600-2011-008/CEC-600-2011-008-SD.pdf (page 20)

[289] California Energy Commission. 2012-2013 Investment Plan Update for the Alternative and Renewable Fuel and Vehicle Technology Program (May 2012). Online at: http://www.energy.ca.gov/2012publications/CEC-600-2012-001/CEC-600-2012-001-CMF.pdf (page 4)

10 Shore Power

Table 50: Potential Costs and Benefits and Additional Screening Criteria for Implementation of Shore Power Policies to Washington Consumers and Businesses

Potential Action for Consideration	
• Implement At-Berth standards in the state of Washington	
Potential Costs and Benefits to WA Consumers	**Potential Costs and Benefits to WA Businesses**
• No consumer costs from shore power projects have been identified • Improved air quality through reduction in emissions	• Increased costs for vessel construction or retrofit • Increased competitiveness as more global ports equip vessels with shore power capabilities • Reduced energy costs while vessels call at port • Shore power infrastructure requires investment from ports and companies to design, build, and install shore power technology both on land and vessels. These projects represent opportunities for engineering and construction jobs within the State of Washington • Shipping companies will see a reduction in costs associated with reduced fuel consumption • Shore power at ports in Washington has the potential to increase the demand on local jurisdictions' electric power supply
Summary of Screening Criteria	
Does the policy target an emissions source of significant magnitude in Washington? The fuel use and emissions from maritime port sources can be significant, with OGVs and harbor craft being major contributors to air pollution and GHG emissions in and around ports. Emissions from marine vessels contributed approximately 3.1 percent (or 3 $MMTCO_2e$) of Washington State's annual GHG emissions in 2010. However, only a portion of these emissions occur when vessels are at-berth. For example, the ocean going vessel hotelling and maneuvering at berth generated about 25 percent of the overall marine emissions in the Puget Sound in 2011.[290] ***What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?*** Port electrification efforts in Washington, California, and several Canadian provinces have yielded positive results in infrastructure investment, achievement of GHG reductions, and economic payback. The volume of reductions, however, are relatively small compared to overall jurisdictional emissions. ***Is the policy discrete and comprehensive, or is it instead a bundle of related policies?*** The policy itself can be discrete and comprehensive, in the form of a program or regulation targeted at reducing emissions from ships at berth, but implementation of the policy requires the integration of	

[290] Puget Sound Maritime Air Forum. Puget Sound Maritime Air Emissions Inventory. August 2012. Page 27. Accessed September 2013 online at: http://www.pugetsoundmaritimeairforum.org/uploads/PV_FINAL_POT_2011_PSEI_Report_Update__23_May_13__scg.pdf

various projects and stakeholders, as Shore Power requires extensive infrastructure improvements both on the terminal side, for supplying the appropriate level of conditioned electrical power, and on-board the vessels that will use the system; and participating ports and maritime companies would need to collaborate.

Can the policy be meaningfully implemented or influenced at the State level?
Yes, as shown in the example of California's At-Berth Regulation, the policy can be levied at the state level, and various projects can also obtain funding from state sources.

10.1 Introduction

Washington State seaports operate ferries, container ships, cruise ships and a variety of other ocean going vessels (OGVs). The port system is a major economic hub in the state. For example, the Port of Seattle supported approximately 29,000 direct and indirect jobs, $2.5 billion of business revenue, and $457.5 million state and local taxes in 2008.[291]

Shore power, also known as port electrification or cold ironing, is the process of transferring the electrical generation needs for OGVs while at berth (docked) from onboard diesel auxiliary engines to cleaner, shore-side, power grids. Shore power is often intended to help improve air quality at ports, but has the added benefit of reducing GHG emissions from OGVs during port calls.

The fuel use and emissions from maritime port sources can be significant, with OGVs and harbor craft being major contributors to air pollution and GHG emissions in and around ports. Emissions from marine vessels also contributed approximately 3.1 percent (or 3 $MMTCO_2e$) of Washington State's annual GHG emissions in 2010. Approximately one-third to one-half of emissions attributed to OGVs come from their auxiliary diesel engines, which are run while the vessel is at berth and require electrical power for everything from lighting to loading and discharging equipment. Reducing the use of diesel auxiliary engines while OGVs are at port reduces GHG emissions and improves air quality by reducing emissions of particulate matter (PM) and nitrogen oxides (NO_x).[292] The Puget Sound Clean Air Agency (PSCAA) calculates that

[291] Port of Seattle. 2009. Port of Seattle Economic Impact. Accessed August 2013 at: http://www.portseattle.org/Supporting-Our-Community/Economic-Development/Documents/EconomicImpact_2009Brochurev2.pdf
[292] Pratt and Harris. 2013. Vessel Cold-Ironing Using a Barge Mounted PEM Fuel Cell: Project Scoping and Feasibility. (February 2013). Page 5. Accessed August 2013 at: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/sand2013-0501_barge_mounted_pemfc.pdf

just eight hours of shore power cuts on-board oil burning by 2.85 metric tons of fuel. For cruise ships, air emissions are reduced by about 30 percent per eight-hour port call.[293]

The shore power approach is generally best suited for vessels that make multiple calls at the same terminal for multiple years. The best candidates for shore power are large container ships, cruise ships, refrigerated (reefer) ships, and specially-designed crude tankers that have diesel-electric engines. Shore power requires extensive infrastructure improvements both on the terminal side, for supplying the appropriate level of conditioned electrical power, and on-board the vessels that will use the system.[294]

California and Canada (primarily British Columbia) have implemented shore power regulation and initiatives, respectively. Washington ports have facilitated private sector infrastructure investments to implement shore power for a cruise terminal at the Port of Seattle and a container ship terminal at the Port of Tacoma. Shore power presents increased competitiveness for ports and businesses as more fleets fit vessels with shore power capabilities,[295] and as shore power technology is adopted more broadly at all West Coast ports, shore power will become more feasible for container and cargo ships that call at Washington ports.[296] No federal standards or control requirements have been promulgated addressing emission reductions from at-berth OGV auxiliary engines.[297]

Another related policy that targets emissions near or at ports is known as positive restraint, and provides another opportunity to reduce reliance on vessel engines while docked.

10.2 Literature Review of Washington Potential

The Port of Seattle, Princess Cruises, and Holland America Line completed a $7.5 million shore power project at Seattle's Terminal 30 in 2005 and 2006. Participating vessels cut annual CO_2

[293] Electrify Transportation in Washington. 2007. Electrify Transportation Briefing Book. (January 2007.) Page 16. Accessed August 2013 at: http://www.plugincenter.net/wp-content/uploads/2010/10/Electrify_Transportation_Briefing_Book.pdf

[294] San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Pages 89-90. Access August 2013 at: http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485

[295] San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Pages 89-90. Access August 2013 at: http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485

[296] Electrify Transportation in Washington. 2007. Electrify Transportation Briefing Book. (January 2007.) Page 16. Accessed August 2013 at: http://www.plugincenter.net/wp-content/uploads/2010/10/Electrify_Transportation_Briefing_Book.pdf

[297] California Air Resources Board (CARB). Adoption of the Regulation to Reduce Emissions from Diesel Auxiliary Engines on Ocean-going Vessels While at Berth. (October 18, 2008). Accessed August 2013 at: http://www.arb.ca.gov/regact/2007/shorepwr07/uid2007.pdf

emissions by up to 29 percent and saw financial savings on energy costs of up to 26 percent per call.[298] The cruise lines' shore power systems were relocated to Terminal 91 in 2009.[299] In October 2010, the Port of Tacoma and Totem Ocean Trailer Express, Inc. (TOTE) completed a $2.7 million shore power project. EPA awarded the Port of Tacoma a $1.5 million grant to construct a shore-side connection and power system at the terminal. TOTE contributed approximately $1.2 million to retrofit two Alaska trade ships that make weekly calls at the terminal. The shore power project estimated a reduction of diesel and GHG emissions by up to 90 percent during TOTE's 100 annual ship calls. That translates to about 1.9 tons of diesel particulates and 1,360 $mtCO_2e$ each year. The infrastructure update sustained an estimated 50 manufacturing and local installation jobs.[300] Shore power projects are not expected to impact consumers.

The Port of Seattle and Tacoma, along with Port Metro Vancouver, have implemented the Northwest Ports Clean Air Strategy, beginning in 2007. The ports have implemented a series of mandatory engine and fuel standards, as well as voluntary measures, aimed at reducing emissions from OGVs, cargo-handling equipment, rail, trucks, and harbor vessels. The Air Strategy is intended to improve air quality with the co-benefit of reducing GHG emissions.[301]

Additionally, WSDOT has investigated a positive restraint system that will allow Washington State Ferry (WSF) vessels to be safely secured in dock for loading and unloading operations with reduced engine power to save fuel. The estimated cost of the required marine structures, vacuum restraint equipment and support system is $4 million per terminal or $8 million per route. WSF consumes 17.7 million gallons of diesel fuel per year. For example, the two vessels on the Edmond Kingston route consume, on average, 2.7 million gallons per year. Twenty percent of the two vessels' fuel usage (540,000 gallons) is consumed pushing into the dock. By using positive restraint to reduce the power of the engines to support hotel loads only, 270,000 gallons per year can be saved, which equals approximately $1 million in fuel costs. In addition, 3,000 operating hours per engine can be reduced annually resulting in approximately $750,000 reduction in engine maintenance costs per year.[302]

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[298] 40 Cities. Port of Seattle Cuts Vessel Emissions by 29% Annually and Saves 26% on Energy Costs per Call. Access August 2013 at: http://www.c40cities.org/c40cities/seattle/city_case_studies/port-of-seattle-cuts-vessel-emissions-by-29-annually-and-saves-26-on-energy-costs-per-call

[299] Cochran Marine. Seattle – Terminal 91 Shore Power Relocation. Accessed August 2013 at: http://www.cochranmarine.com/current-installations/seattle-shore-power-relocation-terminal-91/

[300] Port of Tacoma. First cargo ship in Pacific Northwest plugs into shore power at Port of Tacoma. (October 27, 2010). Accessed August 2013 at: http://www.portoftacoma.com/Page.aspx?cid=4773

[301] Northwest Ports. Northwest Ports Clean Air Strategy, 2012 Implementation Report. (July 8, 2013). Accessed August 2013 at: http://www.portseattle.org/Environmental/Air/Seaport-Air-Quality/Documents/NWPCAS_2012_Progress_Report_20130708.pdf

[302] Washington State Department of Transportation. September 10, 2013. Personal communication with Seth Stark. Data taken from the "11-13 Biennium Scoping Proposed Capital Terminal Improvement Biennium Project Submission Form" for the Edmonds and Kingston Terminals.

Additional notable experience from the western U.S. and Canada may inform potential policy actions for Washington. The following examples provide estimates of the types of economic and GHG impacts that might be achievable in Washington. Policies have been implemented with positive results in California and several Canadian provinces.

In December 2007, the California Air Resources Board (ARB) approved the "Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean-Going Vessels At-Berth in a California Port" Regulation, commonly referred to as the At-Berth Regulation. The purpose of the At-Berth Regulation is to reduce diesel particulate matter (DPM) and nitrogen oxides (NO_x) emissions from diesel auxiliary engines on container ships, passenger ships, and refrigerated-cargo ships while berthing at California Ports. Responding to the At-Berth regulation, the Port of Los Angeles (POLA) and Long Beach (POLB) invested a combined $52.1 million to implement shore power programs, expecting the use of shore power at berth will reduce OGV emissions of CO_2 by 95 percent per vessel call. The Port of San Francisco became the first California port to provide shore power for cruise ships while at berth in October 2010. The project budget was $5.2 million, with estimated reductions in emissions for a 10-hour ship call being approximately 140 pounds of DPM, 1.3 tons of NO_x, 0.87 tons of sulfur oxides (SO_x), and 19.7 mtCO_2e.[303]

Transport Canada, the country's department responsible for developing regulations, policies, and services of transportation, completed the Marine Shore Power Program between 2007 and 2012. The Port Metro Vancouver became the first port in Canada and third in the world to install shore power for cruise ships. The 2009 installation represents a $9 million (CAD) initiative by the Government of Canada, the British Columbia Ministry of Transportation and Infrastructure, Holland America Line, Princess Cruises, BC Hydro and Port Metro Vancouver. Between April and October 2010, Port Metro Vancouver completed 44 shore power connections, which reduced greenhouse gas emissions by 1,521 mtCO_2e. Based on costs at the time of measurement, cruise ships saved an average of $234 (CAD) and 1.78 metric tons of fuel each hour that their engine was shut off while at berth.[304] In 2011, 35 vessels connected to the Ports shore power facilities, reducing GHG emissions by 1,318 mtCO_2e.[305]

In January 2012, the Government of Canada approved a $27.2 million (CAD) Shore Power Technology for Ports Program as part of the country's Clean Air Agenda. As part of the program, Seaspan Ferries Corporation will be installing shore power at the Swartz Bay Ferry

[303] Office of the Mayer, City & County of San Francisco. Mayor Newsom and the Port of San Francisco Inaugurate Cruise Ship Using Shoreside Power. (October 2010). Accessed August 2013 at: http://www.epa.gov/region9/mediacenter/posf-dera/SF-Port-Shore-Power.pdf

[304] Transport Canada. Case Study – Port Metro Vancouver Shore Power Project. (February 2, 2012). Accessed August 2013 at: http://www.tc.gc.ca/eng/programs/environment-sptp-case-study-2690.htm

[305] Port Metro Vancouver. Shore Power at Canada Place. Access August 2013 at: http://www.portmetrovancouver.com/en/about/cruiseandtourism/shorepower.aspx

Terminal in 2013. The project will cost $179,300 (CAD) and will decrease fuel consumption at the Swartz Bay Ferry Terminal by approximately 70,000 litresliters (18,500 gallons) annually, representing a net savings of about $45,000 (CAD) and an approximate 210 mtCO_2e reduction in GHG emissions.[306] Beginning in 2014, the Port of Halifax will be the first port in Atlantic Canada to implement shore power for cruise ships. The shore power infrastructure project represents a $10 million (CAD) initiative among the Government of Canada, the Province of Nova Scotia, and the Port of Halifax. Once installed, the shore power operation will decrease cruise ship idling by seven percent, which represents an annual decrease of approximately 123,000 litresliters (32,500 gallons) of fuel usage and 370 mtCO_2e and air pollutant emissions.[307]

[306] Transport Canada. Shore power arrives at Swartz Bay Ferry Terminal. (March 6, 2013). Accessed August 2013 at: http://www.tc.gc.ca/eng/mediaroom/releases-2013-h024e-7068.htm
[307] Transport Canada. Shore power arrives at the Port of Halifax. (January 23, 2013). Accessed August 2013 at: http://www.tc.gc.ca/eng/mediaroom/releases-2013-h003e-7035.htm

11 Public Benefit Fund (PBF)

Table 51: Potential Costs and Benefits of a Public Benefit Fund to Washington Consumers and Businesses

Potential Action for Consideration	
• Create clean energy business and economic development Public Benefit Fund • Create a Public Benefit Fund to serve electric utilities exempt from I-937 and natural gas utilities • Create a Public Benefit Fund to pursue efficiency that becomes cost-effective only when the price of carbon is included	
GHGs and Costs in Washington	
Three potential program designs are separately considered and quantified	
Implementation Issues and Lessons Learned	
• Cost recovery under I-937 functions similarly to a PBF, but a PBF can result in greater equity across citizens. • Rates must be set such that the PBF generates significant revenues without unduly impacting consumers. • PBF can target renewable energy, energy efficiency, clean energy research, development, and deployment (RD&D), or all of the above. • PBF can be used for low income assistance.	
Potential Costs and Benefits to WA Consumers	**Potential Costs and Benefits to WA Businesses**
• Reduce energy costs for consumers by reducing average bills and by limiting future energy price increases. • Electricity and/or natural gas rates will increase on a per kilowatt-hour or per therm basis as a result of the system benefits charge (SBC)[308], thus, higher energy consumers will pay more on an annual basis. These increased costs may be offset by the availability of resources for energy efficiency improvements. • Increased access to energy conservation and distributed renewable technology incentives and financing. • Improved grid reliability and emissions rates.	• Reduce energy costs for businesses by reducing average bills and by limiting future energy price increases. • Energy intensive sectors may face higher electric and/or natural gas rates. These increased rates may be offset by the availability of resources for energy efficiency improvements. • Increased access to energy conservation and distributed renewable technology incentives and financing. • Increased access to energy research, development, deployment, and other business development funding. • Increased commercialization of innovative or underutilized technologies to serve as a "feeder" to help achieve I-937 goals. • Improved grid reliability and emissions rates. • Expanded clean energy talent pool and job creation. • Improved cleantech competitiveness.
Summary of Screening Criteria	
Does the policy target an emissions source of significant magnitude in Washington?	

[308] A system benefits charge is a small surcharge to all ratepayers on electricity and/or gas consumption that produces revenue to fund the PBF.

Public benefit funds are used to fund utility demand-side management programs. These demand-side emissions sources primarily include electricity and natural gas consumption in the residential, commercial, and industrial sectors. These sources accounted for about 40 percent of State emissions in 2008.[309]

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?
States that use public benefit funds to finance energy efficiency programs have demonstrated a levelized cost of saved energy of between $16 and $33 dollars per megawatt-hour saved for electricity conservation measures and between $0.27 and $0.55 dollars per therm for natural gas conservation measures.[310] For electricity, this cost is generally much cheaper than developing new generation sources and results in significant GHG savings. Several states including California and New York also use public benefit funds for research, development, and deployment programs focused on clean energy business and economic development rather than strictly on GHG reductions.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?
A public benefit fund is simply a funding mechanism for energy programs. States with existing public benefit funds commonly use the money to fund a variety of energy efficiency, renewable energy, and clean energy research, development, and deployment programs.

Can the policy be meaningfully implemented or influenced at the State level?
Public benefit funds are most commonly implemented at the state level. The allocation of funds to underlying programs is typically administered directly by a state public service commission, or through a third-party administrator or utility service providers with public service commission oversight.

11.1 Introduction

A public benefits fund (PBF) is a policy mechanism intended to provide long-term, stable funding to support a variety energy-related programs that benefit the public at large. Specifically, states use PBFs to fund programs related to energy efficiency, investment in renewable energy, reduction of energy usage, environmental concerns, and provide aid to low-income customers.[311] Through the successful reduction of energy usage, PBFs not only reduce GHG emissions but can save customers millions of dollars in energy costs through financial (for example, rebates, grants, loans and performance-based incentives) and technical efficiency assistance, training programs, education, and investment in renewable energy sources.

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[309] Department of Ecology. 2010. Washington State Greenhouse Gas Emissions Inventory 2008 https://fortress.wa.gov/ecy/publications/publications/1002046.pdf
[310] ACEEE. 2009. Saving Energy Cost-Effectively: A National Review of the Cost of Saved Energy through Utility-Sector Energy Efficiency Programs. Accessed August 2013 at: http://www.aceee.org/sites/default/files/publications/researchreports/U092.pdf
[311] DSIRE. 2013. Public Benefit Funds. Accessed August 2013 at: http://www.dsireusa.org/solar/solarpolicyguide/?id=22

PBF revenues are typically collected from ratepayers through a small surcharge, or system benefits charge (SBC), on electricity and/or gas consumption, or through a flat monthly fee. These charges are typically "non-bypassible," meaning they are assessed to all customers in a nondiscriminatory fashion since customers are charged a PBF fee without regard to where they purchase electricity or gas. In other words, the charge is assessed for use of the distribution system rather than based upon the source of the electricity or gas.[312] Alternatively, some PBFs are funded through specified contributions from utilities.[313] Recently, some states have begun to supplement PBFs using alternative compliance payments made by utilities under state renewable portfolio standard (RPS) programs, or the revenue from the sale of carbon emissions allowances in the Regional Greenhouse Gas Initiative (RGGI) auctions.[314]

Despite the general benefits, some utilities and large energy consumers have individual concerns about PBFs. Utility companies with coupled profits and sales may be opposed to a PBF because the energy efficiency and renewable energy programs funded by a PBF may reduce sales, revenue, and profit. In addition, sales may be further reduced if the additional PBF charge increases energy prices enough to warrant energy conservation measures to reduce energy expenditures. By contrast, utilities that have capacity constraints that force them to utilize high-cost peaking power to meet electricity demand generally accept energy efficiency and load management programs funded by PBFs as a means of controlling peak load. In several states, utilities also benefit from PBFs that support their efforts to meet renewable portfolio standards. The unique supply and demand characteristics of affected utilities must be considered carefully in developing a PBF that supports energy efficiency, renewable energy, and other programs without adversely affecting utility profit margins.[315]

Large energy consumers may also oppose a PBF policy due to concerns about added energy costs. Despite these concerns, large energy consumers may receive a large benefit from PBF energy efficiency programs that provide significant energy and cost savings. In addition, PBF programs have the potential to reduce electricity supply constraints, produce lower rates for customers, and increase system reliability through lower peak energy demands. Ultimately, policymakers and program administrators must decide how best to allocate PBF funds to maximize public benefits and appease all stakeholders.[316]

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[312] DOE. 2010. Public Benefit Funds: Increasing Renewable Energy & Industrial Energy Efficiency Opportunities. Accessed August 2013 at: http://www1.eere.energy.gov/manufacturing/states/pdfs/publicbenefitfunds.pdf
[313] Center for Climate and Energy Solutions, 2013. Public Benefit Funds. Accessed August 2013 at: http://www.c2es.org/sites/default/modules/usmap/pdf.php?file=5893
[314] DSIRE. 2013. Public Benefit Funds. Accessed August 2013 at: http://www.dsireusa.org/solar/solarpolicyguide/?id=22
[315] DOE. 2010. Public Benefit Funds: Increasing Renewable Energy & Industrial Energy Efficiency Opportunities. Accessed August 2013 at: http://www1.eere.energy.gov/manufacturing/states/pdfs/publicbenefitfunds.pdf
[316] Ibid

A summary of existing PBF policies with significant clean energy business development appropriations is provided in Section 7.3, with a review of additional PBF programs provided in Appendix B. Section 7.1 summarizes existing work that has been done to evaluate the potential for, and impacts of, a PBF in Washington. Section 7.2 presents original analysis conducted for this report, which evaluates the potential emission reductions from three sample PBF-funded activities in Washington.

11.2 Literature Review of Washington Potential

Washington's Energy Independence Act (Initiative 937) requires utilities to meet energy efficiency and renewable energy targets. The energy conservation section of I-937 requires each electric utility with more than 25,000 customers to "pursue all available conservation that is cost-effective, reliable and feasible." [317] The renewable energy targets require each utility to obtain at least 15 percent of their electricity from new renewable resources by 2020. I-937 allows each qualifying investor-owned utilities to "recover all prudently incurred costs associated with compliance."[318] Cost recovery is achieved through rate adjustments and the charge is stated as a discrete line item on customer bills. This makes cost recovery under I-937 essentially similar to a SBC used in other jurisdictions, however, cost recovery and conservation efforts can be more broadly distributed with a PBF. Under I-937, each utility recovers its own costs from its own customers and the economic burden can vary across customers since some utilities may pursue conservation more or less vigorously than others. A PBF, by contrast, can result in greater equity across citizens and a higher overall level of effort with respect to acquisition of efficiency and renewable energy resources.

If Washington were to implement a PBF to supplement I-937, PBF dollars would need to be invested carefully to avoid redundancy with I-937 programs. For electricity conservation, this would mean that it could be used for conservation that does not meet the I-937 standard for cost-effectiveness, but which may still be relatively low cost as a GHG mitigation strategy. Any PBF dollars invested in renewable generation for qualifying utilities would either be used to contribute to the targets of I-937, or invested separately in renewable energy projects that do not contribute to RPS requirements. Similarly, the costs associated with natural gas conservation efforts by the State's regulated gas utilities, though not mandated by I-937, are also already recovered through rate adjustments or utility-level SBCs.[319]

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[317] RCW 19.285.040 - Energy conservation and renewable energy targets. Accessed August 2013 at: http://apps.leg.wa.gov/rcw/default.aspx?cite=19.285.040

[318] RCW 19.285.050 - Resource costs. Accessed August 2013 at: http://apps.leg.wa.gov/rcw/default.aspx?cite=19.285.050

[319] Utilities and Transportation Commission Website. Accessed August 2013 at: http://www.utc.wa.gov/consumers/energy/Pages/companyConservationPrograms.aspx

In effect, Washington's existing portfolio of ratepayer-funded energy efficiency and renewable energy programs are functionally similar to programs funded by PBFs in other states. To maximize the usefulness of a potential PBF in Washington, funds therefore must be directed to specific activities that do not interfere or overlap with I-937 or existing natural gas conservation initiatives. The following potential opportunities have been identified which may benefit from PBF support[320]:

- Clean energy business and economic development
- Energy efficiency and renewable development support for natural gas utilities and electric utilities not covered by I-937
- Climate change driven energy conservation through consideration for the cost of carbon

These potential opportunities are not meant to be an exhaustive list of initiatives that could be financed through a PBF. Washington could utilize PBF dollars to fund any combination of these initiatives or entirely different programs.

11.2.1 Clean Energy Business and Economic Development

Several states including California and New York, utilize PBF policies to fund energy research, development and deployment programs as well as general clean energy business and economic development initiatives. In 2010, a similar program was recommended for Washington by the Washington Clean Energy Leadership Council (CELC), with support from Navigant Consulting Incorporated, in their *Clean Energy Leadership Plan*. The Leadership Plan recommended a framework for growing clean energy businesses and jobs in Washington by promoting deployment and commercialization of cutting-edge clean energy solutions in the State as a platform for exporting clean energy solutions. The Leadership Plan also suggested a PBF, with a minimum funding level of $20 million, plus one to two times match funding from federal and private sources, as a promising funding source to support the initiative.[321] With total retail electricity sales of approximately 93,700 gigawatt-hours in 2011[322], an average SBC of about $0.00022 per kilowatt-hour would be required to generate $20 million in Washington. Assuming $40 to $60 million in total annual investment, the Plan projects the creation of 25,000 direct clean energy jobs and an additional 25,000 indirect and induced jobs by 2020 compared to business-as-usual if the program were to have begun in 2012. In total, the 50,000 new jobs could

[320] Other activities identified which may warrant further investigation include support for (1) fuel oil and propane efficiency activities and (2) utilities limited by the cost cap in their efforts to meet I-937 renewable generation targets.
[321] Navigant Consulting Inc. 2010. Washington State Clean Energy Leadership Plan Report. Accessed August 2013 at:
http://wacleantech.org/wp-content/uploads/2011/08/CELC_Navigant-Final-Report_Final.pdf
[322] EIA State Energy Data System. Accessed August 2013 at: http://www.eia.gov/electricity/data.cfm#sales

earn nearly $2.5 billion in annual income (in 2010 dollars).[323] The study does not estimate the GHG impacts resulting from actions defined in the Leadership Plan since the primary drivers are job creation and economic development.

Subsequent to the Leadership Plan Report, the CELC presented a series of specific recommendations for implementing the Leadership Plan in a letter to Governor Gregoire and the Legislature in January 2011.[324] The first recommendation in the letter was to establish an "innovative, dynamic Clean Energy Partnership by consolidating and refocusing existing state resources, rather than creating a new organization." As a result, the 2011 Legislature introduced, but did not pass, a bill that would have formally created the Washington Clean Energy Partnership (CEP) and established a funding mechanism. Instead, the 2011 legislature established a more broadly defined new state agency called "Innovate Washington" described by RCW 43.333 as "a collaborative effort between the state's public and private institutions of higher education, private industry, and government and is to be the primary agency focused on growing the innovation-based economic sectors of the state and responding to the technology transfer needs of existing businesses in the state." Innovative Washington's mission was to "make Washington the best place to develop, build, and deploy innovative products, services, and solutions to serve the world." [325] In July, the 2013 Legislature eliminated funding for Innovate Washington after two years of operation.[326]

11.2.2 Energy Efficiency and Renewable Development Support for Natural Gas Utilities and Electric Utilities Not Covered by I-937

Initiative 937 requires each electric utility with more than 25,000 customers to meet energy conservation and renewable generation targets. Seventeen of the State's 62 utilities are currently required to meet I-937 targets and provide approximately 81 percent of the electricity in Washington.[327] This means that utilities responsible for providing the remaining 19 percent of electricity in Washington are not subject to I-937 requirements. Likewise, natural gas utilities are

[323] Navigant Consulting Inc. 2010. Washington State Clean Energy Leadership Plan Report. Accessed August 2013 at:
http://wacleantech.org/wp-content/uploads/2011/08/CELC_Navigant-Final-Report_Final.pdf

[324] Washington Clean Energy Leadership Council. 2011. Letter to the Governor and Legislator. Accessed August 2013 at: http://wacleantech.org/wp-content/uploads/2011/08/CELC-Recommendations-_-Transmittal-Letter_Final.pdf

[325] GreenTech. 2012. The State of Cleantech in Washington, Part I: Clean Energy Leadership. Accessed August 2013 at: http://www.wagreentech.com/2012/02/state-of-cleantech-in-washington-part-i/

[326] Sowa. 2013. Innovate Washington loses state funding. Accessed August 2013 at: http://www.spokesman.com/stories/2013/jul/11/innovate-washington-loses-state-funding/

[327] Department of Commerce EIA Reporting Website. Accessed August 2013 at: http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/EnergyIndependence.aspx

also not covered by I-937[328]. A PBF could be used to finance energy conservation and renewable energy development for the customers of Washington's natural gas and small electric utilities.

Maximizing GHG reductions from this type of PBF-funded program would require careful examination of the incremental effect of investments in electricity efficiency compared to natural gas efficiency. A comparison of incremental effects in the natural gas sector versus the electric sector may include examination of the following sector characteristics:

- The strength of existing mandates for energy efficiency for natural gas utilities relative to electric utilities,
- The strength of market incentives due to the retail per-Btu price of natural gas relative to electricity, and
- The carbon intensity of natural gas relative to electricity (e.g., if natural gas is the incremental resource in the electricity resource stack the direct use of natural gas may actually produce less carbon than the use of electricity to serve the same demand)

The above list is not exhaustive of all sector characteristics that should be examined when optimizing PBF distributions for GHG reductions. Examination of these and other relevant sector characteristics is beyond the scope of this analysis but warrants further investigation.

11.2.3 Climate Change-Driven Energy Conservation through Consideration for the Cost of Carbon

According to the *Sixth Power Plan Midterm Assessment Report*, the lowest cost new generating resource for an energy-short utility is usually a combined-cycle natural gas-fired combustion turbine (natural gas CCCT). The levelized cost of natural gas CCCT is highly dependent on the price of natural gas and is estimated to be about $50, $65, and $80 per megawatt-hour for a plant operating with an average capacity factor of 51 percent and natural gas prices of $2, $4, and $6 per million Btu, respectively[329]. Utilities have little incentive to invest in any energy conservation measures that have higher costs on a per megawatt-hour basis, especially utilities with coupled sales and profits. In addition, the I-937 would presumably not permit a utility to count conservation against its targets if it cost more than the cost of electricity from a new natural gas generation resource. With consideration for the cost of carbon, however, the economics change. The U.S. EPA's most recent estimate of the social cost of carbon for 2015 through 2050 is provided below in 2013 dollars.

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[328] Suppliers of heating oil and propane are also not covered by I-937 and PBF dollars could be used to support their efficiency projects for their customers, however, the potential GHG reductions from these fuels are limited due to low consumption in the State relative to electricity and natural gas

[329] Northwest Power and Conservation Council. 2013. Sixth Power Plan Midterm Assessment Report. Accessed August 2013 at: http://www.nwcouncil.org/media/6391355/2013-01.pdf

Table 52. Social Cost of CO_2 and impact on cost of natural gas generation, 2015-2050 (3 percent discount rate)

Year	Social Cost of Carbon (2013$/metric ton CO_2)[330]	Calculated Increase to Levelized Cost of Electricity for Natural Gas CCCT (2013$/MWh)
2020	$48	$21
2035	$63	$28
2050	$79	$35

Table Note: The SCC values are dollar-year and emissions-year specific.

The social cost of carbon is an estimate of the economic damages including but not limited to changes in net agricultural productivity, human health, and property damages from increased flood risk associated with a small increase in carbon dioxide emissions, conventionally one metric ton, in a given year. This dollar figure also represents the value of damages avoided for a small emission reduction (i.e. the benefit of a carbon dioxide reduction). Based on the emissions of a natural gas CCCT (980 pounds CO_2e per MWh), this equates to an increase in the levelized cost of natural gas CCCT by $21, $28, and $35 per megawatt-hour in 2020, 2035, and 2050, respectively (in 2013 dollars).

The increase in the levelized cost of natural gas CCCT due to consideration for the social cost of carbon would make a greater number of energy conservation measures ”cost-effective” and would result in avoided emissions at a rate of 980 pounds or 0.44 metric tons of carbon dioxide per megawatt-hour saved. In the absence of a legislated price on carbon, Washington could use a PBF to finance energy conservation measures that are not considered cost-effective in the traditional sense when compared to the levelized cost of natural gas CCCT, but are cost-effective when consideration is given to the social cost of carbon.

11.3 Quantification

This section analyzes the potential GHG emission reductions that could be generated from implementation of a PBF in Washington. The work includes new analysis and builds on previous analysis, including the consultant work performed in 2010, and Task 1 analysis of the GHG impacts of I-937. Since a PBF is simply a funding mechanism, the GHG impacts are fully dependent on the specific initiatives funded by the PBF and the size of the fund. These analyses investigate GHG impacts for only a sample of potential programs that could be funded through a PBF and the results should only be used for high-level policy evaluation. Where possible, these analyses project to 2020, 2035, and 2050 to provide a picture of the long-term outcomes that

[330] U.S. EPA Website: The Social Cost of Carbon (adjusted from 2011 to 2013 dollars). Accessed August 2013 at: http://www.epa.gov/climatechange/EPAactivities/economics/scc.html

could be expected from a sample of PBF-funded programs. In particular, these analyses include estimates of the GHG impacts from PBF dollars appropriated for clean energy business and economic development, energy efficiency and renewable development support for utilities not covered by I-937, and climate change driven energy conservation through consideration for the cost of carbon.

11.3.1 Methodology

Separate analyses that utilized different methodologies were performed for three potential PBF-funded programs. Each unique methodology is described in the sections below.

11.3.1.1 Clean Energy Business and Economic Development

Although GHG reductions are not cited as a primary driver for the clean energy business and economic development program defined in the Clean Energy Leadership Plan, reductions are likely to occur as a result of advancement and accelerated commercialization of clean energy technologies, improvement of energy codes and appliance efficiency standards, and related activities. This type of program essentially acts as a “feeder” of technologies, innovations, and information that can be leveraged to meet I-937 energy conservation and renewable generation requirements and to improve the energy code and appliance efficiency standards. This is an important point when estimating GHG emissions and reductions in the State since the majority of reductions from this type of program are indirect and ultimately subsumed by downstream, beneficiary programs.

The investment options to support clean energy business and economic development are virtually limitless and any forecast of rate of technology development carries extremely high uncertainty. For this analysis, energy savings claims and investment levels of a similarly defined program in New York have been scaled to Washington. The assumptions and methodologies used by New York in their estimates are not available. Therefore, rather than recreate those calculations with assumptions suitable for Washington, this analysis scales the energy savings claims made by New York according to their established investment level compared to an assumed investment level in Washington, and then applies Washington-specific emission factors to estimate GHG reductions. It should be noted that the majority of savings claimed by New York are the result of improvements to the energy code and standards which are informed by the state’s PBF-funded Technology and Market Development (T&MD) program. Since Washington has already implemented an aggressive energy code improvement schedule, a PBF-funded clean energy business and economic development program will undoubtedly inform future energy codes but the associated savings are significantly overlapping between the two programs.

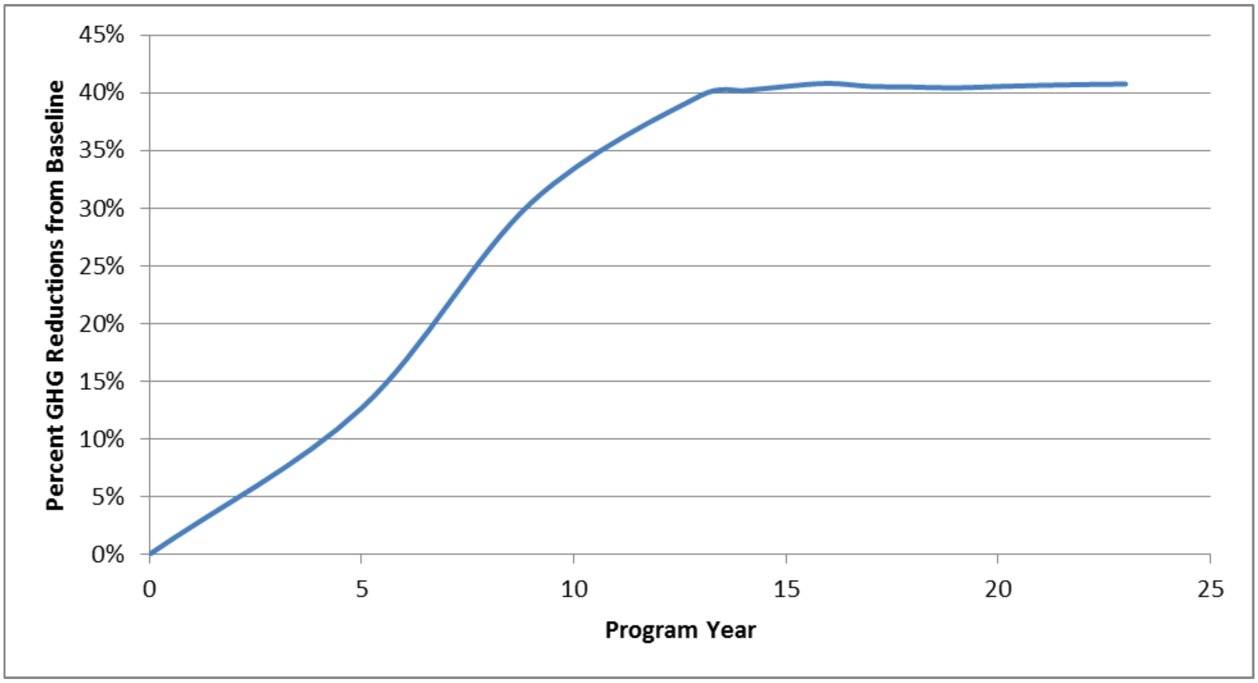
The *NYSERDA Technology and Market Development Program: Semi-Annual Report Through December 31, 2012* projects cumulative annual savings of electricity and natural gas consumption, electricity demand, and carbon dioxide emissions in 2016 and 2020 as a result of program activities and investments made during 2012 through 2016[331]. The report also estimates that 1.2 times match funding will be leveraged through program investments by 2016. This assumption aligns with that made by Navigant in Washington's *Clean Energy Leadership Plan.* Since the annual budget for NYSERDA T&MD program is approximately $105 million including 14 percent administrative, evaluation, and other operational costs, and the recommended program funding level in Washington is $20 million, all energy savings figures presented by NYSERDA are scaled-down by a factor of 20 to 105 (about 19 percent). Projected Washington emissions savings are calculated separately due to differences in regional grid emission factors between Washington and New York.

11.3.1.2 Energy Efficiency and Renewable Development Support for Utilities Not Covered By I-937

The method used to estimate the GHG impacts of achieving I-937 requirements at utilities with less than 25,000 customers included mimicking the pace of GHG reductions on a percentage basis as determined in the Task 1 analysis of I-937 for qualifying utilities and offsetting the start date of the program from 2007 to 2016. This strategy ensures that assumptions are consistent across tasks, and accounts for effects of the later program start date. Since I-937 and the associated draft Task 1 analysis cover utilities responsible for providing about 81 percent of electricity in Washington, this analysis covers the remaining utilities responsible for providing about 19 percent of electricity in the State. As a result, this analysis forecasts baseline scenario emissions for non-qualifying utilities by multiplying the baseline scenario emissions forecast for qualifying utilities (as calculated in the analysis of I-937 under Task 1) by a factor of 19/81, or about 0.24. This analysis also assumes the pace of GHG reductions relative to the baseline scenario will mimic the pace of GHG reductions calculated in the draft Task 1 analysis for qualifying utilities. The pace of GHG reductions as calculated in the draft Task 1 analysis is presented in the table below on a percentage basis.

[331] NYSERDA. 2013. Operating Plan for Technology and Market Development Programs (2012–2016). Accessed August 2013 at: http://www.nyserda.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/-/media/Files/General/System%20Benefits%20Charge/nyserda_tmd_semiannual_report.pdf

Figure 9. Percent GHG Reduction from Baseline for Qualifying Utilities Under I-937 (Draft Task 1 Analysis Results)



Shifting the program start year for small utilities to 2016 results in the following pace of emissions reductions:

Table 53. Pace of Emissions Reductions Relative to Baseline for Achieving I-937 Targets at Utilities with Less than 25,000 Customers Assuming a Program Start Year of 2016

Calendar Year	Program Year	Percent GHG Reduction
2020	5	13%
2035	20	40%

11.3.1.3 Climate Change Driven Energy Conservation through Consideration for the Cost of Carbon

This analysis does not attempt to estimate the supply of available electricity conservation measures that become cost-effective relative to building new generation sources in each target year when the cost of carbon is considered. Instead, this analysis estimates the increase in levelized cost of developing natural gas CCCT generation in each target year as a result of the cost of carbon. Cost increase was determined by multiplying the emission rate for natural gas CCCT technology by the average social cost of carbon in each target year as defined by the EPA for a discount rate of three percent. Ultimately, this cost increase makes a number of energy conservation measures cost-effective relative to developing new natural gas CCCT generation. In the absence of a carbon cost, these measures were not considered cost-effective.

Since natural gas CCCT generates emissions and energy conservation measures do not, there are GHG savings associated with electing to develop energy conservation measures in lieu of developing new natural gas CCCT generation to accommodate the same demand. These GHG savings are simply represented by the emission rate of natural gas CCCT, defined as 980 pounds per megawatt-hour of generation.[332] This analysis does not attempt to quantify a likely amount of conservation acquired based on PBF size or the supply of available conservation measures. Instead, this analysis provides a scalable cost per metric ton of saved carbon dioxide. Results are provided in the Quantification section below.

11.3.2 Assumptions, Exclusions, and Data Sources

Separate analyses that utilized different assumptions, exclusions and data sources were performed for three potential PBF-funded programs. Each unique set of assumptions, exclusions and data sources is described in the sections below.

11.3.2.1 Clean energy business and economic development

The following assumptions about a clean energy business development program funded through a PBF policy are included in this analysis:

- The program begins in 2016
- Annual state funding through a PBF is $20 million from 2016 through 2020
- Administration, evaluation, and other operational costs represent 14 percent of total program costs
- Match funding achieves 1.2 times total investments and disbursements by 2020 (i.e., after five program years)
- Electricity and natural gas savings achievement are 19 percent of NYSERDA claims; This ratio was selected to match the program budget ratio
- Electricity emission factors assumed to continuously improve from 2009 to 2050 according the rate projected for the NWPP by AEO2013

This analysis relies on the data sources summarized in Table 32 below.

[332] Department of Commerce. 2012. Survey of Combined Cycle Combustion Turbine Greenhouse Gas Emission Rates. Accessed 2013 at: http://www.leg.wa.gov/documents/legislature/ReportsToTheLegislature/Survey%20of%20Commercially%20Available%20Turbines_FINAL_11%205%2012%20pdf_a776d3a6-d603-42ad-b998-19bbf1c98a31.pdf

Table 54: Primary data sources used to quantify GHG impacts of a Washington State PBF-funded clean energy business and economic development program

Data	Source
NYSERDA T&MD program electricity and natural gas savings projections, total and annual investment levels, and anticipated match funding	NYSERDA. 2013. NYSERDA Technology and Market Development Program: Semi-Annual Report Through December 31, 2012 http://www.nyserda.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/-/media/Files/General/System%20Benefits%20Charge/nyserda_tmd_semiannual_report.pdf
Recommended annual investment level for Washington State	Navigant Consulting Inc. 2010. Washington State Clean Energy Leadership Plan Report http://wacleantech.org/wp-content/uploads/2011/08/CELC_Navigant-Final-Report_Final.pdf
Electricity CO_2e emission factor for Northwest Power Pool	EPA. 2012. eGRID2012 year 2009 Summary Tables http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2012V1_0_year09_SummaryTables.pdf
Electricity emission factor improvement rate	EIA. 2013. Annual Energy Outlook 2013. Electric Power Projections for Northwest Power Pool Area http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2013&subject=0-AEO2013&table=62-AEO2013&region=3-21&cases=ref2013-d102312a
Natural gas CO_2, CH_4, and N_2O emission factors	The Climate Registry. 2013. The Climate Registry's 2013 Default Emission Factors (http://www.theclimateregistry.org/downloads/2013/01/2013-Climate-Registry-Default-Emissions-Factors.pdf)
Global Warming Potential for CO_2, CH_4, and N_2O	IPCC. 1995. IPCC Second Assessment Report: Climate Change 1995 (SAR) (https://docs.google.com/uc?export=download&confirm=no_antivirus&id=0B1gFp6Ioo3aka3NsaFQ3YlE3XzA)

11.3.2.2 Energy efficiency and renewable development support for utilities not covered by I-937

The following assumptions about a small utility energy efficiency and renewable development program funded through a PBF policy are included in this analysis:

- The program begins in 2016
- Projected baseline GHG emissions at small utilities are proportional to baseline GHG emissions estimated for utilities covered by I-937 in all program years according to the relative share of electricity currently provided by the utilities (i.e., 19% for small utilities and 81% of I-937-covered utilities)
- The pace of GHG reductions relative to the baseline scenario over time and on a percentage basis matches the pace of GHG reductions calculated and forecasted in the draft Task 1 analysis for qualifying utilities under I-937

This analysis relies on the data sources summarized in Table 55 below.

Table 55: Primary data sources used to quantify GHG impacts of a Washington State PBF-funded energy efficiency and renewable development program for small utilities

Data	Source
Baseline emissions forecast and pace of reductions on a percentage basis	Task 1 analysis of the GHG impacts of I-937

11.3.2.3 *Climate change driven energy conservation through consideration for the cost of carbon*

The following assumptions about a climate change-driven energy conservation program funded through a PBF policy are included in this analysis:

- The program begins in 2016
- Avoided GHGs are the result of reducing demand through energy conservation in lieu of meeting demand with new generation from natural gas CCCT technology
- The emission rate for natural gas CCCT technology is 980 pounds or 0.44 metric tons of carbon dioxide per megawatt-hour
- The average social cost of carbon is $48, $63, and $79 per metric ton of carbon dioxide at a discount rate of three percent for 2020, 2035, and 2050, respectively (in 2013 dollars)

This analysis relies on the data sources summarized the Table 56 below.

Table 56: Primary data sources used to quantify GHG impacts of a Washington State PBF-funded climate change-driven energy conservation program

Data	Source
Natural Gas CCCT Emission Rate	Department of Commerce. 2012. Survey of Combined Cycle Combustion Turbine Greenhouse Gas Emission Rates. Accessed 2013 at: http://www.leg.wa.gov/documents/legislature/ReportsToTheLegislature/Survey%20of%20Commercially%20Available%20Turbines_FINAL_11%205%2012%20pdf_a776d3a6-d603-42ad-b998-19bbf1c98a31.pdf
Social Cost of Carbon in 2020, 2035, and 2050 (adjusted from 2011 to 2013 dollars)	U.S. EPA Website: The Social Cost of Carbon (adjusted from 2011 to 2013 dollars). Accessed August 2013 at: http://www.epa.gov/climatechange/EPAactivities/economics/scc.html
Consumer Price Index (CPI) for 2011 and 2013	U.S. Department Of Labor - Bureau of Labor Statistics ftp://ftp.bls.gov/pub/special.requests/cpi/cpiai.txt

11.3.3 Results

The sections below present the individual results for all three potential PBF-funded programs presented above. These results are based on several general assumptions and in some cases limited data and are intended to be used only for high-level policy evaluation.

11.3.3.1 Clean energy business and economic development

As noted above, direct GHG reductions are not a primary driver for this type of program, and direct reductions are likely to be dwarfed by indirect reductions that occur as a result of technologies, innovations, and information leveraged to meet I-937 energy conservation and renewable generation requirements, and to improve the energy code and appliance efficiency standards. This is an important point when considering the results presented below since the majority of reductions from this type of program are overlapping with downstream, beneficiary programs.

Based on the anticipated benefits of the NYSERDA T&MD program, and adjusted for the anticipated Washington investment level, the expected direct and indirect benefits in Washington are estimated in Table 57.

Table 57. Hypothetical Washington Clean Energy Business and Economic Development Program Estimated Direct and Indirect Benefits through Five Program Years

Budget and Benefits	Units	Quantity
Total Budget 2016-2020	$	100 million
Program Investments and Disbursements	$	86 million
Administrative and Operational Costs	$	14 million
Match Funding Acquired 2016-2020	$	106 million
Total Electricity Savings*	MWh	110 thousand
Total NG Savings*	MMBtu	570 thousand
Total Demand Savings*	MW	30
Total System-wide CO_2 Reduction*	**Metric Tons**	**70,000**

* Benefits are cumulative annual savings in 2020 (i.e., after 5 program years)

NYSERDA also presents isolated direct savings from projects and technology installations directly funded by the program. If scaled to Washington's assumed program budget, the estimated direct savings in Washington are approximated in Table 58.

Table 58. Hypothetical Washington Clean Energy Business and Economic Development Program Estimated Benefits for Directly Funded Projects and Technology Installations through Five Program Years

Direct Impacts	Units	Quantity
Electricity Savings*	MWh	40,000
NG Savings*	MMBtu	120,000
Demand Savings*	MW	10
System-wide CO_2 Reduction*	Metric Tons	20,000

* Benefits are cumulative annual savings in 2020 (i.e., after 5 program years)

It is clear from these results that the direct and total program impacts on GHGs is marginal compared to total state emissions. This is to be expected since the primary drivers for this type of program are job creation and business and economic development rather than GHG reductions. For this reason, cost per metric ton of carbon dioxide reduced is not a relevant metric for this funding option and, thus, is not quantified in this analysis.

11.3.3.2 Energy efficiency and renewable development support for utilities not covered by I-937

Task 1 analysis of qualifying utilities under I-937 indicates that GHG emissions will be reduced by about 10 percent in the fifth program year and just over 40 percent in the fifteenth program year. If utilities with less than 25,000 customers meet the targets defined by I-937 beginning in 2016 for their share of generation in Washington, the following GHG reductions may be achieved.

Table 59. Emissions Reductions Relative to Baseline for Achieving I-937 Targets at Utilities with Less than 25,000 Customers Assuming a Program Start Year of 2016

Calendar Year	Program Year	Projected Baseline Scenario GHGs ($MMTCO_2$)	Percent GHG Reduction Relative to Baseline	GHG Reduction ($MMTCO_2$)
2020	5	4.5	13%	0.6
2035	20	7.1	41%	2.9

Compiled total cost of compliance data was not available for Washington utilities required to meet the conservation and renewable energy targets defined by I-937. However, a study of utility energy efficiency programs in other states indicates that these programs typically achieve a levelized cost of saved electricity of $16-33 per megawatt-hour and a levelized cost of saved natural gas of $0.27-55 per therm.[333] These costs represent utility costs only and do not include participant expenditures on program-sponsored projects. For renewable energy, the Annual Energy Outlook indicates levelized costs in the range of $87-144 per megawatt-hour for popular renewable technologies such as wind, solar PV and biomass.[334] Additional analysis is warranted to determine the SBC required to the I-937 targets based on these levelized costs.

Data was not available to estimate Washington-specific emissions abatement costs associated utility energy efficiency and renewable energy programs. Literature suggests abatement costs in other jurisdictions of ranging from a cost of $51 to a savings of $103 per metric ton of carbon

[333] ACEEE. 2009. Saving Energy Cost-Effectively: A National Review of the Cost of Saved Energy through Utility-Sector Energy Efficiency Programs. Accessed August 2013 at: http://www.aceee.org/sites/default/files/publications/researchreports/U092.pdf

[334] Energy Information Administration. 2013. Levelized Cost of New Generation Resources in the Annual Energy Outlook 2013. Accessed September 2013 at: http://www.eia.gov/forecasts/aeo/electricity_generation.cfm

dioxide for energy efficiency programs, and abatement costs ranging from a cost of $146 to a savings of $15 per metric ton of carbon dioxide for renewable energy programs. The table below provides abatement costs for more specific types of energy efficiency and renewable energy programs.

Table 60. Cost-effectiveness Comparison of Emissions Reduction Measures (Parentheses Indicate Negative Numbers that Should be Interpreted as Cost Savings)

Policy Category	Emissions Reduction Measure	Emissions Abatement Cost (2010$/mtCO2e)
Energy Conservation (funded by PBF or PACE)	Financial Incentives and Instruments/ Demand Side Management Programs	($43)d
	Improvements to Existing Buildings with Emphasis on Building Operations	($80)e to $7b
	Lighting	($97)b to $51c
	Electronic Equipment	($103)b
	HVAC Equipment	$5c to $50b
	Building Shell	($47)b to $21c
	Residential Water Heaters	$9b
	Conversion Efficiency	($17)b
Renewable Energy Generation (funded by PBF or PACE)	Distributed Renewable Energy Incentives	$146a
	Wind	$22b to $114e
	Solar Photovoltaic	$32b to $51c
	Solar Thermal	$134e to $142c
	Geothermal	($15)c to $102e
	Small Hydropower	$100e
	CHP	($40)b to $20e

[a] = Washington CAT (Washington)
[b] = McKinsey MACC (United States)
[c] = Bloomberg MACC (United States)
[d] = Johns Hopkins MACC (United States)
[e] = Sweeney and Weyant MACC (California)

11.3.3.3 Climate change driven energy conservation through consideration for the cost of carbon

Consideration for the social cost of carbon increases the levelized cost of energy for natural gas CCCT by $21, $28, and $35 per megawatt-hour in 2020, 2030, and 2050, respectively. In addition, at a savings rate of 0.44 metric tons carbon dioxide per megawatt-hour (the GHG emission rate of natural gas CCCT technology), Washington could avoid about 440,000 metric tons of carbon dioxide per year for every one million megawatt-hours of demand met through energy conservation measures in lieu of developing new natural gas CCCT generation.

By definition, the social cost of carbon represents the emissions abatement cost under this program option. These abatement costs are $48, $63, and $79 per metric ton of carbon dioxide for 2020, 2035, and 2050, respectively.

11.4 Implementation History

This section summarizes public benefits funds that support clean energy business development implemented in other jurisdictions. It is intended to provide context for the above analysis, and an indication of the relative success of PBFs in other jurisdictions.

California: California created a PBF in 1998 to fund renewable energy, energy efficiency, and research, development and demonstration (RD&D) projects. Originally, the PBF collected a public goods charge (PGC) only on ratepayer electricity use, but a gas surcharge was added in 2001. The California Public Utilities Commission (CPUC) separately collects funds for the California Solar Initiative (CSI), the Self-Generation Incentive Program, the Renewables Portfolio Standard and other programs, but they are not captured in this analysis. In 2011, the state failed to pass legislation authorizing PGC collections in 2012 or later years. However, the Electric Program Investment Charge (EPIC) fund was created to collect funds to continue support for renewable energy and RD&D projects. In addition, a portion of the Procurement Energy Efficiency Balancing Account (PEEBA) was used to continue support for EE and low-income assistance programs on an interim basis. Further CPUC action is needed to continue funding of these programs.[335]

The California PGC/EPIC surcharge is non-bypassable, and the CPUC oversees the fund. Generally, the California Energy Commission (CEC) administers the renewable energy and RD&D programs, while utilities administer the energy efficiency and low-income assistance programs. California's surcharges on ratepayer electricity use average $0.0054/kWh for energy efficiency, $0.0016/kWh for renewable energy, and $0.0015/kWh for RD&D. From inception through about 2011, the PGC fund distributed approximately $228 and $62.5 million annually for energy efficiency and RD&D, respectively. Renewables received $135 million annually from 2002 to 2007 and $65.5 million annually from 2008 to 2011. Beginning 2005, natural gas subaccount baseline funding was $12 million with increases of up to $3 million annually to a $24 million cap. According to EPIC investment planning documents, $368.8 million has been budgeted for applied research and development, technology demonstration and deployment, and market facilitation from 2012 to 2014.[336]

[335] DSIRE. 2013. California Public Benefits Funds for Renewables and Efficiency. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA05R
[336] Ibid

Over the 15-year life of California RD&D programs, investments have totaled $839 million and attracted $1.35 billion in match funding.[337] The current version of California's R&D program is named the Public Interest Energy Research (PIER program and it is was estimated that 2,800 direct and 4,500 indirect full-time jobs were sustained during 2012 as a result of PIER-funded projects and these projects will produce 27,700 direct, indirect, and induced jobs in the long-term. California utilizes PIER-funded R&D to inform energy codes and appliance efficiency standards, claiming that $27.6 million invested from 1999 to 2008 will result in $10.1 billion in benefits to ratepayers between 2005 and 2025 from 122,600 gigawatt-hours of electricity savings and 1.1 billion therms of natural gas savings.

New York: The New York Public Service Commission (PSC) established a system benefits charge (SBC), in 1996 to support energy efficiency, education and outreach, research and development, and low-income energy assistance. SBC funds are collected from customers of the state's six investor-owned electric utilities. The SBC program is administered by NYSERDA and only customers that pay the SBC are eligible for assistance through the programs it funds.

The SBC has gone through several iterations since it was first created in 1996 and was most recently extended for an additional five years through December 31, 2016. The renewed authorization (SBC IV) shifted many activities and programs away from some areas that had previously been funded by the program. For example, the various demand-side energy efficiency programs under the Energy $mart program were shifted to state's Energy Efficiency Portfolio Standard (EEPS) which is funded separately. SBC IV funds the Technology and Market Development (T&MD) Program and has an annual budget of about $104.7 million per year for 2012 through 2016.[338] The mission of the T&MD program is to "test, develop, and introduce new technologies, strategies and practices that build the statewide market infrastructure to reliably deliver clean energy to New Yorkers." Specific objectives include: (1) moving new or under-used technologies and services into marketplace to serve as a "feeder" to help achieve EEPS & RPS goals; (2) validating emerging energy efficiency, renewable, and smart grid technologies/strategies and accelerate market readiness in New York State; (3) stimulating technology and business innovation to provide more clean energy options and lower cost

[337] California Energy Commission. 2011. Renewable Energy Program 2011 Annual Report To The Legislature. Accessed August 2013 at: http://www.energy.ca.gov/2011publications/CEC-300-2011-007/CEC-300-2011-007-CMF.pdf

[338] NYSERDA. 2013. Operating Plan for Technology and Market Development Programs (2012–2016). Accessed August 2013 at: http://www.nyserda.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/-/media/Files/General/System%20Benefits%20Charge/nyserda_tmd_semiannual_report.pdf

solutions, while growing New York State's clean energy economy; and (4) spurring actions and investments to achieve results distinct from incentive-based programs.[339]

[339] NYSERDA. 2013. Operating Plan for Technology and Market Development Programs (2012–2016). Accessed August 2013 at: http://www.nyserda.ny.gov/Publications/Program-Planning-Status-and-Evaluation-Reports/-/media/Files/General/System%20Benefits%20Charge/nyserda_tmd_semiannual_report.pdf

12 Property Assessed Clean Energy (PACE) Programs

Potential Action for Consideration

- Pass enabling legislation at the State level to remove barriers to local administration of Property Assessed Clean Energy programs, which support energy conservation and renewable energy.

GHGs and Costs in Washington	GHG Reductions (MMTCO2e) 2020	2035	2050	Cost ($/mt$CO_2$e)
$10 million annual investment for 5 years	0.02	0.05	0.6	$(171)

Implementation Issues and Lessons Learned

- Must define qualifying building types (residential, commercial, industrial) and qualifying improvements (e.g., energy efficiency, renewable energy)
- PACE programs to date have been small because the funding mechanism is in its infancy
- Must establish the assessment lien position relative to mortgages and other tax assessments. There are currently legal challenges related to this issue in the residential sector that have largely stalled residential PACE implementation.
- Requires seed funding for early loans, or involvement of private firms to manage debt.
- There are several PACE lending models, such as warehoused, pooled bond, or owner-arranged/open market.

Potential Costs and Benefits to WA Consumers

- Elimination of large up-front costs for energy retrofits combined with a long loan payback period of up to 20 years.
- Energy efficiency or renewables improvements will generally yield net savings on annual energy purchases.
- Consumers incur the cost of the loan principle and interest; however, interest paid on PACE loans is tax deductible.[340]

Potential Costs and Benefits to WA Businesses

- Opportunities for local construction businesses and contractors to retrofit buildings with energy efficiency and renewables technology.
- Increased economic output and opportunity for job creation not only in the PACE program, but also for businesses impacted by PACE such as local builders, banks, and private lenders.
- Businesses participating in a PACE program will incur cost of the loan principle and interest; however, interest paid on PACE loans is tax deductible.[341]

Summary of Screening Criteria

Does the policy target an emissions source of significant magnitude in Washington?
PACE programs target emissions from electricity and fossil fuel consumption in the residential, commercial and industrial sectors. Together, the electricity consumption sector and residential/commercial/industrial (RCI) sector accounted for about 40% of State emissions in 2008.[342]

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?
Since PACE programs only provide financing and are generally administered at the local level, costs to the state are minimal for oversight and general administration functions only. Some resources are also

[340] Clean Technica. Open PACE Markets Provide Most Benefit to Property Owners. Accessed August 2013 online at: http://cleantechnica.com/2013/05/21/open-pace-markets-provide-most-benefit-to-property-owners/
[341] Clean Technica. Open PACE Markets Provide Most Benefit to Property Owners. Accessed August 2013 online at: http://cleantechnica.com/2013/05/21/open-pace-markets-provide-most-benefit-to-property-owners/
[342] Department of Ecology. 2010. Washington State Greenhouse Gas Emissions Inventory 2008 https://fortress.wa.gov/ecy/publications/publications/1002046.pdf

required initially to pass enabling legislation. Ultimately, the majority of costs associated with GHG reductions are incurred by participating consumers. To date, the volume of reductions from PACE programs has been small because most programs are still in their infancy and have limited fund sizes (typically less than $30 million). Some programs also fund water conservation and other non-energy projects which contributes to the observed small volume of reductions.

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?
PACE is discrete and comprehensive as a clean energy financing mechanism that is repaid by an assessment added to the owner's property tax bill. The tax lien is unique to PACE and provides security to lenders and allows them to lend at favorable interest rates. These tax liens stay with the property rather than the property owner which alleviates concerns that investments will outlive the period of ownership before the asset is sold. The property and project types, as well as the participant eligibility criteria are subject to state and or local program requirements.

Can the policy be meaningfully implemented or influenced at the State level?
PACE programs are generally implemented at the local level where property taxes are managed but require enabling legislation at the state-level. The key features that often must be added to existing state law to enable PACE include (1) the authority to finance improvements on private property; (2) the authority to finance renewable energy and energy efficiency improvements; and (3) an opt-in feature.[343]

12.1 Introduction

Property assessed clean energy (PACE) programs provide a unique loan mechanism to property owners for the deployment of energy efficient technologies and renewable energy at residential, commercial and industrial facilities. These loans allow owners to pay for energy improvements over time, avoiding the barrier of upfront investment costs. By promoting energy conservation and renewable power generation, PACE programs capture energy cost savings and realize environmental co-benefits including reduced emissions from fossil energy consumption, water conservation and improved air quality.

The underlying PACE mechanism is common to all programs: a local government provides or arranges for financing that is repaid with a property tax-like assessment with a term length of up to 20-years. The tax lien is unique to PACE and provides security to lenders and allows them to lend at favorable interest rates. PACE loans can optionally stay with the property despite ownership changes. If a building owner sells their property before the PACE loan is paid off, the loan can either be paid off at the time of sale or transferred with the property to the new owner. Since commercial building ownership changes about every four to six years on average[344], this

[343] DOE. 2013. Clean Energy Finance Guide: Chapter 12. Commercial Property-Assessed Clean Energy (PACE) Financing.
http://www4.eere.energy.gov/wip/solutioncenter/finance_guide/sites/default/files/docs/ch12_commercial_pace_all.pdf
[344] Johnson Controls. 2010, An Awakening in Energy Efficiency: Financing Private Sector Building Retrofits. Accessed September 2013 at:

feature is critical for building owners to invest in efficiency measures with payback periods of four years or more.

Interest in residential PACE was stymied in 2010 when the Federal Housing Finance Agency (FHFA) ordered Fannie Mae and Freddie Mac to stop buying PACE encumbered mortgages due to concerns regarding PACE loans that acquire a priority lien over existing mortgages.[345] A few law suits have been filed in response to the FHFA's position on residential PACE but all have been unsuccessful. Some residential PACE programs have continued to move forward with PACE loans receiving a subordinate lien position relative to existing mortgages, however, this strategy results in increased risk to private investors and significantly inhibits their interest in investing in PACE programs. The FHFA limitations do not affect commercial PACE and many programs have demonstrated early successes. As more commercial PACE programs have launched and achieved early stage success in the last two years, interest in passing or amending flawed legislation has increased[346].

Today, 30 states including Oregon, California, and the District of Columbia can implement PACE programs. Each existing PACE program is unique and reflects different enabling acts, budgetary resources, program administration strategies, and level of community and local government support[347]. In addition, the property and project types eligible for PACE financing, as well as the participant eligibility criteria are subject to individual state and or local program requirements. Although PACE programs are authorized by state law, they are typically administered at the city or county level. This means that PACE programs require some initial legwork by state governments to pass PACE-enabling legislation but carry very limited costs at the state level on an ongoing basis. State legislation generally includes but is not limited to the following elements:[348]

- Definition of qualifying building types (e.g., residential, commercial) and qualifying improvements (e.g., energy efficiency, renewable energy)
- Granting of authority to municipalities to establish an energy improvement district and financing program, issue debt to finance projects, and use other legally available funds

http://www.johnsoncontrols.com/content/dam/WWW/jci/be/solutions_for_your/private_sector/Financing_PrivateSector_whitepaper_FINAL.pdf

[345] Federal Housing Finance Agency (FHFA). FHFA Statement on Certain Energy Retrofit Loan Programs. (July 6, 2010). Accessed July 2013 at: http://www.fhfa.gov/webfiles/15884/PACESTMT7610.pdf

[346] PACENow. 2013. Annual Report. Accessed August 2013 at: http://pacenow.org/wp-content/uploads/2013/06/Annual-report-6.18.13.pdf

[347] PACENow. 2013. Annual Report. Accessed August 2013 at: http://pacenow.org/wp-content/uploads/2013/06/Annual-report-6.18.13.pdf

[348] PACENow. 2013. C-PACE Legislation Checklist. Accessed August 2013 at: http://pacenow.org/wp-content/uploads/2013/06/PACENow-C-PACE-Legislative-Checklist.pdf

- Establishment of the assessment lien position relative to mortgages and other taxes and assessments
- Specification of whether the assessment lien stays with property upon sale

One of the primary challenges state and local programs face when launching a PACE program is acquiring seed funding, or a pool of funding dollars from which lending can occur. Many active PACE programs launched with seed funding provided by federal grants through the American Recovery and Reinvestment Act of 2009 (ARRA). However, ARRA funds and other potential federal funding sources have essentially dried up as a result of cuts to federal spending. Likewise, the recent economic recession in the U.S. has led to budgetary issues at the state and local government levels as well. Three common models for PACE lending are summarized below:[349,350]

Warehoused. In this model, a large line of credit (in the millions of dollars) is secured from one or more lenders that can be used on an as-needed basis to fund projects within a defined period of time. The loans from financed projects can be aggregated and sold on the secondary market and sale proceeds are used to replenish the line of credit. Alternatively, the program administrator could use general or reserve funds to seed a loan pool.

Pooled Bond. In this model, the program administrator aggregates applications for PACE financing from building owners and issues a revenue bond(s) to fund the projects. The primary challenge with this method is the time required for the program administrator to collect a sufficient number of applications. The resulting project delay could prove unattractive to building owners who need a fixed project implementation timeline and certainty about the interest rate, which may change while other project applications are being accumulated.

Owner-arranged/Open Market. In this model, program participants arrange their own financing and use the enforceability of the property lien as security. The hands-off nature of this model is administratively less complex and therefore less costly to the implement than other models, and it provides participants with flexibility to negotiate their own rates, terms, conditions, and schedules. This model, however, is likely only accessible to participants with significant holdings due to the large transaction costs associated with arranging a loan. In

[349] DOE. 2013. Clean Energy Finance Guide: Chapter 12. Commercial Property-Assessed Clean Energy (PACE) Financing.
http://www4.eere.energy.gov/wip/solutioncenter/finance_guide/sites/default/files/docs/ch12_commercial_pace_all.pdf

[350] M.C. Furman Associates and ICF International. 2013. Montgomery County, Maryland Commercial Building Energy Efficiency Policy Study. Accessessed August 2013 at:
http://www6.montgomerycountymd.gov/content/dep/downloads/Energy/FINALCommercialandMulti-FamilyStudy.pdf

addition, it may be difficult to package loans with different terms and conditions for resale on the secondary market using this model, limiting program scalability.

Unlike utility energy programs funded through a system benefits charge or cost recovery rate adjustments assessed to all ratepayers, participation in PACE is voluntary. PACE programs can complement utility programs by financing "deeper" energy retrofit measures and measures for smaller customers that are beyond the scope of utility programs. The low interest rates and relatively long repayment terms means the PACE programs can create an immediate positive cash flow to building owners. In other words, energy cost savings achieved though PACE-financed energy improvements, can exceed loan repayment costs on an annual basis resulting in net savings.

PACE programs can become self-funded through loan repayments (i.e., revolving fund), however, there are necessary implementation and subsequent administrative costs. The size and scope of each individual PACE program determines administrative costs, but costs normally comprise of start-up costs, seed funding, initial expenses, and ongoing operating costs to maintain the program. These costs include municipal personnel to oversee each program, fees paid to third party administrators and/or lenders, and marketing expenses. Municipalities may be able to recover some of these administrative costs through application or project fees, increased interest rates, or other sources such as grants.[351]

Though not technically a cost, many PACE program allocate budget for a debt service reserve fund utilized in the event of late payments or defaults by participants. The Climate Smart Loan Program in Boulder, Colorado, set aside $2.4 million as a reserve fund to help secure program bonds while distributing over $9 million in PACE financing.[352] There are many ways to fund the reserve, but a common method is using assessment bonds to add a percentage fee rate (sometimes 5-10 percent) to the financed amount for each participant, allowing the participants to pay for it.[353] Adding this additional rate, however, may make participants hesitant about the cost of PACE financing, so an appealing option to consumers is to have PACE communities use

[351] Sustainable Cities Institute. Property Assessed Clean Energy Program Overview. Accessed August 2013 online at: http://www.sustainablecitiesinstitute.org/view/page.basic/class/feature.class/Lesson_PACE_Financing
[352] National Renewable Energy Laboratory. 2011. Economic Impacts from the Boulder County, Colorado, ClimateSmart Loan Program: Using Property-Assessed Clean Energy (PACE) Financing. Accessed August 2013 at: http://www.nrel.gov/docs/fy11osti/52231.pdf
[353] Note that if that bond does not experience any defaults, then that the PACE program can use that reserve money to make the final loan payment to the property owner.

their own funds to stock the reserve.[354] It is important to note that loan eligibility criteria are strict[355], and default rates on PACE loans have been very low.[356]

Research conducted by ECONorthwest in April 2011 suggests that PACE programs have the potential to generate significant economic and fiscal impacts. Specifically, modeling of hypothetical PACE programs in Columbus, Ohio, Long Island, New York, Santa Barbara, California, and San Antonio, Texas indicates that $4 million in total PACE project spending across the four cities ($1 million in spending in each city) will generate $10 million (about $67,000 per job), on average.[357]

ECONorthwest also modeled the gross spending effects at the local level of consumer energy cost savings achieved through the four hypothetical programs. The analysis estimates that for every $1,000 in annual energy cost savings lasting 25 years, economic output would increase $21,000, personal income would increase $7,000, combined federal, state and local tax revenue would increase $3,000, and 0.2 local jobs would be created.[358] The study notes that the results of the modeling effort do not account for any utility revenue losses that would partially offset impacts of increased consumer spending. These analyses suggest that enabling PACE programs in Washington has the potential to increase economic output, tax revenue, and job creation in addition to reducing energy consumption and GHG emissions.

The next section discusses the potential for PACE programs in the State of Washington. A summary of existing PACE and their relative successes is provided in Section 12.4 with a thorough review provided in Appendix B. Section 12.2 summarizes existing work that has been done to evaluate the potential for, and impacts of, a PACE program in Washington. Section 12.3 presents original analysis conducted for this report, which evaluates the potential emission reductions and some of the associated costs and benefits of PACE in Washington in the target years 2020, 2035, and 2050.

[354] DOE 2013, Chapter 12 p. 14.
[355] A full list of criteria is include in Chapter 12 (page 19) of DOE's Clean Energy Finance Guide. Important criteria include that applicants have to have a clear title to the property, applicants have no recent default notices or foreclosures, applicants have no recent bankruptcies, and applicants are current on mortgage payments among other criteria.
[356] Alliance to Save Energy. The Inception of PACE Financing, its Support, and its Potential Accessed September 2013 online at: http://www.ase.org/resources/inception-pace-financing-its-support-and-its-potential
[357] ECONorthwest. 2011. Economic Impact Analysis of Property Assessed Clean Energy Programs (PACE). Accessed August 2013 at: http://pacenow.org/wp-content/uploads/2012/08/Economic-Impact-Analysis-of-Property-Assessed-Clean-Energy-Programs-PACE.pdf
[358] Ibid

12.2 Washington Potential

State-level PACE-enabling legislation has the potential to provide a variety of benefits to Washington including energy efficiency improvements and GHG reductions in the buildings sector as well as increases in gross economic output, federal, state and local tax revenue, and clean energy jobs. GHG reductions of approximately 1,100 to 1,300 $mtCO_2e$ per year have been estimated for PACE programs in Maine[359] and in Boulder, Colorado.[360] These emissions reductions are somewhat low and may not reflect the full potential of PACE since these programs are in their infancy and often have limited funding. As PACE programs mature and consumers become more aware, the potential for GHG reductions is likely to increase substantially.

The primary uses for PACE in Washington would likely be to finance participant costs associated with utility energy efficiency and renewable energy programs driven by I-937 and to finance energy conservation projects that are outside the scope of these utility programs. Consumers who participate in utility programs typically incur additional costs which can inhibit participation despite program incentives. For some programs, customer costs make up the difference between the incremental cost of energy efficiency measures and any program incentives such as rebates. For other programs, customers incur the entire cost while the program administrator provides other incentives such as technical assistance. A study of utility energy efficiency programs across the U.S. indicates that about 45 percent of the total costs of these programs are paid for directly by participants on average.[361] PACE financing could increase participation in utility programs by providing consumers with access to long-term, low-interest loans. Similarly, enabling PACE might encourage customers of utilities with limited or no demand-side energy efficiency and renewable energy programs to take action independently. With respect to potential GHG reductions, these potential uses of PACE financing would likely result in a significant amount of overlap with I-937, however, PACE would be expected to increase participation in utility-sponsored programs under I-937 and increase private investment

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[359] Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: http://www.efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf. Estimates external to study using the following assumptions: all savings are from primary heating fuel (savings by fuel are 90% fuel oil, 5% NG, 5% Propane); 2013 Climate Registry default emission factors for CO_2, CH_4, and N_2O; IPCC Second Assessment Report GWPs.

[360] National Renewable Energy Laboratory. 2011. Economic Impacts from the Boulder County, Colorado, ClimateSmart Loan Program: Using Property-Assessed Clean Energy (PACE) Financing. Accessed August 2013 at: http://www.nrel.gov/docs/fy11osti/52231.pdf. Estimate external to study using the following assumptions: average participant savings of 1,786 kWh/yr for electricity and 74.9 therms/yr for natural gas; eGRID2012 electricity CO_2e emission factor for WECC Rockies subregion; 2013 Climate Registry default natural gas emission factors for CO_2, CH_4, and N_2O, IPCC Second Assessment Report GWPs.

[361] ACEEE. 2009. Saving Energy Cost-Effectively: A National Review of the Cost of Saved Energy through Utility-Sector Energy Efficiency Programs. Accessed August 2013 at: http://www.aceee.org/sites/default/files/publications/researchreports/U092.pdf

energy conservation. This increase in private investment may act to decrease the cost of utility programs.

No studies of the potential of state-enabled PACE programs in Washington were found in the research for this report; however, PACE has been recognized by the City of Seattle[362] and Governor Inslee[363] as a policy option for attracting and leveraging public and private-sector capital to finance energy efficiency improvements in the RCI sector. Seattle's Climate Action Plan acknowledges that financing programs such as PACE will be critical to achieving "deep" energy efficiency gains from building retrofit assistance programs.[364] The 2012 Washington State Energy Strategy indicates that Washington has considered meter-based/on-bill financing, a demand side energy efficiency financing mechanism similar to PACE.[365]

PACE programs and on-bill financing both reduce up-front costs and align the timing of costs and benefits to customers. A key feature of both program types is loan responsibility may be passed from one property owner to the next. This feature gives property owners incentive to invest in energy efficiency upgrades even if they plan to sell the property in the near-term. The primary difference between on-bill financing and PACE is that on-bill financing requires loan payment through a tariff on utility bills while PACE utilizes a property tax-like assessment. The tax lien is a major advantage for PACE in attracting lenders since it provides greater security than other financing options. PACE programs also typically utilize federal grants, state or local funding sources, or traditional lenders for loans while utilities often provide loans directly in on-bill financing programs. As a result, on-bill financing programs are heavily reliant on whether utilities have the resources and expertise to comply with state-specific consumer lending laws, to become lending institutions, and to completely redesign billing systems.[366]

12.3 Quantification

The analysis described below calculates the amount of electricity savings program participants can achieve based on a hurdle rate, or minimum required rate of return on an energy conservation project. Program participants are assumed to achieve a level of annual energy cost savings that exceed the annual loan repayment including interest, thereby creating immediate

[362] City of Seattle. Climate Action Plan: Building Energy TAG Preliminary Recommendations. April 23, 2011. Online at: http://clerk.ci.seattle.wa.us/~public/meetingrecords/2012/cbriefing20120423_3c.pdf
[363] Inslee. n.d. Building a New Economy For Washington: Clean Technology. Accessed August 2013 at: http://www.jayinslee.com/issues/Inslee-Jobs-Clean-Tech.pdf
[364] City of Seattle. Climate Action Plan: Building Energy TAG Preliminary Recommendations. April 23, 2011. Online at: http://clerk.ci.seattle.wa.us/~public/meetingrecords/2012/cbriefing20120423_3c.pdf
[365] Washington State Department of Commerce. December 2011. 2012 Washington State Energy Strategy. Online at: http://www.leg.wa.gov/documents/legislature/ReportsToTheLegislature/2012%20WSES_23140184-41ff-41d1-b551-4675573845db.pdf (pages 109-112).
[366] ACEEE On-bill Financing 2013.

positive cash-flow. This analysis also estimates the required levelized cost of saved energy to achieve the assumed hurdle rates but does not attempt to determine if real conservation opportunities exist in Washington at this cost. Further analysis may be warranted to understand the supply and associated levelized cost of real opportunities for consumers in Washington that are not already being captured by utility programs under the Energy Independence Act, Initiative 937.

This analysis focuses solely on potential electricity savings in the commercial sector since several of the assumptions used in this analysis were derived from the *Sixth Northwest Conservation and Electric Power Plan*[367] which does not analyze direct-use natural gas in detail and since there is currently significant uncertainty in the legal status of the residential sector as discussed above. Further, most lenders are more interested in commercial sector PACE financing because it is more lucrative and dollars per project are generally higher.

Ultimately, it can be expected that a share of PACE financing will be used to achieve natural gas savings at a level in which the cost-effectiveness is in equilibrium with the cost effectiveness of electricity conservation measures. In other words, participants will generally aim to maximize energy cost savings and, as a result, will not choose to implement an electricity conservation measure if a natural gas conservation measure is more cost-effective. Determining the available natural gas conservation supply that is in equilibrium with electricity conservation supply on a cost-effectiveness basis is beyond the scope of this analysis.

12.3.1 Methodology

The foundation of the methodology used to quantify the energy and GHG impacts of a PACE program in Washington is the participant hurdle rate. The hurdle rate represents the amount by which energy cost savings accrual rate from financed conservation measures must exceed the PACE loan repayment rate (including interest). For example, a building owner with a hurdle rate of 20 percent and a loan repayment rate of $10,000 per year will require that implemented energy conservation measures must achieve energy cost savings at least $12,000 per year, otherwise, the building would not have participated in the program. As a result, the first step of this analysis was to establish the size and rollout schedule for a PACE fund in Washington. This analysis does not attempt to evaluate the supply and costs of real energy conservation measures available to Washington consumers, which is necessary for appropriately sizing the PACE fund. Instead, this analysis was designed to provide results that are scalable in to any size PACE fund in increments of $50 million. To that effect, this analysis assumes a $50 million PACE fund with a rollout schedule of $10 million in financing provided in each of the first five years of the program. In addition, the fund is designed to be revolving in the sense that collected loan

[367] Northwest Power and Conservation Council. 2013. Sixth Northwest Conservation and Electric Power Plan. Accessed August 2013 at: http://www.nwcouncil.org/energy/powerplan/6/plan/

repayment funds (including interest) minus administrative costs are immediately made available for new loans. Since interest is captured by the fund and reissued for new loans, the size of the fund grows over time as a function of the forecasted interest rate minus any defaults. The amount of loan repayment dollars for new loans provided in each program year was calculated based on the loan amount, the loan term, and the forecasted interest rate. Separate calculations were made for an assumed loan-term of 15 years and 20 years. As discussed in the previous section, this analysis focuses solely on potential electricity savings in the commercial sector since several of the assumptions used in this analysis were derived from the *Sixth Northwest Conservation and Electric Power Plan*[368] which does not analyze direct-use natural gas in detail and there is currently significant uncertainty in the legal status of the residential sector. Further analysis may be warranted to capture natural gas and residential sector savings potential in the future.

The next step was to determine the first-year energy cost savings required to exceed annual loan repayment by assumed hurdle rates of 15 percent and 20 percent. This was done for each year between 2016 and 2050 by multiplying the total loan repayment in each year by 115 and 120 percent. First-year electricity savings were then calculated by dividing the first-year energy cost savings by the forecasted retail commercial electricity price. These electricity savings were cumulated over time to determine the cumulative annual electricity savings from PACE financed energy conservation. It should be noted that this calculation only includes cumulated electricity savings from measures that had not exceeded their useful life. For the purposes of this analysis, separate calculations were performed assuming a useful life of 15 years and 20 years. The last step in this analysis was to multiply the cumulative annual energy savings by the forecasted electricity emissions factor in each program year to calculate cumulative annual GHG reduction potential.

All calculations described above were executed using a simple spreadsheet-based model developed for this analysis. Iterative model runs were performed using different combinations of assumptions for hurdle rate, loan term, and useful measure life. The model was run using all possible combinations of high and low assumption values for participant hurdle rate, loan term, and measure life. Additionally, the model required that measure life be greater than or equal to loan term to ensure the reality that conservation measures must be lifetime cost-effective or they would not have been implemented. The results from this analysis are presented as a range of potential GHG reductions in each target year using the maximum and minimum reduction values calculated by the model for each target year..

12.3.2 Assumptions, Exclusions, and Data Sources

The following assumptions for a scalable PACE program are included in this analysis:

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[368] Northwest Power and Conservation Council. 2010. Sixth Northwest Conservation and Electric Power Plan. Accessed August 2013 at: http://www.nwcouncil.org/energy/powerplan/6/plan/

- Scalable pilot program rollout includes $10 million per year over five year beginning in 2016 (i.e., $50 million invested by 2020)
- All loan repayment dollars (including principal and interest) are returned to the fund for re-issue in the form of new loans (i.e., revolving fund) except from administration costs
- State and local program administration costs are estimated as 50 percent of the loan interest rate in each program year and are deducted out of the revenue getting recycled back into the revolving PACE fund.
- Interest rate increases from about 6 percent in 2016, to about 6.9 percent in 2020, and then grows linearly to about 7.5 percent in 2050.
- Hurdle rate analyzed are 15 percent and 20 percent in excess of the annual loan repayment amount including principal and interest
- Conservation measure life analyzed: 15 years and 20 years
- Loan term analyzed: 15 years and 20 years
- Retail commercial sector electricity prices increase linearly from $93.66/MWh in 2016 to $99.20/MWh in 2020, and then decline 0.35 percent per year through 2050 (in 2013 dollars)
- Electricity savings are proportional to electricity cost savings (demand savings and demand cost savings are not captured)

This analysis relies on the data sources summarized in the table below.

Table 61: Primary data sources used to quantify GHG impacts of a scalable PACE program in Washington

Data	Source
Loan interest rate forecast (AA Utility Bond interest rate used as a proxy)	EIA. 2013. Annual Energy Outlook 2013. Macroeconomic Indicators (Table A20) http://www.eia.gov/forecasts/aeo/pdf/0383(2013).pdf
Retail commercial electricity price forecast (extrapolated from 2030 through 2050 and adjusted from 2006$ to 2013$)	Northwest Power and Conservation Council. 2010. Sixth Northwest Conservation and Electric Power Plan http://www.nwcouncil.org/energy/powerplan/6/plan/
Electricity CO_2e emission factor for Northwest Power Pool	EPA. 2012. eGRID2012 year 2009 Summary Tables http://www.epa.gov/cleanenergy/documents/egridzips/eGRID2012V1_0_year09_SummaryTables.pdf
Electricity emission factor improvement rate	EIA. 2013. Annual Energy Outlook 2013. Electric Power Projections for Northwest Power Pool Area http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2013&subject=0-AEO2013&table=62-AEO2013&region=3-21&cases=ref2013-d102312a

12.3.3 Results

This analysis estimates that for every $50 million of commercial sector PACE financing provided equally over the first five program years, carbon dioxide emission could be reduced by up to 0.03 $MMTCO_2$, 0.07 $MMTCO_2$, and 0.08 $MMTCO_2$ in 2020, 2035, and 2050, respectively. These potential reductions are likely to overlap significantly, but not entirely, with reductions from I-937 if the PACE is implemented in the service territory of utilities subject to I-937. The table below summarizes the results of potential emission reductions estimated for different sets of input assumptions. The sets of assumptions include all possible combinations of high and low assumptions for participant hurdle rate, loan term, and measure life with a requirement that loan term cannot exceed measure life.

Figure 10. Potential Emission Reductions for Every $50M in PACE Financing during the First 5 Program Years[369]

Hurdle Rate (%)	Loan Term (years)	Measure Life (years)	Potential Emission Reductions ($MMTCO_2$/$50M)		
			2020	2035	2050
15%	15	15	0.02	0.04	0.06
15%	15	20	0.02	0.06	0.07
15%	20	20	0.02	0.05	0.05
20%	15	15	0.03	0.04	0.06
20%	15	20	0.03	0.07	0.08
20%	20	20	0.02	0.05	0.05
Estimated Range of Potential Reductions			**0.02-0.03**	**0.04-0.07**	**0.05-0.08**

These results are intended to be scalable. For example, increasing total PACE financing during the first five program years by a factor of ten, from $50 million over five years to $500 million over five years, would be expected to increase potential emission reductions by a factor of ten, or up to 0.8 $MMTCO_2$ per year by 2050. Similarly, reducing the funding by a magnitude of ten would reduce emissions accordingly.

The average costs and reductions for the six combinations of input assumptions discussed above were used to calculate a NPV cost savings of about $171 per metric ton of carbon dioxide equivalent for the period 2020-2035. As shown in the table below, this value is the result of about $103 million in cost savings and GHG reductions of just over 0.6 million metric tons of carbon dioxide equivalent during that time period.

Table 62. Costs of a PACE program

Million $USD	2020	2035	NPV 2020-2035[a]

[369] This assumes financing is provided in equal amounts over the first five program years

Cost to Government	**$8.90**	**$(1.00)**	**$1.70**
Loan Pool Funding	$10.00	$-	$8.20
Administrative Costs	$0.30	$0.30	$1.70
Loan Repayment Revenue	$(1.40)	$(1.20)	$(8.20)
Cost to Consumers	$(5.50)	$(19.00)	$(104.00)
Loan Repayment	$1.40	$1.20	$8.20
Energy Cost Savings	$(6.90)	$(20.00)	$(113.00)
Net Costs	**$3.40**	**$(19.60)**	**$(103.00)**
Total GHG Reductions (MMTCO_2e)	**0.02**	**0.05**	**0.60**
Cost per Metric Ton CO_2e ($)			**$(171.00)**

[a] 5 percent discount rate applied, NPV 2013

Costs captured in this analysis include initial funding of the loan pool, program administration costs, loan repayment, and consumer energy cost savings. Loan repayment only represents a wealth transfer from participants back to the government. Administration costs were taken as half the interest rate in year program year and subtracted out of the revenue getting recycled back into the revolving PACE fund. Benefits captured include the value of energy cost savings for participants. Participant energy cost savings may translate into utility lost revenue, however, those loses were not quantified in this analysis. In addition, all tax revenue associated with the program is considered a wealth transfer and, thus, is ignored in this analysis. It should be noted that PACE literature suggests that it is likely that jobs will be created as result of PACE-induced spending and that this may support local business and the economy, but these benefits are not quantified in this analysis.

12.4 Implementation History

This section summarizes PACE programs implemented in other jurisdictions. The following programs that have produced PACE performance data are included:

Maine PACE Loan Program: Launched in April 2011, the Maine PACE Loan Program provides $6,500 to $15,000 loans to Maine homeowners to finance the cost of eligible energy saving improvements and offers repayment periods of 5, 10, or 15 years at a fixed interest rate of 4.99 percent APR, with no processing fees.[370] PACE loans are available for residential buildings with one to four units that meet a set of minimum underwriting requirements and are located in municipalities that have passed a PACE ordinance. In addition, energy efficiency improvements packages must generate savings of at least 20 percent of home energy usage or 25 percent of heating and hot water energy usage to qualify for a PACE loan. PACE-eligible energy

[370] DSIRE. 2013. Maine PACE Loans. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=ME20F

improvements include, but are not limited to: insulation, air sealing, energy efficient heating systems, lighting and appliances, windows and doors, and solar energy systems. Maine's PACE law dictates that loans do not have a senior priority over a primary home mortgage.[371]

As of February 2013, a total of 158 Maine municipalities had passed PACE ordinances and entered into an agreement with Efficiency Maine to administer the loan program on their behalf. Residents of these towns comprise about three quarters of the state population and have submitted a total of more than 1,800 loan applications[372]. Efficiency Maine has established a $20.4 million revolving loan fund for the PACE and PowerSaver Loan Program[373] primarily using Federal grant money through the DOE BetterBuildings Program. As homeowners pay back the loans, the loan fund will be replenished for the next round of homeowner applicants[374].

Boulder County, Colorado, ClimateSmart Loan Program (CSLP): The ClimateSmart Loan Program offered loans to Boulder County property owners who wanted to make energy efficiency and renewable energy improvements to their property. In June 2010, residential financing was cancelled and the loan program was put on-hold until issues with the FHFA and federal mortgage regulators, Fannie Mae and Freddie Mac, could be resolved. Subsequently, the commercial loan program was also suspended.[375]

The Boulder County, Colorado, CLSP was the first test of PACE financing on a multi-jurisdictional level (involving individual cities as well as the county government). It was also the first PACE program to comprehensively address energy efficiency measures and renewable energy, and it was the first funded by a public offering of both taxable and tax-exempt bonds. Initiated in 2009, the first phase of the CSLP included two rounds of residential project financing and resulted in about $9.8 million in project loans. Associated program costs and fees were about $0.8 million and funding of a reserve account for the bonds added $2.4 million.[376]

The minimum borrowing level for the first phase of the CLSP was $3,000 per home. The maximum borrowing limit for open loans (using taxable bonds), was the lesser of 20 percent of

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[371] Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: http://www.efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf

[372] Ibid

[373] The PowerSaver Loan Program covers the same home energy improvements as PACE, but offers a wider range of loan amounts, is available statewide, and has slightly different eligibility criteria.

[374] Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: http://www.efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf

[375] Boulder County, Colorado Website. Accessed August 2013 at: http://www.bouldercounty.org/env/sustainability/pages/cslp.aspx

[376] National Renewable Energy Laboratory. 2011. Economic Impacts from the Boulder County, Colorado, ClimateSmart Loan Program: Using Property-Assessed Clean Energy (PACE) Financing. Accessed August 2013 at: http://www.nrel.gov/docs/fy11osti/52231.pdf

actual property value, or $50,000. For income-qualified loans (using tax-exempt bonds), the maximum borrowing limit was set to $15,000 per home. Interest rates on PACE loans ranged from 5.2 percent to 6.8 percent depending on the type of bond and the issue. PACE loans were repaid through a 15-year assessment on each participant's property taxes (senior lien). If a property owner sells a PACE-assessed home or business, the assessment stays with the property, with responsibility passing to the next owner until the debt is paid.[377]

Sonoma County, California, Sonoma County Energy Independence Program (SCEIP): Sonoma County's Energy Independence Program gives residential and non-residential property owners the option of financing energy efficiency, water efficiency and renewable energy improvements through a voluntary assessment on their property tax bills. The property tax assessments are attached to the property, not the property owner, meaning that if the property is sold, the assessment stays with the property. In 2010, Sonoma County's PACE program was temporarily suspended in response to the FHFA's statement of concerns regarding residential PACE financing on July 10, 2010 but was immediately re-opened by the Sonoma County Board of Supervisors on July 13, 2010.[378]

The minimum funding level offered by SCEIP is $2,500 and assessments may not exceed 10 percent of the property value[379]. In addition, the sum of all debt associated with the property cannot exceed 100 percent of the value of the property. The SCEIP can be combined with utility and state rebates, but financing will only be available for the post-incentive cost. Tax credits will not affect the amount of financing available[380]. The repayment period is 10 years for amounts from $2,500 to $4,999 and projects over $5,000 may be repaid over a term of either 10 or 20 years, at the property owner's option. Projects of $60,000 up to $500,000 require approval by the Program Administrator, and projects over $500,000 require specific approval by the Board of Supervisors. The current interest rate for SCEIP assessment contracts is 7 percent simple interest. The interest rate is fixed at the time the assessment contract and implementation agreement are signed and will not rise.[381]

Commercial and industrial properties must first have an energy audit before participating in the program. Energy audits are not required for residential participants, but they are strongly

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[377] Ibid

[378] DSIRE. 2013. Sonoma County – Energy Independence Program. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F

[379] Sonoma County Energy Independence Program FAQs. Accessed August 2013 at: http://residential.sonomacountyenergy.org/lower.php?url=faqs-75

[380] DSIRE. 2013. Sonoma County – Energy Independence Program. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F

[381] Sonoma County Energy Independence Program FAQs. Accessed August 2013 at: http://residential.sonomacountyenergy.org/lower.php?url=faqs-75

recommended. Beginning March 1, 2011, the SCEIP offers rebates of up to 75 percent for the cost of energy analyses performed by certified raters.[382]

A key SCEIP enhancement effective July 1, 2011, is the requirement of achieving 10 percent energy efficiency improvement on the property prior to (or along with) the financing of renewable generation upgrade projects. This approach supports SCEIP's regional goal to "reduce and produce," and it strengthens the market position of the SCEIP assessment portfolio.[383]

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[382] DSIRE. 2013. Sonoma County – Energy Independence Program. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F
[383] Ibid

13 Feed-in-Tariff

Table 63: Potential Costs and Benefits of a Feed-in-Tariff to Washington Consumers and Businesses

Potential Action for Consideration				
• Replace Washington's existing combination of net metering and a tax incentive mechanism with a Feed-in-Tariff in Washington.				
GHGs and Costs in Washington	**GHG Reductions ($MMTCO_2e$)**			**Cost ($/mt$CO_2$e)[384]**
	2020	**2035**	**2050**	
Program cap of 375 MW (scalable)	0.5	0.5	0.5	$30 to $500

Implementation Issues and Lessons Learned

- The success of a FIT policy depends on many variables, including existing renewable energy generation, community acceptance of renewable energy and associated costs, and interconnection codes and standards.[385]
- Whether to base rates on cost of generation or avoided cost
- Program caps serve to moderate the potential cost to ratepayers and system integration impacts of introducing a large number of FIT-funded renewable resources, while project caps can serve to moderate the number of large projects and/or broaden the type of technologies.[386]
- Whether to focus on small-scale or large-scale projects
- Payments need to be high enough to attract investors without resulting in windfall profits and undue burden on ratepayers.[387]
- Complexities include interconnection codes, standards and practices, metering requirements and the siting process for renewable energy systems.[388]
- Must consider contract length, interconnection rules and agreements, program and project caps, tariff revisions, payment differentiation and bonus payments.[389]

Potential Costs and Benefits to WA Consumers	**Potential Costs and Benefits to WA Businesses**
• As FIT programs are supported by ratepayers through above-market costs, electricity rates are likely to increase. • The resulting impact to the average household electricity bill is undetermined in the U.S., as FIT programs are still in their infancy.[390] • Germany's FIT cost consumers a 3% rate increase in the lifetime of the program, with a	• As FIT programs are supported by ratepayers through above-market costs, electricity rates are likely to increase. • As FIT programs are still in their infancy in the US, the impact to businesses is still undetermined.

[384] 5 percent discount rate, NPV 2013
[385] The National Association of Regulatory Utility Commissioners (NARUC). *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions.* June 2010. Report accessed August 2013 at http://www.naruc.org/Publications/NARUC%20Feed%20in%20Tariff%20FAQ.pdf
[386] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[387] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[388] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[389] NARUC. Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions. June 2010.
[390] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

5% increase in 2008 alone, averaging \$2.66 to \$8.00 per month.[391]

Summary of Screening Criteria

***Does the policy target an emissions source of significant magnitude in Washington*?**

In 2010, the electricity sector accounted for 21.5 percent of statewide GHG emissions, emitting 20.7 $MMTCO_2e$.[392] In 2010, conventional hydroelectric accounted for about 66 percent of the electricity generation, while natural gas, nuclear and coal accounted for 10 percent, 8.9 percent and 8.2 percent respectively.[393] Coal and natural gas accounted for about 16.4 percent (15.8 $MMTCO_2e$) and 5 percent (4.8 $MMTCO_2e$) of statewide GHG emissions respectively.[394]

What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?

The German FIT is a success and is considered to be the 'international gold standard'.[395] In Germany, the cost of reductions for solar in 2010 was €537 or (\$714)/$mtCO_2e$ with a volume reductions of 7 $MMTCO_2e$, while the cost of reductions for wind was €44 or (\$58.5)/ $mtCO_2e$ with volume of reductions of 27 $MMTCO_2e$.[396]

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?

FIT is a discrete and comprehensive policy. FIT can enhance the deployment of renewable energy and help states meet their Renewable Portfolio Standards (RPS) by providing another revenue stream to deploy more renewable generation resources.

Can the policy be meaningfully implemented or influenced at the State level?

FIT policy could be meaningfully implemented or influenced at the state level dependent on program design.

13.1 Introduction

Although Washington's GHG emissions from the electricity sector are small relative to the contribution of this sector in other regions, in absolute terms they represent 20.7 $MMTCO_2e$, or 21.5 percent of statewide emissions. Washington has recognized the potential to reduce these emissions through further implementation of clean, renewable energy sources, implementing a renewable portfolio standard (RPS) through Initiative 937 to encourage utilities to invest in renewable sources. A FIT can help accelerate the deployment of renewable energy and has the ability to target small, distributed generation of renewable energy by providing a fixed incentive.

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[391] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

[392] Washington State Department of Ecology. *Washington State Greenhouse Gas Emissions Inventory 2009-2010.* December 2012. Report accessed August 2013 at https://fortress.wa.gov/ecy/publications/publications/1202034.pdf

[393] http://www.eia.gov/electricity/state/Washington/

[394] Washington State Department of Ecology. *Washington State Greenhouse Gas Emissions Inventory 2009-2010.* December 2012.

[395] Institute for Self Reliance. *U.S. CLEAN Programs: Where Are We Now? What Have We Learned?* June 2012. Report accessed August 2013 at http://www.ilsr.org/wp-content/uploads/2012/06/US-CLEAN-programs-ilsr.pdf

[396] Marcantonini and Ellerman. The Cost of Abating CO2 Emissions by Renewable Energy Incentives in Germany. Accessed August 2013 at: http://cadmus.eui.eu/bitstream/handle/1814/25842/RSCAS_2013_05rev.pdf?sequence=1

These small, customer-owned renewable resources might otherwise be unavailable to the electric utilities

A FIT is a policy mechanism designed to accelerate investment in and deployment of renewable energy technologies by offering long-term contracts with a set price to renewable energy producers. The FIT provides certainty to potential energy producers by establishing guaranteed price schedules and eliminating the need for contractual negotiations with utilities, for eligible projects. The FIT payment design varies, and is often differentiated by technology, size of project, and resource quality. Using higher payment levels may incentivize a certain type or size of resource, helping to meet policy goals such as an RPS or a goal to increase distributed resources.[397]

Guaranteed contract terms inherent in FIT policies enable project developers to finance a larger proportion of the project with debt financing, as opposed to equity, which puts further downward pressure on the cost of capital. FIT, which place a legal obligation on utilities to purchase electricity from renewable energy generators at a guaranteed rate for a determined length of time, are most effective in encouraging private finance. They are long-term contracts with a highly credit-worthy entity and a strong balance sheet and have driven relatively fast scale-up of renewable energy markets.[398]

A 2009 study examined FIT policy in Europe and the United States and concluded that FIT could unlock the potential of dispersed generation and community ownership of renewable energy while decreasing the economic and legal costs of doing business and increasing the social and economic benefits.[399] Experience around the world suggests that FITs could be used effectively to meet a number of U.S. state policy goals, including job creation, economic development, and meeting state renewable energy targets.[400] Moreover, FITs can be fine-tuned to encourage particular project attributes with respect to technology type or project size and they can be flexibly adapted to match different electricity market structures.

FITs are focused on setting the right price to drive renewable energy development while RPS policies are focused on the quantity of renewable energy deployment leaving the price up to the marketplace. FITs can help fulfill an RPS with payments structured to encourage various

[397] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

[398] American Council on Renewable Energy. Strategies to Scale-Up U.S. Renewable Energy Investment. 2013. Accessed September 2013 at: http://www.acore.org/images/uploads/Strategies-to-Scale-Up-US-Renewable-Energy-Investment.pdf

[399] Institute for Self Reliance. *Feed-in tariffs in America Driving the Economy with Renewable Energy Policy that Works.* April 2009. Report accessed August 2013 at http://www.ilsr.org/feedin-tariffs-america-driving-economy-renewable-energy-policy-works/

[400] National Renewable Energy Laboratory (NREL). *State Clean Energy Policies Analysis (SCEPA) Project: An Analysis of Renewable Energy Feed-in Tariffs in the United States*. June 2009. Report accessed August 2013 at http://www.nrel.gov/docs/fy09osti/45551.pdf

targeted technologies and may create a stronger price incentive for investors resulting in higher project development. However, FIT rates are not always aligned with the market and program costs may be high in comparison to an RPS program, and therefore some argue that RPS may be a more sustainable policy in the long run.[401]

As both RPS and FIT are designed to enhance increase the deployment of renewable energy they can be structured to work together. An RPS establishes a target for renewable generation; a FIT provides a mechanism for buying renewable generation from the utility's customers. A number of states have recently implemented FITs[402] and several utilities have launched utility-specific FIT policies to help meet their RPS. RPS policies require electric utilities to provide renewable electricity to their customers, typically as a percentage of total energy use; thereby prescribing how much customer demand must be met with renewables. In 2006, Washington passed Initiative 937 and became the second state after Colorado to pass a RPS by ballot initiative. Initiative 937 calls for electric utilities that serve more than 25,000 customers in the state of Washington to obtain 15 percent of their electricity from new renewable resources by 2020 and to undertake all cost-effective energy conservation. Of Washington's 62 utilities, 17 are considered qualifying utilities, representing about 81 percent of Washington's load.[403]

In May 2005, Washington enacted Senate Bill 5101, establishing production incentives for individuals, businesses, and local governments that generate electricity from solar power, wind power or anaerobic digesters.[404] Washington's FIT policy mechanism, called the Renewable Energy Investment Cost Recovery Incentive Program[405], opened in 2006 and is optional for utilities. However, for participating utilities those do choose to participate by providing contracted pay rates to eligible generators specified by the legislation. The utilities' payments are fully reimbursed by the state for the contracted cost through a credit against their public utility tax liability up to a specified limit. The program expires in 2020. The tariff legislated rates are set between $0.12/kWh to $0.54/kWh for eligible solar, wind, and anaerobic digestion projects, with ranges depending on technology type and in-state manufacturing designation. Projects may

[401] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[402] California, Hawaii, Vermont, and Washington were the first states in the U.S. to establish feed–in tariffs (http://www.epa.gov/statelocalclimate/state/topics/renewable.html)
[403] Department of Commerce EIA Reporting Website. Accessed August 2013 at: http://www.commerce.wa.gov/Programs/Energy/Office/Utilities/Pages/EnergyIndependence.aspx
[404] DSIRE. Washington Incentives/Policies for Renewable Energy. Renewable Energy Cost Recovery Incentive Payment Program. Accessed September 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=WA27F
[405] Washington State Legislature. WAC 458-20-273. Renewable energy system cost recovery. Accessed September 2013 at: http://apps.leg.wa.gov/wac/default.aspx?cite=458-20-273

not exceed 75 kW and tax incentives are limited to single customers that may not receive more than $5,000 per project per /year.[406]

In 2009, Washington passed SB 6170 qualifying community solar projects up to 75 kilowatts (kW) to receive the production incentive. The production incentives range from $0.30/kWh to $1.08/kWh and are capped at $5,000 per year. SB 6170 also increased the tax credit that utilities may claim for awarding production incentives from a limit of $25,000 or 0.25 percent of a utility's taxable power sales (whichever is greater) to $100,000 or 0.5 percent of a utility's taxable power sales.[407] The incentives apply to power generated as of July 1, 2005, and remain in effect through June 30, 2020.[408]

While Washington has no limitations on the generating capacity of eligible cost-recovery systems (with the exception of limiting community solar projects to a generating capacity of 75 kW), payment caps limit the size of eligible systems.

Since 2006, the average annual growth of renewable energy systems certified under WAC 458-20-273 over the previous year has been about 49 percent, with the highest growth rate in renewable energy systems being fiscal 2007 (135.3 percent) after the program's inception followed by fiscal year 2013 at 73.6 percent.[409] Since 2006, a total of 4202 renewable energy systems (19.6 MW) of renewables have been approved; with 4022 PV systems (18,522 kW), 125 wind systems (582 kW) and one digester (450 kW).[410]

A key difference between the Washington tax incentive mechanism and a true FiT is that the tax incentive is offered as a supplemental payment instead of an actual purchase of the renewable generation. The renewable generation in almost all cases is consumed by the project owner through a net metering arrangement with the utility. Owners effectively are paid at the utility's retail electric rate, which varies across Washington utilities from 3 cents/kWh to more than 10 cents/kWh. If the utility purchases the generation through a purchased power agreement (PPA), the tax incentives are paid in addition to the rate established in the PPA.

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[406] Energy Information Administration. Electricity Feed-In Tariffs and similar programs. State Policies as of May 2013. Accessed September 2013 at: http://www.eia.gov/electricity/policies/provider_programs.cfm
[407] Department of Energy. Renewable Energy Cost Recovery Incentive Payment Program. Accessed September 2013 at: http://energy.gov/savings/renewable-energy-cost-recovery-incentive-payment-program
[408] DSIRE. Washington Incentives/Policies for Renewable Energy. Renewable Energy Cost Recovery Incentive Payment Program. Accessed September 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=WA27F
[409] Washington State Department of Revenue. *Growth from Renewable Energy Cost Recovery Program*. (August 2013). Accessed September 2013 at: http://dor.wa.gov/Docs/Pubs/Incentives/RenewableEnergyProgramProgress.pdf
[410] Washington State Department of Revenue. *Growth from Renewable Energy Cost Recovery Program*. (August 2013).

13.1.1 Literature Review of Washington Potential

Replacing Washington's existing combination of net metering and a tax incentive mechanism with an actual FIT could help accelerate the deployment of renewable energy sources, reduce GHG emissions as well as achieve other important economic development and social goals. Accelerating the deployment of renewable energy sources through FITs could ease the transition from undesirable, more carbon intensive electricity generation energy sources, such as coal-fired power plants, to more desirable electricity generation sources, such as wind and solar.

The main attraction of the FIT is that it has shown high success in different economic and legal contexts in other countries for quickly driving the production of renewable energy by providing a guaranteed return for developers and reducing the red tape associated with connecting renewable energy systems to the grid. However, because the program is supported by ratepayers, electricity rates will likely increase as they have in Europe, though the impact of a FIT may vary significantly across the U.S. and other jurisdictions.[411] Washington's renewable tax incentive FIT policy mechanism is borne by taxpayers rather than ratepayers, through tax credits. The cost of the Renewable Energy Cost Recovery Program has grown from $52,729 in fiscal year 2007 with 10 utilities participating in the program, to $1,155,125 in fiscal year 2012 with 32 utilities participating in the program.[412]

Typically, the economic impact of a FIT will likely vary by ratepayer class; notably residential, commercial and industrial customers. To the extent the FIT represents an 'above market cost' the FIT increases the cost of electricity to households and businesses. In 2009, the Division of Energy Planning within the Vermont Department of Public Service evaluated the economic impacts of Vermont FIT and found that for households, the economic impact is largely through an income effect whereby households reduce expenditures on 'all other' items to pay for a rising electric bill. Similarly, the productive sectors of the economy, industrial and commercial ratepayers are faced with limited options as well. They will pay higher electric bills which raise their cost of production and may leave them disadvantaged relative to out-of–state competition. When the composite price falls below the forecasted market price, the cost of electricity to homes and businesses will decrease relative to what it would have been. For those years where FIT fall below market costs the opposite effects would occur whereby households and businesses benefit from lower energy bills.[413] A 2010 DOE study found that while electricity rates may increase, the resulting growth in the renewable energy market may also stimulate the State economy by creating jobs to

[411] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[412] Washington State Department of Revenue. Growth from Renewable Energy Cost Recovery Program. (August 2013).
[413] Vermont Department of Public Service, Division of Energy Planning. *The Economic Impacts of Vermont Feed in Tariffs.* December 2009. Report accessed August 2013 at http://www.renewwisconsin.org/policy/ARTS/MISC%20Docs/DPS%20White%20Paper%20Feed-in%20Tariff.pdf

site, develop, and build the renewable energy systems. This is especially true during the construction phase of capital-intensive renewable projects.[414]

While the California and Vermont FITs differ; notably in terms of 1) overall program cap, with California's FIT capping at 500 MW and Vermont's FIT capping at 50 MW; and 2) payment structure, with California's payments based on avoided costs in contrast to Vermont's FIT payments based on cost of generation and profit. Despite their differences, studies evaluating their economic impacts may provide some insight into potential impacts for Washington State.

In a 2010 study, the Energy and Resources Group at the University of California estimated that the FIT enacted by the Renewable Energy and Economic Stimulus Act (REESA) would have a range of economic benefits to the state of California; notably that the FIT would: [415]

- Create three times the number of jobs from 2011-2020. This equates to generating about 280,000 additional direct job-years or 28,000 job-years on average per year from 2011-2020 with an additional 27,000 indirect and induced jobs per year. More jobs are generated in the first part of the decade than in later years.
- Increase direct state revenues by an estimated $1.7 billion from sales tax, use tax, and income taxes over the next decade and estimated induced revenues of about $600 million from increased employee compensation and the impact of FIT program costs. This does not include any savings to the state in avoided unemployment benefits.
- Stimulate up to $50 billion in total new investment in the state which in turn is eligible for up to $15 billion in Federal tax benefits for project developers.

The study concluded that the REESA FIT provides a highly cost-effective avenue to assist in the state's efforts to achieve the 33 percent Renewable Portfolio Standard (RPS) target by 2020. The California study corresponds with key findings and results from Ontario's FIT program, in that it increased the amount of clean energy in Ontario's supply mix, created 31,000 direct and indirect clean energy jobs, and attracted over $20 billion in private sector investment to Ontario during challenging economic times.[416]

The 2010 California study found that increased investments in renewable energy deployment may lead to higher employment upfront from the construction, installation and manufacturing sectors. This surge in employment, however, may be counteracted to a certain degree by

[414] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[415] Renewable and Appropriate Energy Laboratory, Energy and Resources Group, University of California, Berkeley (University of California, Berkeley). *Economic Benefits of a Comprehensive Feed-In Tariff: An Analysis of the REESA in California*. July 2010. Report accessed August 2013 at http://rael.berkeley.edu/sites/default/files/Kammen,%20FIT%20Study.pdf
[416] Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.

ratepayers having to pay higher electricity bills initially and having a lower level of disposable income, resulting in less employment from consumer spending.[417] Similarly, the 2009 Vermont study found that initial capital investments as a result of the FIT were expected to provide a temporary boost to employment (especially construction and related trades) and personal incomes across Vermont. The study estimated the impacts to quickly diminish as projects are completed, with some minor positive job and income effects in following years from indirect spending resulting from higher incomes in sectors that service and support project build out.[418]

While data on US FIT programs is not readily available, a 2010 study by World Future Council assessed the success of FIT in North America based on set criteria, including program caps, project size, contract terms and number of technologies included. The Vermont program earned a score of 54/100 largely because the program is limited to only 50 MW, or about 2 percent of existing generation. California scored a 28/100 largely due to its one size fits all policy with a tariff based on avoided cost. In addition, California's feed in tariff was found to have a very low program cap, a low project size cap and tariffs that vary by time of day.[419] In comparison, the study found that Ontario's FIT to be the most progressive in North America and scored an 84/100. The program awarded nearly 80MW of contracts to homeowners for rooftop social PV and about 2,500 MW of contracts for wind, solar, biogas and hydro projects, 20 percent off which were awarded to homeowners, farmers, community and aboriginal groups.[420]

Expanding the FIT program in Washington could help enhance and accelerate the deployment of renewable energy sources while also supporting other policy goals, such as GHG reduction and creation of clean energy jobs. Designing a FIT compatible with existing policies and economic goals will be critical for policy efficacy and success. The payment schedule is critical to sending the appropriate signals to investors as are subsequent policies, standards and procedures to facilitate the deployment of renewable energy once contracts are in place. Key elements of a successful FIT include: 1) contract length, with longer-term contracts providing a stable policy environment; 2) interconnection rules and agreements, with streamlined processes allowing energy generators to connect to the grid and ensuring that renewable resources are able to contribute to the power mix; 3) program and project caps; while program caps limit the potential for renewable energy projects, program caps can serve to moderate the potential cost to ratepayers and system integration impacts of introducing a large number of FIT-funded renewable resources and project caps can serve to moderate the number of large projects and/or

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417 University of California, Berkeley. *Economic Benefits of a Comprehensive Feed-In Tariff: An Analysis of the REESA in California*. July 2010.
418 Vermont Department of Public Service, Division of Energy Planning. *The Economic Impacts of Vermont Feed in Tariffs.* December 2009.
419 Institute for Self Reliance. *Feed-in tariffs in America Driving the Economy with Renewable Energy Policy that Works.* April 2009
420 The World Future Council. *Grading North American Feed-in Tariffs.* May 2010.

broaden the type of technologies; 4) while tariff revisions may ensure probability and program sustainability, they should be clearly communicated to investors to maintain a stable policy environment; 5) payment differentiation can incentivize certain technologies, resource type or size of resource and 6) bonus payments can influence power producer behavior and promote efficiencies and policy priorities such as using locally sourced materials.[421]

13.2 Quantification

This section provides a simplified estimate of the GHG reductions that can be expected for Washington State from the implementation of a feed-in-tariff program (FIT). FIT programs vary in both size and structure. Some programs are geared to small distributed renewable generation projects, such as California's which originally set a qualifying capacity limit of 1.5 MW, but has since increased that limit to 3 MW. Others limit the total generation capacity that is eligible for participation in the program (Vermont's FIT is limited to only 50 MW cumulatively) whereas others such as Ontario's FIT program, don't limit either the capacity of an individual project or the total capacity eligible for the program. Because of the variation in program specifications, this reduction quantification methodology targeted the development of a reduction factor per MWh of generation added through the program. This can be combined with estimates of generation using different program design parameters and assumptions. The calculated reduction factor for a FIT program was 0.867 Metric Tons CO_2e per MWh of renewable generation.

Many existing FIT policies set "caps" on capacity both for individual projects and for the overall program. The individual project caps (3 MW in California), are designed to ensure the program is only utilized by customer-owned and other small scale renewable projects. The capacity cap for the overall program is put in place to limit the maximum participation and constrain total costs. Existing FIT programs in California and Germany have adjusted these caps as the programs evolve to increase participation and expand the impacts of the programs.

It is also important to note that any FIT program in Washington may not generate significant additional reductions beyond what is already expected through the Renewable Portfolio Standard as part of I-937, but instead could be a mechanism through which utilities can meet a portion of their RPS targets. California's FIT program attempts to use their FIT in this way as the policy states the intent is *"to encourage electrical generation from small distributed generation that qualifies as "eligible renewable energy resources" under the RPS Program."*[422] However, this depends on the policy design in Washington and whether or not customer-owned renewable generation through the FIT program may be counted towards the RPS target, or whether the RPS targets may be increased in recognition of utilities ability to capture the FIT eligible renewable

[421] NARUC. Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions. June 2010.
[422] http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/167679.pdf, page 3.

sources. In either case the reduction factor provided in this estimate will enhance the understanding of any FIT program's contribution to the overall reductions provided by increased renewable generation.

13.2.1 Methodology

Because a FIT program in Washington would be a complementary to the RPS, the methodology to calculate a reduction factor was done in the context of I-937. The reductions from the RPS component of I-937 were calculated by forecasting emissions from a business as usual (BAU) baseline that had no set renewable requirements using DOE and Regional fuel mix forecasts. The BAU was then compared to a policy emission forecast that set renewable targets. The policy scenario applied assumptions on the fuel mix of displaced generation in order to estimate how much existing fossil energy would be replaced with renewables under the RPS.

As the specific design parameters for a FIT in Washington are unclear, this analysis provides a reduction factor to illustrate how a FIT might contribute to meeting I-937 goals. This was done by performing a sensitivity analysis on the modeled reductions from I-937, by adjusting the level of renewable consumption in each of the target years to determine what the incremental reductions were for every added MWh of renewable generation. The specifics of the I-937 methodology that was the basis of this calculation can be referenced in the previous analysis *Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State.* This analysis assumes a constant fuel mix for added fossil generation in the baseline forecast, and a constant fuel mix for displaced fossil generation in the policy forecast. Therefore, the reduction factor is constant through 2030, despite year to year variability. This analysis is only applicable through 2030 because fuel mix and load growth forecasts are only available and valid in that timeframe, with uncertainty growing too large beyond 2030 to create viable estimates. However, the reduction factor could be applied in future years to get an order of magnitude estimate of potential reductions (hundreds, thousands, or millions of tons).

The calculated reduction factor was applied to a total of three scenarios using different tariff levels. The results can be linearly scaled at different capacity caps, for example if the program capacity cap were doubled, the costs and reductions as calculated here would double as well, assuming the cap was reached in both scenarios. For the purposes of this analysis only one capacity cap was chosen and then examined at different tariff levels. Washington State has roughly half the electricity generation of California, so the capacity cap chosen for the analysis was 375 MW, half of the current California cap of 750 MW of eligible capacity. The three cost scenarios are based on the low, median, and high incentives currently provided by Washington State's tax incentive program of $0.12, $0.33, and $0.54 per kWh. Costs are determined by subtracting out the alternative cost of electricity using California's FIT 2011 price referents which are based on the predicted annual average cost of production for a combined-cycle natural gas (NGCC) fired baseload proxy plant, of $0.091 per kWh

13.2.2 Assumptions, Exclusions, and Data Sources

The following assumptions were used in estimating the GHG reduction factor for renewable generation associated with a FIT program in the state of Washington.

- The FIT program would be a complementary program to the RPS
- Assumed the program cap of 375 MW of eligible capacity is reached within 3 years.
- Assumed project size cap at 3 MW (up from the current tax incentive programs limit of 75 kW, which should allow the 375 MW capacity to be reached in 3 years with greater diversity in project types, not just rooftop solar.
- The U.S. Average generation of 3,320 MWh per MW of installed Renewable Capacity[423] is dominated by utility scale wind and hydro, current solar projects under the Washington 2005 tax incentive are averaging 1,000 MWh per MW[424], however with the assumed increase in the project capacity cap, it is expected more diversity and greater generation as project scales increase. A value of 1500 MWh per MW was used for this analysis.
- Each incremental MWh of renewable generation results in 0.867 Metric Tons of GHG reductions.
- Alternative cost of electricity generation of $0.091/kWh is based on CA 2011 market price referents. No time of day adjustments made and contract signings are assumed to be evenly distributed in 2013, 2014 and 2015, and assumed contract length of 15 years.[425]
- Tariff price per kWh is based on the low, median, and high price of the range of incentives currently paid under Washington's 2005 fixed price tax incentive program. The mid-level tariff rate of $0.33/kWh is relatively similar to the assumed cost of installed solar, and can be representative of a tariff level targeted to the cost of solar.

Figure 11: Constant Fuel Mix for Displaced Fossil Generation

Fuel Source	Percent of Displaced Generation from Increased Renewables
Hydro	0.00%
Coal	74.70%
Cogen	0.00%
NG	25.00%
Nuclear	0.00%
Petroleum	0.30%
Landfill Gases	0.00%

Based on Washington CAT ES Policy Option Analysis 2007, p 47: http://www.ecy.wa.gov/climatechange/interimreport/122107_TWG_es.pdf

423 http://www.eia.gov/renewable/state/
424 Glenn Blackmon – WA Government
425 http://www.cpuc.ca.gov/PUC/energy/Renewables/Feed-in+Tariff+Price.htm

13.2.3 Results

The result of the analysis to determine a reduction factor, reductions, and costs associated with the FIT program under different scenarios are provided in the table below. The reduction factor was calculated to be 0.867 metric tons CO_2e avoided per MWh of renewable generation. This value can be applied to other scenarios using alternative assumptions on program design to further examine FIT programs in Washington.

Table 64. Potential GHG reductions, FIT payments, and renewable generation from FIT implementation.

Scenario 375 MW Capacity Cap	$0.12 / kWh		$0.33 / kWh		$0.54 / kWh	
Total Annual Generation (MWh)	1,207,632		1,207,632		1,207,632	
Reduction Factor	0.867		0.867		0.867	
Total Reductions (MMTCO_2e)	0.5		0.5		0.5	
% of 2020 Renewable Generation | % 2020 Total Generation from FIT Sources	6%	1%	6%	1%	6%	1%
FIT Incentive | Cost of Alternative ($/ kWh)	$0.12	$0.091	0.33	$0.091	$0.54	$0.091
Annual Tariff Cost | Annual Cost of Production (Million $)	67.5	64.1	185.6	64.1	303.8	64.1
Net Incentive (Million $)	3.4		121.5		239.6	
Cost of Alternative - NGCC (Million $)	51.5		51.5		51.5	
Net Cost (Million $)	**16.0**		**134.2**		**252.3**	
Cost per Metric Ton of Reductions	**$32.91**		**$275.16**		**$517.41**	

13.3 Implementation History

FITs are used to a limited extent around the United States, but they are more common internationally. Historically, FITs have been associated with a German model in which the government mandates that utilities enter into long-term contracts with generators at specified rates, typically well above the retail price of electricity. In the United States, where FITs are comparatively new, FITs or similarly structured programs are mandated to varying degrees in a limited number of states. However, a different model has also emerged in which utilities independently establish a utility-level FIT, either voluntarily or in response to state or local government mandates.[426] This section reviews FIT programs in Germany, Ontario, and California.

Germany

The Renewable Energy Sources Act, also known as EEG (Erneuebare-Energien-Gesetz) law, has enabled renewable energy investments in large scale throughout Germany through the use of FITs. In 2011, the FIT program rates were significantly enhanced as part of a government policy, called "Energiewende", to accelerate the phase out of eight nuclear plants totaling 20.9 GW of electric power generation capacity. Amendments in 2012 increased the term of the FIT guaranteed rate from 15 years to 20 years for some installations, designed to spur new projects and investments in Germany, particularly smaller ones. FIT rates vary based on source fuels, such as hydropower, land fill gas, sewage gas, mine gas, biomass (bio waste and small manure biogas), geothermal, on-shore wind, off-shore wind, and solar. There is also a lower tariff provided for self-consumption at certain sites.

Germany has established fixed FIT rates for 2012 to 2021, providing clear long term investment protection and guidance for developers, though these rates fluctuate based on technology, installation size, and are based on levelized project costs. With the new amended and enhanced rates, Solar Photovoltaic (PV) has become a very attractive technology. Renewable energy accounted for total investment of €22.9 Billion in 2011, with PVs accounting for €15.0 Billion. The total economic output of German based renewable energy manufactures and installers was €24.94 Billion, including exports.

By 2020, the goal is to have 14 percent of total energy sourced from renewables, which will be achieved by using renewables to provide 35 percent of electricity, 18 percent of thermal energy and 10 percent in transportation sector, leading to a 40 percent reduction in GHGs when compared to 1990 standards. The renewable energy source goals increase incrementally each decade thereafter until 2050 when renewables are expected to provide 80 percent of the electricity, 60 percent of thermal energy. With 25 percent reduction through efficiency, the overall reduction in GHG is anticipated to be 80 percent to 95 percent by 2050.

Ontario

In early 2009, the Green Energy & Green Economy Act passed, establishing Ontario's FIT program designed to create new clean energy industries and jobs, boost economic activity and the development of renewable energy technologies, and improve air quality by phasing out coal-fired electricity generation by 2014.[427] Qualifying renewable technologies include biogas,

[426] EIA. May 2013. Feed-in tariff: A policy tool encouraging deployment of renewable electricity technologies. Accessed August 2013 at: http://www.eia.gov/todayinenergy/detail.cfm?id=11471

[427] Ontario Ministry of Energy. Feed-In Tariff Program Two-Year Review. Accessed September 2013 at: http://www.energy.gov.on.ca/en/fit-and-microfit-program/2-year-fit-review/

renewable biomass, landfill gas, solar photovoltaic (PV), hydro power and wind power.[428] The Ontario Power Authority (OPA) is responsible for implementing the FIT Program. Within two years OPA signed about 2,000 small and large FIT contracts with clean energy producers totaling approximately 4,600 MW.[429] Ontario's FIT program has played a significant role in jumpstarting renewable energy, ranking #4 and #11 in North America for solar and wind deployment. It has also enabled widespread participation in renewable energy generation with 1 in 7 Ontario farmers participating and earning a return on their investment.[430]

FIT Program has been key to making Ontario a leader in clean energy production and manufacturing. FIT attracted more than $20 billion in private sector investment to Ontario during challenging economic times, welcomed more than 30 clean energy companies to the province as of 2011[431] and created more than 31,000 jobs as of 2013.[432] By the end of 2014, Ontario will be the first jurisdiction in North America to replace coal-fired generation with cleaner sources of power.[433] Ontario has shut down 10 of 19 coal units and reduced the use of coal by nearly 90 per cent since 2003.[434] Moreover, Ontario is on track to procure 10,700 MW of non-hydro renewable energy generation by 2015.[435] To support the long-term sustainability of the FIT Program, OPA has set annual procurement targets of 150 megawatts for small FIT and 50 megawatts for microFIT for each of the next four years, beginning in 2014.

The biggest challenge for the FIT program is the overwhelming demand. Signed contracts for nearly 5,000 megawatts of new renewable energy capacity will allow the province to meet most of its 2030 renewable energy target, 12 years early.[436] While Ontario's FIT program has

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[428] Ontario Power Authority. Feed-In Tariff (FIT) Program, FAQs. Accessed August 12, 2013. http://fit.powerauthority.on.ca/faqs

[429] Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report.* March 2012. http://www.energy.gov.on.ca/docs/en/FIT-Review-Report-en.pdf

[430] Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.

[431] Ontario Ministry of Energy. Feed-In Tariff Program Two-Year Review. Accessed September 2013 at: http://www.energy.gov.on.ca/en/fit-and-microfit-program/2-year-fit-review/

[432] Energy Manager Today. Ontario's Buy Local Feed-In Tariff Stuck In A Rut After Initial Success. May 20, 2013. Accessed September 2013 at: http://www.energymanagertoday.com/ontarios-buy-local-feed-in-tariff-stuck-in-a-rut-after-initial-success-092031/

[433] Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report.* March 2012.

[434] Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report.* March 2012.

[435] Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report.* March 2012.

[436] Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.

stumbled with less than 10 percent of its contracted capacity deployed, it remains competitive with leading U.S. states.[437]

California

On February 14, 2008, the California Public Utilities Commission (CPUC) authorized the purchase of up to 480 MW of renewable generating capacity from renewable facilities smaller than 1.5 MW. The FIT provides a mechanism for small renewable generators to sell power to the utility at predefined terms and conditions, without contract negotiations, setting the price paid to small generators at the level of the Market Price Referent (MPR). In 2009, eligible project size was increased to 3 MW. [438] The original FIT program closed on July 24, 2013, and was replaced by a renewable market adjusting tariff (ReMAT).

In May 2012, the CPUC implemented a new pricing mechanism and program rules for the FIT program, the ReMAT, in response to stakeholders' petitions for modification.[439] The ReMAT allows the FIT price to adjust in real-time based on market conditions. ReMAT is being implemented by IOUs to comply with the IOU's portion of the 750 MW state-wide feed-in tariff program mandated by SB 32.[440] ReMAT includes two principle components: First, the starting price increases or decreases for each product type based on the market's participation in the program and applies to three FIT product types (ie.i.e. baseload, peaking as-available, and non-peaking as-available). Second, a two-month price adjustment mechanism may increase or decrease the price for each product type every two months based on the market response. The IOU-share of MWs under the revised FIT program is 493.6 MW.[441]

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[437] Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.

[438] California Public Utilities Commission. *Feed-in Tariffs Legislative History*. Accessed August 2013 at: http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/fit_legislativeHistory.htm

[439] WSGR. *California Public Utilities Commission Adopts Terms of Standard FIT Contract and Revised Tariffs.* June 2013. Article access August 2013 at http://www.wsgr.com/WSGR/Display.aspx?SectionName=publications/PDFSearch/wsgralert-standard-FIT-contract.htm

[440] PG&E. Renewable Market Adjusting Tariff (ReMAT) Feed-In Tariff (FIT). Program Overview. (PowerPoint Presentation). Accessed September 2013 at: http://www.pge.com/includes/docs/pdfs/b2b/energysupply/wholesaleelectricsuppliersolicitation/standardcontractsforpurchase/ReMAT_Webinar1_Overview.pdf

[441] WSGR. *California Public Utilities Commission Adopts Terms of Standard FIT Contract and Revised Tariffs.* June 2013.

14 Commercialization of Offshore Wind and Ocean Energy

Table 65: Potential Costs and Benefits and Additional Screening Criteria for Commercialization of Off-Shore **Energy to Washington Consumers and Businesses**

Potential Action for Consideration	
• A policy, or set of policies, designed to support the commercialization of ocean energy in Washington could help enhance and accelerate the deployment of off-shore energy sources while also supporting other policy goals, such as GHG reduction and creation of clean energy jobs.	
Potential Costs and Benefits to WA Consumers	**Potential Costs and Benefits to WA Businesses**
• As offshore energy is still in the research and development phase, potential impacts to consumers are still undetermined.	• As offshore energy is still in the research and development phase, potential impacts to businesses are still undetermined.
Summary of Screening Criteria	
Does the policy target an emissions source of significant magnitude in Washington*?** Yes, once deployed offshore energy has the potential to replace an emission source of significant magnitude in Washington. In 2010, the electricity sector accounted for 21.5 percent of statewide GHG emissions, emitting 20.7 $MMTCO_2e$.[442] With offshore winds blowing harder and more uniformly than on land, NREL finds that the Pacific Northwest has about 342 GW of gross offshore wind resource, with 15.1 GW in shallow waters (0-30 meters in depth), 21.3 GW at transitional waters (30-60 meters in depth) and 305.3 GW in deep waters (more than 60 meters in depth), though these gross resource values will likely shrink by 60 percent or more after all environmental and socioeconomic constraints are taken into account .[443] A DOE study, published in August 2012, found that 7.5 percent of Washington State's annual load could be met with wave energy by 2030, and 36 percent of the load by 2050, assuming 80 percent cost reduction is achieved, and at 70 percent deployment density.[444] ***What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful? DOE is engaged in several ongoing offshore wind activities and invested a total of $708,133 for offshore wind technology development in Washington State from 2006-2012[445] and is expected to award about $50 Million to the WindFloat Pacific Project from February 2013 through December 2017 for full project implementation of a 30 MW offshore wind demonstration project.[446] NREL estimates a current baseline	

[442] Washington State Department of Ecology. *Washington State Greenhouse Gas Emissions Inventory 2009-2010.* December 2012. Report accessed August 2013 at https://fortress.wa.gov/ecy/publications/publications/1202034.pdf

[443] National Renewable Energy Laboratory (NREL). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers.* (September 2010). Accessed September 2013 at http://www.nrel.gov/wind/pdfs/40745.pdf

[444] Previsic, M. The Future Potential of Wave Power in the United States. U.S. DOE EERE. August 2012. Accessed August 2013 at: http://www.oregonwave.org/wp-content/uploads/The-Future-of-Wave-Power-MP-9-20-12-V2.pdf

[445] US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Offshore Wind Projects. Fiscal Years 2006-2012*. (December 2012) Accessed September 2013 at http://www1.eere.energy.gov/wind/pdfs/offshore_energy_projects.pdf

[446] http://pnwer.org/Portals/26/Sen%20Roblan%20-%20Principle%20Power%20and%20the%20Wind%20Float%20Pacific%20Project.pdf

of installed capital costs for offshore wind at $4,250 per kilowatt (kW) based on energy market surveys.[447] As other types of offshore energy are still in the research and development phase, volume and cost of GHG reductions is still undetermined. Nonetheless, the DOE Water Power Program finds ocean energy has realized significant returns on the federal investment to date and anticipates significant key accomplishments in the years to come.[448,449] A 2012 DOE study estimated wave technology costs to be about $4,347/kW of capital costs and about $163/kW annual operations and maintenance costs.[450] A study by the International Energy Agency estimated the investment cost of wave power at between $6,800 and $9,000/kW, but expects it to be reduced to $5,700/kW by 2020 and to $4,700/kW by 2030 as a result of technology learning and larger deployment. The EIA also estimated the cost of tidal stream power in 2010 between $6,000 and $7,800/kW (US$ 2008), and projected it to decline to $5,000/kW by 2020, and to $4,100/kW by 2030.[451] The European Commission estimates that wave energy could avoid 1.0 – 3.3 $mtCO_2e$/year in Europe by 2020. The corresponding maximum cumulative avoided CO_2e emission for the period 2010 to 2030 could be up to 275 Mt CO_2e.[452]

Is the policy discrete and comprehensive, or is it instead a bundle of related policies?
Commercialization of offshore energy could be designed as a discrete and comprehensive policy targeting the advancement and deployment of specific offshore energy technologies or could be part of a bundle of related policies targeting innovation, research and development, advancement of new technologies as well as attracting private sector investments and clean energy companies in Washington.

Can the policy be meaningfully implemented or influenced at the State level?
Yes. Depending on program design, commercialization of offshore energy could be meaningfully implemented or influenced at the state level to achieve policy goals beyond GHG emissions reductions, such as economic development and social policy goals.

14.1 Introduction

Although Washington's GHG emissions from the electricity sector are small relative to the contribution of this sector in other states, in absolute terms they represent 20.7 $MMTCO_2e$, or 21.5 percent of statewide emissions. Washington has recognized the potential to reduce these emissions through further implementation of clean, renewable energy sources, such as offshore energy. In November 2011 the Washington Ocean Energy Conference was held in Bremerton,

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[447] EERE. *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States. (February 2011.)* Accessed September 2013 at

[448] US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Marine and Hydrokinetic Energy Projects. Fiscal Years 2008-2012.* (January 2013) Accessed August 2013 at http://www1.eere.energy.gov/water/pdfs/wp_accomplishments_brochure.pdf

[449] DOE EERE Water Power Program website accessed August 2013 at http://www1.eere.energy.gov/water.

[450] Previsic, M. The Future Potential of Wave Power in the United States. U.S. DOE EERE. August 2012. Accessed August 2013 at: http://www.oregonwave.org/wp-content/uploads/The-Future-of-Wave-Power-MP-9-20-12-V2.pdf

[451] Energy Technology Systems Analysis Programme. Marine Energy. Accessed August 2013 at: http://www.iea-etsap.org/web/E-TechDS/PDF/E08-Ocean%20Energy_GSgct_Ana_LCPL_rev30Nov2010.pdf

[452] EU Strategic Energy Technologies Information System. Ocean wave energy: Technology Information Sheet. Accessed August 2013 at: http://setis.ec.europa.eu/publications/technology-information-sheets/ocean-wave-energy-technology-information-sheet

WA, producing a high level of interest and enthusiasm for a multi-stakeholder effort focused on the challenges and opportunities of ocean energy off the Washington Coast.[453] The vast ocean energy resource in Northwest waters was noted as having potential advantages in a number of respects, including considerable economies of scale for offshore installations, reduced environmental impacts, and proximity to population centers.[454] Governor Gregoire's interest in the potential of ocean energy and related economic opportunities associated with development of related technologies was also conveyed at the conference, pointing out the need for tax and other incentives.[455]

Offshore winds tend to blow harder and more uniformly than on land, providing the potential for increased electricity generation and smoother, steadier operation than land-based wind power systems.[456] A 2010 NREL study found that the Pacific Northwest has about 342 GW of gross offshore wind resource, with 15.1 GW in shallow waters (0-30 meters in depth), 21.3 GW at transitional waters (30-60 meters in depth) and 305.3 GW in deep waters (more than 60 meters in depth). This wind mapping effort, however, does not currently account for a range of siting restrictions and public concerns. These gross resource values will likely shrink by 60% or more after all environmental and socioeconomic constraints have been taken into account. [457]

The opportunities for advancing offshore wind technologies are accompanied by significant technology challenges as offshore wind technologies are still in the very early stages of development. Moreover, offshore wind installations have higher capital costs than land-based installations per unit of generating capacity, largely because of turbine upgrades required for operation at sea and increased costs related to turbine foundations, balance-of-system infrastructure, interconnection, and installation. NREL estimates a current baseline of installed capital costs for offshore wind at $4,250 per kilowatt (kW) based on energy market surveys. [458] Nonetheless, NREL finds that high electricity costs in coastal regions, more energetic wind regimes offshore, and close proximity of offshore wind resources to major electricity demand centers could allow offshore wind to compete relatively quickly with fossil fuel-based electricity

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[453] Clean Tech West Sound website accessed August 2013 at http://ctwsound.com/events/
[454] Clean Tech West Sound. *Washington State Ocean Energy Conference*. (2011) http://ctwsound.com/wp-content/uploads/2012/07/WSOEC_SummaryofSpeakersRemarks_2011.pdf
[455] Clean Tech West Sound. *Washington State Ocean Energy Conference*. (2011)
[456] NREL. *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers.* (September 2010).
[457] NREL. *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers.* (September 2010).
[458] EERE. *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States. (February 2011.)* Accessed September 2013 at http://www1.eere.energy.gov/wind/pdfs/national_offshore_wind_strategy.pdf

generation in many coastal areas.[459] While the opportunities for offshore wind are abundant, the technical, infrastructure and permitting barriers and challenges remain significant.[460]

Ocean energy involves the generation of electricity from waves, tides, currents, the salinity gradient, and the thermal gradient of the sea, with wave and tidal energy currently being the most mature technologies. Various wave and tidal energy systems have been deployed in several countries, and these technologies are making the transition from research to demonstration projects to market penetration. Though ocean energy is not yet competitive with more mature renewable energy technologies such as wind, it has the potential to be highly predictable as compared with other renewable generation assets, enhancing its value to the utility industry and its customers.

With ocean energy offering the potential for long-term carbon emissions reduction, government policies are contributing to accelerating the development and deployment of ocean energy technologies. The global marine energy resource exploitable with today's technology is estimated to be about 140 – 750 TWh/year, rising to 2,000 TWh/year or 13 percent of world electricity consumption (which is about 15,400 TWh/year).[461] The DOE estimates the total available U.S. wave energy resource to be at 2,640 TWh/yr, with Alaska containing the largest number of locations with high kinetic power density, followed by other coastal states, including Washington, Oregon and California.[462]

Policy instruments to promote ocean energy technologies in the U.S. entail research and development programs and grants, national research and testing facilities, and permitting regimes in the outer continental shelf. At the national level, the Department of Energy's (DOE) Water Power Program aims to accelerate the technological development and deployment of innovative water power technologies capable of generating electricity from water, such as hydropower, wave, tidal, and current devices, by funding research and development activities through competitive solicitations. The DOE finds that there is a vast amount of energy available in ocean waves and tides and estimates the total available U.S. wave energy resource to be at 2,640 TWh/yr. Given the limits of device arrays, approximately 1,170 TWh/ yr of the total resource is

[459] EERE. *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States.* (February 2011.)
[460] NREL. *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers.* (September 2010).
[461] EU Strategic Energy Technologies Information System. *Ocean wave energy: Technology Information Sheet*. Accessed August 2013 at: http://setis.ec.europa.eu/publications/technology-information-sheets/ocean-wave-energy-technology-information-sheet
[462] US Department of Energy, Energy Efficiency and Renewable Energy (DOE EERE) Wind and Water Power Program. U.*S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Marine and Hydrokinetic Energy Projects. Fiscal Years 2008-2012.* (January 2013)

theoretically recoverable, with 250 TWh/yr for the West Coast.[463] The DOE therefore invests, supports and participates in programs, partnerships and projects across the country; including the Northwest National Marine Renewable Energy Center (NNMREC), the West Coast Governors Alliance (WCGA) and demonstration projects in Puget Sound, WA.

The NNMREC is a DOE funded partnership between the University of Washington and Oregon State University whose primary purpose is to support wave and tidal energy development for the United States. The DOE funds are matched at a 50 percent level by contributions from the University of Washington and the Center partners. This is to ensure that the Center is a true public-private partnership and strives to meet the needs of all marine energy stakeholders.[464] NNMREC's mission is to facilitate the development of marine energy technology, inform regulatory and policy decisions, and to close key gaps in scientific understanding with a focus on student growth and development. More specifically, project objectives are to develop facilities to serve as integrated test Center for wave & tidal energy developers; evaluate potential environmental and ecosystem impacts; optimize devices and arrays; improve forecasting; and increase reliability and survivability.

As part of the West Coast Governors Alliance (WCGA) on Ocean Health, Washington, Oregon and California have agreed to collaborate with the Bureau of Ocean Energy Management (BOEM), DOE, Federal Energy Regulatory Commission (FERC), National Oceanographic and Atmospheric Administration (NOAA), and other agencies to evaluate the potential benefits and impacts of renewable ocean energy projects off the West Coast. An additional goal is to develop the planning and regulatory structure for these activities. The Renewable Ocean Energy Action Coordination Team is charged with exploring the feasibility for offshore alternative ocean energy development and evaluating the potential environmental impacts of these technologies.[465] Washington has great ocean energy resources, with high tidal resources in the Puget Sound, WA. Having a clean, renewable, and predictable source of energy in the Puget Sound that could be connected directly into the shared local grid could provide many environmental, operational, and economic benefits.[466]

From 2008 through 2012, the DOE Water Power Program funded $12,878,199 for marine and hydrokinetic energy programs and projects in Washington State. The Snohomish County Public

[463] US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Marine and Hydrokinetic Energy Projects. Fiscal Years 2008-2012.* (January 2013)
[464] Northwest National Marine Renewable Energy Center website accessed August 2013 at http://depts.washington.edu/nnmrec/partners.html
[465] West Coast Governors Alliance on Ocean Health website accessed August 2013 at http://www.westcoastoceans.org/index.cfm?content.display&pageID=110
[466] Snohomish County Public Utility District #1 website accessed August 2013 at http://www.snopud.com/PowerSupply/tidal/tidalbg/tidalbgenergy.ashx?p=1509

Utility District #1 (PUD) has received funding for tidal energy in-water testing and development in Puget Sound. The PUD is the second largest public utility in Washington, and is well positioned to share key learning among other regional and national stakeholders. NNMREC and the District have collaborated on multiple projects related to this effort, including site-characterization and development of monitoring capabilities. On March 1, 2012, the PUD filed a final license application with FERC for the Admiralty Inlet Pilot Tidal Project. This DOE-funded project represents approximately $10 million of federal investment and will deploy two grid-connected 6 meter diameter turbines in Admiralty Inlet in 2013. The open-center turbines are ducted, horizontal axis tidal devices. Field measurements in this location are ongoing, making this the best characterized tidal site in the United States.[467] In January 2013 FERC released a draft environmental assessment that found that placing two turbines in Admiralty Inlet would not harm the environment or nearby fiber-optic cables. While the owner of the fiber-optic cables disagrees with concerns about effects on killer whales and native plants, if all goes well for the Snohomish County PUD, the turbines could be in place in mid-2014.[468]

In addition, in March of 2011, Columbia Power Technologies' "SeaRay" wave energy converter was deployed in Puget Sound, WA. This 1:7 scale wave energy converter device was successfully tested over the course of one full year, being remotely controlled and operated from Corvallis, Oregon. This unique point absorber technology directly couples the motion of waves to the electrical generator via a direct drive, rotary power take-off. Capture of critical, in-water performance data will help inform the future designs of wave energy converters.[469]

Similarly, DOE is engaged in several ongoing offshore wind activities and has invested a total of $93.4 million through the American Reinvestment and Recovery Act of 2009 (Recovery Act) into offshore-related activities within the Wind Program.[470] From 2006 through 2012, the DOE Offshore Wind Program funded $308,703,626, $708,133 of which was allocated to Washington State for offshore wind technology development.[471] In addition, DOE is awarding $4 Million to the WindFloat Pacific Project from February 2013 through February 2014 and is expected to award an

[467] US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Marine and Hydrokinetic Energy Projects. Fiscal Years 2008-2012.* (January 2013)
[468] Pacific Fishery Management Council. *Ocean Energy Notes* (January 29, 2013). Accessed August 2013 at http://www.pcouncil.org/wp-content/uploads/Ocean-Energy-Notes.pdf
[469] US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Marine and Hydrokinetic Energy Projects. Fiscal Years 2008-2012.* (January 2013)
[470] EERE. *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States. (February 2011.)* Accessed September 2013 at http://www1.eere.energy.gov/wind/pdfs/national_offshore_wind_strategy.pdf
[471] US DOE EERE Wind and Water Power Program. *U.S. Department of Energy Wind and Water Power Technologies Office Funding in the United States: Offshore Wind Projects. Fiscal Years 2006-2012*. (December 2012).

additional $47 Million from May 2014 through December 2017 for full project implementation of a 30 MW offshore wind demonstration project.[472]

14.2 Literature Review of Washington Potential

Policy mechanisms could help accelerate the deployment of wind and ocean energy, lead to the reduction of GHG emissions as well as achieve other important economic development and social goals. Ocean energy has potential as a predictable, renewable energy source that could help to reduce GHG emissions, mitigate risks associated with fossil fuel price volatility, and provide long-term energy security. Additional potential benefits include creating jobs and other significant economic development opportunities as well as improving public health from reduced emissions. While ocean energy has a great deal of potential, it is still in the development phase and not yet competitive with more mature renewable energy technologies such as wind. Further research and development is required and critical barriers need to be addressed, from permitting to grid-connectivity, in order to leverage its potential to be a highly predictable source of energy relative to other renewable generation assets.

In 2012, Washington State's electric utility fuel mix comprised of about four percent of non-hydro renewable energy sources, with about 3.32 percent of wind, 0.34 percent of biomass and 0.33 percent of waste.[473] Meanwhile, coal accounted for 13.4 percent of the electric utilities' fuel mix and 79.3% of carbon emissions.[474] Investing in ocean energy technologies could position Washington to phase out less desirable, carbon intensive electricity generation energy sources, such as coal-fired power plants. The IPCC found that ocean energy has the potential to deliver long-term carbon emissions reductions as ocean energy technologies do not generate GHGs during operation and have low lifecycle GHG emissions. GHG emissions may arise from different aspects over the lifecycle of an ocean energy system, however, including raw material extraction, component manufacturing, construction, maintenance and decommissioning. The IPCC estimates lifecycle GHG emissions from wave and tidal energy systems to be are less than 23g CO_2e/kWh, with a median estimate of lifecycle GHG emissions of around 8g CO_2e/kWh for wave energy.[475] Utility-scale deployments with transmission grid connections can be used to displace carbon-emitting energy supplies.

[472] http://pnwer.org/Portals/26/Sen%20Roblan%20-%20Principle%20Power%20and%20the%20Wind%20Float%20Pacific%20Project.pdf
[473] State of Washington Department of Commerce. *Washington State Electric Utility Fuel Mix Disclosure Reports for Calendar Year 2012*. July 2013. Report accessed August 2013 at http://www.commerce.wa.gov/Documents/Utility-Fuel-Mix-Reports-Data-CY2012.pdf
[474] State of Washington Department of Commerce. *Washington State Electric Utility Fuel Mix Disclosure Reports for Calendar Year 2012*. July 2013.
[475] Lewis, A., et al, 2011: Ocean Energy. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Although ocean energy technologies are at an early stage of development, there are encouraging signs that the investment cost of technologies and the levelized cost of electricity generated will decline from their present non-competitive levels as R&D and demonstrations proceed, and as deployment occurs.[476] A 2013 DOE shows that for a range of existing technologies and devices and considering basic technical and economic factors, there are many areas potentially suitable for marine renewable energy development off the Washington coast.[477]

The DOE finds that there is a vast amount of energy available in ocean waves and tides, with high tidal resources in the Puget Sound, WA, and that a cost-effective marine and hydrokinetic (MHK) industry could provide a substantial amount of electricity from highly predictable waves and currents to the nation. Moreover, the DOE Water Power Program finds that the newly emerging MHK industry holds tremendous potential for job growth as MHK technologies progress towards commercial readiness.[478] Navigant Consulting estimated about 14 full time employees per MW generated directly from the ocean wave or tidal energy market.[479] In addition, as the ocean energy market grows, it could also provide opportunities in related and supporting industries. Supply chain opportunities range from design, fabrication, component supply and assembly to site surveys, installation, commissioning and testing, performance assessment, environmental assessment and monitoring, and servicing and maintenance. The European Commission estimates that marine energy has the potential to generate 10 to 12 jobs per MW in the EU-27. As the ocean energy market grows, it could also provide opportunities in related and supporting industries. Supply chain opportunities range from design, fabrication, component supply and assembly to site surveys, installation, commissioning and testing, performance assessment, environmental assessment and monitoring and servicing and maintenance.

While there are many opportunities in the Pacific Northwest for developing ocean energy, ocean energy technology is relatively new and still in the development phase and there is significant uncertainty regarding when wave, tidal, and other ocean energy technologies will be producing grid-connected energy. Furthermore, multiple barriers exist for ocean energy technologies, such

[476] Lewis, A., et al, 2011: Ocean Energy. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
[477] DOE. *Geospatial Analysis of Technical and Economic Suitability for Renewable Ocean Energy Development on Washington's Outer Coast.* (June 2013). Accessed September 2013 at http://www.msp.wa.gov/wp-content/uploads/2013/07/PNNL_EnergySuitability_Final-Report.pdf
[478] US DOE EERE Water Power Program. *Water Power for a Clean Energy Future.* (April 2013). Accessed August 2013 at: http://www1.eere.energy.gov/water/pdfs/wp_accomplishments_brochure.pdf
[479] Navigant Consulting. *Job Creation Opportunities in Hydropower: Final Report. (Powerpoint Presentation).* (September 20, 2009). Accessed August 2013 at: http://www.hydro.org/wp-content/uploads/2010/12/NHA_JobsStudy_FinalReport.pdf

as gaining site permits, the environmental impact of technology deployments, and grid connectivity for transmitting the energy produced.[480]

Permitting and obtaining Federal approval to install ocean energy projects can be cumbersome and is one of the key factors delaying the deployment of ocean energy.[481] Progress has been made to allow the pilot testing of new technologies on a smaller scale before going through the full permitting process.[482] In 2010, legislation passed by the Washington Legislature provided a framework for coastal and marine spatial planning (CMSP).[483] Nonetheless, marine technologies are new, unproven, and their cumulative environmental impacts are not known. Though ocean energy systems are expected to have little negative impact on the environment, the technologies are too new to gauge all factors. Testing and design tools should be developed and validated to help accelerate development and successful deployment. Design requirements and guidelines would help expedite ocean energy technologies to viable commercial designs. Moreover, resource assessments for ocean energy are currently incomplete and have high uncertainty.[484] A method for reporting the resource quantities for comparison with standard energy metrics is still not well developed. Ocean energy resources need to be quantified in terms of raw resources and extractable electric resources. Guidelines must be developed to make this potential consistent with other renewable energies.

Many research, development, test and evaluation activities are underway in Washington and Oregon and others have yet to be planned. Prior to commercialization, effectively engaging and collaborating with key stakeholders, such as in the crabbing and fishing industry, will be key to minimize conflicts as will the development of enabling technologies (such as anchors, moorings, wave energy converters) to reduce conflict with key stakeholders and existing users, and recognizing limitations in available installation equipment. A 2013 DOE study concluded that marine renewable energy as a potential new use of ocean space and resources in Washington is viewed favorable by some as a local, renewable energy source offering new opportunities for employment, economic development in coastal communities, increased energy independence, and a role for the state in a new and innovative industry while others are concerned that marine renewable energy could displace traditional ocean activities or negatively impact the marine environment, coastal recreation, ocean views, or the electricity grid.[485] Furthermore, as the availability of transmission lines will impact the rate at which ocean energy can be

[480] US. DOE EERE Federal Energy Management Program. *Ocean Energy Technology Overview*. (July 2009). Accessed August 2013 at https://www1.eere.energy.gov/femp/pdfs/44200.pdf
[481] US. DOE EERE Federal Energy Management Program. *Ocean Energy Technology Overview*. (July 2009).
[482] US. DOE EERE Federal Energy Management Program. *Ocean Energy Technology Overview*. (July 2009).
[483] http://ctwsound.com/wp-content/uploads/2012/07/WSOEC_SummaryofSpeakersRemarks_2011.pdf
[484] US. DOE EERE Federal Energy Management Program. *Ocean Energy Technology Overview*. (July 2009).
[485] DOE. *Geospatial Analysis of Technical and Economic Suitability for Renewable Ocean Energy Development on Washington's Outer Coast.* (June 2013).

commercialized, planning for upgrades with utility companies should be integrated in overall ocean energy projects.

Designing and developing policies to support the commercialization of ocean energy in in Washington could help enhance and accelerate the deployment of ocean energy sources while also supporting other policy goals, such as GHG reduction and creation of clean energy jobs. Designing a policy compatible with existing policies and economic goals will be critical for policy efficacy and success.

15 Landfill Methane Capture

Table 66: Potential Costs and Benefits and Additional Screening Criteria for Implementation of a Landfill Methane Capture Policy to Washington Consumers and Businesses

Potential Action for Consideration	
• Consider implementing a Landfill Methane Capture policy similar to California's. Under California regulation, landfills with greater than 450,000 tons of waste-in-place, a landfill gas heat rate greater than or equal to 3.0 MMBtu per hour, and which received waste after January 1, 1977 must install and operate a landfill GCCS with 99 percent destruction removal efficiency for methane. Hazardous waste landfills, construction and demolition landfills, and landfills regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) are exempt.[486]	
Potential Costs and Benefits to WA Consumers	**Potential Costs and Benefits to WA Businesses**
• $0.09 per month per Californian • Reduction in NMOC emissions	• Estimated capital investment of over $27 million to design, construct, and install required landfill GCCS, and an additional $6.4-$14 million annually in recurring costs. Total costs for technology, operation, monitoring and maintenance are estimated at approximately $335 million. • Costs to landfill operators may translate into jobs in related sectors.
Summary of Screening Criteria	
Does the policy target an emissions source of significant magnitude in Washington? Solid waste management resulted in 2.1 $MMTCO_2e$ of emissions in Washington in 2010, or 2 percent of the States total GHG emissions in that year. This has grown from 1.0 $MMTCO_2e$ in 1990, or about 1 percent of the State's total emissions in that year. ***What has been the volume and cost of GHG reductions in other jurisdictions, and has the policy been considered successful?*** At this time, California is the only state in the U.S. that has implemented a landfill methane policy more stringent than the federal rules, and program evaluation data on emissions reductions and costs are unavailable. In general, the Landfill Methane Control Measure represents a relatively low cost means of reducing CH_4 emissions according to California modeling. However, several parties commented during the public comment period that the ARB estimates were lower than many individual landfills would experience. For smaller landfills, the costs to mitigate CH_4 will be greater on a per $mtCO_2e$ basis. ***Is the policy discrete and comprehensive, or is it instead a bundle of related policies?*** The policy is discrete and comprehensive, as it would be a state-level regulation over landfills of a certain size or design. ***Can the policy be meaningfully implemented or influenced at the State level?***	

[486] California Air Resources Board. *Implementation Guidance Document for the Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills*. July 2011. Accessed August 2013 at: http://www.arb.ca.gov/cc/landfills/docs/guidance0711.pdf

Yes. The policy would be implemented at the state level.

15.1 Introduction

The anaerobic degradation of organic waste creates methane (CH_4), a potent GHG that is 21 times more heat trapping than carbon dioxide. Modern municipal solid waste (MSW) landfills are managed anaerobically (in the absence of oxygen), and emit CH_4 emissions over time, in varying amounts depending on landfill management practices. Typically, CH_4 comprises approximately 50 percent of landfill gas (LFG). In the U.S., landfills account for 17.5 percent of all CH_4 emissions, or about 1.8 percent of total GHG emissions.[487]

Federally, the New Source Performance Standard (NSPS) regulates large MSW landfills, and requires those with greater than 50 megagrams (Mg) emissions per year of non-methane organic compounds (NMOC) to install gas collection and control systems (GCCS). Although these systems are implemented for the management of NMOC, the management practice of combusting LFG also destroys the CH_4 component of the gas. Landfill GCCS capture and combust CH_4 generated at landfills, preventing it from being released to the atmosphere, or capture it for energy use if it is generated in large enough amounts.

The NSPS applies only to landfills with a design capacity of 2.5 million metric tons or greater.[488] However, many landfills in the U.S. are smaller than this, and there is no federal standard requiring GCCS at those sites. California implemented a Landfill Methane Control Measure as part of their AB 32 Global Warming Solutions Act to target smaller landfills that still have significant CH_4 emissions.

California Landfill Methane Control Measure: Under California regulation, landfills with greater than 450,000 tons of waste-in-place, a landfill gas heat rate greater than or equal to 3.0 MMBtu per hour, and which received waste after January 1, 1977 must install and operate a landfill GCCS with 99 percent destruction removal efficiency for methane. Hazardous waste landfills, construction and demolition landfills, and landfills regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) are exempt.[489] At this time, California is the only state in the U.S. that has implemented a landfill methane policy more

[487] U.S. Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011*. April 12, 2013. Accessed August 2013 at: http://epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf

[488] U.S. Environmental Protection Agency. *Rule and Implementation Information for Standards of Performance for Municipal Solid Waste Landfills*. Accessed July 2013 at: http://www.epa.gov/ttnatw01/landfill/landflpg.html

[489] California Air Resources Board. *Implementation Guidance Document for the Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills*. July 2011. Accessed August 2013 at: http://www.arb.ca.gov/cc/landfills/docs/guidance0711.pdf

stringent than the federal rules, and program evaluation data on emissions reductions and costs are unavailable.

In general, the Landfill Methane Control Measure represents a relatively low cost means of reducing CH_4 emissions according to California modeling. However, several parties commented during the public comment period that the ARB estimates were lower than many individual landfills would experience. For smaller landfills, the costs to mitigate CH_4 will be greater on a per $mtCO_2e$ basis.

During policy development, the California ARB quantified costs and benefits of the Landfill Methane Control Measure for two sectors of the economy: landfill operators and regulators. The total costs to affected businesses are approximately $111 million. These costs include site monitoring, system installation, operation and maintenance, and reporting, much of which must be conducted on-site or in-state. The annual costs to the government for implementation and compliance monitoring is estimated to range from $24,500 to $1.2 million.[490]

Over the life of the measure, the ARB calculated that the Landfill Methane Control Measure would cost the average California household $0.09 per month.[491] This cost would not be expected to significantly impact household consumption and spending.

As noted, the federal NSPS regulation requiring landfill GCCS at large gassy landfills was not developed to manage CH_4. Rather, it targets volatile organic compounds (VOCs) and NMOCs which are harmful to air quality and present health concerns. However, the technology for mitigating these compounds – combustion – also destroys the methane contained in LFG. For landfills regulated under NSPS, the destruction and management of methane could thus be considered a co-benefit. Conversely, a policy that targets methane for destruction will have the co-benefit of mitigating VOCs and NMOCs.[492]

15.2 Literature Review of Washington Potential

Landfills that accepted MSW on or after January 1, 1980 and generate methane in amounts equivalent to 25,000 metric tons of CO_2e or more per year are required to report to EPA under the Greenhouse Gas Reporting Program. EPA's definition of an MSW landfill includes the landfill, LFG collection systems, and destruction devices for LFGs (including flares). Since there are no notable studies on the potential of a Landfill Methane Capture policy similar to California's in Washington, a broad, high-level analysis was conducted to understand the potential magnitude of impact of such a policy in Washington.

[490] Ibid.
[491] Ibid.
[492] Ibid.

In 2011, 23 facilities in Washington reported 1.4 $MMTCO_2e$ of emissions and in California, 118 facilities reported 7.5 $MMTCO_2e$.[493] Assuming that the same percentage of facilities in Washington and California were below the reporting threshold (and therefore did not report to the GHGRP), the 2011 ratio of Washington emissions from reporting landfills to California emissions from reporting landfills was used to calculate expected costs to Washington (about 18.6 percent). Using this ratio and the cost and emission reduction data detailed in Appendix A, the following high-level estimates of potential impacts in Washington were calculated:

Total costs over a 23 year time frame would be at $20.72 million (2008 USD). The overall cost-effectiveness estimates inclusive of private and public costs of the measure range from a low of \$5.50 per $mtCO_2e$ to a high of \$11.38 per $mtCO_2e$ over the measure's expected life, with an average of \$8.64 per $mtCO_2e$.[494]

California ARB estimates, scaled to Washington, would result in the following costs to affected businesses over the life of the measure:

- Capital: $1.5 million
- Annual Operations and Maintenance (O&M): $8 million
- Monitoring: $11.2 million
- Reporting: $10,117
- TOTAL: $20.72 million

Additionally, California ARB estimates, scaled to Washington, would result in the following costs to affected government agencies which manage landfills:

- Capital: $3.5 million
- Annual O&M: $19.6 million
- Monitoring: $18.9 million
- Reporting: $46,667
- TOTAL: $42 million

Based on scaled California data, annual emission reductions in Washington may range from a low of 0.2 $MMTCO_2e$ in the first year of implementation to an estimated high of 0.4 $MMTCO_2e$

[493] EPA. Facility Level Information on Greenhouse Gas Tool. Accessed September 2013 at: http://ghgdata.epa.gov/ghgp/main.do
[494] California Air Resources Board. *Staff Report: Initial Statement of Reasons for the Proposed Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills*. May 2009. Accessed August 2013 at: http://www.arb.ca.gov/regact/2009/landfills09/isor.pdf

in the final year. California The cumulative emission reductions resulting from the measure would be 7.2 $MMTCO_2e$ over 23 years.[495]

[495] California Air Resources Board. May 2009.

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Appendix A: Literature Review of Existing Policies

Contents

1 Overview

This appendix was submitted as an intermediate deliverable provided to the State of Washington, in which policies implemented in other jurisdictions were researched in the literature, and summarized across a variety of topics. Table 1 summarizes the primary sections that are included in each policy analysis, and defines some of the basic terms and concepts applied.

Table 1. This table presents the primary sections included in each policy analysis and describes the categories used to evaluate data and analyses from other jurisdictions.

GHG Costs and Benefits	
Cost of Reductions	Provides an indication of overall cost effectiveness, ideally represented in dollars per metric ton of CO_2e avoided. However, this metric was not always available in the literature, and in its place summary costs of program implementation or funding levels have been provided.
Volume of Reductions	Represents the quantity of GHG emissions reductions that have been attributed to a given policy.
Programmatic Status	Summarizes observations about the program or policy's successes or failures, and indicates its current operational status.
Emissions Leakage	Emissions leakage occurs when reducing emissions in one jurisdiction or from one source leads to an increase in emissions in another jurisdiction or from another source. For example, cordon areas, defined as zones for which drivers are assessed a charge for passing into or out of, may cause motorists to avoid these roads and congest non-cordon roads, resulting in increased emissions in those congested areas.
Energy and Economic Impacts	
Independence from Fossil Fuels, and Economic Impact	Summarizes any reductions in fossil fuel use as a result of the policy, providing any costs and benefits associated with these reductions.
Impacts on Fuel Choice	Documents how a policy affects consumer and business decisions on fuel choice.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Qualitatively assesses opportunities for new manufacturing infrastructure, and investments in cleaner energy and energy efficiency. This category also includes data relating to jobs and job creation, specifically focusing on in-state opportunities.
Impact on Different Sectors of the Economy	Categorizes the relative impact upon different sectors of the jurisdiction's economy, including power rates, agriculture, manufacturing, and transportation fuel costs.
Household Impacts and Co-Benefits	
Effect on Household Consumption and Spending	Reviews any impacts to individuals and households with specific attention to income, energy savings, fuel, food, and housing costs.
Measures to Mitigate to Low-income Populations, or Economic Impact	Accounts for any actions taken to mitigate economic burden on low-income populations that are impacted by the policy. Examples of policy actions include tax credits or increases in family benefit payments, pensions and allowances to assist households to meet cost increases.

APPENDIX A: Literature review of existing policies

Significant Co-benefits	Presents any environmental, health, or economic co-benefits associated with the policy type. For example, an increase in the adoption of commercial heavy duty electric trucks as a result of purchase incentives can reduce GHG emissions and also improve public health as a result of decreased criteria pollutant emissions.

2 California Cap-and-Trade Program

Policy Definition	Targeted Sector or Emissions
The California Cap and Trade program is the centerpiece of California's AB32 compliance strategy. It places a cap on total covered GHG emissions, and allows trading among regulated industry.	Economy-wide (Electricity, RCI, Transportation, Industrial Process)

GHGs and Costs

- 146.7 $MMTCO_2e$ reductions in 2020 from the capped sector, of which 34.4 $MMTCO_2e$ reductions are attributed to cap (not driven by complementary policy)
- Cost of reductions estimated at $15-30 per tCO2e through 2020.

Implementation Issues and Lessons Learned

- Includes cost containment mechanisms including offsets, free allocation, and price containment reserves.
- Faced legal challenges to use of offsets.
- Policy to address resource shuffling and potential GHG leakage (displacement of emissions to another jurisdiction) must reconcile grid reliability issues.

Costs and Benefits to Consumers	Costs and Benefits to Businesses
• ARB estimates minimal, if any, impact on household income (0 to 0.1 percent decrease) • Modest decrease in labor demand (0.3 to 0.6 percent) under expected prices. • Residential expenses are anticipated to increase 0.5 to 0.6 percent in 2020, while transportation expenses decrease 0.3 percent. • To mitigate impact to electricity rates, the regulation includes the Allocation to Electrical Distribution Utilities for the Protection of Electricity Ratepayers.	• ARB anticipates increased investments in efficient buildings, technologies, and advanced fuels. • Cap and Trade program will reduce total economic output by a modest 0.1 percent, from 2.4 to 2.3 percent. • Projected shift towards sectors driven by cleaner and more efficient technologies. • Small business energy expenses are expected to increase by 0.2 percent to 2.7 percent. • A report by BCG estimates detrimental impacts and job losses in the oil refining sector, including increased production costs of up to $0.69 per gallon, though the assumptions underlying these findings have been contested by expert review.

The California Global Warming Solutions Act of 2006 (AB 32) set targets for greenhouse gas (GHG) reductions in the State of California relative to an anticipated business as usual trajectory. By 2020, the bill calls for California emissions to return to the 1990 level of 427 million metric tons of carbon dioxide equivalent ($MMTCO_2e$), a reduction of approximately 77 $MMTCO_2e$. To reach this goal, the AB 32 Climate Change Scoping Plan Document established a suite of policy mechanisms with a cap-and trade program as the centerpiece.[1]

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[1] California Air Resources Board. December 2008. Climate Change Scoping Plan: a framework for change. Accessed August 2013 at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

The California Cap and Trade Program will regulate approximately 35 percent of California's GHG emissions in the first compliance period (2013-2014) by covering the electricity sector and certain industrial sectors. The program will expand to cover 85 percent of California emissions in the second and third compliance periods (2015-2017 and 2018-2020) when transportation fuels and natural gas suppliers are included. In addition to emissions from in-state sources, electricity imported to California is also subject to a compliance obligation corresponding to its emissions. This compliance obligation is the responsibility of the electricity importer, and not the out-of-state entity generating the power.[2]

The California program allows the use of GHG offsets to meet up to 8 percent of each regulated entity's compliance obligation. The California Air Resources Board (ARB) has adopted four offset protocols for use, and has approved two private organizations to assist in implementation of the offsets program as Offset Project Registries. There is general concern, however, that there will be insufficient offset supply to meet the demand, particularly in early years, and many regulated entities are pushing ARB to develop additional categories of eligible projects. The four offset protocols approved by ARB and two additional project types currently being developed by ARB through a public process are:[3]

- U.S. Forest Projects Compliance Offset Protocol
- Urban Forest Projects Compliance Offset Protocol
- Livestock Projects Compliance Offset Protocol
- Ozone-Depleting Substance (ODS) Compliance Offset Protocol
- Mine Methane Capture Compliance Offset Protocol (under development)
- Rice Cultivation Compliance Offset Protocol (under development)

Figure 1 below shows the annual emission caps for California under AB 32. The blue area indicates the total allowances issued by the state, which is equal to the cap. The red area represents the maximum quantity of GHG offsets that could be used *in addition to allowances* to cover regulated emissions. The use of offsets allows an increase in covered emissions, but requires a decrease in emissions from non-covered sources. There is a large increase in the cap in 2015, when transportation fuels and natural gas suppliers are added.

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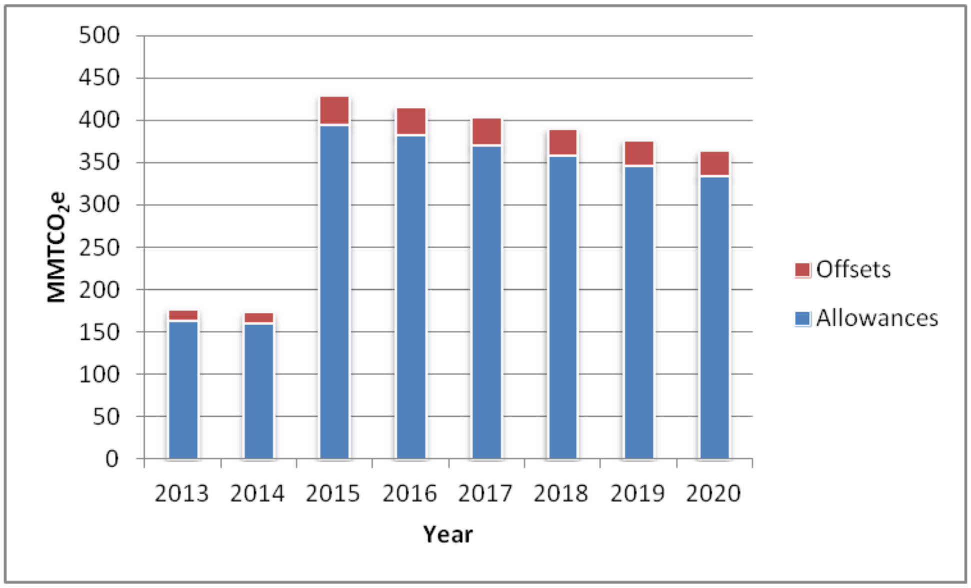
[2] California Environmental Protection Agency, Air Resources Board. April 2013. Article 5: California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanisms. Accessed July 2013 at: http://www.arb.ca.gov/cc/capandtrade/ct_rf_april2013.pdf

[3] California Air Resources Board. June 2013. Compliance Offset Program. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/offsets/offsets.htm

Figure 1: Cap on California GHGs under AB 32[4]



Allowances are distributed through a variety of mechanisms including free allocation to industry, free allocation to electricity distributors (for the benefit of ratepayers), and auctions. The percent of freely allocated allowances will decline over time. For vintage 2013, over 90 percent of allowances were freely allocated, with the following distribution:[5,6]

- 53,894,995 MMTCO_2e freely allocated to industry
- 65,196,769 MMTCO_2e freely allocated to investor-owned electric utilities
- 30,514,316 MMTCO_2e freely allocated to publicly-owned electric utilities
- 132,603 MMTCO_2e freely allocated to electric co-ops.

Auctions are held on a quarterly basis and include both current vintage allowances and an advance auction of future vintage allowances. The auction mechanism utilizes a settlement price corresponding to the minimum price – working downwards from the highest bid – at which all available allowances are sold. There is also a price floor below which allowances will not be sold. The price floor was $10.00 in 2012, increasing five percent plus inflation each year

[4] California Code of Regulations. July 2013. California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanism to Allow for the Use of Compliance Instruments Issued by Linked Jurisdictions. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/ctlinkqc.pdf

[5] California Air Resources Board. January 2013. Vintage 2013 Industrial Allowance Allocation by Sector. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/allowanceallocation/sector_based_industrial_allocation.pdf

[6] California Air Resources Board. September 2012. Annual Allocation to Electrical Distribution Utilities under the Cap-and-Trade Program (Sections 95892 and 95870). Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/allowanceallocation/electricity_allocation.pdf

thereafter. There have been three auctions conducted to date, with prices for current vintages ranging from $10.09 to $14.00 per mt$CO_2$e.[7]

The California program has been designed under the Western Climate Initiative (WCI) and with WCI partners, and from the beginning has been intended to link to other cap and trade programs.[8] In February 2007, the Governors of Arizona, California, New Mexico, Oregon, and Washington signed an agreement to develop a regional target for GHG emission reductions and develop a market-based program to achieve the target, establishing the WCI.[9] The Governors of Montana and Utah and the Premiers of British Columbia, Manitoba, Ontario, and Quebec joined the WCI during 2007 and 2008. However, the shifting political landscape in the region, along with economic concerns from the financial crisis, led several states to pull out of the WCI. Arizona, Montana, New Mexico, Oregon, Utah and Washington formally withdrew from the WCI in 2011. California, British Columbia, Ontario, Quebec and Manitoba are continuing to work together through Western Climate Initiative, Inc. (WCI, Inc.) to develop a cap-and-trade program.[10] California and Quebec have developed cap and trade programs, and these are poised to be linked beginning in 2014. California Governor Jerry Brown formally approved linkage in 2013, and staff in California and Quebec are working to establish necessary policy frameworks.[11] The California cap and trade program presents an opportunity for the state of Washington, should it pursue a cap and trade program, to link with it and potentially other partners to create a larger cap and trade program.

2.1 GHG Impacts

The California Cap and Trade program is one of over a dozen policies implemented under AB 32, and is expected to work in conjunction with complementary policies to reduce GHG emissions. Many of the complementary policies target covered emissions, and emission reductions from these policies may not be attributable to cap and trade. In total, California projects achieving 146.7 MMTCO_2e reductions in 2020 from the capped sector. Of these, 112.3 MMTCO_2e are expected to come from complementary policies. Market forces associated with

[7] California Air Resources Board. July 2013. Auction Information. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/auction/auction.htm
[8] Western Climate Initiative. March 2009. Design Recommendations for the WCI Regional Cap-and-Trade Program. Accessed August 2013 at: http://www.westernclimateinitiative.org/document-archives/wci-design-recommendations
[9] Western Climate Initiative. Archived site. http://www.westernclimateinitiative.org/index.php
[10] Western Climate Initiative, Inc. (WCI, Inc.) is a non-profit corporation formed to provide administrative and technical services to support the implementation of state and provincial greenhouse gas emissions trading programs. WCI Inc. http://www.wci-inc.org/index.php
[11] California Environmental Protection Agency, Air Resources Board. April 2013. Air Resources Board sets date for linking cap-and-trade program with Quebec. Accessed July 2013 at: http://www.arb.ca.gov/newsrel/newsrelease.php?id=430

cap and trade are expected to generate the additional 34.4 MMTCO_2e reductions necessary to meet the 2020 cap, and to facilitate the complementary measures.[12]

As the program is in the first year of its first compliance period, it is too early to assess programmatic success or costs. Early auction results saw prices ranging between $10.00 and $14.00. However, the allowance cost would only reflect the cost of abatement if there was a perfectly economic market with perfect information, so these prices should not be viewed as a realistic cost of abatement.[13]

Table 2: GHG Costs and Benefits of the CA Cap and Trade Program

California	
Cost of Reductions	According to modeling conducted by the California ARB, the **cost of reductions is estimated to be between $15-$30 in 2020**.[14] Clearing prices from allowance auctions conducted to date are as follows: • November 14, 2012: $10.09 (vintage 2013), $10.00 (vintage 2015)[15] • February 19, 2013: $13.62 (vintage 2013), $10.71 (vintage 2016)[16] • May 16, 2013: $14.00 (vintage 2013), $10.71 (vintage 2016)[17]
Volume of Reductions	Cap and trade is one of many measures implemented under AB 32, which are cumulatively expected to reduce California emissions by approximately 30 percent (169 MMTCO_2e) relative to the business-as-usual scenario. Emission reductions from the capped sector will be approximately 147 MMTCO_2e in 2020, and **cap and trade itself is expected to be responsible for approximately 34 MMTCO_2e reductions in 2020.**[18]
Programmatic Status	California is in the first year of its program and it is too early to judge success.

[12] California Air Resources Board. December 2008. Climate Change Scoping Plan: a framework for change. Accessed August 2013 at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf
[13] In a perfectly efficient market, the cost of allowances would be equal to the cost of reducing a ton of CO2e. This would occur because firms whose costs of abatement were higher than the prevailing market price would purchase allowances rather than reduce emissions, and those whose costs of abatement were lower than the market price would reduce emissions at this lower cost in order to sell allowances at the higher cost.
[14] California Air Resources Board. October 2010. Staff Report: Initial Statement of Reasons. Accessed August 2013 at: ihttp://www.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm
[15] California Air Resources Board. June 2013. Quarterly Auction 1, November 2012: Summary Results Report. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/auction/november_2012/updated_nov_results.pdf
[16] California Air Resources Board. June 2013. Quarterly Auction 2, February 2013: Summary Results Report. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/auction/february_2013/updated_feb_results.pdf
[17] California Air Resources Board. June 2013. Quarterly Auction 3, May 2013: Summary Results Report. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/auction/may-2013/updated_may_results.pdf
[18] California Air Resources Board. December 2008. Climate Change Scoping Plan: a framework for change. Accessed August 2013 at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

Emissions Leakage	The California program has been designed to mitigate emission leakage through free allocation of emission allowances to industry. Additionally, concerns have been raised regarding **resource shuffling**, and rules have been implemented to prevent it. Resource shuffling "involves a plan, scheme, or artifice undertaken by a First Deliverer of electricity to reduce its emissions compliance obligation by engaging in an impermissible substitution of higher emissions resources with relatively lower emissions resources."[19] In response to an August 6, 2012 letter from FERC Commissioner Moeller raising a concern about the resource shuffling rules impact on grid reliability[20], **ARB has suspended enforcement of this provision for the first 18 months of active allowance trading**.[21]

2.2 Energy and Economic Impacts

During the early years of California's Cap and Trade program, a relatively small portion of allowances will be auctioned, but over time this portion will increase. California estimates that the auction of allowances under California's Cap and Trade regime will generate billions of dollars for the State of California between the first auction in November 2012 and the program's third compliance period in 2020, with approximately $200 million in auction revenues estimated for 2012-2013 and $400 million in 2013-2014[22].

The California Department of Finance (Finance) and ARB drafted, through a public consultation process, a three-year investment plan to identify "investments to help achieve greenhouse gas reduction goals and yield valuable co-benefits."[23] The intent was that the plan would be submitted to the California Legislature, which would in turn appropriate cap and trade revenue to State agencies for implementation of programs to further the objectives of AB 32. The California Legislature passed a $96.3 billion budget for the fiscal year 2013-2014 on Friday June 13, 2013. Although the Investment Plan recommended allocating cap and trade revenue to a variety of pre-existing programs that could begin to use the funds immediately, the approved FY 2013-2014 budget instead borrowed the expected $500 million in auction proceeds to meet other budgetary needs. Governor Brown has stated that he borrowed the $500 million to provide more time to set up programs that will use the funding effectively. No timetable for repayment has yet been issued.[24]

[19]California Air Resources Board. Cap-and-Trade Regulation Instruction al Guidance, Appendix A: What is Resource Shuffling? November 2012. http://www.arb.ca.gov/cc/capandtrade/emissionsmarketassessment/resourceshuffling.pdf
[20] Philip D. Moeller. August 6, 2012. Letter to California Governor Edmund G. Brown.
[21] Mary D. Nichols. August 11, 2012. Letter to Commissioner Philip D. Moeller.
[22] State of California, 2013-14 Governor's Budget Summary, accessed July 2013 at: http://www.dof.ca.gov/documents/FullBudgetSummary_web2013.pdf
[23] California Department of Finance. May 2013. Cap and Trade Auction Proceeds Investment Plan: Fiscal Years 2013-14 through 2015-16, page 1. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/final_investment_plan.pdf
[24] Mulkern, Anne C. *Gov. Brown proposes to borrow $500M from cap-and-trade revenue*. ClimateWire. May 15, 2013

Estimates on the overall economic impact of the California program vary, though not widely. California ARB modeling indicates that cap and trade will reduce fuel use, and cause only a 0.1 percent decrease to total economic output. These results are generally consistent with two additional macroeconomic studies of the impacts of AB 32 implementation, one by the University of California and another cooperative study by Charles River Associates and the Electric Power Research Institute. Each of these three models projects a full business-as-usual forecast using a general equilibrium macroeconomic approach, and compares it to a forecast under which AB 32 policies including cap and trade have been implemented. All three indicate economic growth. A comparative analysis performed by the Center for Resource Solutions concludes that the ARB modeling is the most sophisticated; therefore these results are provided in the tables that follow. [25]

A study commissioned by the Western States Petroleum Association (WSPA) and conducted by the Boston Consulting Group (BCG) reached different conclusions. Key findings of the BCG report include an increase in the cost of making gasoline and diesel of $0.14 to $0.69 per gallon, with higher costs possible depending on auction prices. Further, BCG concluded that under cap and trade carbon costs could be very volatile in early years, which could in turn cause market disruptions. In conjunction with other policies implemented under AB 32, BCG estimated that refinery closures could result in the loss of 28 to 51 thousand jobs, far outpacing their estimate of 2.5 to 5 thousand jobs in the energy efficiency sector.[26]

In May 2013, the UC Davis Policy Institute released a report that summarized expert evaluation of the BCG study. The report was funded by the WSPA, Rockefeller Brothers Fund, and the Alliance of Automobile Manufacturers. The expert review generally concluded that the BCG report was too narrow in scope (looked solely at the refining sector), and included a variety of problematic assumptions. The UC Davis report noted that BCG failed to consider other both plausible alternatives to meeting the Low Carbon Fuel Standard that would have lower costs, and the likelihood that the oil refinery sector would diversify into low carbon fuels or line up alternate domestic supplies.[27]

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[25] Center for Resource Solutions. 2009. Climate Policy and Economic Growth in California. Accessed September 2013 at: http://www.resource-solutions.org/pub_pdfs/Climate%20Policy%20and%20Economic%20Growth%20in%20California.pdf

[26] Boston Consulting Group. 2012. Understanding the impact of AB 32. Accessed September 2013 at: http://cafuelfacts.com/wp-content/uploads/2012/07/BCG_report.pdf

[27] UC Davis Policy Institute for Energy, Environment and the Economy. 2013. Expert Evaluation of the Report: "Understanding the Impacts of AB32". Accessed September 2013 at: http://policyinstitute.ucdavis.edu/files/general/pdf/2013-05-09_Expert-Evaluation-of-BCG-Report.pdf

Table 3: Energy and Economic Impacts of the CA Cap and Trade Program

California	
Independence from Fossil Fuels, and Economic Impact	California ARB modeling predicts **decrease in fuel use by 2 to 4 percent in 2020.**[28] Independent analysis also shows that **expenditures on out of state crude will be reduced by approximately $10 billion in 2020**. In addition, the value of decreased exposure to fuel price shocks in 2020 is valued at $18.8 to $29.6 billion.[29]
Impacts on Fuel Choice	Analysis by EDF et al. estimates **the avoidance of 75 million barrels of oil and 189 trillion BTUs of natural gas annually**. [30]
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	In response to Cap and Trade, ARB anticipates increased investments in efficient buildings, technologies, and advanced fuels. In addition, state revenues from allowance sales will be used to support transportation infrastructure, energy efficiency, and related programs as recommended in the Investment Plan. [31]
Impact on Different Sectors of the Economy	ARB modeling indicates that the **Cap and Trade program will reduce total economic output by a modest 0.1 percent, from 2.4 to 2.3 percent**. There is also a projected **shift towards sectors driven by cleaner and more efficient technologies**. Small business energy expenses are expected to increase by 0.2 percent to 2.7 percent.[32] A report by BCG estimates detrimental impacts and job losses in the oil refining sector, including increased production costs of up to $0.69 per gallon, though the assumptions underlying these findings have been contested by expert review.

In addition to trading, to mitigate potential impacts on California businesses, the program contains several targeted design elements:[33]

- **Offsets:** The use of GHG offsets is permitted for up to 8 percent of each regulated entity's annual compliance obligation. However, there is concern that there will not be sufficient supply of offsets to meet this 8 percent ceiling due to the limited number of eligible offset project types. Additionally, the offset market has been slow to develop partially due to a

[28] California Air Resources Board. October 2010. Staff Report: Initial Statement of Reasons. Accessed August 2013 at: ihttp://www.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm
[29] Environmental Defense Fund, Center for Resources Solutions, and Energy Independence Now. September 2010. Shockproofing Society: How California's Global Warming Solutions Act (AB 32) Reduces the Economic Pain of Energy Price Shocks. Accessed August 2013 at: http://www.resource-solutions.org/pub_pdfs/Shockproofing%20Society.pdf
[30] Ibid.
[31] California Department of Finance. May 2013. Cap and Trade Auction Proceeds Investment Plan: Fiscal Years 2013-14 through 2015-16, page 1. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/auctionproceeds/final_investment_plan.pdf
[32] California Air Resources Board. October 2010. Staff Report: Initial Statement of Reasons. Accessed August 2013 at: ihttp://www.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm
[33] California Code of Regulations. July 2013. California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanism to Allow for the Use of Compliance Instruments Issued by Linked Jurisdictions. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/ctlinkqc.pdf

buyer liability provision which places responsibility for invalidated credits with the regulated entity rather than the offset provider. Various insurance and contract mechanisms are evolving to mitigate invalidation risk.

- **Allocation for Industry Assistance:** To protect the competitiveness of California businesses, the regulation freely allocates a portion of required allowances to California businesses. The industry assistance factor, which defines the percent of allowances allocated to each business, is a value between 30 percent and 100 percent. The industry assistance factor varies based on industry exposure, and decreases through time.

- **Price Containment Reserve:** The price containment reserve withholds four percent of total allowances across all three compliance periods. From the start of the program, this strategic reserve will be available should there be a supply shortage or prices increase in the market above the current price of the containment reserve. At such time, ARB will release allowances from the reserve at a price initially equal to $40 which escalates in future years.

2.3 Household Impacts and Co-Benefits

The use of the revenue generated to date, and the projected billions in additional funds to be generated in the coming years, is constrained by several pieces of legislation. In addition to AB 32, AB 1532, SB 535, and SB 1018, signed by Governor Brown in 2012 require 25 percent of available money be allocated to projects providing benefit to disadvantaged communities, and 10 percent to projects physically located in disadvantaged communities. To assist this process, CalEPA developed a multi-criteria assessment tool known as CalEnviroScreen, which examines 11 categories of pollution and environmental factors as well as seven population characteristics and socioeconomic factors. The tool analyzes each ZIP code in the state across each indicator to assess both the burden of pollution and population characteristics; the top 10 percent of ZIP codes are deemed "disadvantaged communities."[34] Maps and lists of the ZIP codes identified are publicly available.

Additionally, California's program design includes several elements intended to mitigate household impacts, including the Allocation to Electrical Distribution Utilities for the Protection of Electricity Ratepayers.[35] This element is designed to ensure that ratepayers do not suffer sudden increases in their utility bills as a result of cap and trade. It functions by providing electrical distribution utilities with free allowances that they are required to sell at auction to emitters (in some cases themselves). The revenue generated at auction must then be used by the

[34] California Environmental Protection Agency. April 2013. California Communities Environmental Health Screening Tool, Version 1 (CalEnviroScreen 1.0). Accessed August 2013 at: http://oehha.ca.gov/ej/pdf/042313CalEnviroScreen1.pdf

[35] California Code of Regulations. July 2013. California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanism to Allow for the Use of Compliance Instruments Issued by Linked Jurisdictions. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/ctlinkqc.pdf

utility solely to benefit their retail ratepayers.[36] The benefit may be delivered in a variety of forms including a bill dividend.[37]

Table 4: Household Impacts and Co-Benefits of the CA Cap and Trade Program

California	
Effect on Household Consumption and Spending	ARB estimates **minimal, if any, impact on household income** (0 to 0.1 percent decrease), as well as a **modest decrease in labor demand** (0.3 to 0.6 percent) under expected prices. **Residential expenses are anticipated to increase 0.5 to 0.6 percent** in 2020, while **transportation expenses decrease 0.3 percent**.[38] Separately, EDF et al. values the policy's ability to buffer Californians against the costs of a future fuel price shock at $332 to $670 savings per year per household ($4.8 to $9.6 billion total, based on projected fuel price ranges). This is in addition to anticipated fuel savings discussed previously.[39]
Measures to Mitigate to Low-income Populations, or Economic Impact	To mitigate impact to electricity rates, the regulation includes the **Allocation to Electrical Distribution Utilities for the Protection of Electricity Ratepayers.**[40] Additionally, several pieces of legislation require the expenditure of 25 percent of Cap and Trade revenue to be allocated to projects benefiting disadvantaged communities, and 10 percent spent in those communities.[41] However, the FY2013-FY2014 budget did not allocate any cap and trade funds for these purposes, instead borrowing $500 million for other programs. When the $500 million is repaid, those funds will be subject to these requirements for future spending.
Significant Co-benefits	Overall **reduction in criteria pollutants**. However, there is also an environmental justice concern. Plaintiffs in a court challenge allege that due to the fact that cap and trade does not require any single source to reduce emissions, some sources may in fact increase emissions and associated criteria pollutants. Should this happen, there would be a detrimental impact on the nearby residents and businesses.[42]

[36] http://www.arb.ca.gov/cc/capandtrade/allowanceallocation/allowanceallocation.htm
[37] http://breakingenergy.com/2013/01/09/california-ratepayers-to-receive-cap-and-trade-dividend/
[38] California Air Resources Board. October 2010. Staff Report: Initial Statement of Reasons. Accessed August 2013 at: http://www.arb.ca.gov/regact/2010/capandtrade10/capandtrade10.htm
[39] Environmental Defense Fund, Center for Resources Solutions, and Energy Independence Now. September 2010. Shockproofing Society: How California's Global Warming Solutions Act (AB 32) Reduces the Economic Pain of Energy Price Shocks. Accessed August 2013 at: http://www.resource-solutions.org/pub_pdfs/Shockproofing%20Society.pdf
[40] California Code of Regulations. July 2013. California Cap on Greenhouse Gas Emissions and Market-Based Compliance Mechanism to Allow for the Use of Compliance Instruments Issued by Linked Jurisdictions. Accessed August 2013 at: http://www.arb.ca.gov/cc/capandtrade/ctlinkqc.pdf
[41] AB 1532, SB 535, and SB 1018
[42] See, e.g., *Association of Irritated Residents, et al. v. California Air Resources Board*

3 Regional Greenhouse Gas Initiative (RGGI)

Policy Definition	Targeted Sector or Emissions
The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort among nine northeast states in the U.S. to regulate and reduce GHG emissions from the power sector. It places a cap on total electric utility GHG emissions, and allows trading among regulated industry.	Electric Power
GHGs and Costs	
• Capped electric sector were reduced 13 percent from 2009 to 2012 and according to the 2011 RGGI Investment Report the revenue generated by the auctions has led to strategic energy projects decreasing emissions by 12 million mtCO_2e over the life of the projects. • From September 2008 to June 2013, auction clearing prices have ranged from a low of $1.86 to a high of $3.51, with an average of $2.35/mt$CO_2$e with cumulative proceeds totaling $1.35 billion.[43]	
Implementation Issues and Lessons Learned	
• Initial emission cap was set too high, over allocation of allowances led to low market prices. • New Jersey withdrew from the program in 2011 citing economic reasons. • The most effective program element in reducing GHG emissions has been the reinvestment of allowance revenues collected by the states in energy efficiency and clean energy projects.	
Costs and Benefits to Consumers	**Costs and Benefits to Businesses**
• Through 2011 $86 million of the collected program funds have gone to low income rate relief energy efficiency improvement programs. Another $37 million has gone to general rate relief. • Households in the RGGI region recognized a nearly $1.1 billion net gain due to improvements in energy efficiency resulting from RGGI revenues.	• Analysis Group estimates 1.6 billion in economic value and 16,000 Job years added to the states. • Long term costs to utilities of up to 1.6 billion due to lost revenue from improved consumer efficiency and conservation. Short term costs passed on to consumers. • RGGI proceeds for several types of programs leads to more purchases of goods and services.

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort among nine northeast states in the U.S. to regulate and reduce GHG emissions from the power sector. RGGI is composed of individually-operating emission trading programs within each state that together have created a regional market for emission allowances. Development of RGGI began in 2003, with the first memorandum of understanding (MOU) being released in 2005. The first auction of emission allowances occurred in 2008, with the first three-year compliance period starting in January 2009. RGGI currently operates in nine Northeast and Mid-Atlantic States in the U.S.: Connecticut, Delaware, Maine, Massachusetts, Maryland, New Hampshire, New York, Rhode Island, and Vermont (New Jersey participated through 2011, but withdrew citing the programs impact on business and consumers as reasoning). Each State program was developed based on the agreed upon RGGI Model Rule, which includes capping emissions from the electric power plants and requiring that a certain percentage of emission allowances are provided through

[43] http://www.rggi.org/market/co2_auctions/results

participation in regional auctions rather than free allocation. Currently, around 90 percent of all allowances are provided through auction, with the remaining sold directly to qualified sectors.[44]

RGGI allows for the use of offsets from certain project types to substitute for emission allowances, up to 3.3 percent of a utility's reported emissions, encouraging investment in particular project types identified as high priority by the states. RGGI has its own offset protocols which cover the following project types:

- Capture or destruction of CH_4 from landfills;
- SF_6 reductions from electricity transmission and distribution equipment;
- CO_2 sequestration through afforestation;
- CO_2 reductions through non-electric end-use energy efficiency in buildings; and,
- Avoided CH_4 emissions through agricultural manure management operations.

RGGI is also looking to replace the existing afforestation offset protocol with a new forestry protocol based on the one used by California's Air Resources Board. This new protocol would cover improved forest management, reforestation, and reduced land use change (forest conversion).[45]

RGGI is highly focused, covering only the electricity sector. Unlike many other cap and trade programs, it does not cover other high emitting sectors, such as industrial manufacturing. The sole focus of RGGI – the electric sector in the northeast – is very different from Washington's electric sector. Figure 2, developed from the U.S Energy Information Administration's electricity production data (for Washington on the left, and the combined electric sector of the RGGI states on the right) shows that about 48 percent of the electric sector is fossil fuel, with another 33 percent from nuclear in the RGGI covered states. These add up to 81 percent, compared to a combined 14 percent for these fuels in Washington State. On the other hand, hydro is 81 percent of instate generation for Washington and only 13 percent for RGGI-participating states.[46]

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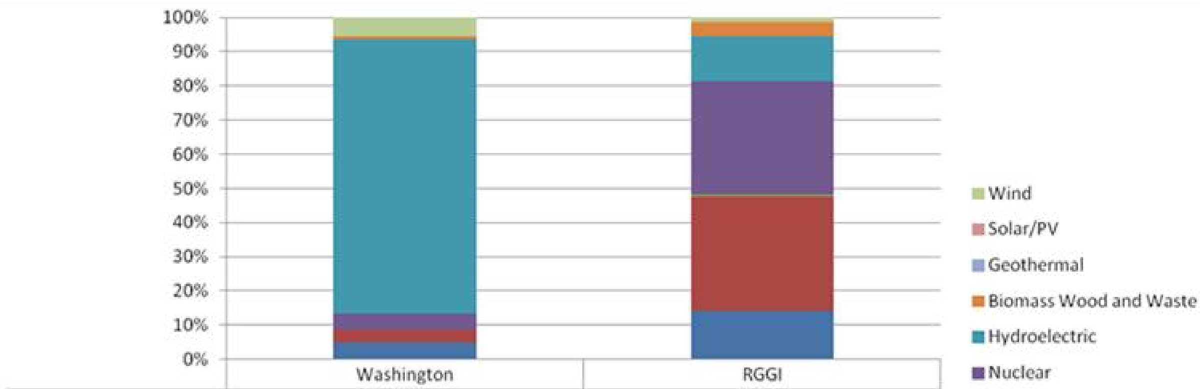
[44] Environmental Defense Fund – "RGGI: The World's Carbon Markets: A Case Study Guide to Emissions Trading"; http://www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_rggi_case_study_may_2013.pdf

[45] RGGI Program Review News Release: RGGI States Propose Lowering Regional CO2 Emissions Cap 45%,Implementing a More Flexible Cost-Control Mechanism; http://www.rggi.org/docs/PressReleases/PR130207_ModelRule.pdf

[46] Energy Information Administration. State Profiles and Energy Estimates, Table C9: Electric Power Sector Consumption Estimates, 2011. Accessed July 2013 at: http://www.eia.gov/state/seds/data.cfm?incfile=sep_sum/html/sum_btu_eu.html

Figure 2: Electricity Generation Fuel Shares for Washington and RGGI Covered States[47]



	Washington	RGGI
Wind	5%	1%
Solar/PV		0%
Geothermal	0%	0%
Biomass Wood and Waste	1%	4%
Hydroelectric	81%	13%
Nuclear	5%	33%
Petroleum	0%	1%
Natural Gas	4%	33%
Coal	5%	14%

Given the significant differences between the covered RGGI sector and that sector in Washington, there is limited value in considering the quantitative findings from RGGI. However, although some findings from RGGI are not likely to translate to a similar program in Washington, there still may be value in qualitatively understanding the results and highlighting lessons learned from the structure of the program and its evolution over time.

Several common themes and recommendations emerge from studies and analyses on RGGI. In particular, the original RGGI MOU required that, in 2012, the states conduct a comprehensive program review of their Emission Trading Programs through a regional stakeholder process that engaged not only the regulated community, but environmental nonprofits, consumer and industry advocates, and other interested stakeholders as well. [48] The recommendations below represent the most commonly identified best practices or lessons that should be taken from RGGI. These lessons are followed by a list of actions taken by RGGI States to address the findings.

Issues Identified

- There was a significant excess supply of allowances relative to actual emission levels in the region.

[47] Ibid.
[48] RGGI 2012 Program Review: Summary of Recommendations to Accompany Model Rule Amendments; http://www.rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Recommendations_Summary.pdf

- Emissions have never approached the cap, peaking at 135 million tons in 2010 and dropping to 118 million tons in 2011. In 2012, with NJ dropping from the program, RGGI-covered emission levels hit a low of about 92 million[49].
- The current cost control measures in the program, which are based upon expansion of the percentage of offset allowances allowable for compliance, would likely be ineffective in controlling costs if the emissions cap is reached.

Programmatic Changes Incorporated as a Result of Findings[50]

- The 2014 regional cap has been reduced from 165 million (already adjusted down from 188 million due to NJ's dropping out) to 91 million tons – roughly equivalent to 2012 emissions levels and a reduction of 45 percent of the previous cap. The cap will decline 2.5 percent each year from 2015 to 2020.
- The participating states will address the bank of excess allowances held by market participants with two interim adjustments for banked allowances.
- The participating states will establish a cost containment reserve (CCR), which is a reserved quantity of allowances, in addition to the cap, that would only be available if defined allowance price triggers were exceeded ($4 in 2014, $6 in 2015, $8 in 2016, and $10 in 2017, rising by 2.5 percent, to account for inflation, each year thereafter). Current auction prices have averaged $2.33 over the course of the program.
- Covered entities must now retain enough allowances to cover at a minimum 50 percent of their emissions in any given year, and at the end of the compliance period must still surrender allowances to cover their emissions over the entire three-year period.
- The participating states do not intend to reoffer unsold 2012 and 2013 allocation year CO_2 allowances during the second control period.

The participating states will conduct ongoing program evaluation to continually improve RGGI. The participating states committed to commencing comprehensive program review no later than 2016.

3.1 GHG Impacts

To date, the RGGI GHG cap has far exceeded the emission levels of the covered electric power producers, making it unclear what portion of emission reductions since 2010 can be attributed to the program, and what portion has resulted from other factors. A New York State Energy Research and Development Authority analysis concluded that *"…three categories of factors are the primary drivers of the decreased CO_2... : 1) lower electricity load (due to weather; energy efficiency programs and customer-sited generation; and the economy); 2) fuel-switching from petroleum and coal to natural gas (due to relatively low natural gas prices); and 3) changes in*

[49] RGGI CO2 Allowance Tracking System; https://rggi-coats.org/eats/rggi/index.cfm?fuseaction=home.home&clearfuseattribs=true

[50] RGGI 2012 Program Review: Summary of Recommendations to Accompany Model Rule Amendments; http://www.rggi.org/docs/ProgramReview/_FinalProgramReviewMaterials/Recommendations_Summary.pdf

available capacity mix (due to increased nuclear capacity availability and uprates; reduced available coal capacity; increased wind capacity; and increased use of hydro capacity)".[51] RGGI is credited with helping reduce electric load and increasing renewable capacity through its funding of renewable energy and energy efficiency programs.

RGGI rules require that a minimum 25 percent of auction revenues be spent by the states for consumer benefit or strategic energy purposes. In practice however, almost all of the revenues have been spent this way by the states. From a revenue utilization perspective, the program is therefore operating similarly to a public benefit fund (PBF) policy, where a transfer of funds occurs, usually from rate payers to the government, to fund projects for the public benefit. These projects typically include clean energy and energy efficiency. As the cap is lowered and its emission impacts become more apparent, the program will see a benefit from both the PBF aspect as well as cap driven reductions based on changes in generation fuel sources, increased conservation, and innovation in clean and efficient energy technologies.

Error! Reference source not found., below, summarizes some of the available GHG-related information for reductions associated with RGGI.

Table 5: GHG Costs and Benefits of the RGGI Cap and Trade Program

RGGI	
Cost of Reductions	From September 2008 to June 2013, auction clearing prices have ranged from a low of \$1.86 to a high of \$3.51, with an average of \$2.35/mtCO_2e with cumulative proceeds totaling \$1.35 billion.[52] According to the most recent RGGI investment report, which covers the entire first assessment period roughly 4.5 percent of the \$825.5 million total program proceeds went to program administration and RGGI Inc., 66 percent of revenue has been invested in energy efficiency, and 5 percent in renewable energy (of which over \$100 million is committed to future projects). The remaining goes to rate reductions, other municipal investments and state general funds. A total of about \$482 million has been invested in energy projects through the first compliance period.[53]
Volume of Reductions	Total emissions from the capped electric sector were reduced 13 percent from 2009 to 2012, dropping 13.7 million mtCO_2e from 106.5 to 92.7 million mtCO_2e.[54] Additionally, according to the 2011 RGGI Investment Report the revenue generated by the auctions has led to strategic energy projects, including energy efficiency throughout these states that will decrease emissions by 12 million mtCO_2e over the life of the projects.[55]

[51] Environmental Defense Fund – "RGGI: The World's Carbon Markets: A Case Study Guide to Emissions Trading"; http://www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_rggi_case_study_may_2013.pdf
[52] http://www.rggi.org/market/co2_auctions/results
[53] RGGI 2011 Investment Report; http://www.rggi.org/docs/Documents/2011-Investment-Report.pdf
[54] RGGI CO2 Allowance Tracking System; https://rggi-coats.org/eats/rggi/index.cfm?fuseaction=home.home&clearfuseattribs=true
[55] RGGI 2011 Investment Report; http://www.rggi.org/docs/Documents/2011-Investment-Report.pdf

Programmatic Success	The program is generally considered a success in studies reviewed for this analysis, despite a misjudgment in setting the cap for the initial compliance period. The low cost of allowances has limited the impact on consumer electricity prices, and the states have been successful in effectively utilizing the funds to invest in energy efficiency and clean energy programs to reduce emissions. The reinvestment of allowance revenues by the states has been the most successful part of the program in reducing emissions.
Emissions Leakage	The general consensus is that leakage of emissions has not been a problem because of the overabundance of allowances and the low allowance cost. Because the updated Model Rule has called for lowering the cap, renewed focus on leakage has been required by the 2012 review, which includes looking for way to incorporate imported electricity into the program.[56]

3.2 Energy and Economic Impacts

There is limited information on RGGI's specific energy impacts because of the other drivers of change which occurred during the same timeframe as the program. A study published by the Analysis Group in November of 2011[57] on the economic impacts of RGGI's first compliance period, with a particular focus on the impact auction proceeds had on the states' economies, found that:

"RGGI produced $1.6 billion in net present value economic value added to the ten-state region. The region's economy—and each state's as well—benefits from RGGI program expenditures. When spread across the region's population, these economic impacts amount to nearly $33 per capita in the region."

Figure 3 was taken from the same referenced Analysis Group Report on the economic impact of the first compliance period (2009 -2011) for RGGI.

[56] Environmental Defense Fund – "RGGI: The World's Carbon Markets: A Case Study Guide to Emissions Trading"; http://www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_rggi_case_study_may_2013.pdf
[57] Analysis Group: "The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States"; http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Economic_Impact_RGGI_Report.pdf

Figure 3: Findings of Analysis Group Report (Graphic Excerpted from Analysis Group Report)

Summary of Economic Impacts, by RGGI State and Region Discounting Dollars Using a Social Discount Rate

		Value Added[1] (millions of $)	Employment[2]
Connecticut	$	189	1,309
Maine		92	918
Massachusetts		498	3,791
New Hampshire		17	458
Rhode Island		69	567
Vermont		22	195
New England Subtotal	**$**	**888**	**7,237**
New York	$	326	4,620
New York Subtotal	**$**	**326**	**4,620**
Delaware	$	63	535
Maryland		127	1,370
New Jersey		151	1,772
RGGI States in PJM Subtotal	**$**	**341**	**3,676**
Regional Impact[3]	$	57	601
Grand Total	**$**	**1,612**	**16,135**

Notes:
[1] Value Added reflects the actual economic value added to the state and regional economies, and therefore does not include the costs of goods purchased from or manufactured outside of the state or region.
[2] Employment represents job-years as outputted from IMPLAN.
[3] Regional Impact reflects the indirect and induced impacts resulting within the RGGI region as a result of state dollar impacts.
[4] Results are discounted to 2011 dollars using a 3% social discount rate.

Additional economic impact data are summarized in **Error! Reference source not found.**

Table 6: Energy and Economic Impacts of the RGGI Cap and Trade Program

RGGI	
Independence from Fossil Fuels, and Economic Impact	Revenues from RGGI's first compliance period have contributed to in-state energy programs and projects that have led to a direct reduction of $756 million in fuel expenditures that would have gone outside the region. [58]
Impacts on Fuel Choice	No specific impacts on fuel choice cited.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Through the first compliance period of 2009-2011 around $480 million of the over $800 million collected from allowances has been reinvested in energy efficiency projects and clean and renewable energy technology development. RGGI provides case studies on a sample of these project types.

[58] RGGI Program Review News Release: RGGI States Propose Lowering Regional CO2 Emissions Cap 45%,Implementing a More Flexible Cost-Control Mechanism; http://www.rggi.org/docs/PressReleases/PR130207_ModelRule.pdf

Impact on Different Sectors of the Economy	While the overall long run cost to power plant owners between 2008 and 2011 is estimated at $1.6 billion, mostly attributable to lower sales as a result of induced energy efficiency.[59] However according to EDF, "The allocation of RGGI proceeds to several types of programs leads to more purchases of goods and services (for example, engineering services for energy audits, energy efficiency equipment, labor for installing solar panels, etc.) that provide an economic stimulus." [60]

3.3 Household Impacts and Co-Benefits

Several studies indicated that the cost of carbon allowances (which remains low) was successfully passed on to the consumers. However, due to the overall reduced consumption due to efficiency projects and general rate relief provided by the state with a portion of the RGGI funds, studies also indicated that consumers are expected to save money overall due to the program in the long term. **Error! Reference source not found.**, below, summarizes the available household impact and co-benefit information for the RGGI program.

Table 7: Household Impacts and Co-Benefits of the RGGI Cap and Trade Program

RGGI	
Effect on Household Consumption and Spending	Households in the RGGI region recognized a nearly $1.1 billion net gain due to improvements in energy efficiency resulting from RGGI revenues. In addition, according to EDF: [61]
Measures to Mitigate to Low-income Populations, or Economic Impact	Through 2011, over $86 million of the collected program funds have gone to low income rate relief and low income energy efficiency improvement programs to reduce energy bills and mitigate any price increases from RGGI. Another $37 million has gone to general rate relief, which may also impact low-income populations.[62] According to the EDF: "RGGI funds were used to protect customers from electricity price increases and were invested into energy efficiency. Consumers end up gaining from these investments because their overall electricity bills go down as a result of improvements in energy efficiency."[63]
Significant Co-benefits	None quantified.

[59] Analysis Group: "The Economic Impacts of the Regional Greenhouse Gas Initiative on Ten Northeast and Mid-Atlantic States"; http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Economic_Impact_RGGI_Report.pdf
[60] Environmental Defense Fund – "RGGI: The World's Carbon Markets: A Case Study Guide to Emissions Trading"; http://www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_rggi_case_study_may_2013.pdf
[61] Analysis Group's November 2011 Report; http://www.analysisgroup.com/uploadedFiles/Publishing/Articles/Economic_Impact_RGGI_Report.pdf
[62] RGGI 2011 Investment Report; http://www.rggi.org/docs/Documents/2011-Investment-Report.pdf
[63] Environmental Defense Fund – "RGGI: The World's Carbon Markets: A Case Study Guide to Emissions Trading"; http://www.ieta.org/assets/Reports/EmissionsTradingAroundTheWorld/edf_ieta_rggi_case_study_may_2013.pdf

4 European Union Emissions Trading Scheme (EU ETS)

<table>
<tr><th>Policy Definition</th><th>Targeted Sector or Emissions</th></tr>
<tr><td>Launched in 2005, the European Union Emission Trading Scheme (EU ETS) operates in all 28 EU countries as well as Iceland, Liechtenstein and Norway, covering sectors that are responsible for approximately 45 percent of total GHG emissions. It places a cap on covered GHG emissions, and allows trading among regulated industry.</td><td>Economy-wide (power plants, a wide range of energy-intensive industry sectors and commercial airlines.)</td></tr>
<tr><th colspan="2">GHGs and Costs</th></tr>
<tr><td colspan="2">• Emissions in the sectors covered by the ETS declined from 2005 to the end of 2010 by more than 13 percent. Studies give a range of approximately 2–5 percent below estimated emissions levels in the absence of the program, which equates to 120 million to 300 million tons.
• Estimates place the total cost at less than 1 percent of the European Union's GDP as low as 0.01 percent of the EU's GDP[14]</td></tr>
<tr><th colspan="2">Implementation Issues and Lessons Learned</th></tr>
<tr><td colspan="2">EU ETS provides important lessons learned for any cap and trade program, most importantly as they relate to the following areas which detailed in write up below.
• Measuring Success and Impacts
• Setting an appropriate emissions cap
• Allocation methods and considerations
• Offsets, linking with other programs, and price containment</td></tr>
<tr><th>Costs and Benefits to Consumers</th><th>Costs and Benefits to Businesses</th></tr>
<tr><td>• Health benefits of improved air quality if the EU ETS tightened its 2020 cap would be in the range of $4.3 billion to $10.4 billion.[64]
• Several covered sectors have successfully passed on the cost of allowance to consumers by raising prices.
• European Commission estimated that the EU would save an average of $26 billion (€20 billion) in fuel costs each year from 2016 to 2020.</td><td>• Lime, cement, basic iron and steel, pulp and paper, and power sectors are the most at risk for increased costs and negative employment impacts.
• There has been a lack of innovation as a result of the EU ETS. This lack is assumed to be due to the fact that the carbon market established an insufficient price signal.
• Leakage of emissions and competitive advantages from covered sectors or countries to uncovered sectors or countries has not been an issue due to free allocations of allowances for at risk sectors and country policies, i.e. reimbursement for indirect costs of compliance. According to the Carbon Trust total leakage by 2020 is unlikely to exceed 1% of EU Emissions.[65]</td></tr>
</table>

Launched in 2005, the European Union Emission Trading Scheme (EU ETS) operates in all 28 EU countries as well as Iceland, Liechtenstein and Norway, covering sectors that are responsible for approximately 45 percent of total GHG emissions in those countries. The first phase was set

[64] European Commission Staff Working Paper, "Analysis of options beyond 20% GHG emission reduction: Member State results," January 30, 2012; http://ec.europa.eu/clima/news/articles/news_2012013002_en.htm
[65] Carbon Trust - EU ETS Impact on Profitability and Trade; http://www.carbontrust.com/media/84892/ctc728-euets-impacts-profitability-and-trade.pdf

up to be experimental to help develop the market and lasted from 2005 through 2007. The second phase went from 2008 through 2012. The third phase of the EU ETS runs from 2013-2020, and aims to lower emissions from covered sectors by 21 percent from 2005 levels by 2020.[66] The third phase includes some significant program changes. The scope of the EU ETS will be expanded to include additional sectors and gases, and an overall EU cap will used instead of individual member state set caps.[67] The default allocation method in the third phase will be auctions, though there will continue to be free allocation to manufacturing[68] and industries identified as at risk of leakage.[69] The EU ETS market has historically utilized the Clean Development Mechanism (CDM) and Joint Implementation (JI) to generate and obtain international offsets from developing and developed nations. In addition, the EU is pursuing sector-based offset crediting through a new market mechanism.[70] Finally, the EU ETS is pursuing linkage with the Australian cap and trade system, beginning in 2015.[71]

The EU ETS represents the largest, most studied GHG cap and trade system, and it has faced significant challenges and criticisms during its existence, including debates over offset eligibility, over-allocation, and backloading. This analysis will summarize some of the existing analyses, but focus on eliciting lessons learned from the program's history in terms of the overall design and implementation.

Several common themes and recommendations are apparent after reviewing the multiple studies and analyses on the EU ETS. These should be carefully examined and evaluated when designing any type of cap and trade or market based reduction program. The recommendations below were taken directly from several of the studies reviewed and represent the most commonly identified lessons that should be taken from the EU ETS.

Measuring Success and Impacts

- The European Commission said that data limitations preclude definitive conclusions about the ETS's effect during Phase I. Current literature and studies are inconclusive because the EU ETS was not designed with a monitoring framework in mind, as Phase 1 was expected to be a trial and error process. A monitoring framework should be part of the initial design and in place from the beginning.[72]

[66] European Commission. July 2013. The EU Emissions Trading System (EU ETS). Accessed July 2013 at: http://ec.europa.eu/clima/policies/ets/index_en.htm
[67] http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf
[68] European Commission. January 2013. Free allocation based on benchmarks. Accessed July 2013 at: http://ec.europa.eu/clima/policies/ets/cap/allocation/index_en.htm
[69] European Commission. January 2013. Carbon leakage. Accessed July 2013 at:: http://ec.europa.eu/clima/policies/ets/cap/leakage/index_en.htm
[70] European Commission. January 2013. International carbon market. Accessed July 2013 at: http://ec.europa.eu/clima/policies/ets/linking/index_en.htm
[71] European Commission. August 2012. Australia and European Commission agree on pathway towards fully linking emissions trading systems. Accessed July 2013 at: http://ec.europa.eu/clima/news/articles/news_2012082801_en.htm
[72] U.S. Government Accountability Office (GAO), 2008 report - Lessons Learned from the European Union's Emissions Trading Scheme and the Kyoto Protocol's Clean Development Mechanism.; http://www.gao.gov/new.items/d09151.pdf

- Over-allocation of allowances has posed challenges in assessing the program's long-term economic impacts. Key questions still remain as a result, (i) how tight a cap should be set in going forward to deliver a price point on emission allowance that will provide the desired level of emission abatement, and (ii) what consequences does this cap have for economic growth and competitiveness?[73]
- Even with much higher carbon price expectations than the market delivered, only a small fraction of businesses expected downsizing or relocation due to these climate based policies, showing that negative impacts to employment and competition might not be significant, even with prices up to €40.[8]

Setting the Cap

- Accurate current and historical emissions data are essential to setting the right emissions cap.[7]
- Emissions caps and resulting allowance allocations should be based on measured and verified historical emissions, rather than on estimated or projected emissions.[74]
- There has been an observed lack of innovation in clean energy and energy efficiency as a result of the EU ETS, which is consistent with the common view that the carbon market established an insufficient price signal to induce innovation.[8]
- The cap should be ambitious to encourage businesses to think creatively about reducing GHG emissions and spur innovation.[9]
- The EU ETS can, and should, continue with deeper emission cutbacks post-2012, as this is not expected to damage European competitiveness overall. [75]
- A trading program should provide enough certainty and should cover a long enough time period to influence technology investment decisions.[76]
- The best way to stimulate long-term emission reduction investments is by maintaining a predictably declining, enforceable, science-based cap on carbon. There should also be a mechanism to decouple emissions growth from economic growth.[77]

Allocation

- The method for allocating allowances will have important economic effects.[11]

[73] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf
[74] Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf
[75] Carbon Trust - EU ETS Impact on Profitability and Trade; http://www.carbontrust.com/media/84892/ctc728-euets-impacts-profitability-and-trade.pdf
[76] U.S. Government Accountability Office (GAO), 2008 report - Lessons Learned from the European Union's Emissions Trading Scheme and the Kyoto Protocol's Clean Development Mechanism; http://www.gao.gov/new.items/d09151.pdf
[77] Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

- The windfall profits that occurred in some member states can be avoided using a variety of policy tools. There should be appropriate regulatory oversight of public utilities, and auction some or all allowances.[12]
- Several studies summarized by the U.K. Department of Energy and Climate Change concluded that free allocation may have a negative effect on both the environmental and cost effectiveness of the EU ETS. Reducing free allocation would therefore appear to be a good policy objective in going forward, without losing sight of the key objective of free allocation to mitigate the risk of carbon leakage and job losses.[78]
- The extent and pace at which free allocations are reduced should differ between sectors according to their degree of cost and trade exposure.[10]

Offsets, Linking, and Price Containment

- Offsets provide a way for covered sectors to meet their targets that may cost less than reducing their own emissions, however (1) the resources necessary to obtain offset project approval may reduce the cost-effectiveness and quality of projects; (2) the need to ensure the credibility of offset reductions presents a significant regulatory challenge; and (3) due to the tradeoffs with offsets, the use of such programs may be, at best, a temporary solution.[11]
- It must be ensured that offset programs have rigorous monitoring and accounting methodologies to certify that emission reductions are “additional".[12]
- Reforms should be adopted that allow offset credits only from jurisdictions that have capped some portion of their emissions.[12]
- If allowance banking from year-to-year is allowed to help firms minimize cost and increase flexibility over time, the program must provide a predictable long-term policy environment that allows for this to occur and be incorporated into planning.[12] There were studies that had sharp criticisms of banking allowances as part of the program, so this should be carefully considered.
- If linking to other emissions trading programs, do so preferentially with those that adopt caps or limits on major emitting sectors.[79]

Effective governance and regulatory bodies are necessary to prevent tax fraud and theft.[14].

4.1 GHG Impacts

Because GHG reductions are predetermined with the setting of the emissions cap, it is often assumed that assessing the GHG impacts of the program would be simple. However, because of the economic downturn and other unrelated factors, there has been considerable debate over what portion of the EU’s emission reductions since 2005 can be attributed to the EU ETS. **Error!**

[78] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf

[79] Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

Reference source not found., below, summarizes some of the available GHG-related information for Phase I and Phase II of the EU ETS.

Table 8: GHG Costs and Benefits of the EU ETS Cap and Trade Program

EU ETS	
Cost of Reductions	There is little or no information on the operational cost of the EU ETS, however the economic cost of reductions to the member nations has been much smaller than expected. Most estimates place the total cost at less than 1 percent of the European Union's GDP as low as 0.01 percent of the EU's GDP[14]. Several studies claim that if all allowances were auctioned, rather than freely allocated, there would be no economic cost and could potentially see significant economic gains.[80] Allowances on the EU market have traded at a high of €32 in 2006 and at prices near zero when the price crashed during the in 2007, but rebounded to trade back over €30 in 2008.[81] Currently prices are trading slightly above €4.
Volume of Reductions	Emissions in the sectors covered by the ETS declined from 2005 to the end of 2010 by more than 13 percent. By 2009, the EU's 27 member states saw GHG emissions decrease by 17 percent relative to 1990 levels, while GDP grew by more than 40 percent.[14] There are differing views on the level of reductions that the EU ETS is responsible for. Several studies found that emissions across all regulated sectors declined by around 3 percent in Phase I and during the first two years of Phase II.[15] Other studies are less specific giving a range of approximately 2–5 percent below estimated emissions levels in the absence of the program, which equates to 120 million to 300 million tons.[14] A study by New Energy Finance indicates that "*the ETS was responsible for 40 percent of the 3 percent reduction in emissions in the EU in 2008, the first year of the ETS's post-pilot Phase II, with the recession accounting for only about 30 percent of the observed reductions. More recent research indicates that these trends continued beyond 2008. In 2009 alone, for example, the ETS was likely responsible for more than 230 million tons of* CO_2 *reductions.*"[14]
Programmatic Success	As the first GHG cap and trade scheme, the EU ETS has been successful in discovering and addressing several design issues. Through trial and error the program has faced and addressed numerous problems and given insight and lessons learned to other programs around the world. This continues today as the EU ETS attempts to backload 900 million allowances to address over-allocation and add the aviation sector to the program. Success in reducing emissions has been superseded by emission reductions due to economic decline and the lower cost of natural gas relative to coal. Because of over allocation and low allowance prices the economic impact has been minimal, but this has also led to unintended windfall profits for some sectors and created uncertainty in the market limiting the overall effectiveness of the program compared to initial expectations.

[80] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf
[81] http://www.theguardian.com/environment/2013/jan/24/eu-carbon-price-crash-record-low

Emissions Leakage	According to most studies, leakage of emissions from covered sectors or countries to uncovered sectors or countries has not been an issue due to design elements such as free allocations of allowances for at risk sectors and individual country policies, such as the U.K.'s reimbursement policy for indirect costs of compliance. According to the Carbon Trust total leakage by 2020 is unlikely to exceed 1 percent of EU Emissions.[82]

While the majority of the existing studies on the GHG impacts of the EU ETS do seem to indicate it was responsible for a significant portion of the reductions seen in the EU, the empirical evidence gathered by surveying many of the covered firms across different countries in the EU suggests otherwise. Very few of the surveyed firms in any sector or country credited the EU ETS as being the main driver in reducing emissions.[83]

4.2 Energy and Economic Impacts

There is limited information on the energy and economic impacts of the EU ETS. Current literature and studies are inconclusive about these impacts, although some general insights are expressed in **Error! Reference source not found.**.

Table 9: Energy and Economic Impacts of the EU ETS Cap and Trade Program

EU ETS	
Independence from Fossil Fuels, and Economic Impact	A recent report by the European Commission estimated that the EU would save an average of $26 billion (€20 billion) in fuel costs each year from 2016 to 2020.[84]
Impacts on Fuel Choice	There is no evidence so far that links the realized emission reductions from the program to specific mechanisms. For example, whether abatement has been achieved by switching fuels or by installing a more efficient technology cannot yet be answered. This is because large, country-specific data sets that compare covered firms with non-covered firms in the same high energy intensive sectors are not available.[85] Simply comparing high-level fuel consumption at the country level may show changes in fuel choice, but those cannot be credited to the EU ETS without more rigorous analysis. Some studies attempted to compare covered sectors with non-covered "control" sectors, but because the covered sectors are energy intensive and the non-covered sectors tend not to be, the results were inconclusive.

[82] Carbon Trust - EU ETS Impact on Profitability and Trade; http://www.carbontrust.com/media/84892/ctc728-euets-impacts-profitability-and-trade.pdf
[83] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf
[84] Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf
[85] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf

Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	There has been a lack of innovation as a result of the EU ETS. This lack is assumed to be due to the fact that the carbon market established an insufficient price signal, and that a higher carbon price is required for inducing innovation. However, there may be other factors that limited innovation for new energy technologies other than the low price of carbon allowances. There was some evidence of carbon abatement technology adoption which was more compelling than evidence on genuine innovation of new technologies or methods.[86]
Impact on Different Sectors of the Economy	Studies showed conflicting results of the effects on company profits and employment. One U.K. study identified lime, cement, basic iron, and steel as industrial activities that are more carbon-cost-sensitive and at risk. However, these industries comprise only a small percent of the economy and overall employment. Generally, the EU ETS has accounted for at risk sectors by providing free emission allowances.[87] The EDF cited several reports confirming that the cost impacts to the power, iron and steel, and pulp and paper industries would be minimal, the highest being a small segment of the pulp and paper industry which could see a 3 percent to 6 percent cost increase.[88]

The EU ETS has been criticized for the windfall profits of companies who passed on the price of carbon to customers even though their allowances were obtained for free,[89] but there was little evidence that the EU ETS had an adverse effect on the international competitiveness of regulated firms. Nonetheless, EU ETS covered firms had a slightly higher probability to downsize in response to carbon pricing than non-covered firms.[90]

A study done by Carbon Trust showed that overall, the EU ETS can afford to make more drastic cutbacks in Phase III without damaging U.K. or European competitiveness overall. The study found that some key sectors will require policy intervention to avoid more significant impacts. The study found that the production of lime, cement, basic iron and Steel as stand out industrial activities that are far more carbon-cost-sensitive. However these at risk sectors in the U.K. only comprise about 0.2 percent of the economy and 0.1 percent of employment, but may be more significant in other countries. The EU ETS has accounted for these at risk sectors by providing

[86] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf

[87] Carbon Trust - EU ETS Impact on Profitability and Trade; http://www.carbontrust.com/media/84892/ctc728-euets-impacts-profitability-and-trade.pdf

[88] Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

[89] Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf

[90] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf

free allocation of emission allowances, but this does not necessarily prevent trade effects in the future.[91]

One literature review that summarized multiple studies concluded that there were ambiguous results from testing the premise that the EU ETS weakened net exports of goods from covered countries into non-regulated countries. There was also evidence that a number of sectors were able to pass through the costs of emission permits on to final product markets.[92]

4.3 Household Impacts and Co-Benefits

There are no direct impacts on households as a result of the EU ETS, as they are not covered under the regime. However many studies found that the cost of carbon allowances (which remains low) was successfully passed on to the consumers in many sectors.[93] **Error! Reference source not found.**, below, summarizes the available household impact and co-benefit information for the EU ETS program.

Table 10: Household Impacts and Co-Benefits of the EU ETS Cap and Trade Program

EU ETS	
Effect on Household Consumption and Spending	Studies qualitatively discussed the fact that several sectors successfully passed on allowance costs to consumers, but did not provide quantitative impact analysis.[92,94]
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted
Significant Co-benefits	A recent report by the European Commission estimated that the health benefits of improved air quality if the EU ETS tightened its 2020 cap would be in the range of $4.3 billion to $10.4 billion.[95,93]

[91] Carbon Trust - EU ETS Impact on Profitability and Trade; http://www.carbontrust.com/media/84892/ctc728-euets-impacts-profitability-and-trade.pdf
[92] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf
[93] UK Government Dept. of Energy and Climate Change; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48449/5725-an-evidence-review-of-the-eu-emissions-trading-sys.pdf
[94] Environmental Defense Fund - "The EU Emissions Trading System, Results and Lessons Learned"; http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf
[95] European Commission Staff Working Paper, “Analysis of options beyond 20% GHG emission reduction: Member State results,” January 30, 2012; http://ec.europa.eu/clima/news/articles/news_2012013002_en.htm

5 New Zealand Emissions Trading Scheme

Policy Definition	Targeted Sector or Emissions
The New Zealand Emissions Trading Scheme (ETS) is the system in which New Zealand Units (NZUs) are traded. Under the ETS, certain sectors are required to acquire and surrender NZUs or other eligible emission units to account for their direct GHG emissions or the emissions associated with their products.	Covers forestry, energy, fishing, industry, liquid fossil fuels, synthetic gases, and waste. The agriculture sector was originally scheduled to enter the scheme in January 2015, but this date has been pushed back.

GHGs and Costs

- An estimate of emissions from 1990 to 2050 was calculated as part of the Trading Scheme Review in 2011 and showed that New Zealand was on track to meet their 2008 – 2015 target of remaining at 1990 emission levels (1990 emissions were 59.8 $MMTCO_2e$).
- The projections show emissions at slightly above 1990 levels in 2020, which is not on track to meet the countries stated goal of 10 to 20 percent below 1990 levels in this year.
- The estimates show large swings in net emissions after 2020, largely due to land use change in the forestry sector.
- The ETS includes a fixed price cap of NZ$25 (US$20.14) per NZU. Combined with the "one-for-two" surrender obligation, where entities are required to surrender only one NZU for every two mtCO2e, this results in an effective maximum emissions price of NZ$12.50 (US$10.07) per metric ton.

Implementation Issues and Lessons Learned

- The NZ ETS has come under fire recently as it allows international Emission Reduction Units (ERUs) in uncapped amounts to be used to offset government issued emission allowances (NZUs).
- NZUs have dropped from about NZ$20 (US$16) in 2011 to about NZ$2 (US$1.61) in early 2013, largely because participants can cover their emissions with an unlimited number of inexpensive international offsets.
- Transitional measures to limit price exposure originally designed to be temporary have been extended indefinitely and include a price cap, one-for-two surrender obligation, free allocation of NZUs, and offsetting for the forestry sector.

Costs and Benefits to Consumers	Costs and Benefits to Businesses
• The Reserve Bank of New Zealand (RBNZ) estimated that under the NZ ETS prices of fuel and electricity would rise by between 3 and 8 percent, increasing consumer price index (CPI) inflation by 0.3 percent. • Inclusion of the industrial processing sector in the scheme was not expected to have a noticeable impact on consumer prices.	• Expected impact on total business expenditures of NZ$465 million (US$374.65), or 0.3 percent, of GDP in 2013 and NZ$702 million (US$565.60), or 0.4 percent GDP, in 2015 • Expected impact on GDP of -0.1 to -1.0 percent of 2020 level, depending on the scenario modeled.

Launched in 2008, the New Zealand Emissions Trading Scheme (NZ ETS) covers all six Kyoto gases, and like the California scheme, progressively covers more sectors, with an aim of including all sectors by 2015. Forestry was the first sector included in the scheme in January 2008. The liquid fossil fuels, stationary energy, and industrial processes sectors joined in July 2010 and the waste and synthetic GHG sectors joined in January 2013. The agriculture sector was originally scheduled to enter the scheme in January 2015. This date has been pushed back until the New Zealand Parliament determines that sufficient technologies are available to reduce emissions in the sector and that international competitors are taking sufficient action on their agriculture emissions.[96] Participants in the agriculture sector are still required to report their emissions.

Under the mandatory ETS, compliance entities are required to obtain and surrender New Zealand Units (NZUs), or other eligible units including international emission units, to account for their direct GHG emissions or the emissions associated with their products. The NZ ETS provides for the transitional free allocation of NZUs to the agriculture sector and certain trade-exposed emission intensive industrial sectors.[97] The original aim of the NZ ETS was to have full auctioning by all sectors in 2013; however, the allocation of a limited number of free NZUs was extended through amendments in 2012.

The NZ ETS is currently operating as a non-binding cap within the country's overarching global agreement under the Kyoto Protocol. Under the Protocol, New Zealand had a legally binding target to maintain average annual emissions at 1990 levels (59.6 $MMTCO_2e$[98]) in the period from 2008 to 2012[99], which they met with a surplus of units. Subsequently, New Zealand did not sign on for a second commitment period under the Kyoto Protocol, instead choosing a non-binding pledge for emission reductions under the Convention Framework.[100] The country has pledged to reduce emissions between 10 percent and 20 percent below 1990 levels by 2020 and, in March 2011, announced a reduction target of 50 percent below 1990 levels by 2050.[101]

One interesting design element of the NZ ETS is that it covers the upstream entities associated with the electricity sector, such as producers and importers of coal and natural gas, as opposed to downstream entities such as electricity generators. It is assumed that the costs of the ETS obligations are passed on to the downstream entities. However, there is a voluntary opt-in mechanism which allows downstream entities to take on the mandatory participant's ETS obligation. For example, an electricity generator that uses coal can choose to take on the surrender obligation of the mining company that it buys its coal from.

The New Zealand government opted for a price-based mechanism for reducing emissions, primarily because it provides flexibility and can be linked to international GHG reduction efforts. The government decided against an emissions tax because it would have required regular

[96] New Zealand Ministry of the Environment. April 2013. Agriculture in the Emissions Trading Scheme. http://www.climatechange.govt.nz/emissions-trading-scheme/participating/agriculture/
[97] New Zealand Ministry of the Environment. Allocation in the New Zealand Emissions Trading Scheme. http://www.mfe.govt.nz/publications/climate/allocation-nz-ets-dec07/allocation-nz-ets-dec07.html
[98] New Zealand Ministry of the Environment. April 2013. New Zealand's Greenhouse Gas Inventory 1990–2011 and Net Position. http://www.mfe.govt.nz/publications/climate/greenhouse-gas-inventory-2013-snapshot/index.html
[99] United Nations Framework Convention on Climate Change. Kyoto Protocol. Targets for the first commitment period. http://unfccc.int/kyoto_protocol/items/3145.php
[100] New Zealand Ministry of the Environment. The Kyoto Protocol. http://www.mfe.govt.nz/issues/climate/international/kyoto-protocol.html
[101] New Zealand Ministry of the Environment. Reducing Our Emissions. April 2011. http://www.climatechange.govt.nz/reducing-our-emissions/targets.html

alteration to ensure its effectiveness and to keep it in line with international emissions prices. An ETS was chosen as the preferred mechanism for the reasons outlined below. The following points are taken directly from The Framework for a New Zealand Emissions Trading Scheme, prepared in 2007:[102]

- An ETS provides the government with relative certainty about the volume of emissions, and hence the environmental objectives, whereas a tax simply imposes a price on each unit of emissions and does not limit emissions per se
- An ETS is easily linked into the international emissions price and global emission reduction efforts, which minimizes the risk to the New Zealand taxpayer of overshooting or undershooting our Kyoto Protocol and future international commitments
- An ETS provides New Zealand firms with maximum flexibility through enabling them to reduce or offset their emissions (including managing credits and liabilities over time) by accessing emission reduction opportunities at the lowest cost
- An ETS has wide support, being preferred as the primary means of managing New Zealand's emissions in the long term by many submitters on the five discussion documents released in December 2006
- An ETS allows New Zealand to devolve forest credits and liabilities to landowners as part of a broader economic instrument
- An ETS is emerging as the favored measure among developed countries, and early adoption by New Zealand would bring significant benefits

5.1 GHG Impacts

A comprehensive review of the NZ ETS was completed in June 2011 by a government-appointed panel. The review provides an estimate of the net and gross GHG emissions with and without the ETS from 1990–2050. Gross emissions do not include CO_2 sequestration, making net emissions an important measure for New Zealand because the country relies heavily on the forestry sector to act as a carbon sink, which reduces net emissions. Figure 4 presents the country's estimate of net and gross emissions, with and without the ETS, from 1990 to 2050. The figure shows that the country met its goals under the first Kyoto commitment period (2008 – 2015), and shows the challenge the country faces in meeting its 2050 reduction targets.

[102] The Framework for a New Zealand Emissions Trading Scheme. September 2007. http://www.mfe.govt.nz/publications/climate/framework-emissions-trading-scheme-sep07/framework-emissions-trading-scheme-sep07.pdf

Figure 4: New Zealand's net and gross GHG emissions with and without ETS, 1990–2050 [103]

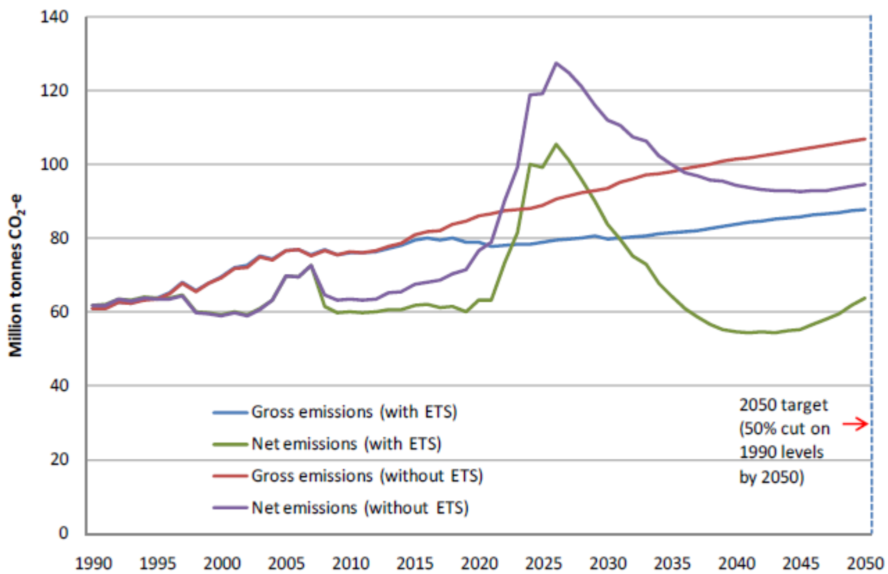


Table 11 summarizes additional GHG related information for the NZ ETS.

Table 11: GHG Costs and Benefits of NZ ETS

New Zealand Emissions Trading Scheme	
Cost of Reductions	The ETS includes fixed price cap of NZ$25 (US$20.14) per NZU. Combined with the "one-for-two" surrender obligation, where entities are required to surrender only one NZU for every two $mtCO_2e$, this results in an effective maximum emissions price of NZ$12.50 (US$10.07) per tonne.[104] NZUs have **dropped from about NZ$20 (US$16) in 2011 to about NZ$2 (US$1.61) in early 2013**, largely because participants can cover their emissions with an unlimited number of inexpensive international offsets.[105]

[103] Emissions Trading Scheme Review Panel. 2011. Doing New Zealand's Fair Share. Emissions Trading Scheme Review 2011: Final Report. Wellington: Ministry for the Environment. http://www.climatechange.govt.nz/emissions-trading-scheme/ets-review-2011/
[104] Ibid.
[105] Thomson Reuters Point Carbon, Carbon Market Australia – New Zealand, Vol 6, issue 2, 1 March 2013. http://www.pointcarbon.com/polopoly_fs/1.2202614!CMANZ20130301.pdf.

Volume of Reductions	An estimate of emissions from 1990 to 2050 was calculated as part of the Trading Scheme Review in 2011 and showed that New Zealand was on track to meet their 2008 – 2015 target of remaining at 1990 emission levels. However, the projections show emissions at slightly above 1990 levels in 2020, which is not on track to meet the countries stated goal of 10 to 20 percent below 1990 levels in this year. The estimates show large swings in net emissions after 2020, largely due to land use change in the forestry sector. However, emissions in 2035 and 2050 were projected to be close to 1990 levels. See Figure 1, above.
Programmatic Status	While it is still early, the NZ ETS has generally been considered successful, and has imposed minimal impacts on regulated entities and households.
Emissions Leakage	**Carbon sequestration in forests** is expected to play a large role in reducing emissions under the ETS. However, stakeholders noted that forestry reductions are not a long term solution for meeting targets, particularly if forests are harvested in the future. Therefore, stakeholder noted that the introduction of abatement measures to reduce gross emissions must also be included.[106]

The panel that prepared the Trading Scheme Review 2011 conducted extensive discussions with ETS participants as well as industry and community stakeholders and identified several key themes surrounding the review and future of the NZ ETS. Three overarching themes were identified from stakeholder input:[107]

Too early to assess full impact – At the time of the review several sectors had not yet joined the scheme, including agriculture, the country's largest emission source, and therefore stakeholders felt that it was too early to effectively assess the full impact of the ETS.

Impacts of ETS have been low for most – The general impression from stakeholders was that at the time of the review, the impact of the ETS was generally low for most submitters. Stakeholders cited transitional measures, free allocation of NZUs, and the short period of time that some sectors have faced obligations as reasons for the low impact. However, the impact was not uniform, with some businesses reporting costs that were higher than average. The panel also found that low income households were disproportionately affected by costs passed through the ETS in energy bills.

Uncertainty and unpredictability – Stakeholders voiced concern over the uncertainty of several aspects of the ETS, including the future of the international GHG framework under the

[106] Emissions Trading Scheme Review Panel. 2011. Doing New Zealand's Fair Share. Emissions Trading Scheme Review 2011: Final Report. Wellington: Ministry for the Environment. http://www.climatechange.govt.nz/emissions-trading-scheme/ets-review-2011/

[107] Ibid.

Kyoto Protocol, the uncertainty of whether the transitional measures would end, and the unpredictability of international carbon markets and future carbon prices.

The panel also asked stakeholders their opinion of how the ETS was operating in terms of administrative efficiency, compliance costs, penalties, and general organization. Stakeholders reported few concerns in relation to the administration of the ETS and in general reported that it was running well and that there were no over burdensome transaction costs.

5.2 Energy and Economic Impacts

Table 12 summarizes additional available energy and economic impacts of the NZ ETS.

Table 12: Energy and Economic Impacts of NZ ETS

New Zealand Emissions Trading Scheme	
Independence from Fossil Fuels, and Economic Impact	As of 2011, the additional generation costs were estimated to be: • **NZ$13.48 (US$10.86)/MWh for coal** • **NZ$7.98 (US$6.43)/MWh for gas** • **NZ$1.80 (US$1.45)/MWh for geothermal generation (for fields with significant fugitive emissions)**.[108]
Impacts on Fuel Choice	One effect of the ETS has been to make electricity generated from renewable energy sources a relatively more profitable option for electricity companies than prior to the ETS. Renewable options, such as woody biomass, are now relatively less expensive than before the ETS and the Ministry of Economic Development projects that there will be a steady increase in woody biomass use.[109]
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Price incentives from the ETS have encouraged the development of new renewable generation in the country. **Eleven new renewable power stations totaling 1,340 MW of capacity were consented in 2010 and 2011**. Of those, 59 percent were wind power, 26 percent geothermal, 13 percent hydro, and 2 percent were tidal.[110]

[108] Emissions Trading Scheme Review Panel. 2011. Doing New Zealand's Fair Share. Emissions Trading Scheme Review 2011: Final Report. Wellington: Ministry for the Environment. http://www.climatechange.govt.nz/emissions-trading-scheme/ets-review-2011/
[109] Ibid.
[110] Climate Spectator. August 2011. http://www.businessspectator.com.au/article/2011/8/1/carbon-markets/smooth-trading-so-far-so-good-nz-ets#ixzz2bUkaBANi

Impact on Different Sectors of the Economy	Impact on total business expenditures of NZ$465 million (US$374.65), or 0.3 percent, of GDP in 2013 and NZ$702 million (US$565.60), or 0.4 percent GDP, in 2015 Expected **impact on GDP of -0.1 to -1.0 percent of 2020 level**, depending on the scenario modeled.[111]

The New Zealand Institute of Economic Research (NZIER) and Infometrics Ltd. were engaged by the Ministry for the Environment to provide economic modeling of the impacts of the NZ ETS in 2020 under a range of scenarios. Scenarios included continuing to exclude the agriculture sector, extending or removing transition measures, and extending or removing free allocation of NZUs. The report found that the impact on New Zealand's GDP could range from -0.1 percent to -1.0 percent of its 2020 level, relative to a scenario where no carbon price is in place and depending on the scenario modeled.[112]

The Emissions Trading Scheme Review 2011 suggested several recommendations for the NZ ETS after 2012. Most of the recommendations have been implemented. With these recommendations, the panel estimated that the impact on total business expenditure on energy would be NZ$465 million (US$374.65), or 0.3 percent GDP, in 2013 and NZ$702 million (US$565.60), or 0.4 percent GDP, in 2015. The panel also estimated impacts specific to the agriculture sector. The impact on the average dairy farmer's expenditure on energy and obligations would be NZ$4,400 per year in 2013, rising to NZ$11,200 per year in 2019. The impact to the average sheep and beef farmer would be NZ$1,600 per year in 2013, rising to NZ$6,700 per year in 2019. The analysis assumed a NZ$25 carbon price.[113]

5.3 Household Impacts and Co-Benefits

Table 13 summarizes the available household impact and co-benefit information for the NZ ETS.

[111] New Zealand Institute of Economic Research. Macroeconomic impacts of the New Zealand Emissions Trading Scheme: A Computable General Equilibrium analysis. March 2011. http://nzier.org.nz/system/files/07.03_BusinessNZ_%20Emissions-2.pdf
[112] Ibid.
[113] New Zealand Institute of Economic Research. Macroeconomic impacts of the New Zealand Emissions Trading Scheme: A Computable General Equilibrium analysis. March 2011. http://nzier.org.nz/system/files/07.03_BusinessNZ_%20Emissions-2.pdf

Table 13: Household Impacts and Co-Benefits of NZ ETS

New Zealand Emissions Trading Scheme	
Effect on Household Consumption and Spending	The Reserve Bank (RBNZ) estimated the effects of the inclusion of the stationary energy sector in the ETS in its June 2010 Monetary Policy Statement. The RBNZ estimated that **prices of fuel and electricity would rise by between 3 and 8 percent, increasing consumer price index (CPI) inflation by 0.3 percent**.[114] Inclusion of the industrial processing sector in the scheme was not expected to have a noticeable direct impact on consumer prices.
Measures to Mitigate to Low-income Populations, or Economic Impact	• NZU price cap of NZ$25 (US$20.14)[115] • Only one allowance must be surrendered for every two tonnes of CO_2e emitted (non-forestry only)[116] • Free allocation of NZUs[117] • Introduction of "offsetting" for forestry sector[118]
Significant Co-benefits	Nitrous oxide emissions in the agriculture sector represent one third of total agricultural emissions. Reduction of these emissions will have an additional environmental co-benefit of improving water quality.[119]

Several transitional measures were included in the NZ ETS to limit price exposure to New Zealand industries. The transitional measures were designed to be temporary; however, most have been extended through amendments to the scheme in 2012.[120] First, compliance entities can continue to purchase NZUs at a fixed price of NZ$25, which effectively serves as a price ceiling, and free allocations of NZUs are given to businesses with emissions-intensive, trade-exposed activities. Second, the scheme has extended the measure that allows non-forestry participants to surrender one allowance for every two tonnes of CO_2e (the "one-for-two" surrender obligation), which effectively halves the price of allowances. Finally, the forestry sector has been given the flexibility to convert land for other use while avoiding NZ ETS deforestation costs by planting a carbon-equivalent area of forest elsewhere, known as "offsetting".[121] In addition, entities can continue to use an unlimited number of international

[114] Reserve Bank of New Zealand June 2010 Monetary Policy Statement. http://www.rbnz.govt.nz/monetary_policy/monetary_policy_statement/2010/jun10.pdf

[115] New Zealand Ministry of the Environment. November 2012. 2012 Amendments to the New Zealand Emissions Trading Scheme (NZ ETS): Questions and answers. http://www.climatechange.govt.nz/emissions-trading-scheme/ets-amendments/questions-answers.html

[116] Ibid.

[117] New Zealand Ministry of the Environment. Allocation in the New Zealand Emissions Trading Scheme. http://www.mfe.govt.nz/publications/climate/allocation-nz-ets-dec07/allocation-nz-ets-dec07.html

[118] New Zealand Ministry of the Environment. Forestry allocation: NZUs for pre-1990 forest. December 2012. http://www.climatechange.govt.nz/emissions-trading-scheme/participating/forestry/allocation/

[119] Emissions Trading Scheme Review Panel. 2011. Doing New Zealand's Fair Share. Emissions Trading Scheme Review 2011: Final Report. Wellington: Ministry for the Environment. http://www.climatechange.govt.nz/emissions-trading-scheme/ets-review-2011/

[120] New Zealand Ministry of the Environment. November 2012. 2012 Amendments to the New Zealand Emissions Trading Scheme (NZ ETS): Questions and answers. http://www.climatechange.govt.nz/emissions-trading-scheme/ets-amendments/questions-answers.html

[121] New Zealand Ministry of the Environment. Forestry allocation: NZUs for pre-1990 forest. December 2012. http://www.climatechange.govt.nz/emissions-trading-scheme/participating/forestry/allocation/

emission units, which has been a main driver in reducing the cost of compliance.[122] The revised legislation does not specify an end date for the extended transition measures; however, they are expected to be in place at least until the next NZ ETS review which is scheduled for 2015.

[122] ECOFYS. May 2013.

6 Australia Carbon Pricing Mechanism

Policy Definition	Targeted Sector or Emissions
Australia's Carbon Pricing Mechanism (CPM) is the centerpiece of the country's Clean Energy Future plan, which includes a set of national policies aimed at reducing GHG emissions. The pricing mechanism was designed to begin with a fixed carbon price for the first three years, then transition to a flexible price cap-and-trade program.	Covers approximately 60 percent of Australia's emissions including emissions from electricity generation, stationary energy, landfills, wastewater, industrial processes, and fugitive emissions.

GHGs and Costs

- The Australian Government estimated that Australia's per capita emissions were around 25 mtCO2e in 2012, and were projected to increase to 27 mtCO2e in 2030 without the CPM. With the CPM, per capita emissions are projected to be 21 mtCO2e in 2030 with domestic abatement only and 13 mtCO2e with domestic and international abatement included.
- In July 2013, one year after the start of the CPM, emissions from electricity generation were down over 12 MMTCO2e, or 6.9 percent.
- The incoming environment minister Greg Hunt estimates that under the CPM emissions will increase from 560 million metric tons to 637 million metric tons between 2010 and 2020.
- The Australian Government estimated carbon prices for the fixed price period will be:
  2012 to 2013 – AU$23.00 (US$21.09) per mtCO2e
  2013 to 2014 – AU$24.15 (US$22.15) per mtCO2e
- Beginning in July 2014, the flexible-price period will begin and prices will be set by the market.

Implementation Issues and Lessons Learned

- The future of the CPM faces a challenge under Australia's new Prime Minister, Tony Abbott, who was elected in September 2013. Abbott ran on a campaign against the CPM and his Liberal-National Coalition has stated that its first order of business will be the repeal of the program.
- The Institute for Energy Research found that it is unlikely that the CPM will achieve least cost abatement. The report also states that political and popular support for the policy has been weak.

Costs and Benefits to Consumers

- The Australian Government estimates that during the first year of the CPM household consumption has grown 1.7 percent and that the move to a flexible-price scheme will reduce the growth in overall consumer prices by around 0.5 percent in 2014-2015.
- The Institute for Energy Research estimates that in the first year of the CPM, household electricity prices have risen 15 percent.
- Approximately 50 percent of revenue generated from the CPM will be used to compensate households.

Costs and Benefits to Businesses

- The incoming environment minister Greg Hunt says the CPM has lead to manufacturing job losses in the aluminum, steel, paper, cement, auto-manufacturing and chemicals sectors and that policy is eroding business competitiveness.
- Measures to reduce risk to business under the CPM include fixed priced carbon units for first three years, price ceiling for first three years of flexible-price scheme, and free allocation of carbon units to certain emissions-intensive and trade-exposed activities.

Under Australia's Carbon Pricing Mechanism (CPM), which took effect in July 2012, liable entities must surrender one carbon unit for every metric ton of CO_2e they emit in each subject year. The CPM covers approximately 60 percent of Australia's emissions and includes emissions from electricity generation, stationary energy, landfills, wastewater, industrial processes, and fugitive emissions, but does not cover agricultural or transportation emissions.[123] Entities in regulated sectors are subject to the CPM if they operate subject facilities with direct (scope 1) emissions that exceed 25,000 mtCO_2e per year.[124] Households, on-road business use of light-duty vehicles, and the agriculture, forestry and fishery industries do not pay a carbon price for transport fuel under the CPM; however, these sectors will continue to pay a transport fuel excise tax. Emissions from certain business transport fuels, such as rail and shipping, are also subject to an effective carbon price through changes to the tax structure that result in a price equivalent to a carbon price on these emissions.[125]

The CPM was structured to begin effectively as a carbon tax (fixed price) and transition later to a cap and trade system (flexible price). Initial designs called for a gradually increasing fixed price for carbon for each of the first three years of implementation (July 2012 to July 2015), then a transition to a flexible-price scheme in July 2015, when the price of carbon units would be set by the market. However, the Australian Government announced in July 2013 that it has planned to move up the start date of the flexible-price scheme to July 2014, one year earlier than expected. The limit on emissions, known as the "pollution cap", in the first year of the flexible-price period will be set once the relevant legislation is amended to make 2014-2015 the first flexible-price year. If no regulations are in effect that declare the carbon pollution cap then a default pollution cap will become effective. The default cap is set at 25 MMTCO_2e below the total covered emissions in 2012-2013, and the default cap for all years after 2014-2015 will be 12 MMTCO_2e below the previous year's cap.[126]

Allowances are purchased from the Australian National Registry of Emissions Units (ANREU), and are also distributed for free through industry assistance programs.[127] The industry assistance programs include the Jobs and Competitiveness Program (JCP), which helps to limit risk for emissions-intensive and trade-exposed activities, and the Coal-Fired Generation Assistance program, which assists emissions-intensive coal-fired generators to adjust to the CPM. Through the JCP, the most emissions-intensive trade-exposed activities receive free carbon units to cover 94.5 percent of average carbon costs in the first year of the carbon price. Less emissions-intensive trade-exposed activities receive free carbon units to cover 66 percent of average carbon costs in the first year. Assistance reduces by 1.3 percent each year to encourage industry to cut pollution.[128] The Coal-Fired Generation Assistance program provides free carbon units to eligible generators that pass an annual power system reliability test and submit a Clean Energy

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[123] Australian Government Clean Energy Regulator: About the carbon pricing mechanism. Accessed July 2013 at: http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/About-the-Mechanism/Pages/default.aspx
[124] Ibid.
[125] Australian Government. Transport Fuels. http://www.cleanenergyfuture.gov.au/transport-fuels/
[126] Australian Government. Starting Emissions Trading on 1 July 2014. Policy Summary. July 2013. http://www.climatechange.gov.au/sites/climatechange/files/files/reducing-carbon/carbon-pricing-policy/cef-policy-summary-moving-ets.PDF
[127] Australian Government Clean Energy Regulator: Industry assistance. Accessed July 2013 at:http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/Industry-Assistance/Pages/default.aspx
[128] Australian Government Clean Energy Regulator . http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/Industry-Assistance/jobs-and-competitiveness-program/Pages/default.aspx

Investment Plan during each year that assistance is available.[129] In addition, the CPM allows for the use of domestic, land-based offsets covering up to 100 percent of the compliance obligation beginning in the flexible price period.[130] After the start of the flexible-price period, allowances will be auctioned by the Clean Energy Regulator, the Government agency responsible for administering the CPM. Free allocation for some entities will continue under the JCP.

The Australian CPM was designed to link to the European Union Emission Trading System (EU ETS) and beginning in 2014, the CPM will permit eligible international carbon units. An interim one-way link, where Australian entities can surrender EU ETS units for compliance, is scheduled to be completed by July 2015, and a full two-way link will be completed by July 2018. This timeframe accommodates the early start to international emissions trading because the link will be in place by July 2015, seven months before the 2014-2015 compliance date of February 1, 2016.[131] International emission units will be limited to 50 percent of an entities liability and the use of other Kyoto offsets, such as emissions reduction projects under the Clean Development Mechanism (CDM) and the Joint Implementation (JI) mechanism, will be phased in and limited to 6.25 percent of an entity's liability in 2014 - 2015, increasing to 12.5 percent in July 2015.[132]

The future of the CPM faces a challenge under Australia's new Prime Minister, Tony Abbott, who was elected in September 2013. Abbott ran on a campaign against the carbon tax and his Liberal-National Coalition has stated that its first order of business will be the repeal of the CPM. The Government has stated that they will introduce legislation to repeal the CPM on the first sitting day of Parliament.[133] The Honourable Greg Hunt, Shadow Minister for Climate Action, Environment and Heritage, has stated that the CPM could then be repealed by July 2014. However, the Liberal-National Coalition does not currently have control of the Senate and therefore will need the Labor party to support the repeal. If the Labor party does not support the repeal, then the ability to pass the legislation will depend on the final makeup of the Senate which will be decided in October or November of 2013.[134] In place of the CPM, the Government will put forward its Direct Action Plan. The Direct Action Plan is an incentive based policy designed to support emissions reduction activities primarily through a government fund

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[129] Australian Government Clean Energy Regulator. http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/Industry-Assistance/coal-fired-generators/Pages/default.aspx

[130] Australian Government Clean Energy Regulator: Eligible emissions units. Accessed July 2013 at http://www.cleanenergyregulator.gov.au/Carbon-Pricing-Mechanism/About-the-Mechanism/Emissions-units/Pages/default.aspx

[131] Australian Government. Starting Emissions Trading on 1 July 2014. Policy Summary. July 2013. http://www.climatechange.gov.au/sites/climatechange/files/files/reducing-carbon/carbon-pricing-policy/cef-policy-summary-moving-ets.PDF

[132] Ibid.

[133] Australian Broadcasting Company. http://www.abc.net.au/news/2013-09-18/tony-abbotts-new-ministry-to-be-sworn-in-today/4963842

[134] RenewEconomy.com.http://reneweconomy.com.au/2013/explainer-what-election-result-means-for-carbon-pricing-59122

(Emissions Reduction Fund) which will use a reverse auction to purchase the lowest cost per ton emission abatement.[135]

6.1 GHG Impacts

If the CPM continues to operate as planned, it will transition to a flexible-price, cap-and-trade style emissions trading scheme in July 2014, one year earlier than expected. During the first year of the program, July 2012 through July 2013, Australia's GHG emissions have decreased, while economic indicators, such as GDP and industrial output, have increased. Since the start of the CPM, emissions from electricity generation, which represent about half of the emissions covered by the CPM, have declined by 7 percent. Table 14 summarizes available GHG related information for the Australian CPM to date.

The Honourable Greg Hunt, Shadow Minister for Climate Action, Environment and Heritage, in a speech to the Grattan Institute Public Seminar in July 2013 stated that the CPM has lead to manufacturing job losses in the aluminum, steel, paper, cement, auto-manufacturing and chemicals sectors. The number of job losses was not provided, and the speech stated that the CPM was not responsible for all of the job losses; however, it cited industry confirmation that the tax has eroding business competitiveness in Australia. The speech also stated that, based on Treasury calculations, emissions will increase from 560 million metric tons to 637 million metric tons between 2010 and 2020.[136]

Table 14: GHG Costs and Benefits of the Australia CPM

Australia CPM

[135] Honorable Greg Hunt, MP, Shadow Minister for Climate Action, Environment and Heritage. *Choosing the Right Market Mechanisms for Addressing Environmental Problems: Incentives for Action under the Coalition's Direct Action Plan for the Environment and Climate Change.* Speech to the Grattan Institute Public Seminar. July 2013. http://grattan.edu.au/static/files/assets/abf7f66f/521_public_seminar_hunt_speech_outline_130716.pdf
[136] Ibid.

Cost of Reductions	The Australian Government estimated carbon prices for the fixed price period will be: • **2012 to 2013 – AU$23.00 (US$21.09) per mtCO_2e** • **2013 to 2014 – AU$24.15 (US$22.15) per mtCO_2e** Beginning in July 2014, the flexible-price period will begin and prices will be set by the market, which may bring the price in line with the EU ETS price, which is currently expected to be around AU$6 (US$5.49) per mtCO_2e.[137] A study conducted by the Institute for Energy Research in September 2013 which estimated the economic impacts of the CPM found the following:[138] • The study found that between 2013 and 2020 there is an average GDP loss of AU$48 (US$44.94) for each metric ton of abatement (more than half of which is sourced from overseas), with costs as high as AU$142 (US$132.94) per metric ton in 2013. • As part of the household compensation package included with the CPM the Australian Government lowered average income tax rates for some (about 560,000) but actually increased marginal tax rates for many more, resulting in an effective tax increase for 2.2 million taxpayers. • The main economic effect of the CPM so far has been to increase energy prices (particularly electricity costs) for households and businesses.
Volume of Reductions	• Total annual emissions as of September 2012 were estimated to be 551.9 MMTCO_2e, a **decrease of 0.2 percent** from September 2011 emissions of 553.2 MMTCO_2e.[139] • The Australian Government estimated that Australia's per capita emissions were around 25 mtCO_2e in 2012, and were projected to increase to 27 mtCO_2e in 2030 without the CPM. With the CPM, per capita emissions are projected to be 21 mtCO_2e in 2030 with domestic abatement only, and 13 mtCO_2e with domestic and international abatement included.[140] • In July 2013, one year after the start of the CPM, emissions from electricity generation were down over 12 MMTCO_2e, or 6.9 percent.[141]

[137] Australian Government. Starting Emissions Trading on 1 July 2014. Policy Summary. July 2013. http://www.climatechange.gov.au/sites/climatechange/files/files/reducing-carbon/carbon-pricing-policy/cef-policy-summary-moving-ets.PDF

[138] Robson, A. PhD. Australia's Carbon Tax: An Economic Evaluation. Institute for Energy Research. September 2013. http://americanenergyalliance.us2.list-manage.com/track/click?u=7cbc7dd79831a84c870f9842e&id=85bd12ab9b&e=8c028b49d1

[139] Australian Government. Quarterly Update of Australia's National Greenhouse Gas Inventory: December 2012. http://www.climatechange.gov.au/climate-change/greenhouse-gas-measurement-and-reporting/tracking-australias-greenhouse-gas-emissio-0/quarterly-update-australias-national-greenhouse-gas-inventory-march-13

[140] Australian Government. How Australia's Carbon Price is Working One Year On. July 2013. http://www.cleanenergyfuture.gov.au/wp-content/uploads/2013/08/carbon-price-one-year-on.pdf

[141] Ibid.

Programmatic Status	The CPM only began in July 2012, and the start of the flexible-price period will not begin until July 2014. However, the first year of the CPM has been a success according to a report by the Government of Australia. In a report prepared in July 2013, the Government reports that emissions from the electricity sector had decreased by 7 percent, renewable energy generation had increased by 25 percent, generation from coal had decreased 12.5 percent, and over 160,000 new jobs had been created. The report also stated that from the period July 2011- May 2012 to July 2012-May 2013, GDP had grown 2.5 percent, industrial production had grown 5.1 percent, retail trade had grown 3.1 percent, and household consumption had grown 1.7 percent. The report did not specify how much, if any, of this growth is attributable to the CPM.[142] The Institute for Energy Research study conducted in September 2013 found that it is unlikely that the CPM will achieve least cost abatement. The report also states that political and popular support for the policy has been weak and that there is a great deal of uncertainty surrounding the future status of the tax, especially in light of the recent national election.[143]
Emissions Leakage	The Institute for Energy Research study found that Australian businesses have seen energy cost increases as a result of the CPM and that many of these businesses have not been unable to pass on these costs increases. The report suggests that the most likely reason for the lack of pass-through of cost increases is that the businesses are either producing goods for export or are competing directly against goods imported from overseas and therefore face a fixed world price for their output. In these cases the CPM is likely to lead to carbon leakage rather than a reduction in global emissions.[144]

6.2 Energy and Economic Impacts

The CPM has had an impact on fuel choice in Australia. Since the start of the CPM, the Australian Government has estimated that electricity generation from renewables has increased 25 percent and generation from coal has decreased 13 percent. The Australian Government estimates that impacts on Australia's economy have been minimal since the start of the program. The Government estimates that over 160,000 new jobs have been created since the start of the CPM and that GDP has grown 2.5 percent, though no causation has been established.[145] The CPM includes several measures to limit the economic impacts and reduce risk to business.

A study by the Institute for Energy Research released in September 2013 assessed the economic impacts of the CPM and found that it is unlikely that the program will achieve least cost

[142] Ibid.
[143] Robson, A. PhD. Australia's Carbon Tax: An Economic Evaluation. Institute for Energy Research. September 2013. http://americanenergyalliance.us2.list-manage.com/track/click?u=7cbc7dd79831a84c870f9842e&id=85bd12ab9b&e=8c028b49d1
[144] Ibid.
[145] Ibid.

abatement. The report also states that political and popular support for the policy has been weak and that there is a great deal of uncertainty surrounding the future status of the tax, especially in light of the recent national election.[146]

Table 15 summarizes available energy and economic impacts of the Australian CPM.

Table 15: Energy and Economic Impacts of the Australia CPM

Australia CPM	
Independence from Fossil Fuels, and Economic Impact	The CPM, along with the country's Renewable Energy Target (20 percent renewable by 2020), have coincided with an increase in generation from clean energy sources. One year after implementation **renewable energy generation has increased by 25 percent and natural gas generation has increased by 4.4 percent**. Generation from coal has decreased by 13 percent. By 2020, renewable energy generation is expected to increase by 60 to 80 percent.[147]
Impacts on Fuel Choice	The CPM has helped to increase electricity generation from renewable sources and natural gas and decrease generation from coal. See above.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	In addition to the increase in renewable energy and natural gas generation noted above, CPM revenue is funding the Government's Clean Technology Program which provides over AU$1(US$0.91) billion to help businesses invest in new energy efficiency and pollution reduction equipment.[148] The Low Income Energy Efficiency Program is providing up to AU$63 (US$57.28) million for energy efficiency measures for around 33,000 low income households.[149]

[146] Robson, A. PhD. Australia's Carbon Tax: An Economic Evaluation. Institute for Energy Research. September 2013. http://americanenergyalliance.us2.list-manage.com/track/click?u=7cbc7dd79831a84c870f9842e&id=85bd12ab9b&e=8c028b49d1
[147] Australian Government. How Australia's Carbon Price is Working One Year On. July 2013. http://www.cleanenergyfuture.gov.au/wp-content/uploads/2013/08/carbon-price-one-year-on.pdf
[148] Ibid.
[149] Ibid.

Impact on Different Sectors of the Economy	**Jobs:** • Since the start of the CPM, over 160,000 new jobs were created across the economy, including clean energy jobs. The source did not specify how many of the jobs created were directly attributable to the CPM [150] • The Honorable Greg Hunt, MP, Shadow Minister for Climate Action, Environment and Heritage, stated in a speech in July 2013 that since the CPM was introduced Australia has seen manufacturing job losses in the aluminum, steel, paper, cement, auto-manufacturing and chemicals sectors.[151] **Electricity:** • Electricity spot prices increased sharply after the start of the CPM in July 2012, then decreased through the start of October 2012. The average spot price in June 2012, just before the start of the CPM, was around AU$37 (US$33.64)/MWh. The average spot price in the three months after the CPM was just over AU$58 (US$52.73)/MWh.[152] The average spot price for the first two months of the 2013 – 2014 financial year was around AU$56 (US$51.16)/MWh.[153] Measures to reduce risk to business under the CPM include: • **Fixed priced carbon units for first three years (2013 – 2015)**:This measure stabilizes the financial impact to entities and avoids price spikes during the implementation of the CPM. • **Price ceiling for first three years of flexible-price scheme (2016 – 2018):** Similar to the fixed price measure, the price ceiling prevents price spikes during the transition to a flexible-price trading scheme. • **Free allocation of carbon units to certain emissions-intensive and trade-exposed activities:** This measure helps emission intensive entities transition to a carbon price and reduces incentives for these entities to relocate to countries with climate policies different than those in Australia.

6.3 Household Impacts and Co-Benefits

The Australian Government expects positive impacts on households from the early move to a flexible-price emission trading scheme. The Government has estimated that annual household costs will be around AU$380 (US$347.17) lower, on average, in the 2014 – 2015 financial

[150] Ibid.
[151] The number of job losses was not provided. Source: Honorable Greg Hunt, MP, Shadow Minister for Climate Action, Environment and Heritage. *Choosing the Right Market Mechanisms for Addressing Environmental Problems: Incentives for Action under the Coalition's Direct Action Plan for the Environment and Climate Change.* Speech to the Grattan Institute Public Seminar. July 2013. http://grattan.edu.au/static/files/assets/abf7f66f/521_public_seminar_hunt_speech_outline_130716.pdf
[152] Australian Energy Market Operator. Carbon Price – Market Review. November 2012. http://www.aemo.com.au/Electricity/Resources/Reports-and-Documents/~/media/Files/Other/reports/CarbonPrice_MarketReview.ashx
[153] Australian Energy Market Operator. Average Price Tables. http://www.aemo.com.au/Electricity/Data/Price-and-Demand/Average-Price-Tables

year.[154] The CPM also includes a range of programs to help households adjust to the financial impacts of a carbon price and includes compensation measures focused on low-to-middle income households. Table 16 summarizes the available household impact and co-benefit information for the Australian CPM.

Table 16: Household Impacts and Co-Benefits of the Australia CPM

Australia CPM	
Effect on Household Consumption and Spending	The Australian Government estimates that an early move to a flexible-price emissions trading scheme will lower household cost of living.[155] • Reduce the growth in overall consumer prices by around 0.5 percent in 2014-2015 • On average, household costs are estimated to be around AU$7.30 (US$6.68) per week lower, or AU$380 (US$347.93) lower per year in 2014-15 as a result of moving to an early flexible-price scheme. During the first year of the CPM, household consumption has grown 1.7 percent.[156] The Institute for Energy Research, in a report released in September 2013, estimates that:[157] • In the first year of the CPM, household electricity prices have risen 15 percent, including the biggest quarterly increase on record. • Currently 19 percent of a typical household electricity bill in Queensland and 16 percent in New South Wales is due to the CPM and other "green" programs such as the renewable energy mandate.
Measures to Mitigate to Low-income Populations, or Economic Impact	The CPM includes compensation measures focused on low-to-middle income households. Approximately 50 percent of revenue generated from the CPM will be used to compensate households, including:[158] • Increase in the tax-free threshold rising from AU$18,200 (US$16,689) in 2012-13 rising to AU$19,400 (US$17,789) in 2015-16 • Increases in family benefit payments, pensions and allowances to assist households to meet cost increases • Households are exempt from the carbon price on transport fuel use, however, households continue to pay a transport fuel excise tax. The Low Income Energy Efficiency Program is providing up to AU$63 (US$57.28) million for energy efficiency measures for around 33,000 low income households.[159]

[154] Australian Government. How Australia's Carbon Price is Working One Year On. July 2013. http://www.cleanenergyfuture.gov.au/wp-content/uploads/2013/08/carbon-price-one-year-on.pdf

[155] Australian Government. Households' cost of living under an early emissions trading scheme (ETS). Fact Sheet. 2013. http://www.climatechange.gov.au/sites/climatechange/files/files/reducing-carbon/carbon-pricing-policy/households-cost-ets.pdf

[156] Australian Government. How Australia's Carbon Price is Working One Year On. July 2013. http://www.cleanenergyfuture.gov.au/wp-content/uploads/2013/08/carbon-price-one-year-on.pdf

[157] Robson, A. PhD. Australia's Carbon Tax: An Economic Evaluation. Institute for Energy Research. September 2013. http://americanenergyalliance.us2.list-manage.com/track/click?u=7cbc7dd79831a84c870f9842e&id=85bd12ab9b&e=8c028b49d1

[158] Deloitte. Australia's carbon pricing mechanism: Key issues for business. 2011. https://www.deloitte.com/assets/Dcom-Australia/Local%20Assets/Documents/Services/Climate%20change%20and%20sustainability/Deloitte_carbon_pricing_mechanism%20.pdf

Significant Co-benefits	Certain projects under the Carbon Farming Initiative (CFI), a program related to the CPM which allows farmers and land managers to earn carbon credits by storing carbon or reducing emissions on their land, includes provisions to promote projects that produce co-benefits to biodiversity or Indigenous communities.[160]

[159] Australian Government. How Australia's Carbon Price is Working One Year On. July 2013. http://www.cleanenergyfuture.gov.au/wp-content/uploads/2013/08/carbon-price-one-year-on.pdf

[160] Australian Government. Carbon Farming Initiative. Avoiding negative outcomes and supporting co-benefits. http://www.climatechange.gov.au/reducing-carbon/carbon-farming-initiative/cfi-handbook-0/avoiding-negative-outcomes-and-supporting

7 British Columbia Carbon Tax

<table>
<tr><th>Policy Definition</th><th>Targeted Sector or Emissions</th></tr>
<tr><td>A carbon tax imposed on fuels based on their carbon intensity. All taxes collected are recycled in a revenue neutral manner through reduction in income taxes.</td><td>Energy</td></tr>
<tr><th colspan="2">GHGs and Costs</th></tr>
<tr><td colspan="2">• Set in 2008 to CAD$10 per mtCO2e, escalating CAD$5 per year to CAD$30 in 2012.
• From 2008 to 2011, BC’s per capita GHG emissions associated with carbon-taxed fuels declined by 10 percent.
• In absence of all other GHG reduction strategies, the carbon tax alone is estimated to cause a reduction in BC’s emissions in 2020 by up to 3 $MMTCO_2e$ annually.</td></tr>
<tr><th colspan="2">Implementation Issues and Lessons Learned</th></tr>
<tr><td colspan="2">• The BC carbon tax is still too low in terms of price to drive a shift to new low-carbon practices and technologies.
• Carbon tax revenues can be used in a variety of ways; BC has used tax revenue to offset personal and corporate income taxes. WA could offset other taxes.
• Corporate tax cuts are now absorbing a substantial share of carbon tax revenues
• As the price per $mtCO_2e$ rises, the carbon tax will become increasingly regressive to low-income households for whom energy costs are a larger portion of overall income.</td></tr>
<tr><th>Costs and Benefits to Consumers</th><th>Costs and Benefits to Businesses</th></tr>
<tr><td>• Increase in gasoline and other energy costs proportional to their energy content.
• Reduction in personal income tax rates, which can compensate for increased energy prices associated with the carbon tax.
• Between 2008 and 2011, the BC GDP has slightly outperformed the rest of the Canadian economy.[161]</td><td>• Increase in gasoline and other energy costs proportional to their energy content.
• Industries with high emissions intensities, such as cement production, petroleum refining, oil and gas extraction and some other manufacturing subsectors have been impacted.
• Reduction in corporate tax rates.
• Increasing the carbon tax beyond the current CAD$30/$mtCO_2e$ would have a stronger negative impact on economic growth.</td></tr>
</table>

On July 1, 2008, British Columbia (BC) implemented the BC Carbon Tax Act, the first carbon tax policy in North America. The BC carbon tax imposes a price on the use of carbon-based fuels, including gasoline, diesel, jet fuel, natural gas, propane, and coal. BC’s carbon tax was designed to be “revenue neutral,” as all revenue generated by the tax is used to reduce other taxes – mainly through cuts to income taxes (personal and corporate), as well as targeted tax relief for vulnerable households and communities, resulting in no overall increase in taxation. Although Washington does not have an income tax, there are other taxes that could be reduced if significant carbon tax revenue were generated. The tax covers three quarters (77 percent) of the province’s GHG emissions from residential, commercial, and industrial sources. The measure is

[161] Elgie and McClay. BC’s Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685

a central component of BC's climate change strategy that aims to reduce GHG emissions by 33 percent below 2007 levels by 2020.[162]

A 2013 review of the program by Sustainable Prosperity concluded that "BC's carbon tax shift has been a highly effective policy to date. It has contributed to a significant reduction in fossil fuel use per capita, with no evidence of overall adverse economic impacts, and has enabled BC to have Canada's lowest income tax rates." However, the authors go on to note that "further economic analysis is needed to reach more firm conclusions about these effects and causality," and that it is "too early to draw solid conclusions on the tax shift's economic effects."[163]

When introduced in 2008, the BC carbon tax was set at CAD$10 (US$9.68) per mtCO_2e. It was designed to rise by CAD$5 (US$4.84) per year thereafter until it reached CAD$30 (US$29.04) per mtCO_2e in 2012. Since different fuels generate different amounts of GHGs when burned, the CAD$30 (US$29.04) per mtCO_2e is translated into tax rates for specific fuel types. For example, the current rate for a liter of gasoline is CAD$0.0667 (US$0.227/gallon) and the current rate for a liter of diesel is CAD$0.0767 (US$0.265/gallon).[164]

According to the BC Ministry of Finance, the revenue-neutral carbon tax is based on the following principles[165]:

- **All carbon tax revenue is recycled through tax reductions.** The government has a legal requirement to present an annual plan to the legislature demonstrating how all the carbon tax revenue will be returned to taxpayers through tax reductions. The money will not be used to fund government programs.
- **Allow time to adjust.** The tax rate started low and increased gradually to allow individuals and businesses time to adjust.
- **Protect low-income individuals and families.** Low-income individuals and families are protected through a refundable Low Income Climate Action Tax Credit designed to offset the carbon tax.
- **The tax has the broadest possible base.** Virtually all emissions from fuel combustion in BC captured by Environment Canada's National Inventory Report are taxed, with no exceptions except those required for integration with other climate action policies in the future and for efficient administration.
- **The tax will be integrated with other measures.** The carbon tax will not, on its own, meet BC's emission-reduction targets, but it is a key element in the strategy. The carbon tax and

[162] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685
[163] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685
[164] British Columbia Ministry of Finance: What is the Carbon Tax?. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/A1.htm
[165] British Columbia Ministry of Finance. Tax Cuts Funded by the Carbon Tax. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/A2.htm

> complementary measures such as "cap and trade" system will be integrated as other measures are designed and implemented.

The tax puts a price on carbon to encourage individuals, businesses, industry, and others to use less fossil fuel and reduce their GHG emissions. In addition, it sends a consistent price signal, ensuring that those who produce emissions pay for them, and makes clean energy alternatives more competitive.[166] According to Sustainable Prosperity, the majority of energy and carbon intensive industries in Canada are overwhelmingly in favor of a price on carbon, but there is no consensus on the pricing mechanism.[167]

Most economists also consider that a carbon tax has several advantages over the alternative pricing instrument, a cap and trade system. These include easier comprehensive coverage of emission sources, administrative simplicity and frugality (it uses existing public and private tax administrative infrastructures), speed of establishment, low transaction costs, price certainty (critical for investment decisions), and transparency for consumers (critical for influencing behavior).[168] Nonetheless, a Congressional Budget Office analysis found that a carbon tax would have a negative effect on the economy prior to accounting for the use of carbon tax revenue. The report also concluded that "some uses of those revenues could substantially offset the total economic costs resulting from the tax itself, whereas other uses would not."[169]

British Columbia is Washington's neighbor to the north, and the carbon tax has five years of implementation history available for review. Additionally, because the transportation sector is such a large portion of Washington's GHG emissions, the application of the carbon tax to transportation fuels in British Columbia may provide insight into consumer response. The revenue neutral nature of British Columbia's carbon tax may also highlight ways to mitigate potential economic impacts.

7.1 GHG Impacts

A review of the BC Carbon Tax Act was completed in July 2013 by researchers at the University of Ottawa. The researchers found that GHG emissions declined by a combined 10 percent from 2008 to 2011 when compared with GHG emissions in 2007, the year before the tax was implemented. GHG emissions in the rest of Canada over the same period saw a reduction of only 1.1 percent. The researchers noted that the experience in BC is consistent with the results

[166] British Columbia Ministry of Finance: Carbon Tax Review, and Carbon Tax Overview. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/carbon_tax.htm
[167] Sustainable Prosperity. Canadian Business Preference on Carbon Pricing. January 2011. Accessed August 2013 at: http://www.sustainableprosperity.ca/dl329&display
[168] Sustainable Prosperity. *British Columbia Carbon Tax Review*. September 2012. Accessed August 2013 at: http://www.sustainableprosperity.ca/dl891&display
[169] Congressional Budget Office. 2013. Effects of a Carbon Tax on the Economy and the Environment. Accessed September 2013 at: http://www.cbo.gov/publication/44223

witnessed in seven European countries that enacted carbon tax shifts in the 1990s.[170] Table 17 summarizes additional GHG related information for the BC Carbon Tax Act.

Table 17: GHG Costs and Benefits of the BC Carbon Tax Act

BC Carbon Tax Act	
Cost of Reductions	The BC Carbon Tax Act was implemented in 2008 with a tax initially set at **CAD$10 (US$9.68) per mtCO_2e. The BC Carbon Tax included a rise of CAD$5 (US$4.84) per year until it reached CAD$30 (US$29.04) per mtCO_2e in 2012**. The current carbon tax rates are[171]: • Gasoline – CAD$0.0667/liter (US$0.227/gallon) • Diesel – CAD$0.00767/liter (US$0.265/gallon) • Coal – high heat value - $CAD62.31/tonne (US$60.34/metric ton) • Coal – low heat value - $CAD53.31/tonne (US$51.63/metric ton) • Natural Gas – CAD$0.057/$m^3$ (US$0.0016/$ft^3$) 2010/11 Carbon Tax Revenue was CAD$741 (US$717) million.[172] A recent review of the policy determined the tax will remain at CAD$30 (US$29.04) per mtCO_2e for the foreseeable future. [173]
Volume of Reductions	From 2008 to 2011, BC's per capita GHG emissions associated with **carbon-taxed fuels declined by 10 percent**. During this period, BC's reductions outpaced those in the rest of Canada by 8.9 percent. [174] Quantitative volumes were not noted. In absence of all other GHG reduction strategies, the **carbon tax alone is estimated to cause reduction in BC's emissions in 2020 by up to 3 MMTCO_2e annually.** [175]
Programmatic Status	Since the implementation of the carbon tax in 2008, BC has seen a drop in fuel consumption and GHG emissions, though some of this may be attributable to the global economic downturn. Additionally, BC households and businesses now pay the lowest income taxes in Canada. [176] After a review of the tax in 2012, BC confirmed it would keep its revenue-neutral carbon tax.[177]

[170] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685
[171] British Columbia Ministry of Finance: How the Carbon Tax Works. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm
[172] British Columbia Ministry of Finance. June Budget Update – 2013/14 to 2014/15, Carbon Tax Review. 2013. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/Carbon_Tax_Review_Topic_Box.pdf
[173] Ibid.
[174] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685
[175] British Columbia Ministry of Finance: How the Carbon Tax Works. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/A4.htm
[176] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685
[177] British Columbia Ministry of Finance: Carbon Tax Review, and Carbon Tax Overview. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/carbon_tax.htm

Emissions Leakage	No GHG leakage was noted in the literature, though there have been reports of BC residents purchasing lower cost gasoline in Washington.[178]

7.2 Energy and Economic Impacts

Economic analysis conducted for the carbon tax review indicates that BC's carbon tax has had, and will continue to have, a small negative impact on GDP in the province. The economic impact varies by industry and some industries are more impacted than others. Following the review, the BC government decided to maintain the current tax rate of CAD$30 (US$29.04) per mtCO_2e, and the carbon tax base will not be expanded or broadened to include industrial processes or other non-combustion emissions.[179] Increasing the carbon tax rates or expanding the base to include industrial process emissions would increase costs for BC business and decrease competitiveness.[180]

A report released in July 2013 found that per capita consumption of petroleum fuels subject to the BC carbon tax decreased by 17.4 percent from the 2007 base year to 2012. Conversely, per capita consumption of petroleum fuels subject to the BC carbon tax increased by 1.5 percent in the rest of Canada over the same time period. Based on the pre-tax trend from 2000-2008 – when BC per capita fuel consumption decreased 0.1 percent per year *less* than the rest of Canada – the author concludes that "while BC was doing about as well as the rest of Canada in reduction gfurel use before 2008, it has done much better since the carbon tax came in – suggesting that the tax was an important contributor to BC's success in reducing fuel use in the past four years." [181] This analysis is presented in Figure 5.

[178] CTV British Columbia. May 2013. Tax gap has B.C.ers driving south for gas: watchdog. Accessed September 2013 at: http://bc.ctvnews.ca/tax-gap-has-b-c-ers-driving-south-for-gas-watchdog-1.1285011
[179] British Columbia Ministry of Finance. June Budget Update – 2013/14 to 2014/15, Carbon Tax Review. 2013. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/Carbon_Tax_Review_Topic_Box.pdf
[180] Ibid.
[181] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685

Figure 5: Sales of Petroleum Fuels Subject to BC Carbon Tax, 2000-2012. (Graphic Excerpted from Elgie and McClay 2013) [182]

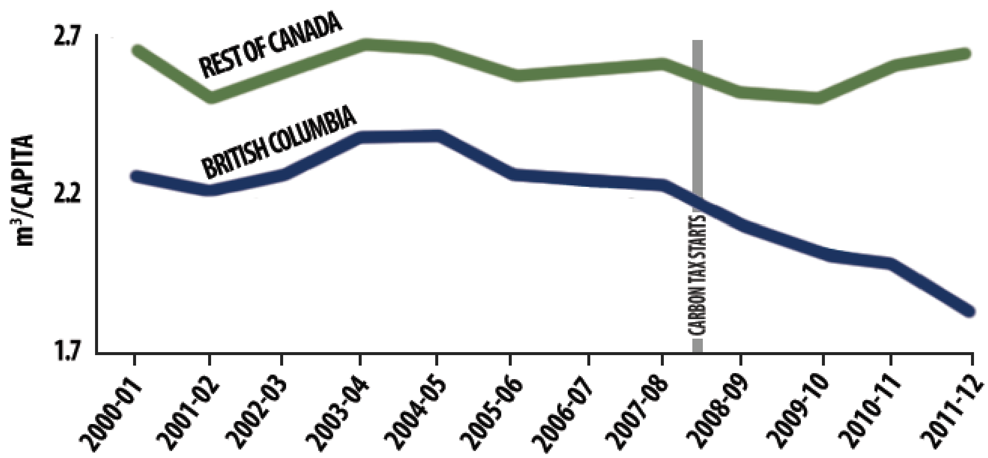

Table 18 summarizes additional available energy and economic impacts of the BC Carbon Tax Act.

Table 18: Energy and Economic Impacts of the BC Carbon Tax Act

BC Carbon Tax Act	
Independence from Fossil Fuels, and Economic Impact	**Reduction of fossil fuel use by 17.4** percent per capita from 2008 to 2012[183] increases energy independence. • **2010/11 Carbon Tax Revenue CAD$741 (US$717) million** • 2010/11 Personal Tax Reductions CAD$391 (US$378) million • 2010/11 Business Tax Reductions CAD$474 (459) million[184] For the 2012/13 fiscal year, the tax reductions are expected to return CAD$260 (US$252) million more to taxpayers than the amount of carbon tax paid.[185]
Impacts on Fuel Choice	Between 2008 and 2012, fossil fuel use in BC has dropped 17.4 percent per capita when compared to the fuel use in 2007. Over the same time period, fossil fuel use in the rest of Canada increased by 1.5 percent.[186] This is represented in Figure 5.

[182] Ibid.
[183] Ibid.
[184] British Columbia Ministry of Finance. *June Budget Update – 2013/14 to 2014/15, Carbon Tax Review.* 2013. Accessed August 2013 at: http://www.bcbudget.gov.bc.ca/2012/bfp/2012_Budget_Fiscal_Plan.pdf
[185] British Columbia Ministry of Finance. *Tax Cuts Funded by Carbon Tax.* Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/A2.htm
[186] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685

Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Analysts determined the carbon **tax is still too low in terms of price to drive a shift to new low-carbon practices and technologies**. Public investment to accelerate low-carbon practices and support demonstration and pilot projects in alternative emerging technologies is also needed. [187]
Impact on Different Sectors of the Economy	Between 2008 and 2011, the BC **GDP has slightly outperformed the rest of the Canadian economy.[188] However, industries with high emissions intensities, such as cement production, petroleum refining, oil and gas extraction and some other manufacturing subsectors have been impacted.** Increasing the carbon tax beyond the current CAD$30/mt$CO_2$e would have a stronger negative impact on economic growth.[189]

7.3 Household Impacts and Co-Benefits

The BC carbon tax affects home heating and vehicle fuelling for BC families. In July 2012, The BC Ministry of Environment estimated that the cost of the carbon tax to fill the gas tank would cost an additional CAD$2.80 (US$2.71) for a compact car, CAD$3.80 (US$3.68) for a mid-sized sedan, and CAD$5.10 (US$4.94) for an SUV. Similar household costs occur for families that use a natural gas or oil furnace to heat their home. Tax reductions included in the revenue neutral policy offset these increased costs on households. The Government also provides programs for families to reduce their emissions and save costs including home retrofit programs and clean energy vehicle incentive programs.[190]

The Low Income Climate Action Tax credit helps offset the impact of the carbon taxes paid by low-income individuals.[191] Another measure to mitigate the carbon tax for families includes the Northern and Rural Homeowner Benefit that helps homeowners outside of metropolitan areas reduce the amount of taxes they pay on their homes.[192]

Modeling of the program found that as the price per mtCO_2e rises, the carbon tax will become increasingly regressive to low-income households. The low-income credit would shrink from one-third of revenues in 2008/09 to 19 percent in 2010/11 and 12 percent in 2012/13. A similar drop is expected to happen to the personal income tax cut. Corporate tax cuts are now absorbing

[187] Sustainable Prosperity. *British Columbia Carbon Tax Review.* September 2012. Accessed August 2013 at: http://www.sustainableprosperity.ca/dl891&display

[188] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685

[189] British Columbia Ministry of Finance. *June Budget Update – 2013/14 to 2014/15, Carbon Tax Review.* 2013. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/Carbon_Tax_Review_Topic_Box.pdf

[190] British Columbia Ministry of Environment. *Making Progress on B.C.'s Climate Action Plan. 2012. Accessed August 2013 at:* http://www.env.gov.bc.ca/cas/pdfs/2012-Progress-to-Targets.pdf

[191] British Columbia. *Low Income Climate Action Tax Credit. Accessed August 2013 at:* http://www2.gov.bc.ca/gov/topic.page?id=E9258ADE1AE3423080A1B2674F4EAABD

[192] British Columbia Ministry of Finance. Tax Cuts Funded by the Carbon Tax. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/A2.htm

a substantial share of carbon tax revenues.[193] Table 19 summarizes the projected impact on households by income group and year. [194]

Table 19. Estimated BC Carbon Tax and Revenue Recycling by Income Group, 2008/09 to 2010/11 (Graphic Excerpted from Lee 2008)

Table 2: BC Carbon Tax and Revenue Recycling by Income Group, 2008/09 to 2010/11

	All households	Lowest quintile	Second quintile	Third quintile	Fourth quintile	Highest quintile
	Average dollars per household (unless otherwise stated)					
2008/09						
Carbon taxes paid (direct and indirect) ($)	253	107	166	247	316	427
Low-income credit ($)	86	129	147	139	13	1
Personal income tax cuts ($)	69	1	18	54	102	167
Corporate income tax cuts ($)	99	15	42	57	60	322
Total recycled benefits ($)	253	145	207	250	175	489
Net gain (loss) ($)		38	40	3	(141)	62
Share of income		0.2%	0.1%	0.0%	(0.2%)	0.0%
2009/10						
Carbon taxes paid ($)	380	161	250	370	473	641
Low-income credit ($)	90	136	155	146	14	1
Personal income tax cuts ($)	162	3	42	127	242	395
Corporate income tax cuts ($)	128	19	54	74	77	416
Total recycled benefits ($)	380	158	251	347	333	812
Net gain (loss) ($)		(3)	1	(24)	(141)	171
Share of income		0.0%	0.0%	0.0%	(0.2%)	0.1%
2010/11						
Carbon taxes paid ($)	507	215	333	494	631	854
Low-income credit ($)	90	136	155	146	14	1
Personal income tax cuts ($)	231	5	60	181	344	562
Corporate income tax cuts ($)	185	28	78	107	112	603
Total recycled benefits ($)	507	168	293	434	469	1165
Net gain (loss) ($)		(47)	(40)	(60)	(162)	311
Share of income		(0.3%)	(0.1%)	(0.1%)	(0.2%)	0.2%

Notes: Estimates are for the full July 1 to June 30 year in accordance with the carbon tax. See Technical Appendix for details on how recycled revenues are allocated across quintiles.

Source: Authors' calculations based on Statistics Canada's Survey of Household Expenditure and Social Planning Simulation Database and Model, and BC Budget 2008.

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[193] Lee. Fair and Effective Carbon Pricing, Lessons from BC. February 2011. Accessed August 2013 at: http://www.policyalternatives.ca/publications/reports/fair-and-effective-carbon-pricing

[194] Lee. Is BC's Carbon Tax Fair?, An impact Analysis for Different Income Levels. October 2008. Accessed August 2013 at: http://www.policyalternatives.ca/sites/default/files/uploads/publications/BC_Office_Pubs/bc_2008/ccpa_bc_carbontaxfairness.pdf

Table 20 summarizes the available household impact and co-benefit information for the BC Carbon Tax Act. Table 19 summarizes the estimated BC carbon tax and revenue recycling by income group.

Table 20: Household Impacts and Co-Benefits of the BC Carbon Tax Act

BC Carbon Tax Act	
Effect on Household Consumption and Spending	The **BC government "recycles" all revenues from the carbon tax back to households and businesses in the form of tax cuts and low-income tax credits**. In 2008/09, the carbon tax was estimated to be moderately progressive, where households saw a net gain from the policy. By 2010/11, the regime is moderately regressive, where only the highest quintile saw a net gain. Table 19 presents the estimated carbon tax costs and tax reductions for households of varying income levels.[195] BC carbon tax policy analysis suggests income tax reductions and credits should be indexed to any future increases in the carbon tax rate. [196]
Measures to Mitigate to Low-income Populations, or Economic Impact	The following personal income tax measures are funded by the BC Carbon Tax Act[197]: • **BC Low Income Climate Action Tax Credit**: CAD$184 (US178) million in reductions in 2011/12; CAD$195 (US$189) million in 2012/13 • Reduction of 5 percent in the first two personal income tax rates: CAD$220 (US$213) million in 2011/12; CAD$235 (US$227) million in 2012/13 • **Northern and Rural Homeowner Benefit of $200**: CAD$66 (US$64) million in 2011/12; CAD$67 (US$65) million in 2012/13
Significant Co-benefits	As a result of the carbon tax shift, **BC is tied with Alberta and New Brunswick for the lowest corporate tax rate in Canada, increasing competitiveness**. It also has the lowest personal income tax rate in Canada, for those earning up to CD$119,000 (US$115,020) [198]

[195] Ibid.
[196] Sustainable Prosperity. British Columbia Carbon Tax Review. September 2012. Accessed August 2013 at: http://www.sustainableprosperity.ca/dl891&display
[197] British Columbia Ministry of Finance. June Budget Update – 2013/14 to 2014/15, Carbon Tax Review. 2013. Accessed August 2013 at: http://www.fin.gov.bc.ca/tbs/tp/climate/Carbon_Tax_Review_Topic_Box.pdf
[198] Elgie and McClay. BC's Carbon Tax Shift After Five Years: Results, An Environmental (and Economic) Success Story. (July 2013). Accessed August 2013 at: http://www.sustainableprosperity.ca/article3685

8 Low Carbon Fuel Standard Detailed Overview

<table>
<tr><th>Policy Definition</th><th>Targeted Sector or Emissions</th></tr>
<tr><td>And LCFS mandates a reduction in the carbon intensity of the transportation fuel mix, on average, over time, considering the entire lifecycle of the fuel. The potential action for consideration in this case is the implementation of a Low Carbon Fuel Standard constituting a 10 percent reduction in the carbon intensity of the fuel mix over a 10 year time period in the State of Washington.</td><td>Transportation</td></tr>
<tr><th colspan="2">GHGs and Costs</th></tr>
<tr><td colspan="2">• California: Total costs, including production, storage, transport and dispensing for various alternative fuels range from $1.4/GGE (cellulosic ethanol) to $7.2/GGE (hydrogen).[199] California ARB estimates GHG reductions in 2020 of 15,800,000 from direct combustion of transportation fuels (in 2020) and 22,900,000 from the full fuel lifecycle (in 2020).[200]
• Oregon: While costs were not estimated for the Oregon LCFS program, the volume of reductions from the program is expected to range from 2,189,000 to 2,285,000 (in 2022).[201]</td></tr>
<tr><th colspan="2">Implementation Issues and Lessons Learned</th></tr>
<tr><td colspan="2">• There may be legal challenges to implementing an LCFS at state as opposed to federal level, as evidenced by the current litigation surrounding California's LCFS.
• Sector exemptions should be carefully considered, such as those included in the California LCFS program. The California LCFS does not cover military activity, the racing industry, the aviation industry, marine fuels, or locomotive fuels.[202] Of important consideration to Washington will be the marine fuel exemption, which will affect the Washington State Ferries.</td></tr>
<tr><th>Costs and Benefits to Consumers</th><th>Costs and Benefits to Businesses</th></tr>
<tr><td>• Fuel prices may fluctuate, based on fuel prices, development of refining capacity for in-state biofuel production or purchase out-of-state alternative fuels, among other factors
• EVs and AFVs are more expensive upfront than traditionally fueled base vehicles. These costs can be largely made up through Federal and state tax</td><td>• Shifts away from petroleum-based fuels (gasoline and diesel) will have negative impacts on businesses involved in oil production, refining and transportation
• Significant increases in biofuel production will positively impact the farming and agricultural sectors of the economy, with</td></tr>
</table>

[199] Baral, A. International Council on Clean Transportation. *Summary Report on Low Carbon Fuel-Related Standards*. (October 2009). Page 11. Accessed July 2013 at: http://www.theicct.org/sites/default/files/publications/ICCT_LCFS_workingpaper_Oct09.pdf (page 11)
[200] California Air Resources Board (CARB). *Proposed Regulation to Implement the Low Carbon Fuel Standard: Volume I: Staff Report: Initial Statement of Reasons*. (March 2009). Page VII-5. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf
[201] Oregon Department of Environmental Quality. *HB 2186: Oregon Low Carbon Fuel Standards and Truck Efficiency*. (March 2013). Page 234. Accessed July 2013 at: http://www.deq.state.or.us/pubs/legislativepubs/2013/HB2186LegRpt2013.pdf
[202] California Air Resources Board (CARB). Final Regulation Order. Subchapter 10. Climate Change. Article 4. Regulations to Achieve Greenhouse Gas Emission Reductions. Subartible 7. Low Carbon Fuel Standard. Section 95480.1(d) Exemption for Specific Applications (Page 3). http://www.arb.ca.gov/fuels/lcfs/CleanFinalRegOrder112612.pdf

credits and over the term of ownership through lower fuel prices.[203]	additional demand for fuel feedstock • Shifts toward natural gas or electricity produced in-state will have positive impacts on businesses involved in those industries

A low carbon fuel standard (LCFS) requires a reduction in the carbon intensity of the transportation fuel mix, on average, over time, considering the entire lifecycle of the fuel. The lifecycle of petroleum-based fuels includes the GHG emissions associated with crude recovery, crude transportation, fuel production, fuel transportation, and end use of the fuel in motor vehicles. The regulated entities tend to be fuel producers and importers who sell motor gasoline and diesel fuel. The most common method for generating the credits required for compliance is the use of ethanol, followed by, to a lesser extent, natural gas and bio-based gases, biodiesel, and electricity.[204]

California and British Columbia have implemented LCFS, Oregon has an existing LCFS that is scheduled to "sunset" in 2015, and Washington has considered implementing an LCFS in the past, including in response to an executive order from then-Governor Christine Gregoire in 2009 to investigate the potential for use of LCFS. If Washington joins California and British Columbia in implementing an LCFS, and if Oregon's LFCS is renewed, the western U.S. and Canada will have developed a "clean fuels" region of harmonized policies and market signals that could serve as an example for broader implementation, potentially at a national level. In 2007, the Washington State Climate Advisory Team's Transportation Sector Technical Work Group estimated that a Low Carbon Fuel Standard that includes a 10 percent carbon intensity reduction by 2020 would result in 15.2 million metric tons CO_2e cumulative emission reductions from 2008 to 2020 at a cost of \$119/mtCO_2e.[205]

At a national level, Congress has adopted a renewable fuels standard (RFS) under the Energy Independence and Security Act (EISA), which requires fuel providers to gradually increase the amount of biofuel in their products through 2022 (both cellulosic and biomass-based, though there are separate targets for each). The goals of an RFS and an LCFS are interrelated, but different, as are their structures. An RFS is explicitly targeted at increasing the supply of renewable fuels, and is generally prescriptive about the fuels that can be used for compliance. An LCFS on the other hand, provides a market mechanism that may be met through the use of renewable fuels, but is not prescriptive about which fuels must be used or to what extent. GHG

[203] Mello, T. B. Ownership costs of traditional versus alternative fuel vehicles: Department of Energy calculator breaks down pricing. Autoweek. February 4, 2013. Accessed September 2013 at: http://www.autoweek.com/article/20130204/carnews/130209970

[204] UC Davis Institute of Transportation Studies, *Status Review of California's Low Carbon Fuel Standard*, S.Yeh, J. Witcover, J. Kessler, Spring 2013, p. 1

[205] Washington State Climate Advisory Team Transportation Policy Option Descriptions. *Transportation Sector Technical Work Group Policy Option Recommendations*. (December 2007). Accessed July 2013 at: http://www.ecy.wa.gov/climatechange/interimreport/122107_TWG_trans.pdf

reductions associated with improved fossil fuel production pathways are as equally legitimate in the context of an LCFS as GHG reductions associated with the use of renewable or alternative fuels. Currently, there is no national LCFS, and studies have returned conflicting results on the potential impacts of implementing such a policy. A national study was conducted by the National LCFS Project in 2010, which included technical analysis and policy design recommendations for establishing an LCFS in the United States.[206] The findings of the study indicated that implementing a national LCFS would reduce petroleum consumption and lower fuel prices for consumers, reduce crop prices for fuel production due to a shift toward cellulosic crops, and reduce national and global GHG emissions.[207] Conversely, in 2010, Charles River Associates found that implementing a national LCFS would cause damaging price shocks in the immediate term due to the limited availability of alternative fuels to meet suggested standards. The resulting economic shock would cause a loss of jobs, reduce household purchasing power, reduce investment, and impact regional and national GDP, according to the analysis. [208] Further discussion of a LCFS policy is included in the Task 3 report on Federal policies.

8.1 Existing Policies

This section summarizes low carbon fuel standards implemented in other jurisdictions. The following programs are included:

The California Air Resources Board Low Carbon Fuel Standard Program: Established under California Assembly Bill (AB) 32 and Governor Schwarzenegger's 2007 Executive Order S-01-07, the California LCFS is a performance-based measure that aims to cut the carbon intensity of transportation fuels by at least 10 percent by 2020.[209] Under the standard, which ARB began implementing in 2010, carbon intensity is measured in grams of CO_2 equivalent per mega-Joule (gCO_2e/MJ), and fuel providers must demonstrate that their fuel mix meets the LCFS standards for each annual compliance period through a system of "credits" and "deficits" whereby the carbon intensity of a particular fuel in the portfolio is either lower than or higher than the standard for gasoline or diesel, respectively.[210] These intermediate targets are set from a baseline carbon intensity for the fuel mix supplied to the state, with a declining average carbon

[206] National Low Carbon Fuel Standard Project. Accessed July 2013 at: http://nationallcfsproject.ucdavis.edu/

[207] National Low Carbon Fuel Standard Project. National Low Carbon Fuel Standard Technical Analysis Report. (July 19, 2012). Page 6. Accessed July 2013 at: http://nationallcfsproject.ucdavis.edu/files/pdf/2012-07-nlcfs-technical-analysis-report.pdf

[208] Montgomery, D., et. al. *Economic and Energy Impacts Resulting from a National Low Carbon Fuel Standard*. Charles River Associates. (June 2010). Pages 2-3. Accessed July 2013 at: http://www.dec.ny.gov/docs/administration_pdf/cra.pdf

[209] California Assembly Bill 32, Chapter 488. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/ab32.pdf, and California Office of the Governor, Executive Order EO S-01-07. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/eos0107.pdf

[210] California Air Resources Board. *Low Carbon Fuel Standard 2011 Program Review Report*. (December 8, 2011). Page 23. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/workgroups/advisorypanel/20111208_LCFS%20program%20review%20report_final.pdf

intensity over time. The performance-based nature in the California LCFS allows for flexibility, as regulated entities can incorporate new or improved technologies into existing production pathways, or develop new production pathways to reduce the carbon intensity of their fuel mix. In addition, credits may be banked and traded on the LCFS market to realize compliance. The California LCFS accounts for emissions associated with both direct and indirect land use change in its development of lifecycle carbon intensities.

There have been several court challenges to the California LCFS regarding the potential impact of the regulation on agricultural and ethanol production practices in other states, challenging that the regulation unfairly impacts out-of-state producers and therefore regulates conduct outside of California. On December 29, 2011, the U.S. District Court for the Eastern Division of California found that the regulation violated the Interstate Commerce Clause of the U.S. Constitution, and further that ARB had failed to establish that there are no alternate means of reaching GHG goals.[211] On April 23, 2012, the U.S. Court of Appeals for the Ninth Circuit granted a stay of injunction while ARB appeals the injunction, which allows ARB to enforce the LCFS program until the appeal is resolved.[212] On June 6, 2013 California's Fifth Court of Appeals issued a provisional ruling in the case of *POET, LLC vs. California Air Resources Board, et al.*, which charged that the LCFS was implemented without adequate study of environmental impacts.[213] In the latest action as of the drafting of this document, the court has allowed ARB to proceed with the existing regulation but has provided formal direction for addressing the concerns raised by the lawsuit.[214]

Oregon Low Carbon Fuel Standard Program: The Oregon LCFS was authorized in 2009 under House Bill 2186, and includes a mandate to cut carbon intensity in cars and trucks by 10 percent per gallon by 2025. During the program design process, safeguards such as exemptions, deferrals, and periodic program reviews, to protect producers, consumers and regulated parties from unintended negative consequences, such as increased prices were included as important topics to address.[215]

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[211] Green Car Congress. *Federal Judge Rules California Low Carbon Fuel Standard Violates Commerce Clause of US Constitution*. (December 30, 2011). Accessed July 2013 at: http://www.greencarcongress.com/2011/12/lcfs-20111230.html

[212] Stoel Rives, LLP. *Energy Law Alert: California Permitted to Enforce Low Carbon Fuel Standard Pending Appeal*. (April 30, 2012). Accessed July 2013 at: http://www.stoel.com/showalert.aspx?Show=9482

[213] The Court of Appeal of the State of California for the Fifth Appellate District. *POET, LLC et al. v. California Air Resources Board et al.* (June 3, 2013). Accessed July 2013 at: http://www.edf.org/sites/default/files/5th%20appelate%20LCFS%20ruling%206.3.13.pdf

[214] Voegele, E. *Court Rules California's LCFS Will Remain in Effect*. Biomass Magazine. (June 6, 2013). Accessed July 2013 at: http://biomassmagazine.com/articles/9068/court-rules-californias-lcfs-will-remain-in-effect/

[215] Oregon Department of Environmental Quality. Oregon Low Carbon Fuel Standards Advisory Committee Process and Program Design. (January 25, 2011). Pages 101-104. Accessed July 2013 at: http://www.deq.state.or.us/aq/committees/docs/lcfs/reportFinal.pdf

HB 1286 contains a sunset provision that would effectively end the LCFS in 2015 unless the legislature votes to override the provision. As of a state Senate vote on July 8, 2013, the LCFS will be allowed to expire in 2015, but the topic may be heard for reconsideration at a short session of the Senate in February 2014.[216] The Oregon Department of Environmental Quality never moved to implement the standards because of the sunset date.

British Columbia Renewable and Low Carbon Fuel Requirements Regulation: British Columbia's LCFS, which was established under the province's Greenhouse Gas Reduction Act (SBC 2008, Chapter 16), applies to all fuels used for transportation in British Columbia, and includes a target of a 10 percent reduction in carbon intensity in those fuels by 2020.[217] Transportation fuel suppliers calculate a weighted average carbon intensity for their fuel mix, and there is currently no credit/deficit trading system for trading allowances, though the regulation allows for 'notional transfers' of emissions among suppliers.[218] British Columbia's LCFS includes only emissions from direct land use change in its development of lifecycle carbon intensities.

Because of regulatory structure, there is a concern that the policy may reduce the use of crudes (such as Canadian oil sands) within the LCFS jurisdiction, but these crudes may still be used elsewhere to produce fuel (with added emissions from additional transportation).[219]

European Union Fuel Quality Directive: The European Union's Fuel Quality Directive was established in 2009 under Directive 2009/30/EC, and requires the GHG intensity of transportation fuels, specifically petroleum, diesel and biodiesel, to be reduced by up to 10 percent by 2020. The policy includes a binding 6 percent reduction in the GHG intensity of these fuels by 2020 for fuel suppliers, with intermediate targets of 2 percent by 2014 and 4 percent by 2017; the remaining 4 percent of the 10 percent target is non-binding, and contingent upon the development of new technologies such as carbon capture and storage (additional 2 percent reduction on the 10 percent target), and the purchase of credits through the Clean Development Mechanism (CDM) (additional 2 percent reduction on the 10 percent target).[220] The EU is

[216] Zheng, Y. The Oregonian. *Oregon Senate rejects 'clean fuels' bill, a top priority for environmental lobby*. (July 6, 2013). Accessed July 2013 at: http://www.oregonlive.com/politics/index.ssf/2013/07/oregon_senate_rejects_clean_fu.html#incart_river; and Greenwire. E&E Publishing. *State Senate rejects clean fuels bill*. (July 8, 2013). Accessed July 2013 at: http://www.eenews.net/greenwire/2013/07/08/stories/1059983987

[217] British Columbia Ministry of Energy and Mines. *Renewable & Low Carbon Fuel Requirements Regulation*. Accessed July 2013 at: http://www.empr.gov.bc.ca/RET/RLCFRR/Pages/default.aspx

[218] Natural Resources Defense Council. *A Comparison of California and British Columbia's Low Carbon Fuel Standards*. (March 2010). Page 4. Accessed July 2013 at: http://climateactionnetwork.ca/archive/webyep-system/program/download.php?FILENAME=53-31-at-PDF_File_Upload_1.pdf&ORG_FILENAME=BC_and_CA_fuel_standard_comparison_FINAL.pdf

[219] Natural Resources Defense Council. March 2010.

[220] European Commission. *Fuel Quality*. Accessed July 2013 at: http://ec.europa.eu/clima/policies/transport/fuel/index_en.htm

currently reviewing the potential to include indirect land use change from biofuels in its Directive.

Of these four programs the following sections present results for the California LCFS and the Oregon LCFS. As WCI partners, and with programs that have sufficient centralized program structure and detailed documentation, these programs were deemed most appropriate for use by Washington.

8.2 GHG Impacts

The volume of GHG emissions reductions ranges depending on the quantity of fuel consumed in the state and on the target set for the LCFS; one-year (2020) estimates from California indicate up to a 22.9 $MMTCO_2e$ reduction from the full fuel life cycle, while one-year (2022) estimates from Oregon indicate up to 2.3 $MMTCO_2e$ reduction. Both programs are in relatively early stages of implementation and have faced significant challenges to program implementation and endurance. Table 21 summarizes the available GHG-related information for the California and Oregon programs.

Table 21: GHG Costs and Benefits of Example LCFS Programs

California	
Cost of Reductions	**Total costs, including production, storage, transport and dispensing for various alternative fuels range from \$1.4/GGE (cellulosic ethanol) to \$7.2/GGE (hydrogen)**[221] The California Electric Transportation Coalition is currently undertaking a comprehensive economic study to understand the Program's macroeconomic impacts.[222]
Volume of Reductions	**15,800,000 $mtCO_2e$ from direct combustion of transportation fuels (in 2020)** **22,900,000 $mtCO_2e$ from the full fuel lifecycle (in 2020)**[223]

[221] Baral, A. International Council on Clean Transportation. *Summary Report on Low Carbon Fuel-Related Standards*. (October 2009). Page 11. Accessed July 2013 at: http://www.theicct.org/sites/default/files/publications/ICCT_LCFS_workingpaper_Oct09.pdf (page 11)

[222] California Electric Transportation Coalition. *California's Low Carbon Fuel Standard: Compliance Outlook for 2020*. (Phase I report). (June 2013). Accessed July 2013 at: http://www.caletc.com/wp-content/downloads/LCFSReportJune.pdf (Phase II will include macroeconomic modeling which will include (1) changes in gross state/regional product, (2) changes in employment and income, (3) changes in total economic production, and (4) inter-industry and aggregate impacts.

[223] California Air Resources Board (CARB). *Proposed Regulation to Implement the Low Carbon Fuel Standard: Volume I: Staff Report: Initial Statement of Reasons*. (March 2009). Page VII-5. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf

Programmatic Status	The program is in the early stages of implementation, and faces ongoing litigation. Costs and benefits of the program will be better understood over time. However, reports have found that the LCFS is on target and is encouraging technological innovation through private investment.[224]
Emissions Leakage	None noted.
Oregon	
Cost of Reductions	None noted.
Volume of Reductions	**2,189,000 to 2,285,000 mtCO_2e (in 2022)**[225]
Programmatic Status	The program has been designed but not implemented as of 2013 because of the pending "sunset" date in 2015
Emissions Leakage	None noted.

8.3 Energy and Economic Impacts

Table 22 summarizes the available energy and economic impact information for the California and Oregon LCFS programs. Ex post data to evaluate the impact of the LCFS in California is not yet available. However, in analyzing the costs and benefits of its LCFS policy, California ARB assumed that future fossil fuel costs would be unchanged, and that net benefits of up to $0.08 per gallon may accrue. However, a study by Boston Consulting Group estimated that implementation of California LCFS would result in increased costs to industry requiring cost recovery of $0.33 to $1.06 per gallon. [226] A subsequent analysis by the UC Davis Policy Institute, however, concluded that the BCG report was too narrow in scope (looked solely at the refining sector), and included a variety of problematic assumptions.[227] Additionally, BCG's cost estimates reflect a compliance pathway where fossil fuel providers are forced to purchase LCFS credits from producers of low carbon fuels. As such, these costs represent a wealth transfer within the economy, and not a net cost to the State.

[224] California Electric Transportation Coalition. Rapid Developments in Alternative Fuels Surpassing Expectations. (Press Release June 13, 2013). Accessed July 2013 at: http://www.caletc.com/wp-content/downloads/LCFSReportJunePressRelease.pdf

[225] Oregon Department of Environmental Quality. *HB 2186: Oregon Low Carbon Fuel Standards and Truck Efficiency*. (March 2013). Page 234. Accessed July 2013 at: http://www.deq.state.or.us/pubs/legislativepubs/2013/HB2186LegRpt2013.pdf

[226] Boston Consulting Group. 2012. Understanding the impact of AB 32. Accessed September 2013 at: http://cafuelfacts.com/wp-content/uploads/2012/07/BCG_report.pdf

[227] UC Davis Policy Institute for Energy, Environment and the Economy. 2013. Expert Evaluation of the Report: "Understanding the Impacts of AB32". Accessed September 2013 at: http://policyinstitute.ucdavis.edu/files/general/pdf/2013-05-09_Expert-Evaluation-of-BCG-Report.pdf

Table 22: Energy and Economic Impacts of Example LCFS Programs

California	
Independence from Fossil Fuels, and Economic Impact	Fossil fuel use will be reduced through increased use and production of biofuels. **This reduced use would produce an overall savings in the state of $11 billion over the 10-year period ($0 - $0.08 per gallon)**[228] No estimated fiscal impact for the first three years**, but potential loss of annual state tax revenue of $80-$370 million in 2020 from lost transportation-fuel taxes, including excise and sales taxes**, depending on the compliance paths chosen [229]
Impacts on Fuel Choice	ARB Staff determined that the LCFS will not significantly impact transportation fuel price or supply.[230]
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	The state estimated that **24 biorefineries** will be constructed as a result of the policy, including both cellulosic ethanol and biodiesel/renewable diesel facilities.[231]
Impact on Different Sectors of the Economy	Expected to generate investment in low-carbon ethanol, biodiesel, renewable diesel, biogas, and natural gas facilities along with investment in alternative vehicle technologies. Costs to oil industry associated with LCFS credit purchase. These may translate to benefits to low carbon fuel providers. Industries involved in the movement of goods, including the trucking industry, have cited potential increases in fuel costs as concern for revenue and employment.[232]
Oregon	
Independence from Fossil Fuels, and Economic Impact	Macroeconomic modeling analysis, sponsored by the Oregon DEQ and conducted during the Advisory Committee process, concluded that an OR LCFS would have significant positive economic effects, unless all low carbon fuel production occurred out of state.
Impacts on Fuel Choice	An LCFS incentivizes the use of lower-carbon fuels, such as biofuels, CNG, LNG, and alternative energy to achieve mandates. The macroeconomic model scenario projection generating the largest positive impact anticipated significant investment in new infrastructure for electricity and compressed natural gas.[233]

[228] ARB March 2009. Page ES-26. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf
[229] Ibid.
[230] Ibid.
[231] Ibid.
[232] California Trucking Association. *The Impact of the Low Carbon Fuel Standard and Cap and Trade Programs on California Retail Diesel Prices*. (April 2012). Accessed July 2013 at: http://caltrux.org/sites/default/files/CTALCFS.pdf
[233] State of Oregon Department of Environmental Quality, Oregon Low Carbon Fuel Standards Advisory Committee Process and Program Design, Final Report, January 25, 2011, Accessed July 2013 at http://www.deq.state.or.us/aq/committees/docs/lcfs/reportFinal.pdf

Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	**Creates 800-29,000 jobs over 10 years, increasing income in Oregon between $60 and $2,630 million over 10 years.**[234] Overall, the six scenarios modeled in the analysis sponsored be the Oregon DEQ involving in-state production of biofuels (A through C and E through G) have fairly similar GSP impacts, ranging from approximately $900 million to about $1.25 billion in additional economic activity.[235]
Impact on Different Sectors of the Economy	**Macro-economic modeling sponsored by the Oregon DEQ showed that each of the following saw at least $50 million in additional volume** (output and value added) in at least one modeling scenario:[236] • Construction • Real Estate • Wholesale Trade • Professional Services • Healthcare • Banking • Waste Management • Administrative Services Further, the DEQ-sponsored macroeconomic assessment found that "no one of these nine specific sectors modeled in this analysis saw significant negative impacts as a result. Also, no sector was projected to experience negative impacts of a size on the scale of the positive impacts identified in these nine."[237]

8.4 Household Impacts and Co-Benefits

Under an LCFS, fossil fuel use will be reduced through increased use and production of biofuels, and production of biofuels may stimulate the local economy. Drawbacks may occur with impacts of crop use on agricultural resources and increased water consumption associated with crop production for biofuel use. Table 23 summarizes the available household impact and co-benefit information for the California and Oregon LCFS programs.

[234] Jack Faucett Associates, Inc. Economic Impact Analysis of the Low-Carbon Fuel Standard Rule for the State of Oregon, Prepared for the Oregon Department of Environmental Quality, 11-AQ-004d, January 2011. Accessed August 2013 at http://www.deq.state.or.us/aq/committees/docs/lcfs/appendixDeconimpact.pdf
[235] Jack Faucett Associates, Inc. Page 30. January 2011
[236] Jack Faucett Associates, Inc. Page 32-33. January 2011.
[237] Jack Faucett Associates, Inc. Page 32. January 2011.

Table 23: Household Impacts and Co-Benefits of Example LCFS Programs

California	
Effect on Household Consumption and Spending	As crop-based biofuel production increases, there will be a competing pressure on fuel prices, which may cause upward pressure on food prices[238] **In its initial statement of reasons, ARB estimated that the policy would result in a net savings over the life of the policy, which would amount to a ($0 - $0.08 per gallon) savings if passed entirely to the consumer.** ARB acknowledged that the savings are highly dependent on the future price of fossil fuels, availability of lower-carbon intensity fuels, and the economic recovery.[239]
Measures to Mitigate to Low-income Populations, or Economic Impact	Program includes safeguards such as exemptions, deferrals, and periodic program reviews, to protect producers, consumers and regulated parties from unintended negative consequences, such as increased prices.[240]
Significant Co-benefits	Reduced particulate matter emissions from diesel.[241] Drawbacks to the program may include:[242] • Increased water consumption associated with Biofuel production • Impacts on agricultural resources Impacts on biological resources with new construction
Oregon	
Effect on Household Consumption and Spending	None noted.
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted.
Significant Co-benefits	Domestic and in-state production of replacement fuels stimulates economy[243]

[238] CARB March 2009. Page ES-29. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf
[239] ARB March 2009. Page ES-26. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf
[240] Oregon Department of Environmental Quality. Oregon Low Carbon Fuel Standards: Advisory Committee Process and Program Design. (January 25, 2011). Pages 101-104. Accessed July 2013 at: http://www.deq.state.or.us/aq/committees/docs/lcfs/reportFinal.pdf
[241] CARB March 2009. Page ES-24. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf
[242] CARB March 2009. Page VII 25-28. Accessed July 2013 at: http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf
[243] Oregon DEQ (January 2011). Page 16.

9 Road Usage Pricing Policies (Cordon and Toll)

Policy Definition	Targeted Sector or Emissions
Road usage charge policies impose direct charges for the use of a roadway or roadways, with various goals for pricing approaches. Goals may include revenue generation or incentivizing behavioral changes such as use of alternative routes or modes of transportation shift, avoiding travel at congested times of the day, or foregoing travel altogether. These policies are often implemented with the primary objective of generating revenue or reducing congestion during off -peak hours, but have the co-benefit of some net reduced vehicle miles traveled (VMT), which limits fuel used for passenger motor vehicle travel and GHG emissions from transportation. Pricing mechanisms may include tolls, cordon pricing, congestion charge zones, or charges on certain vehicle classes.	Transportation

GHGs and Costs

- Pricing strategies to reduce VMT are often implemented as revenue generation and congestion relief policies, with GHG reduction as an ancillary benefit. All of the program data for the Road Usage Pricing Programs of focus in other jurisdictions (tolls and cordon areas) indicated that they were generally successful and generated revenue, though there has been some evidence of traffic leakage onto surrounding, un-priced roads.

Implementation Issues and Lessons Learned

- Depending on pricing implementation, potential to disproportionately impact low income users; mitigation for impacts should be considered
- When considering road pricing options, the potential to limit mobility for non-discretionary users (freight and trucking industry, businesses using the highway system to provide goods and services), should be mitigated

Costs and Benefits to Consumers	Costs and Benefits to Businesses
• Congestion relief • Decrease in travel times • Decrease in traffic accidents due to reduced number of vehicle trips • Toll prices are direct costs to Washington travelers • Consumer cost savings are case-specific, and will depend on the amount of travel, among other factors • Depending on pricing implementation, potential to disproportionately impact low income users; mitigation for impacts should be considered • Revenue raised increases the State's ability to maintain, operate and expand the transportation system	• Potential adverse impact on sales for some city-center retailers (for cordon policies), though the net impact is expected to be negligible[244] • Revenue raised increases the State's ability to maintain, operate and expand the transportation system

[244] Danna, et. al. *A Benefit-Cost Analysis of Road Pricing in Downtown Seattle*. Evans School Review. Vol. 2, Num. 1, Spring 2012. Page 37.Accessed September 2013 at: https://depts.washington.edu/esreview/wordpress/wp-content/uploads/2012/12/ESR-2012-A-Benefit-Cost-Analysis-of-Road-Pricing-in-Downtown-Seattle.pdf

9.1 Existing Policies

This section analyzes existing policies implemented in other jurisdictions related to road usage pricing policies. The following programs are included:

London Congestion Pricing: Since 2003, the city of London has charged a congestion fee based on location and time of day, the first of its kind in a European city.[245] The fee applies in central London on weekdays, with private motorists required to pay a flat rate between the hours of 7:00 am and 6:30 pm for entering the charge area. Motorcycles, licensed taxis, disabled persons, some AFVs, buses, and emergency vehicles are given exemptions, and area residents receive a 90 percent discount on the fee. Payments are made at retail establishments, payment machines, the internet, and by telephone messaging, and vehicle users can purchase weekly, monthly, or annual passes at discounts up to 15 percent.[246]

A 2011 study by the Victoria Policy Institute notes several areas in which the system could be improved: fees could be adjusted based on the number of miles driven within the charging area, fees could be time-variable (highest during the most congested hours), fees could vary by congestion (highest on the most congested roads), overhead costs are high for the London system, and alternate forms of public transportation (namely, the subway system the Tube) could be further supplemented by additional bus service.[247]

Stockholm: From January through August 2006, the city of Stockholm implemented a cordon zone pilot project to test its potential as a road congestion reduction policy proposal. [248] The trial included variable pricing based on the time of day, with fees ranging from 10 SEK to 20 SEK (about US$1.50 to US$3.00) between the hours of 6:30 am to 6:30 pm.[249] The city's central business district is a 24 square mile zone through which 450,000 cars pass daily.[250] Tracking was implemented by IBM, which designed and operated a fully-automated charging system using advanced optical recognition and radio frequency identification (RFID) technologies.[251] Fees varied based on time of day, and could be paid through a variety of mechanisms, including purchase at retail establishments, kiosks, and direct withdrawal from the driver's bank account.

Los Angeles HOT Lane Pilot on the I-110 and I-10 Freeway: In November 2012, the city of Los Angeles, California began a one-year pilot HOT road on 11 miles of formerly high

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[245] Litman, T. Victoria Transport Policy Institute. *London Congestion Pricing*. (November 24, 2011). Accessed July 2013 at: http://www.vtpi.org/london.pdf

[246] Litman, T., pages 2-3.

[247] Litman, T., page 4.

[248] Eliasson, J. *Lessons From the Stockholm Congestion Charging Trial.* Centre for Transport Studies, Royal Institute of Technology. Page 8. Accessed July 2013 at: http://vianordica2008.vegagerdin.is/vetenskapligt_webb/Tisdag/Session3_sal3A/Eliasson2.pdf

[249] Eliasson, J., Page 8.

[250] IBM. *Swedish Road Administration Breaks the Gridlock with a Smart Road Use Management System*. (2005). Page 2. Accessed July 2013 at: ftp://ftp.software.ibm.com/software/solutions/pdfs/ODB-0150-00.pdf

[251] IBM, Page 1.

occupancy vehicle (HOV) roads on the 110 Freeway. Prices on the road range from $0.25 to $1.49 per mile depending on the time of day or amount of traffic.[252] In February 2013, a 14 mile stretch of road on the I-10 was converted to HOT lanes.[253] The pilot was implemented to reduce congestion and improve travel time for commuters. Los Angeles Metro issued its second performance report in July of 2013, with the first issued in March 2013, though an independent evaluation of the program's effectiveness will not be issued until mid-2014.[254]

9.2 GHG Impacts

Road usage pricing policies are often implemented as revenue generation and congestion relief policies, with GHG reduction as a co-benefit. Charging fees in congested areas or during peak travel times incentivizes drivers to limit trips or utilize alternate transportation.

GHG benefits are associated with the reduced VMT that these policies achieve through drivers limiting their number and distance of trips, and using alternate modes of transportation as a result of the policy. No studies were found that listed GHG benefits as the primary cause for implementing a road usage pricing policy, but the reduced VMT achieved through such policies inherently reduce GHG emissions. All of the program data indicated that they were generally successful and generated revenue, though there has been some evidence of traffic leakage onto surrounding, un-priced roads. Table 24, below, further summarizes the available GHG-related information for the London, Stockholm, and Los Angeles programs.

Table 24: GHG Costs and Benefits of Example Road Usage Charge Cordon Programs

London	
Cost of Reductions	The program was **estimated to cost £100 million (around US$155 million) per operating year for the first five years**, including startup costs (£36 million or about US$55 million) and operating costs (£64 million or about US$100 million). The program **was estimated to generate £160 million (about US$250 million)** in revenue (including charge and penalty revenue).[255]

[252] Los Angeles News. *110 Freeway Toll Lanes Open for Business*. (November 10, 2012). Accessed July 2013 at: http://abclocal.go.com/kabc/story?section=news/local/los_angeles&id=8879676
[253] Los Angeles Metro. Accessed July 2013 at: http://www.metro.net/projects/expresslanes/
[254] Hymon, S. *Metro releases latest report with preliminary data on ExpressLanes' performance on 10 and 110 freeways*. The Source. (July 22, 2013). Accessed July 2013 at: http://thesource.metro.net/2013/07/22/metro-releases-latest-report-with-preliminary-data-on-expresslanes-performance-on-10-and-110-freeways/comment-page-2/
[255] Litman, T. Victoria Transport Policy Institute. *London Congestion Pricing*. (November 24, 2011). Page 5. Accessed July 2013 at: http://www.vtpi.org/london.pdf (page 5). Using exchange rate of 1£ = 1.56 US$.

Volume of Reductions	Emission reductions are not discussed – the program was implemented for revenue generation and congestion reduction.
Programmatic Status	The program is considered effective. **A 2011 study estimated that 110,000 motorists a day pay the charge (98,000 individual drivers and 12,000 fleet vehicles), increasingly by mobile phone text message.**[256]
Emissions Leakage	At the onset of the program, there was concern for traffic spillover onto surrounding roads. There has been 10 percent more traffic on peripheral roads, but this can be mitigated by expanding the pricing area and charging variable fees in the future.[257]
Stockholm	
Cost of Reductions	**Estimated €84 million (about US$110 million) generated annually** if the trial had continued to be implemented[258]
Volume of Reductions	CO_2 emissions fell by a small percentage of total Stockholm emissions[259] The number of vehicle miles driven in the inner city declined by 15 percent. [260]
Programmatic Status	**There was a 20-25 percent reduction in traffic in the charged area during charges hours**. The number of vehicle miles driven in the inner city declined by 15 percent. [261]
Emissions Leakage	While some drivers used public transit, others chose to travel during off-peak (non charging) hours.[262] Off-peak travel results in fewer emissions due to less time in traffic and vehicle idling, but does not completely eliminate the emissions from vehicles.
Los Angeles HOT Lane Pilot on the I-110 and I-10 Freeway	
Cost of Reductions	$0.25 to $1.40 per mile depending on the time of day and amount of traffic. Estimated average cost for a solo driver using the HOT lanes is $15 per trip.[263] Carpoolers do not pay tolls, but must pay for transponders. **Preliminary toll revenue for the first six months of the I-110 and the first four months of the I-10 was $6,966,484.**[264]
Volume of Reductions	Reduction in GHGs is one of the key metrics that the pilot will be formally evaluated on in accordance with the federal grant[265] None analyzed to date.

[256] Litman, T., page 3.
[257] Litman, T., page 9.
[258] IBM. *Swedish Road Administration Breaks the Gridlock with a Smart Road Use Management System*. (2005). Page 4. Accessed July 2013 at: ftp://ftp.software.ibm.com/software/solutions/pdfs/ODB-0150-00.pdf
[259] Eliasson, J. Lessons From the Stockholm Congestion Charging Trial. Centre for Transport Studies, Royal Institute of Technology. Page 16. Accessed July 2013 at: http://vianordica2008.vegagerdin.is/vetenskapligt_webb/Tisdag/Session3_sal3A/Eliasson2.pdf (Page 16)
[260] Eliasson, J., Page 14.
[261] Eliasson, J., Page 14.
[262] IBM. *Swedish Road Administration Breaks the Gridlock with a Smart Road Use Management System*. (2005). Page 4. Accessed July 2013 at: ftp://ftp.software.ibm.com/software/solutions/pdfs/ODB-0150-00.pdf
[263] Nelson, L. *Traffic zips in toll lanes, but slows in free lanes*. Los Angeles Times. (April 9, 2013). Accessed July 2013 at: http://articles.latimes.com/2013/apr/09/local/la-me-toll-lane-analysis-20130410
[264] https://www.metroexpresslanes.net/en/about/ExpressLanes_Performance_Update_20130719.pdf Page 5
[265] https://www.metroexpresslanes.net/en/about/ExpressLanes_Performance_Update_20130719.pdf Page 3

Programmatic Status	Six months of data are available for the I-110 HOT lanes, and two months of data are available for the I-10 HOT lanes. The program shows increased use of public transit, higher average speeds in the toll lanes than in general traffic lanes and is generating revenue.
Emissions Leakage	None noted.

9.3 Energy and Economic Impacts

As discussed, the economic reasons for implementing a road usage pricing policy are to reduce traffic in highly congested areas and generate revenue. No cases of fuel switching were cited, as the type of fuel used in a vehicle has no impact on the fee assessed, and reductions in fuel used are achieved through reduced VMT associated with the programs.

There were mixed expectations for the impact of the programs on businesses and the economy, with some positive expectations of revenue generation stimulating the economy and funding road construction and maintenance, and some skepticism surrounding whether road pricing would affect businesses in the affected areas. Table 25, below, further summarizes the available energy and economic impact information for the London, Stockholm, and Los Angeles cordon program and pilots.

Table 25: Energy and Economic Impacts of Example Road Usage Charge Cordon Programs

London	
Independence from Fossil Fuels, and Economic Impact	A study of the London trial found that private automobile travel in cities with alternate transportation was more price sensitive than previously believed.[266] This means that implementing a pricing policy on roadways causes a behavioral shift in travelers away from private automobile travel; reducing VMT and fossil fuel consumption.
Impacts on Fuel Choice	None noted.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	None noted.
Impact on Different Sectors of the Economy	The London Chamber of Commerce has cited the policy has adversely affected city-center retailers.[267]
Stockholm	

[266] Litman, T. Victoria Transport Policy Institute. *London Congestion Pricing*. (November 24, 2011). Page 10. Accessed July 2013 http://www.vtpi.org/london.pdf
[267] Litman, T., page 7.

Independence from Fossil Fuels, and Economic Impact	Reduced number of vehicles, traffic density and time spent in traffic reduces fossil fuel consumption.
Impacts on Fuel Choice	None noted.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	None noted.
Impact on Different Sectors of the Economy	Analysis showed no evidence that businesses inside the cordon were adversely affected by the pricing system.[268]
Los Angeles HOT Lane Pilot on the I-110 and I-10 Freeway	
Independence from Fossil Fuels, and Economic Impact	None noted.
Impacts on Fuel Choice	None noted.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	None noted.
Impact on Different Sectors of the Economy	Increased construction activity**. As part of the HOT lane project, a federal grant of $210.6 million was issues to fund 59 new clean fuel buses, security and lighting improvements at bus stations, bike lockers, the LA Express Park, the construction of a new bus station, expanded transit signal priority in downtown L.A., as well as the conversion of the HOV lanes to HOT lanes.**[269]

9.4 Household Impacts and Co-Benefits

Road usage pricing policies are generally criticized as providing preferential access to those who can afford them. To offset anticipated adverse impacts of pricing, programs have offered exceptions, such as the Lidingö exception in Stockholm for an island whose only way in or out was through a charge zone, or low income vouchers, such as those offered in London and in the Los Angeles pilot. Other options include subsidizing alternative modes of transportation, such as carpooling, vanpooling and public transit. Still, some critics argue that these measures are not enough to offset the costs, and that these policies disproportionately favor those who can afford to take advantage of the priced roads. Table 26 below, further summarizes the available household impact and co-benefit information for the London, Stockholm, and Los Angeles programs and pilots.

[268] Eliasson, J. Lessons From the Stockholm Congestion Charging Trial. Centre for Transport Studies, Royal Institute of Technology. Page 16. Accessed July 2013 at: http://vianordica2008.vegagerdin.is/vetenskapligt_webb/Tisdag/Session3_sal3A/Eliasson2.pdf

[269] https://www.metroexpresslanes.net/en/about/ExpressLanes_Performance_Update_20130719.pdf Page 3

Table 26: Household Impacts and Co-Benefits of Example Road Usage Charge Cordon Programs

London	
Effect on Household Consumption and Spending	None quantified.
Measures to Mitigate to Low-income Populations, or Economic Impact	Motorists with disabilities are exempt from payment, and residents within the priced area receive substantial discounts. Still, critics argue that the fee is double charging on top of registration and fuel taxes, and that exemptions for disabled persons and discounts for city-center residents are not available to lower income residents.[270]
Significant Co-benefits	Revenue generation and congestion relief.
Stockholm	
Effect on Household Consumption and Spending	None noted.
Measures to Mitigate to Low-income Populations, or Economic Impact	Exceptions provided for the island of Lidingö, where the only road that connected the island to the rest of Sweden runs through downtown Stockholm[271]
Significant Co-benefits	Reduced congestion. **Exposure to exhaust emissions in the inner city declined by 10-15 percent.**[272]
Los Angeles HOT Lane Pilot on the I-110 and I-10 Freeway	
Effect on Household Consumption and Spending	None noted.
Measures to Mitigate to Low-income Populations, or Economic Impact	Los Angeles County families with three or more members making less than $37,000 annually are eligible for discounts.[273] **As of July 2013, $75,000 in toll credits had been issued to 3,000 equity plans for low-income commuters.**[274] Income distribution of those using the program is relatively normal around a central $50,000-$74,900 income level:[275]
Significant Co-benefits	Reduced travel time and congestion relief for participants, revenue generation

[270] Litman, T. Victoria Transport Policy Institute. *London Congestion Pricing*. (November 24, 2011). Page 9. Accessed July 2013 http://www.vtpi.org/london.pdf
[271] Eliasson, J. Lessons From the Stockholm Congestion Charging Trial. Centre for Transport Studies, Royal Institute of Technology. Page 9. Accessed July 2013 at: http://vianordica2008.vegagerdin.is/vetenskapligt_webb/Tisdag/Session3_sal3A/Eliasson2.pdf
[272] Eliasson, J., Pages 15-16.
[273] Los Angeles News. *110 Freeway Toll Lanes Open for Business*. (November 10, 2012). Accessed July 2013 at: http://abclocal.go.com/kabc/story?section=news/local/los_angeles&id=8879676
[274] https://www.metroexpresslanes.net/en/about/ExpressLanes_Performance_Update_20130719.pdf Page 14
[275] https://www.metroexpresslanes.net/en/about/ExpressLanes_Performance_Update_20130719.pdf Page 13

10 VMT Charging and Pay-as-you-Drive (PAYD)

Policy Definition	Targeted Sector or Emissions
There are several proposed GHG policies that attempt to reduce vehicle miles traveled (VMT) by private vehicles as a result of pricing each mile driven, including a VMT fee associated with pay-as-you-drive (PAYD) insurance and VMT fees implemented as an alternative to a gas tax. These two policy types are very different in how they are implemented and to whom they apply; however as a GHG policy, both are targeting reduced VMT by putting a price on vehicle trips, so the effectiveness of either is based on the elasticity of demand from this mechanism of cost. As such, a key policy design element for GHG reductions would be to maximize the information feedback to the driver on how much each mile costs. As far as policy implementation, the policies are quite different, as one applies to private insurance companies, whereas the other applies to all drivers and is administered through an overseeing government entity or third-party government supported entity. Both of these two unique policy examples are grouped in this document because of their similarities in how they might affect GHG emissions, as discussed further below.	Transportation

GHGs and Costs

- Pricing strategies to reduce VMT are often implemented as revenue generation and congestion relief policies, with GHG reduction as an ancillary benefit. Data from MBUF program pilots have shown that VMT charges can be implemented to replace the gas tax as the principal revenue source for road funding.[276]

Implementation Issues and Lessons Learned

- Depending on pricing implementation, potential to disproportionately impact low income users; mitigation for impacts should be considered
- When considering road pricing options, the potential to limit mobility for non-discretionary users (freight and trucking industry, businesses using the highway system to provide goods and services), should be mitigated

Costs and Benefits to Consumers	Costs and Benefits to Businesses
• Congestion relief • Decrease in travel times • Decrease in traffic accidents due to reduced number of vehicle trips • Toll prices are direct costs to Washington travelers • Consumer cost savings are case-specific, and will depend on the amount of travel, among other factors • Depending on pricing implementation, potential to disproportionately impact low income users; mitigation for impacts should be considered • Revenue raised increases the State's ability to maintain, operate and expand the transportation system	• Potential adverse impact on sales for some city-center retailers (for cordon policies), though the net impact is expected to be negligible[277] • Revenue raised increases the State's ability to maintain, operate and expand the transportation system

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[276] Whitty, J. 2013. Page 45. Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUCPilotPrelimFind_Feb13.pdf

[277] Danna, et. al. *A Benefit-Cost Analysis of Road Pricing in Downtown Seattle*. Evans School Review. Vol. 2, Num. 1, Spring 2012. Page 37.Accessed September 2013 at: https://depts.washington.edu/esreview/wordpress/wp-content/uploads/2012/12/ESR-2012-A-Benefit-Cost-Analysis-of-Road-Pricing-in-Downtown-Seattle.pdf

VMT charging policies charge drivers according to the number of miles traveled. Such policies may be implemented for revenue generation and/or congestion relief, with GHG reduction as a co-benefit. As cars increasingly become more fuel efficient, state and local governments receive less revenue from the traditional fossil fuel taxes to spend on road infrastructure maintenance and development. Road usage policies are often used to tax mileage traveled to account for highly fuel efficient vehicles, or vehicles that require no fuel. In addition, road usage charges can be used as congestion relief mechanisms, charging fees in congested areas or during peak travel times to incentivize drivers to limit trips or utilize alternate transportation.

These policies can be implemented as either as a government tolling or Mileage Based User Fee (MBUF), or through the use of PAYD insurance policies, as discussed below.

Government VMT Fees: As cars increasingly become more fuel efficient, state and local governments receive less revenue from the traditional fossil fuel taxes to spend on road infrastructure maintenance and development. A MBUF can be used to tax mileage traveled rather than fuel consumed, to account for highly fuel efficient vehicles, or vehicles that require no fuel. Under government VMT programs, a fee is assessed based on the number of vehicle miles that are traveled. Often, this fee replaces the gasoline tax to generate revenue for road infrastructure maintenance and development in response to increasing fuel efficiency in vehicles which is causing declining revenues. Under this system, users are paying for their actual use of the transportation system, rather than paying based on the quantity of fuel that their vehicles consume. These programs can be as simple as a flat fee charged per mile based on odometer readings, or tiered fees based on distance, location, and other factors. Implementation can be done through various mechanisms, including pay-at-the-pump and onboard vehicle monitoring devices.

The Rocky Mountain Institute estimates that there is a nationwide potential for between a 12 and 15 percent reduction in VMT with the implementation of a VMT tax, at a present value cost (in 2009 dollars) of $168 billion for the entire country.[278]

Pay-As-You-Drive Insurance, or Usage-Based Insurance: Under PAYD insurance, the cost of insuring a motor vehicle is contingent on the type of vehicle, time, distance traveled, location, and behavior.[279,280] Pay-as-you-drive insurance is currently offered in over 35 states, including

[278] Rocky Mountain Institute. *Summary of U.S. VMT Reduction Strategies*. (2011). Accessed July 2013 at: http://www.rmi.org/RFGraph-Summary_of_US_VMT_reduction_strategies
[279] Orenstein, B. *Who's doing what? The rise of usage-based auto insurance*. Insure. (September 4, 2012). Accessed July 2013 at: http://www.insure.com/car-insurance/usage-based-insurance-update.html
[280] National Association of Insurance Commissioners and the Center for Insurance Policy and Research. *Usage-Based Insurance and Telematics*. (last updated May 29, 2013). Accessed July 2013 at: http://www.naic.org/cipr_topics/topic_usage_based_insurance.htm

Washington, in a variety of forms, through a variety of providers. “Low mileage discounts” are available in Washington State through several providers.[281]

A 2008 Brookings study found that upon implementing nationwide pay-as-you-go insurance policies for all drivers, “[…] driving would decline by 8 percent nationwide, netting society the equivalent of about $50 billion to $60 billion a year by reducing driving-related harms. This driving reduction would reduce carbon dioxide emissions by 2 percent and oil consumption by about 4 percent. To put it in perspective, it would take a $1-per-gallon increase in the gasoline tax to achieve the same reduction in driving.”[282]

Beginning in 2012, pay-as-you-go became available in Oregon.[283] Progressive Universal Insurance Co. was the pilot company in Oregon[284], with seven companies now offering it in the State.[285] The policy is voluntary, and offers the benefit of reduced insurance cost to safe or infrequent drivers (up to a 45 percent reduction, depending on driving patterns), with the tradeoff of reduced privacy (mileage and location are tracked via a GPS-enabled device that also detects erratic braking and high speeds for some insurance companies).

In March of 2012, HB 2361 was signed by the Governor of Washington, after having passed the House 73-23 and Senate 38-10, with an effective date of June 7, 2012. The bill exempts certain information on usage-based insurers (including the usage-based component of the insurance rate) and users (including names and individual identification data of the insured) from public inspection during state filings. The bill also protects the insured from having data on their location collected by the insurance company without disclosure to and consent from the insured.[286] There are no known remaining legal barriers to PAYD insurance in Washington, and therefore no actions that the State can take to encourage its use.

10.1 Existing Policies

This section analyzes Oregon’s Road Usage Charge Pilot Program, which represents a regional example of a pilot government MBUF. Following the pilots discussed below, in July 2013,

[281] Pay-As-You-Go Insurance from Onstar/National General Insurance -- Low-Mileage Discount Offered in 35 States. Accessed July 2013 at: http://www.lowmileagediscount.com/what-is-payg/lmd-states.asp
[282] Bordoff, J. and P. Noel. *Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity*. The Brookings Institution. (July 2008). Accessed July 2013 at: http://www.brookings.edu/research/papers/2008/07/payd-bordoffnoel
[283] The Sightline Institute. *Pay-As-You-Drive Car Insurance*. Accessed July 2013 at: http://www.sightline.org/research/payd/
[284] Oregon Environmental Council. *Pay-As-You-Drive Insurance*. Accessed July 2013 at: http://www.oeconline.org/our-work/climate-protection/transportation/other-transportation-solutions/payd
[285] Hunsberger, B. *Pay-as-you-drive car insurance: Trade your privacy for a price break?* The Oregonian. (March 2, 2013). Accessed July 2013 at: http://www.oregonlive.com/finance/index.ssf/2013/03/pay-as-you-go_car_insurance_tr.html
[286] Engrossed Substitute House Bill 2361. http://apps.leg.wa.gov/documents/billdocs/2011-12/Pdf/Bills/House%20Passed%20Legislature/2361-S.PL.pdf

Oregon became the only state to allow drivers to choose between a gallon-based tax and a MBUF, allowing up to 5,000 drivers to enlist in a voluntary program.[287]

State of Oregon Road Usage Charge Pilot Program: The State of Oregon Department of Transportation conducted a Road User Fee Pilot Project in 2007 in Portland,[288] and a Road Usage Charge Pilot Project in 2012.

The 2007 study involved three volunteer test groups: VMT, rush hour, and control. The VMT group was assessed a flat charge per mile driven, the rush hour group was assessed a premium on the fee in congested zones during peak times, and the control group paid the standard fuel tax throughout the 10 month trial.[289] Mileage tracking devices were fit onto all vehicles in the study, and participants used a "pay-at-the-pump" method for payment, where the devices communicated the charge to the gas pump when participants refueled their vehicles.

The 2012 study, which ran from November 2012 through February 2013, was refined based on lessons learned in the 2007 pilot, and focused on vehicles getting greater than 55 miles per gallon.[290] The high MPG rating for vehicles in the pilot was designed into the program to show the impact of replacing the state gas tax for highly fuel-efficient vehicles.[291] The 2012 study tested five mileage data collection and reporting plans: unlimited mileage for a flat annual or monthly fee, basic reporting of mileage without vehicle location data (one managed be the Oregon Department of Transportation and one managed by a private provider), advanced reporting of miles with vehicle location (managed by a private provider), and smartphone reporting of mileage reporting and vehicle location data (managed by a private provider). The study included 45 participants from Oregon, 21 from Washington, and 27 from Nevada.[292]

10.2 GHG Impacts

GHG benefits are associated with the reduced VMT that these policies achieve through drivers limiting their number and distance of trips, and using alternate modes of transportation as a result of the policy. No studies were found that listed GHG benefits as the primary cause for implementing a PAYD policy, but the reduced VMT achieved through such policies inherently

[287] Vock, *D. State gas tax could be replaced by mileage tax*. USA Today. August 1, 2013. Accessed August 2013 at: http://www.usatoday.com/story/news/nation/2013/08/01/oregon-gas-mileage-tax/2608067/
[288] Whitty, J. *Oregon's Mileage Fee Concept and Road User Fee Pilot Program*. Oregon Department of Transportation. (November 2007). Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUFPP_finalreport.pdf
[289] Whitty, J. *Oregon's Mileage Fee Concept and Road User Fee Pilot Program*. Oregon Department of Transportation. (November 2007). Page 42. Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUFPP_finalreport.pdf
[290] Oregon Department of Transportation. *Road Usage Charge Pilot Program*. Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/Pages/rucpp.aspx
[291] Oregon Department of Transportation. *Oregon's Road Usage Charge Program Frequently Asked Questions*. Accessed September 2013 at: http://roadchargeoregon.org/frequently-asked-questions/
[292] Whitty, J. *Road Usage Charge Pilot Program Preliminary Findings*. Oregon Department of Transportation. (February 2013). Page 7. Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUCPilotPrelimFind_Feb13.pdf (page 7)

reduce GHG emissions. Table 27, below, summarizes the available GHG-related information for the Oregon VMT charge pilot. There can be significant capital costs involved in starting a mileage-based charging program, but as the vehicle fleet becomes more fuel efficient, the revenue generated through mileage charges would surpass the revenue generated through gasoline taxes. In general, the Oregon pilot program was viewed as a success based on the objectives of the program design, which included ease of implementation and use, and potential for public adoption.

Table 27: GHG Costs and Benefits of the Oregon VMT Charging Pilot

Oregon	
Cost of Reductions	For the 2007 pilot, the total estimated start-up cost of the mileage fee at the state level was estimated to be $32,801,000 over a 20 year period.[293] For the 2012 pilot, the cost to users was $0, and approximately 44 total minutes over the trial.[294]
Volume of Reductions	None noted – the pilot was a technology feasibility assessment rather than a broad study of behavioral changes in response to the pricing mechanism.
Programmatic Status	Yes – the study found that existing technology used in new ways, a mileage fee could be implemented to replace the gas tax as the principal revenue source for road funding. The 2007 pilot study found that 91 percent of study participants would pay the road usage fee rather than a gas tax if given the option.[295] The 2012 study successfully met its objectives of demonstrating an easy-to-use system with multiple implementation choices and multiple vendors.[296]
Emissions Leakage	None noted.

10.3 Energy and Economic Impacts

Table 28, below, summarizes the available energy and economic impact information for the Oregon PAYD pilot. Findings from the Oregon pilot study did not note any impacts on fuel choice or energy independence, but did note that the impact on fuel distributors and gas stations (when implementing a pay-at-the-pump program) undertook additional administrative burdens, which were easily surmountable, as the technology was essentially automated. No cases of fuel switching associated with VMT charging policies were cited, as the type of fuel used in a vehicle

[293] Whitty, J. *Oregon's Mileage Fee Concept and Road User Fee Pilot Program*. Oregon Department of Transportation. (November 2007). Pages 31 and 61. Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUFPP_finalreport.pdf

[294] Whitty, J. *Road Usage Charge Pilot Program Preliminary Findings*. Oregon Department of Transportation. (February 2013). Page 29. Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUCPilotPrelimFind_Feb13.pdf

[295] www.oregon.gov/ODOT/HWY/RUFPP/docs/RUFPP_finalreport.pdf (page vi)

[296] Whitty, J. 2013. Page 45. Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUCPilotPrelimFind_Feb13.pdf

has no impact on the fee assessed, and reductions in fuel used are achieved through reduced VMT associated with the programs.

Table 28: Energy and Economic Impacts of the Oregon VMT Charging Pilot

Oregon	
Independence from Fossil Fuels, and Economic Impact	None noted – the pilot was a technology feasibility assessment rather than a broad study of behavioral changes in response to the pricing mechanism.
Impacts on Fuel Choice	None noted.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	None noted.
Impact on Different Sectors of the Economy	Distributors and gas stations bear some new accounting burdens, administration is essentially automated and can be integrated easily into existing transaction processes.[297]

10.4 Household Impacts and Co-Benefits

Table 29, below, summarizes the available household impact and co-benefit information for the Oregon MBUF pilot. Findings of the Oregon pilot programs indicated minimal impact on household consumption, that the fees were perceived as equitable, and that mileage-based fees will generate more revenue for the government than the fuel tax as the vehicle fleet becomes more fuel efficient.

Table 29: Household Impacts and Co-Benefits of the Oregon VMT Charging Pilot

Oregon	
Effect on Household Consumption and Spending	None noted – the pilot was a technology feasibility assessment rather than a broad study of behavioral changes in response to the pricing mechanism.
Measures to Mitigate to Low-income Populations, or Economic Impact	A road usage charge is generally perceived as being equitable by the participants in study[298]

[297] Whitty, J. *Oregon's Mileage Fee Concept and Road User Fee Pilot Program*. Oregon Department of Transportation. (November 2007). Page vii. Accessed July 2013 at: www.oregon.gov/ODOT/HWY/RUFPP/docs/RUFPP_finalreport.pdf
[298] Whitty, J. 2013. Page 6. Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUCPilotPrelimFind_Feb13.pdf

Significant Co-benefits	Revenue generation: results from the 2012 pilot showed that the road usage charge generates as much or more revenue when compared with the fuel tax, so long as the fleet to which it applies has a fuel economy of at least 19.2 mpg[299]

[299] Whitty, J. 2013. Page 30. Accessed July 2013 at: http://www.oregon.gov/ODOT/HWY/RUFPP/docs/RUCPilotPrelimFind_Feb13.pdf

11 Electric Vehicle (EV) Purchase Incentives and Infrastructure Support

Policy Definition	Targeted Sector or Emissions
EV purchase incentives and infrastructure support are programs providing funding to EV vehicle and charging technology development to increase the penetration of EVs into the automotive market. Types of incentives include but are not limited to grants, loans, tax exemptions, and purchase vouchers	Transportation

GHGs and Costs

- **Oregon Commercial Electric Trucks:** Oregon has invested approximately $4 million and estimates reductions of 4,768 $mtCO_2e$ per year.
- **California Clean Vehicle Rebate Program (CVRP):** The CVRP has distributed 30,399 rebates for a total of over $66 million for eligible vehicles, amounting to reductions of approximately 57,758 $mtCO_2e$ per year.
- **The EV Project:** Total costs of the program in Washington for 2013 are estimated at $1.2 million with reductions equating to 1,593 $mtCO_2e$ per year.

Implementation Issues and Lessons Learned

- Potential interactions with a low carbon fuel standard.
- Increases in EV incentives can increase consumer purchasing of EVs.
- Customer incentives may help meet emissions and Zero Emissions Vehicle (ZEV) mandate goals. Since the current sales tax exemption in Washington applies only to vehicles fueled solely by electricity, the proposed incentives may shift purchasing to a higher proportion of transitional zero emissions vehicles such as plug-in hybrids.
- Need for additional commercial/public infrastructure incentives to support EV adoption and market penetration.

Costs and Benefits to Consumers	Costs and Benefits to Businesses
• Public health benefits from reduced emissions. • Increase in vehicle prices as a result of incremental vehicle technology prices. California has estimated that the average new vehicle purchase costs will increase by about $1,900.[300] • Increased purchase costs are expected to be offset by reduced operating costs, ultimately resulting in a net savings of up to $4,000 over the lifetime of the vehicles.[301]	• Opportunities for engineering and manufacturing jobs within the states incentivizing EVs.[302] • Shifts away from petroleum-based fuels (gasoline and diesel) will have negative impacts on businesses involved in oil production, refining and transportation. • As a result of potentially increasing electricity sales from increased EV charging, there may be shifts toward electricity produced in-state that will have positive impacts on businesses involved in the electricity sector.

[300] p.147 of the CARB study referenced in the ZEV section: http://www.arb.ca.gov/regact/2012/leviiighg2012/levisor.pdf.
[301] p. 209 of the CARB study referenced in the ZEV sectionhttp://www.arb.ca.gov/regact/2012/leviiighg2012/levisor.pdf.
[302] (governor's plan page 5: http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf)

Fuel consumption in the transportation sector is the largest source of emissions in the State of Washington. Transportation activities resulted in 42.2 mmtCO_2e of emissions, or 44 percent of total emissions in Washington in 2010. The largest share of emissions from this source resulted from consumption of on-road gasoline and diesel (21.9 and 8 mmtCO_2e, respectively), making incentives to purchase electric vehicles (EVs) and fund infrastructure construction and charging support an important step to reducing on-road GHG emissions.

Currently, the State of Washington offers certain tax exemptions and demonstration grants to incentivize the use of EVs, and requires any regional planning organization containing a county with a population over 1 million within its jurisdiction to collaborate with the State and local governments to promote electric vehicle use.[303] Because of the relatively clean electricity fuel mix in Washington State due to the large presence of hydropower, transferring transportation energy from fossil-based fuels to electric power could significantly aid in reducing GHG emissions from the transportation sector.

Washington has been a leader in facilitating the early adoption of EVs. This section summarizes examples of EV programs that focus on vehicle purchase and infrastructure investment and incentives. Market penetration and adoption of EVs can be further increased through incentives such as loans, grants and rebates for charging technology and infrastructure development to minimize the investment cost of purchasing and using EVs for consumers. As Federal and other states' incentives for some programs such as EVs may be receding, there may be potential for other types of policies that can influence individual consumer adoption rates and fleet purchases.[304]

11.1 Existing Policies

This section analyzes existing policies implemented in other jurisdictions which target incentives to purchase and fund infrastructure for EVs. Each of the programs described below was considered as examples of EV purchase and charging technology and infrastructure incentive programs relevant to Washington. Many of these programs have not publically provided emissions reduction data and those that do are generally preliminary results or estimates. The studies listed below provided quantitative data, and will be further analyzed in the following subsections:

- Oregon Commercial Electric Truck Incentive Program (CETIP)
- California Clean Vehicle Rebate Project (CVRP)
- The EV Project

[303] U.S. DOE EERE. Alternative Fuels Data Center (Washington- and policy- specific database query). Online at: http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&tech[]=3270&search_button=y

[304] Lee van der Voo, Electric car industry leaders told to focus on policy, Sustainable Business Oregon, December 6, 2012, Accessed August 2013 at http://sustainablebusinessoregon.com/articles/2012/12/electric-car-industry-leaders-told-to.html?page=all

Drive Oregon[305] **- Commercial Electric Truck Incentive Program (CETIP):** Through the Commercial Electric Truck Incentive Program (CETIP), the Oregon Department of Transportation (ODOT) provides vouchers to reimburse commercial fleets for $20,000 for each qualified zero emission truck purchased. Vehicles eligible for this program must be new, titled and licensed in Oregon, have a gross vehicle weight rating of over 10,000 pounds, and must replace an existing diesel vehicle. Federal Congestion Mitigation and Air Quality (CMAQ) funds totaling $4 million have been approved for the CETIP, and the ODOT estimates that they will distribute 200 vouchers within the first year of the program. Trucks must be used primarily in CMAQ-eligible areas of Oregon.[306,307,308]

California Clean Vehicle Rebate Project (CVRP): The purpose of the CVRP is to encourage and accelerate zero- and near-zero emission, on-road light-duty vehicle deployment and technology innovation. The CVRP provides rebates of up to $2,500 for California purchasers or lessees of light-duty zero-emission vehicles (ZEVs) and plug-in hybrid electric vehicles (PHEVs). A minimum of 93 percent of the CVRP funds go to rebates for purchasers of *new* eligible on-road vehicles.[309]

The EV Project: Managed by Ecototality, and sponsored by the U.S. DOE, the EV Project offered Electric Vehicle Supply Equipment (EVSE) at no charge to Nissan LEAF and Chevrolet Volt customers in exchange for collecting vehicle and charge information and data. The program provided a Blink wall charger at no cost and up to $400 towards the charger installation cost. Although not a specific jurisdictional program, the EV Project publishes comprehensive data on avoided GHG emissions and cost reductions from EVs, generated significant lessons learned on user behavior and charger installations, and was active in cities in Washington, Oregon, California, Arizona, Illinois, Texas, Tennessee, Georgia, Pennsylvania, New Jersey, and Washington D.C. The EV Project was scheduled to conclude in June 2013, and Ecotality filed for bankruptcy on September 16, 2013, as a result of insufficient sales, liquidity constraints, and difficulty obtaining the long-term financing.[310] No information was available to determine whether the bankruptcy was a result of poor management of the program or business struggles with other aspects of the business's engagement in the electric car industry. One of the most valuable aspects of the EV Project may be the data it collected from nationwide installations, users' charging habits, and partnerships with commercial host sites, which is available for public access.

[305] Drive Oregon. Online at: http://driveoregon.org/
[306] Oregon Department of Transportation CTEIP Presentation (June 22, 2012). Online at: http://www.oregon.gov/ODOT/HWY/OIPP/docs/cetiproadmap5.pdf
[307] Drive Oregon. Commercial Electric Truck Incentive Program. (August 30, 2012). Online at: http://driveoregon.org/press/commercial-electric-truck-incentive-program/
[308] U.S. DOE EERE. Alternative Fuels Data Center (Oregon CTEIP). Online at: http://www.afdc.energy.gov/laws/law/OR/10112
[309] Center for Sustainable Energy California. Clean Vehicle Rebate Project (CVRP). Online at: http://energycenter.org/index.php/incentive-programs/clean-vehicle-rebate-project
[310] Reuters. Ecotality, an electric car charger maker, files for bankruptcy September 17, 2013. Accessed September 2013 at http://www.reuters.com/article/2013/08/12/us-ecotality-bankruptcy-idUSBRE97B0K320130812

Delaware Vehicle-to-Grid Energy Credit: This policy encourages the development of vehicle-to-grid technologies, which can provide peak power supply to utilities from individual vehicles. In this program, retail electricity customers with at least one grid-integrated EV can qualify to receive kilowatt-hour credits for the energy discharged to the grid from their EV's battery at the same price rate that the customer pays to charge that battery. Because this energy credit is offered at the same price rate that the customer pays to charge that battery, so the customer can bank revenue while their car is discharging to the grid. As defined in the Delaware State Code, a grid-integrated EV is a battery-powered motor vehicle with the ability for two-way power flow between the vehicle and the electric grid as well as communications hardware and software that allow for external control of battery charging and discharging.[311] Depending on the energy market and how long the vehicle owner can allow the car to discharge energy to the grid, annual revenue generated for the customer could range from $400-$5,000,[312] although this opportunity comes at the expense of battery degradation effects associated with vehicle-to-grid services.[313]

Electric Vehicles in Illinois: The Illinois Department of Commerce and Economic Opportunity (DCEO) offers rebates to governments, businesses, educational institutions, non-profits, and individual residents toward the installation of Level 2 EV charging stations. These rebates cover 50 percent of equipment and installation costs up to the following amounts:

- $3,750 per networked[314] single station and $7,500 per networked dual station.
- $3,000 per non-networked single station and $6,000 per non-networked dual station.

The maximum rebate award is $49,000, or 50 percent of the total project cost for up to 15 stations, whichever is less. Furthermore, the Illinois DCEO incentivizes EV adoption through grant funds to support EV supply equipment production to expand and develop related businesses such as component manufacturers.[315] Other potential future Illinois EV charging and infrastructure support incentives recommended by the Illinois Electric Vehicle Advisory Council include:

- A program for multi-unit residential buildings to install EV charging stations in shared or common area parking spaces.

[311] State of Delaware Online Delaware Code: Title 26, Chapter 10, Section 1014g. Online at: http://delcode.delaware.gov/title26/c010/index.shtml
[312] University of Delaware. The Grid-Integrated Vehicle with Vehicle to Grid Technology. Online at: http://www.udel.edu/V2G/QandA.html
[313] C. Waldron and P. Kobylarek, The Reality of Electric Vehicles and the Grid, Electric Light & Power, January 1, 2011, accessed August 2013 at http://www.elp.com/articles/print/volume-89/issue-1/sections/the-reality-of-electric-vehicles-and-the-grid.html
[314] Note that a networked station indicates that the station has a cellular or internet connection.
[315] Illinois Department of Commerce and Economic Opportunity. Electric Vehicles in Illinois. Online at: http://ildceo.net/dceo/bureaus/energy_recycling/ev.htm

- State agencies providing local grants to install public EV charging stations in strategic locations in communities to facilitate EV charging and maximize usage by local commuters and other travelers.[316]

Texas River Cities: The Texas River Cities Plug-in EV (PEV) Initiative managed by Austin Energy, is a regional planning effort to promote clean and efficient electric drive cars for Central Texas, one of many Electric Vehicle Community Readiness Projects across the country. Sponsored by the U.S. DOE with Recovery Act funds, the Texas River Cities has developed an infrastructure readiness plan to provide tools and templates to strategically accelerate the adoption of EVs.[317] Austin Energy offers residential customers and PEV owners a rebate of 50 percent of the cost of the purchase and installation of a Level 2 (240V) Charging Station. The maximum rebate amount for a Level 2 (240V station) is $1,500.[318]

Oregon Alternative Fuel Tax Credit: The Oregon Department of Energy (ODOE) has up to $20 million available in the current biennium for business tax incentives for public transit services and AFV and EV infrastructure. AFV and EV infrastructure that qualify for the transportation incentives include projects such as electric vehicle charging, blender pumps and CNG systems. Project applicants can apply for a maximum credit of up to 35 percent of eligible project costs.[319] Oregon also offers residential energy tax credits equal to 25 percent of project costs not to exceed $750. Eligible projects include electric vehicle charging stations, vehicle-attached charging stations and compressed natural gas fueling stations.[320]

11.2 GHG Impacts

The Oregon CETIP program analyzed here mostly pertains to providing cleaner vehicle alternatives to diesel trucks and buses. This program would be particularly relevant to reducing emissions in Washington's urban areas where commercial truck and public bus transit are high. The Oregon data provide preliminary estimates of the benefit of the program. In contrast to the Oregon program, the California CVRP and the EV Project are programs targeted at vehicles generally in the residential sector rather than the commercial sector. As of August 12, 2013, the California CVRP alone had distributed 30,399 rebates for a total of over $66 million for eligible vehicles.[321] Using methods and assumptions from The EV Project's 2012 report, *Lessons*

[316] Illinois Electric Vehicle Advisory Council. Final Report to Governor Pat Quinn and the Illinois General Assembly (December 2011). Online at: http://www.ildceo.net/NR/rdonlyres/96A30601-9C66-44DD-91BF-416E080AF9C8/0/20111230EVACFinalReport.pdf
[317] Texas River Cities Plug-in Electric Vehicle Initiative. Online at: http://texasrivercities.com/
[318] Austin Energy Special Offers for PEV Owners. Online at: http://www.austinenergy.com/About%20Us/Environmental%20Initiatives/plug-in%20Partners/drivers.htm
[319] Oregon Department of Energy. Online at: http://www.oregon.gov/energy/BUSINESS/Incentives/Pages/EIP-Trans.aspx
[320] [320] Oregon Department of Energy. Online at: http://www.oregon.gov/ENERGY/TRANS/Pages/hybridcr.aspx
[321] Center for Sustainable Energy California. Clean Vehicle Rebate Project (CVRP) Statistics. Online at: http://energycenter.org/programs/clean-vehicle-rebate-project/cvrp-project-statistics

Learned – The EV Project Greenhouse Gas (GHG) Avoidance and Cost Reduction[322], SAIC quantified the cost of emissions reductions and the volume of reductions based on California's estimated yearly avoided emissions per vehicle of 1.9 mtCO_2e.[323]

It is important to note that the Oregon CETIP quantifies emissions reductions as tailpipe reductions while the California CVRP and the EV Project employed a method to quantify reductions over the full life cycle of the EVs. Table 30 summarizes the costs and reductions from Oregon's CETIP, the CVRP, and the EV Project[324].

Table 30: GHG Costs and Benefits of EV purchase and charging technology and infrastructure support incentives.

Oregon Commercial Electric Truck Incentive Program (CETIP)[325]	
Cost of Reductions	**Oregon has invested approximately $4 million.**[326]
Volume of Reductions	**4,768 mtCO_2e per year.**[327]
Programmatic Status	No data readily available.
Emissions Leakage	Displaced emissions were not quantified; however, there are likely displaced tailpipe emissions. EVs have no tailpipe emissions, but they do run on electricity, so tailpipe emissions are displaced to the electricity sector. According to a 2012 study by the EV Project, the overall U.S. emissions displaced to the electricity sector are lower than those from vehicle tailpipes, yielding a net reduction of GHG emissions.[328]
California Clean Vehicle Rebate Program (CVRP)	
Cost of Reductions	**The CVRP has distributed 30,399 rebates for a total of over $66 million for eligible vehicles.**[329]
Volume of Reductions	**57,758 mtCO_2e per year.**[330]

[322] The EV Project. Lessons Learned – The EV Project Greenhouse Gas (GHG) Avoidance and Cost Reduction (July 2012). Prepared for the U.S. Department of Energy Award #DE-EE0002194. Online at: http://www.theevproject.com/cms-assets/documents/106077-891082.ghg.pdf
[323] Ibid (page 13).
[324] Note that this analysis focuses solely on data for Washington State. The EV Project has participants from multiple states including Washington, Oregon, California, Arizona, Texas, Tennessee, Illinois, Georgia, Pennsylvania, New Jersey, and Washington D.C.
[325] The Oregon CETIP is replacing 200 diesel trucks with electric trucks.
[326] Oregon Department of Transportation CTEIP Presentation (June 22, 2012). Online at: http://www.oregon.gov/ODOT/HWY/OIPP/docs/cetiproadmap5.pdf (Slide 10).
[327] Ibid. Note that Slide 10 is assumed to have been reported in short tons, so short tons were converted to metric tons to get the volume of reductions.
[328] The EV Project. Lessons Learned – The EV Project Greenhouse Gas (GHG) Avoidance and Cost Reduction (July 2012). Prepared for the U.S. Department of Energy Award #DE-EE0002194. Online at: http://www.theevproject.com/cms-assets/documents/106077-891082.ghg.pdf (page 20)
[329] Center for Sustainable Energy California. Clean Vehicle Rebate Project (CVRP) Statistics. Online at: http://energycenter.org/programs/clean-vehicle-rebate-project/cvrp-project-statistics
[330] Volume of Reductions = Total number of CVRP Rebates (30,399) x California Avoided Emissions Factor (1.9 mtCO_2e)

Programmatic Status	According to a May 2013 survey of CVRP recipients, EV customers are highly satisfied with their decision to drive EVs and use their plug-in EVs as their primary mode of transportation. **Furthermore, 95 percent of the survey respondents mentioned that the CVRP was an important motivating factor in their decision to purchase an EV.** The survey also mentions that driver satisfaction is high, but the satisfaction with public charging infrastructure is low.[331]
Emissions Leakage	Displaced emissions were not quantified; however, there are likely displaced tailpipe emissions. EVs have no tailpipe emissions, but they do run on electricity, so tailpipe emissions are displaced to the electricity sector. According to a 2012 study by the EV Project, the overall U.S. emissions displaced to the electricity sector are lower than those from vehicle tailpipes, yielding a net reduction of GHG emissions.[332]
The EV Project (Washington)[333]	
Cost of Reductions	Cumulative enrollment through the second quarter of 2013 in Washington was 1,062 vehicles. Each vehicle received a charger valued at $700 and up to $400 installation costs. **Total costs are therefore estimated at $1.2 million.**
Volume of Reductions	The EV Project estimates that Washington participants reduced emissions by 1.5 mtCO_2e annually per vehicle[334], **which equates to 1,593 mtCO_2e cumulatively per year**.
Programmatic Status	The program is considered a success thus far with a total of over 8,100 vehicles participating nationwide in the program, 8,200 residential chargers installed and 3,750 public commercial chargers installed.[335]
Emissions Leakage	According to a 2012 study by the EV Project, overall U.S. emissions displaced to the electricity sector are lower than those from vehicle tailpipes, yielding a net reduction of GHG emissions.[336]

[331] Center for Sustainable Energy California. Clean Vehicle Rebate Project (CVRP) May 2013 Survey. Online at: http://energycenter.org/programs/clean-vehicle-rebate-project/vehicle-owner-survey/may-2013-survey

[332] The EV Project. Lessons Learned – The EV Project Greenhouse Gas (GHG) Avoidance and Cost Reduction (July 2012). Prepared for the U.S. Department of Energy Award #DE-EE0002194. Online at: http://www.theevproject.com/cms-assets/documents/106077-891082.ghg.pdf (page 20)

[333] Data for the EV Project relates to GHG avoidance and cost savings due to charging and driving EVs as opposed to internal combustion engine vehicles (ICEVs) (i.e., the CO_2e avoided by charging an EV rather than using gasoline in an ICEV). In a 2012 EV Project study , the Nissan LEAF represents the EV while a mid-sized 28.6 mile per gallon vehicle represents the ICEV. The study assumed that a Nissan LEAF would drive 12,000 miles and use 4,080 kWh of energy per year, and calculated the avoided emissions results for each state in the U.S. based on state-specific grid emissions factors. Fuel cost savings were estimated using the average cost per gallon of gasoline (on May 1, 2012) and the average U.S. electricity cost per kWh.

[334] The EV Project. Lessons Learned – The EV Project Greenhouse Gas (GHG) Avoidance and Cost Reduction (July 2012). Prepared for the U.S. Department of Energy Award #DE-EE0002194. Online at: http://www.theevproject.com/cms-assets/documents/106077-891082.ghg.pdf (Adapted from Table 3-5, pages 13-15)

[335] The EV Project: EVSE and Vehicle Usage Report 2nd Quarter of 2013. Online at: http://www.theevproject.com/cms-assets/documents/127233-901153.q2-2013-rpt.pdf (page 2)

[336] The EV Project. Lessons Learned – The EV Project Greenhouse Gas (GHG) Avoidance and Cost Reduction (July 2012). Prepared for the U.S. Department of Energy Award #DE-EE0002194. Online at: http://www.theevproject.com/cms-assets/documents/106077-891082.ghg.pdf (page 20)

11.3 Energy and Economic Impacts

In considering energy and economic impacts for the programs analyzed here, a major effect of switching to cleaner fuels such as electricity is the reduction in fuel use. As seen in Table 31 below, the Oregon CETIP estimates annual diesel savings of over 540,000 gallons[337]. The California CVRP and the EV Project could displace approximately 12 million gallons[338] and 445,000[339] gallons of gasoline, respectively. With increases in the number of EV charging facilities and infrastructure, there will likely be increased market penetration of EVs, further reducing dependence on fossil fuels. Greater market penetration will also likely advance economic development and jobs in a variety of sectors, from manufacturing and transportation to agriculture and the service industry. Error! Reference source not found. outlines the energy and economic impacts associated with EV purchase and charging technology and infrastructure support incentives.

Table 31: Energy and Economic Impacts of EV purchase and fueling technology and infrastructure support incentives.

Oregon Commercial Electric Truck Incentive Program (CETIP)	
Independence from Fossil Fuels, and Economic Impact	Estimated 540,780 gallons of petroleum diesel saved annually.[340]
Impacts on Fuel Choice	Use of electricity in place of petroleum.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Engineering, construction, installation, and maintenance of fuel infrastructure, especially along highly travelled corridors and at participating vehicle purchaser station (for example, bus fleet garage).
Impact on Different Sectors of the Economy	No data readily available.
California Clean Vehicle Rebate Program (CVRP)	
Independence from Fossil Fuels, and Economic Impact	The 2012 EV Project estimates that 420 gallons of gasoline are displaced annually per vehicle.[341] **That is a total of approximately 12 million gallons of gasoline displaced in California.**[342]

[337]James, A. 2012. *Oregon Commercial Electric Truck Incentive Program: EV Roadmap 5 Conference Presentation.* Online at: http://www.oregon.gov/ODOT/HWY/OIPP/docs/cetiproadmap5.pdf

[338] Assuming that each rebate from the CVRP is provided for one car, meaning that there are 30,399 vehicles represented in this program. 30,399 vehicles x 420 gallons displaced per vehicle = 12,159,600 gallons displaced.

[339]In the 2012 EV Project study referenced above, the Nissan LEAF represents the EV while a mid-sized 28.6 mile per gallon vehicle represents the ICEV. The study assumed that a Nissan LEAF would drive 12,000 miles per year. Thus, 12,000 miles/28.6 miles per gallon = 420 gallons of gasoline displaced per vehicle.

[340] Oregon Department of Transportation CTEIP Presentation (June 22, 2012). Online at: http://www.oregon.gov/ODOT/HWY/OIPP/docs/cetiproadmap5.pdf (Slide 10)

[341]In a 2012 EV Project study referenced above, the Nissan LEAF represents the EV while a mid-sized 28.6 mile per gallon vehicle represents the ICEV. The study assumed that a Nissan LEAF would drive 12,000 miles per year. Thus, 12,000 miles/28.6 miles per gallon = 420 gallons of gasoline displaced per vehicle.

[342] Assuming that each rebate from the CVRP is provided for one car, meaning that there are 30,399 vehicles represented in this program. 30,399 vehicles x 420 gallons displaced per vehicle = 12,159,600 gallons displaced.

Impacts on Fuel Choice	Use of electricity in place of petroleum.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	There will be opportunities for engineering, construction, installation, and maintenance of public charging infrastructure. According to the CVRP 2013 survey, respondent satisfaction for public charging was low[343], so there could be improvements and additions to public charging infrastructure.
Impact on Different Sectors of the Economy	No data readily available.
The EV Project (Washington)	
Independence from Fossil Fuels, and Economic Impact	Using assumptions from the 2012 EV Project study, there is likely to be 420 gallons of gasoline displaced per vehicle annually.[344] **With 1,062 vehicles in Washington for this program, that is over 445,000 gallons of gasoline displaced, with estimated cost savings of $1,437 per vehicle and $1.5 million total in Washington.**
Impacts on Fuel Choice	**For the EV Project as a whole (all states participating), consumption of over 2.9 million gallons of gasoline has been avoided.** [345]
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	There will be opportunities for engineering, construction, installation, and maintenance of public charging infrastructure. Increased electricity demand from EV charging may spur new opportunities to support clean energy in the electricity sector as clean energy would help reduce overall lifecycle emissions.
Impact on Different Sectors of the Economy	No data readily available.

11.4 Household Impacts and Co-benefits

As a result of decreased fuel use and mobile emissions, the adoption of EVs generates benefits to public health. With the cleaner technologies of new or retrofitted vehicles, the Oregon CETIP estimated reductions in pollutants such as particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen oxide (NOx), hydrocarbons, and carbon monoxide (CO). Air quality can improve with decreases in these pollutants, potentially improving the health and surrounding environments truck drivers, and employees of the companies and jurisdictions participating in these types of commercial EV programs. Table 32 shows the reductions to the pollutants quantified for each program.

[343] Center for Sustainable Energy California. Clean Vehicle Rebate Project (CVRP) May 2013 Survey. Online at: http://energycenter.org/programs/clean-vehicle-rebate-project/vehicle-owner-survey/may-2013-survey (page 19)
[344]In the 2012 EV Project study referenced above, the Nissan LEAF represents the EV while a mid-sized 28.6 mile per gallon vehicle represents the ICEV. The study assumed that a Nissan LEAF would drive 12,000 miles per year. Thus, 12,000 miles/28.6 miles per gallon = 420 gallons of gasoline displaced per vehicle.
[345] The EV Project: EVSE and Vehicle Usage Report 2nd Quarter of 2013. Online at: http://www.theevproject.com/cms-assets/documents/127233-901153.q2-2013-rpt.pdf (page 3)

Table 32: Household Impacts and Co-Benefits of EV purchase and charging technology and infrastructure support incentives.

Oregon Commercial Electric Truck Incentive Program (CETIP)	
Effect on Household Consumption and Spending	No data readily available.
Measures to Mitigate to Low-income Populations, or Economic Impact	No data readily available.
Significant Co-benefits	Potential reduction in adverse effects to public health from diesel emissions. Annual reductions include: **$PM_{2.5}$ = 1.6 metric tons** **NO_x = 50.2 metric tons** **Hydrocarbons = 2.9 metric tons** **CO = 15.6 metric tons**[346]
California Clean Vehicle Rebate Program (CVRP)	
Effect on Household Consumption and Spending	No data readily available.
Measures to Mitigate to Low-income Populations, or Economic Impact	No data readily available.
Significant Co-benefits	No data readily available.
The EV Project (Washington)	
Effect on Household Consumption and Spending	**The EV Project estimates a net savings of $1,437 per vehicle[347] and $1,526,328 cumulatively[348] for residents in Washington as a result of energy cost savings.**
Measures to Mitigate to Low-income Populations, or Economic Impact	No data readily available.
Significant Co-benefits	No data readily available.

[346] Oregon Department of Transportation CTEIP Presentation (June 22, 2012). Online at: http://www.oregon.gov/ODOT/HWY/OIPP/docs/cetiproadmap5.pdf (Slide 10)
[347] The EV Project. Lessons Learned – The EV Project Greenhouse Gas (GHG) Avoidance and Cost Reduction (July 2012). Prepared for the U.S. Department of Energy Award #DE-EE0002194. Online at: http://www.theevproject.com/cms-assets/documents/106077-891082.ghg.pdf (Adapted from Table 4-1, pages 16-18).
[348] Total Annual EV Savings = Annual EV Savings per Individual Vehicle ($1,437) x Number of Vehicles Enrolled in EV Project as of the Second Quarter in 2013 (1,062 vehicles in Washington)

12 Alternative Fuel Vehicle (AFV) Purchase Incentives and Infrastructure Support, including Advanced Biofuels

Policy Definition	Targeted Sector or Emissions
AFV purchase incentives and infrastructure support are programs providing funding to AFV vehicle and fueling technology development to increase the penetration of AFVs into the automotive market. Types of incentives include but are not limited to grants, loans, tax exemptions, and purchase vouchers.	Transportation

GHGs and Costs

- **New York City Clean-fueled Bus Program:** Program costs are approximately $10.2 million with estimated GHG reductions 144,434 $mtCO_2e$ over the lifetime of vehicles.
- **Illinois Green Fleet Program:** Grant money spending is at $148,472 with estimated reductions at 3,705 $mtCO_2e$ per year.
- **Western New York Biodiesel:** The total cost of the project to date is $420,000, and has led to a 15 percent reduction in CO2 emissions from their original diesel emissions baseline.
- **USDA Advanced Biofuel Payment Program:** In June 2013, the USDA announced up to $98.6 million to support the production of advanced biofuels, and an opportunity for eligible producers to submit applications. No emissions reduction data was available at the time of this research.
- **California Energy Commission AFV Program:** Research indicates that the CEC awarded around $140 million to biofuels through the first for investment plans as of December 2011. The CEC estimates there to be GHG emissions reductions anywhere from between 1,326,694 $mtCO_2e$ and 6,682,472 $mtCO_2e$ by 2020.

Implementation Issues and Lessons Learned

- Potential interactions with the low carbon fuel standard.
- Increases in AFV incentives can increase consumer purchasing of AFVs.
- Need for additional commercial/public infrastructure incentives to support AFV adoption and market penetration.

Costs and Benefits to Consumers	Costs and Benefits to Businesses
• Public health benefits from reduced diesel emissions. • Consumers receive incentives for their purchase and use of AFVs, generally reducing the up-front cost of the vehicle. Consumers may incur the cost of interest on loans received to purchase an AFV. • Fuel prices may fluctuate based on development of refining capacity for in-state biofuel production or purchase out-of-state alternative fuels, among other factors.	• Opportunities for engineering and manufacturing jobs within the State of Washington. • Shifts away from petroleum-based fuels (e.g., gasoline and diesel) will have negative impacts on businesses involved in oil production, refining and transportation. • Significant increases in biofuel production will positively impact biofuel production, refining, and transportation along with the farming and agricultural sectors of the economy as a result of additional demand for fuel feedstock

As mentioned in the previous EV section, fuel consumption in the transportation sector is the largest source of emissions in the State of Washington, making incentives to purchase alternative fuel vehicles (AFVs) and fund associated infrastructure construction and fueling support an important step to reducing on-road GHG emissions. Currently, Washington provides certain tax exemptions for AFVs, and provides loans and grants for research and development in the production of alternative fuels.[349] Fuels powering AFVs are less carbon-intensive than traditional fossil fuels, allowing AFV fuel use to reduce GHG emissions from the transportation sector. Market penetration and adoption of EVs and AFVs can be further increased through incentives such as loans, grants and rebates for fueling technology and infrastructure development to minimize the investment cost of purchasing and using EVs and AFVs for consumers.

12.1 Existing Policies

This section analyzes existing policies implemented in other jurisdictions which target incentives to purchase and fund infrastructure for AFVs. Each of the programs described below were considered as examples of AFV purchase incentive and fueling technology and infrastructure programs relevant to Washington.[350] Many of these programs have not publically provided emissions reduction data and those that do are generally preliminary results or estimates. The studies listed below provided quantitative data, and will be further analyzed in the following subsections:

- New York City Transit Authority Clean-fueled Bus Program
- Illinois Green Fleet Program
- Western New York Biofuel Initiative
- The USDA Advanced Biofuel Payment Program
- California Alternative and Renewable Fuel and Vehicle Technology Program

New York Alternative Fuel and Advanced Vehicle Funding[351] and Heavy-Duty Alternative Fuel and Advanced Vehicle Purchase Vouchers[352,353]: The New York State Energy Research and Development Authority (NYSERDA) AFV Program provides financial assistance and technical information to encourage fleets in the State of New York to purchase EVs and AFVs and install fueling facilities or charging stations. AFVs and EVs that qualify for funding use natural gas, propane, and electricity, including certain hybrid-electric vehicles. Projects that have benefitted from this program include the New York City Transit Authority Clean-fueled

[349]U.S. DOE EERE. Alternative Fuels Data Center (Washington- and policy- specific database query). Online at: http://www.afdc.energy.gov/laws/search?p=search&location[]=WA&search_button=y
[350] Note that the Oregon Alternative Fuel Loans policy originally to be considered under this section of the policy analysis was switched to the AFV/EV infrastructure section as that program focuses more on infrastructure than vehicle purchase.
[351] New York State Energy Research & Development Authority (NYSERDA). Alternative Fuel Vehicle Program. Online at: http://www.nyserda.ny.gov/BusinessAreas/Energy-Innovation-and-Business-Development/Research-and-Development/Transportation/Alternative-Fuel-Vehicles.aspx
[352] NYSERDA. New York Truck - Voucher Incentive Program (NYT-VIP). Online at: https://truck-vip.ny.gov/index.php
[353] It is important to note that the New York program includes incentives for both EVs and AFVs, but has been placed under this section due to the tendency of the programs to focus on AFVs.

Bus Program, the Clean Air School Bus Program, the New York Truck Voucher Incentive Program, and Albany International Airport natural gas airport fleet project.[354]

Illinois Green Fleets: The Illinois Green Fleets program began in 2000, and gives recognition to corporate and small business, government, and other fleets in Illinois that are excellent examples of "greening" their fleet operation. The Green Fleets program is an umbrella for other initiatives such as the Alternative Fuel Rebates Program and the Illinois Clean Diesel Grant Program. The Alternative Fuel Rebates Program offers rebates to anyone for using E85 or biodiesel fuels (20 percent blend or higher), for purchasing a new AFV, or for converting a conventional vehicle to alternate fuel (e.g., E85, B20, natural gas, propane, hydrogen, and electric). The Clean Diesel Grant Program focuses on diesel upgrades and conversion of engines to increase efficiency in mainly buses and trucks.[355]

Western New York Biodiesel Initiative: The NYSERDA AFV Program provides financial assistance and technical information to encourage fleets in the State of New York to purchase AFVs and install fueling facilities or charging stations.[356] NYSERDA provided roughly $420,000 dollars to biodiesel infrastructure and fuel deployment projects in Western New York. $60,000 goes to biodiesel infrastructure like tanks and dispensers while the remaining $360,000 is allocated for purchasing 1.2 million gallons of B-20 fuels for programs that support this initiative.[357]

The USDA Advanced Biofuel Payment Program: This program, within the USDA's Rural Development Office, provides payments[358] to biofuel producers to support and expand production of advanced biofuels.[359] Under this program, payments are made to eligible producers based on the amount of advanced biofuels produced from renewable biomass, other than corn kernel starch. Biofuel can be made from a variety of non-food sources, including waste products. Examples of eligible feedstocks include, but are not limited to, crop residue, animal, food and yard waste material, vegetable oil, and animal fat. To be eligible, producers must enter into a contract with USDA Rural Development for advanced biofuels production and submit records to document their production.[360] Through this and other programs, USDA is working to support

[354] Examples of NYSERDA AFV program case studies online at: http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx
[355] Illinois Environmental Protection Agency. Illinois Green Fleets. Online at: http://www.illinoisgreenfleets.org/
[356] New York State Energy Research & Development Authority (NYSERDA). Alternative Fuel Vehicle Program. Online at: http://www.nyserda.ny.gov/BusinessAreas/Energy-Innovation-and-Business-Development/Research-and-Development/Transportation/Alternative-Fuel-Vehicles.aspx
[357] New York State Energy Research & Development Authority (NYSERDA). Western New York Biodiesel Initiative Case Study. Online at: http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx
[358] One payment is based on actual production and another payment is based on incremental production.
[359] U.S. Department of Agriculture Advanced Biofuel Payment Program. Online at: http://www.rurdev.usda.gov/BCP_Biofuels.html
[360] U.S. Department of Agriculture Rural Development Energy Programs Fact Sheet. Online at: http://www.rurdev.usda.gov/SupportDocuments/RD_energy_factsheet_1928_2009_final.pdf

the research, investment and infrastructure necessary to build a strong biofuels industry that creates jobs and broadens the range of feedstocks used to produce renewable fuel.

California Alternative and Renewable Fuel and Vehicle Technology Program (ARFVT)[361]**:** This program provides funding of up to $100 million annually, leveraging public and private investment to develop and deploy clean, efficient, and low-carbon alternative fuels and technologies.[362] California's objective is to produce 20 percent of biofuels used in state by 2010, 40 percent by 2020, and 75 percent by 2050. The CEC developed and adopted three investment plans since 2008 that guide more than $361 million in total awards for the first four fiscal years of the ARFVT Program, of which $114.9 million was allocated to biofuels. Using funds from this first investment plan (fiscal years 2008-09 and 2009-10), plus a portion of funds from the second investment plan (fiscal year 2010-2011), the Energy Commission funded 86 projects totaling $197.4 million to date, of which $64 million was awarded to biofuels.[363] The most recent investment plan, covering fiscal years 2012-2013, allocates $20 million and $21.5 million to alternative fuel production and alternative fuel infrastructure, respectively[364].

Utah AFV and Fueling Infrastructure Grants and Loans: The Utah Clean Fuels Vehicle Grant and Loan Program is funded through the Clean Fuels and Vehicle Technology Fund, and provides grants and loans to assist businesses and government entities in alleviating the following costs:

- Converting vehicles to operate on clean fuels.
- Incremental cost of purchasing original equipment manufactured clean fuel vehicles.
- Retrofitting diesel vehicles with U.S. EPA verified closed crankcase filtration devices, diesel oxidation catalysts, and/or diesel particulate filters.
- Fueling equipment for public and private sector business and government vehicles (these grants require federal and non-federal matching funds).[365]

Accomplishments to date include the purchase of eight CNG refuse trucks and two CNG transit buses, and the conversion of five vehicles to run on a cleaner fuel.[366]

[361] California Energy Commission. California's Alternative & Renewable Fuel & Vehicle Technology Program. Online at: http://www.energy.ca.gov/drive/

[362] California Energy Commission. Background Information: 2013-2014 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program. Online at: http://www.energy.ca.gov/2012-ALT-2/background.html

[363] California Energy Commission. Benefits report for the Alternative and Renewable Fuel and Vehicle Technology Program (December 2011). Online at: http://www.energy.ca.gov/2011publications/CEC-600-2011-008/CEC-600-2011-008-SD.pdf (page 20)

[364] California Energy Commission. 2012 -2013 Investment Plan U Vehicle Technology Program (May 2012). Online at: http://www.energy.ca.gov/2012publications/CEC-600-2012-001/CEC-600-2012-001-CMF.pdf (page 4)

[365] U.S. DOE EERE. Alternative Fuels Data Center (Utah Laws and Incentives for Vehicle Drivers and Owners). Online at: http://www.afdc.energy.gov/laws/laws/UT/user/3260

Texas Clean Transportation Triangle (CTT) Program (Natural Gas): A program of the Texas Emissions Reduction Plan (TERP), the CTT program provides grants to create natural gas fueling stations along interstate highways.[367] The purpose of this program is to develop a foundation for a natural gas vehicle market that is self-sustaining through strategic distribution of fueling facilities and the expansion of natural gas use in larger vehicles. LNG stations are eligible for up to $250,000 grants while CNG stations can receive a maximum of $100,000 in funding. Total funding available for the program amounted to $1.8 million as of January 2013.[368]

12.2 GHG Impacts

The New York and Illinois programs analyzed here mostly pertain to providing cleaner vehicle alternatives to diesel trucks and buses. These programs would be particularly relevant to reducing emissions in Washington's urban areas where commercial truck and public bus transit are high. The Illinois data provide preliminary estimates of the benefit of the program while the New York data come from a case studies completed by the New York City Transit Authority. In contrast to these three programs, the USDA and California programs mainly target advanced biofuel production and AFV technology development. Table 30 summarizes the costs and reductions of these five AFV programs as there was no data for the other programs described above.

Table 33. GHG Costs and Benefits of AFV purchase and fueling technology and infrastructure support incentives.[369]

New York City Transit Authority Clean-fueled Bus Program[370]	
Cost of Reductions	Program costs are approximately **$10.2 million**.[371]

[366] Utah Department of Environmental Quality. Division of Air Quality, Mobile Sources and Transportation Section. Clean Fuel Vehicle Grant and Loan Program. Online at: http://www.cleanfuels.utah.gov/grants/grantsintro.htm
[367] Texas Commission on Environmental Quality. Clean Transportation Triangle (CTT) Program. Online at: http://www.tceq.texas.gov/airquality/terp/ctt.html/
[368] Texas Commission on Environmental Quality. Clean Transportation Triangle (CTT) Program: Solicitation 582-13-31009 Presentation at the CTT Grant Workshop (January 23, 2013). Online at: http://www.tceq.texas.gov/airquality/terp/ctt.html/
[369] It is assumed that the New York and Illinois programs quantified GHG emissions reductions as tailpipe reductions, but the case studies did not indicate the type of reductions quantified. Furthermore, it is assumed that the CEC program calculated reductions on a life-cycle basis as the report alluded to "biofuel production projects" and not just reductions from vehicles.
[370] The New York City Clean-fueled Bus Program purchased 192 compressed natural gas and 91 diesel hybrid-electric buses.
[371] NYSERDA/New York City Clean-Fueled Bus Program Case Study: Hybrid-electric and Natural Gas Buses. Online at: http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx

Volume of Reductions	**144,434 $mtCO_2e$ over lifetime of vehicles.**[372] Note that other programs estimate volume of emissions reductions on an annual basis, but this estimate is over the lifetime of the vehicles. NYSERDA did not provide the estimated lifetime of these vehicles.
Programmatic Status	Yes, according to the case study "drivers, passengers, and the public now perceive hybrid-electric and CNG buses positively, and drivers report that passengers are impressed with the new technology." A goal was public acceptance of the new technology.[373]
Emissions Leakage	No anticipated displacement.
Illinois Green Fleet: Clean Diesel Grant Program[374]	
Cost of Reductions	**A 2009 grant application to U.S. EPA pegs spending at $148,472.**[375]
Volume of Reductions	**3,705 $mtCO_2e$ per year.**[376]
Programmatic Status	20 projects have been completed through 2012.[377]
Emissions Leakage	No anticipated displacement.
Western New York Biodiesel Initiative	
Cost of Reductions	**The total cost of the project to date is $420,000**, and has led to a 15 percent reduction in CO_2 emissions from their original diesel emissions baseline.[378]
Volume of Reductions	Although no quantitative data are available, analysis by NYSERDA estimates a reduction of 15 percent in CO_2 emissions from their original diesel emissions baseline due to the program.[379]
Programmatic Status	Yes, 160 heavy-duty diesel vehicles, including buses and dump trucks, are participating in the program. **At the time of the case study, over 615,000 gallons of B20 had been used in these vehicles that have traveled more than 2.6 million miles.** Furthermore, there was a seamless transition to the B20 fuel, no reported loss in engine power, and fuel economy consistent with straight diesel.[380]
Emissions Leakage	No anticipated displacement.

[372] Ibid.
[373] Ibid.
[374] The Illinois Green Fleet program converted roughly 270 vehicles (trucks, buses, and locomotives) to clean fuels.
[375] Illinois Green Fleets: Green Jobs, Clean Diesel, Clean Air. 2009. *A Grant Application submitted to the U.S. Environmental Protection Agency-Region 5 by the Illinois Environmental Protection Agency, the American Lung Association of Illinois, and the Respiratory Health Association of Metropolitan Chicago on behalf of the Illinois Clean Diesel Workgroup*, (page 10). Online at: http://www.recovery.illinois.gov/documents/Applications/IEPA%2066.039%20National%20Clean%20Diesel.pdf.
[376] Ibid. Note that this number was converted from short tons to metric tons.
[377] Illinois Green Fleets: Illinois 2012 DERA Grant Projects Completed (April 8, 2013). Online at: http://www.illinoisgreenfleets.org/2012-dera-grant-projects.pdf
[378] NYSERDA Western New York Biodiesel Initiative Case Study. Online at: http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx
[379] Ibid.
[380] Ibid.

USDA Advanced Biofuel Payment Program	
Cost of Reductions	To date, over 280 producers in 45 states and territories have received \$192.5 million in payments.[381] **In June 2013, the USDA announced up to \$98.6 million to support the production of advanced biofuels, and an opportunity for eligible producers to submit applications**.[382]
Volume of Reductions	Data not readily available.
Programmatic Status	This program is considered a success and has supported the production of more than 3 billion gallons of advanced biofuel and the equivalent of more than 36 billion kilowatt hours of electric energy.[383]
Emissions Leakage	There were no quantitative data readily available.
CEC Alternative and Renewable Fuel and Vehicle Technology Program	
Cost of Reductions	As of December 2011, **\$64 million** was awarded to biofuels through the first two investment plans, and an additional **\$76 million** is being allocated to biofuels and alternative fuel production in the 3rd and 4th investment plans.
Volume of Reductions	**The CEC estimates annual carbon emission reductions from biofuel production projects by 2020 to be between 1,326,694 mtCO_2e and 6,682,472 mtCO_2e**.[384]
Programmatic Status	The CEC finds that the economic and environmental benefits resulting from the first round of ARFVT Program funding awards to be a success and demonstrates measurable progress toward achieving multiple state policy goals. [385]
Emissions Leakage	There were no quantitative data readily available, but biofuel production can cause some emissions from land use and processing.

12.3 Energy and Economic Impacts

In considering energy and economic impacts for the programs analyzed here, a major effect of switching to cleaner fuels such as biodiesel or natural gas is the reduction in fuel use. Each of these programs provides substantial displacement of petroleum fuels to advanced biofuels. Table

[381] U.S. Department of Agriculture. News Release: USDA Announces A Notice of Contract Proposals to Support Advanced Biofuels Production (June 11, 2013). Online at: http://www.usda.gov/wps/portal/usda/usdahome?contentid=2013/06/0123.xml

[382] U.S. Department of Agriculture. News Release: USDA Announces A Notice of Contract Proposals to Support Advanced Biofuels Production (June 11, 2013). Online at: http://www.usda.gov/wps/portal/usda/usdahome?contentid=2013/06/0123.xml or http://www.gpo.gov/fdsys/pkg/FR-2013-06-11/pdf/2013-13778.pdf

[383] . Department of Agriculture. News Release: Producers in 38 States Receive Funds to Support Advanced Biofuel Production. Online at: http://www.rurdev.usda.gov/STELPRD4020614_print.html

[384] California Energy Commission. Benefits report for the Alternative and Renewable Fuel and Vehicle Technology Program (December 2011). Online at: http://www.energy.ca.gov/2011publications/CEC-600-2011-008/CEC-600-2011-008-SD.pdf (page 26)

[385]Ibid (page 1).

34 presents the jurisdictional data on the energy and economic impacts of AFV purchase and charging technology and infrastructure support incentives.

Table 34. Energy and Economic Impacts of AFV purchase and charging technology and infrastructure support incentives.

New York City Transit Authority Clean-fueled Bus Program	
Independence from Fossil Fuels, and Economic Impact	**Estimated 10,250,968 gallons of diesel displaced over the lifetime of the vehicles.**[386]
Impacts on Fuel Choice	Use of natural gas in place of petroleum.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Engineering, construction, installation, and maintenance of fuel infrastructure.
Impact on Different Sectors of the Economy	No data readily available.
Illinois Green Fleet: Clean Diesel Grant Program	
Independence from Fossil Fuels, and Economic Impact	**Estimated 403,837 gallons of diesel saved per year**.[387]
Impacts on Fuel Choice	No data readily available.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Opportunities for jobs to retrofit vehicles with new technology. **Estimated creation of 123 new jobs from multiple projects under this program.**[388]
Impact on Different Sectors of the Economy	No data readily available.
Western New York Biodiesel Initiative	
Independence from Fossil Fuels, and Economic Impact	**The Initiative anticipates increased independence from fossil fuels with an estimated 123,000 gallons of diesel displaced by the B20 fuel**.[389]

[386] NYSERDA/New York City Clean-Fueled Bus Program Case Study: Hybrid-electric and Natural Gas Buses. Online at: http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx

[387] Illinois Green Fleets: Green Jobs, Clean Diesel, Clean Air. 2009. *A Grant Application submitted to the U.S. Environmental Protection Agency-Region 5 by the Illinois Environmental Protection Agency, the American Lung Association of Illinois, and the Respiratory Health Association of Metropolitan Chicago on behalf of the Illinois Clean Diesel Workgroup*, (page 10). Online at: http://www.recovery.illinois.gov/documents/Applications/IEPA%2066.039%20National%20Clean%20Diesel.pdf

[388] Illinois Green Fleets: Green Jobs, Clean Diesel, Clean Air. 2009. *A Grant Application submitted to the U.S. Environmental Protection Agency-Region 5 by the Illinois Environmental Protection Agency, the American Lung Association of Illinois, and the Respiratory Health Association of Metropolitan Chicago on behalf of the Illinois Clean Diesel Workgroup*, (page 4). Online at: http://www.recovery.illinois.gov/documents/Applications/IEPA%2066.039%20National%20Clean%20Diesel.pdf

[389] NYSERDA Western New York Biodiesel Initiative Case Study. Online at: http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx

Impacts on Fuel Choice	Use of biodiesel in place of diesel for participants.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	**$60,000 has been invested in biodiesel infrastructure like tanks and dispensers, and $360,000 is allocated for purchasing 1.2 million gallons of B20 fuels for programs that support this initiative**.[390]
Impact on Different Sectors of the Economy	There is the potential for engineering, construction, installation, and general maintenance of fuel infrastructure.
USDA Advanced Biofuel Payment Program	
Independence from Fossil Fuels, and Economic Impact	Reduces dependence on fossil fuels.
Impacts on Fuel Choice	Data not readily available.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	The on-road diesel market alone is about 35 billion to 40 billion gallons per year[391], indicating that there is the potential for the growing biodiesel market.
Impact on Different Sectors of the Economy	Advanced biofuel industry supports economic development and jobs in a variety of sectors, from manufacturing and transportation to agriculture and service industry.
CEC Alternative and Renewable Fuel and Vehicle Technology Program	
Independence from Fossil Fuels, and Economic Impact	**The CEC estimates that by 2020 biodiesel and ethanol production will displace petroleum anywhere from 9.4-378.1 million gallons and 14-59.2 million gallons annually, respectively.**[392]
Impacts on Fuel Choice	Increased use of biodiesel and ethanol in place of diesel and gasoline.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	In December 2011, CEC published projected job benefits from the entire ARFVT Program, and **estimates that 5,400 jobs will be created to help implement their Program-funded projects, of which 1,912 are anticipated to be short-term jobs (1-18 months) and 3,482 are anticipated to be long-term jobs.** [393]
Impact on Different Sectors of the Economy	Job creation will be in manufacturing, construction, engineering as well as operation and maintenance. The CEC estimates about 1,500 jobs created in fuel production alone by the commercialization phase.[394]

12.4 Household Impacts and Co-benefits

[390] Ibid.
[391] The National Biodiesel Board. Advanced Biofuel Here and Now Brochure (August 2011). Online at: http://www.biodiesel.org/docs/default-source/ffs-basics/biodiesel--advanced-biofuel---here-and-now-brochure.pdf?sfvrsn=4
[392] California Energy Commission. Benefits report for the Alternative and Renewable Fuel and Vehicle Technology Program (December 2011). Online at: http://www.energy.ca.gov/2011publications/CEC-600-2011-008/CEC-600-2011-008-SD.pdf (page 34)
[393] Ibid (page 37).
[394] Ibid (page 37).

As a result of decreased fuel use and mobile emissions, the implementation of AFV programs generates benefits to public health. With the cleaner technologies of new or retrofitted vehicles, the New York and Illinois programs estimated reductions in pollutants such as particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen oxide (NOx), hydrocarbons, and carbon monoxide (CO). The Western New York Biodiesel Initiative stated that there was a major reduction in diesel odor and particulate matter emitted from the vehicles.[395] Air quality can improve with decreases in these pollutants, potentially improving the health and surrounding environments for school children, mass transit riders, truck drivers, and employees of the companies and jurisdictions participating in these AFV programs. Table 35 shows the reductions to the pollutants quantified for each program.

Table 35. Household Impacts and Co-Benefits of AFV purchase and charging technology and infrastructure support incentives.

New York City Transit Authority Clean-fueled Bus Program	
Effect on Household Consumption and Spending	No data readily available.
Measures to Mitigate to Low-income Populations, or Economic Impact	No data readily available.
Significant Co-benefits	Potential reduction in adverse effects to public health from diesel emissions. Reductions over the lifetime of the vehicles include: **PM_{10} = 89 metric tons** **NOx = 1,682 metric tons**[396]
Illinois Green Fleet: Clean Diesel Grant Program	
Effect on Household Consumption and Spending	No data readily available.
Measures to Mitigate to Low-income Populations, or Economic Impact	No data readily available.
Significant Co-benefits	Potential reduction in adverse effects to public health from diesel emissions. Annual reductions include: **$PM_{2.5}$ = 5.7 metric tons** **NOx = 907 metric tons** **Hydrocarbons = 8.3 metric tons**[397]

[395] NYSERDA Western New York Biodiesel Initiative Case Study. Online at: http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx

[396] NYSERDA/New York City Clean-Fueled Bus Program Case Study: Hybrid-electric and Natural Gas Buses. Online at: http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx

[397] Illinois Green Fleets: Green Jobs, Clean Diesel, Clean Air. 2009. *A Grant Application submitted to the U.S. Environmental Protection Agency-Region 5 by the Illinois Environmental Protection Agency, the American Lung Association of Illinois, and the Respiratory Health Association of Metropolitan Chicago on behalf of the Illinois Clean Diesel Workgroup*, (page 10). Online at: http://www.recovery.illinois.gov/documents/Applications/IEPA%2066.039%20National%20Clean%20Diesel.pdf

Western New York Biodiesel Initiative	
Effect on Household Consumption and Spending	No data readily available.
Measures to Mitigate to Low-income Populations, or Economic Impact	No data readily available.
Significant Co-benefits	Potential reduction in adverse effects to public health from diesel emissions. There has been a major reduction in diesel odor and particulate matter emitted from the vehicles.[398]
USDA Advanced Biofuel Payment Program	
Effect on Household Consumption and Spending	Data not readily available.
Measures to Mitigate to Low-income Populations, or Economic Impact	Data not readily available.
Significant Co-benefits	In addition to job creation and reduced carbon emission, advanced biofuels also create economic development opportunities, reduce urban air pollutants improve public health, and provide long-term energy security.
CEC Alternative and Renewable Fuel and Vehicle Technology Program	
Effect on Household Consumption and Spending	No data readily available.
Measures to Mitigate to Low-income Populations, or Economic Impact	No data readily available.
Significant Co-benefits	In addition to job creation and reduced carbon emission, advanced biofuels also create economic development opportunities, reduce urban air pollutants improving public health, and provide long-term energy security.

398 NYSERDA Western New York Biodiesel Initiative Case Study. Online at: http://www.nyserda.ny.gov/Publications/Case-Studies/AFV-Case-Studies.aspx

13 Investments in Public Transit Infrastructure

Policy Definition	Targeted Sector or Emissions
Public transit includes any means of mass transportation for the general public, which can include buses, trolleys, trains, metro systems, and ferries, among others. Public transit is often provided for reasons other than GHG reduction, including increased mobility of the population and accessibility to transportation, affordability of transportation, and reduced congestion. GHG reduction benefits from public transit come from moving a larger number of people on less fuel, and often cleaner fuel, than traditional passenger motor vehicle travel, reducing fossil fuel consumption, and therefore GHG emissions. In Washington as elsewhere, public transit is primarily a local activity serving the specific needs of each community.	Transportation

GHGs and Costs

GHG emission reductions directly attributable to public transit infrastructure development are difficult to quantify due to the high number of variables involved. In July of 2010, Johns Hopkins University and the Center for Climate Strategies estimated that transit expansion would result in 27.05 MMTCO2e annual reduction in GHG emissions nationwide by 2020, at an expected \$16.72/mtCO_2e cost. The analysis of expected reductions considered actions at the federal, state and local levels to implement transit programs, which included additional federal funding, additional state funding and "fast tracking" capital investment, and increased development of transit capacity and maintenance level of effort at the local level.

In 2008, the Washington State Climate Advisory Team quantified expected cumulative GHG savings of development and expansion of "Transit, Ridesharing, and Commuter Choice Programs" to be 23.6 MMTCO2e for the State of Washington from 2008-2020 (cost was not quantified). This policy included reducing statewide per capita VMT and working with local governments and regional planning organizations to achieve state targets.

Implementation Issues and Lessons Learned

- GHG reductions from expansion of public transit systems are achievable only when riders are taken off of the road at high enough levels to offset the GHG emissions from the operation of the transit system itself. Optimal reductions are achieved when systems are operating at or near ridership capacity. Therefore, it is important to increase ridership on existing infrastructure (which can be done by increasing frequency and reliability of service, among other alternatives) in addition to planning for system expansion.

Costs and Benefits to Consumers	Costs and Benefits to Businesses
• Funding for state-sponsored public transit improvements would likely come from an increase in taxes (fuel, motor vehicle excise) • Funding from local transit authorities would come from an increase in fares (ferries and transit) or local sales taxes • Benefits include improved mobility and accessibility to transportation to those who can not afford private vehicles or those who prefer to use public transportation in lieu of personal vehicles (providing a reliable and cost-saving alternative), and improved community and environment[399]	• Increasing public transit service may reduce the need for businesses to offer parking for employees • Funding for state-sponsored public transit improvements would likely come from an increase in taxes (fuel, motor vehicle excise)

[399] Connecting Washington Task Force. January 6, 2012. Page 2.

- For consumers using public transit, reduced fuel consumption costs transportation expenditures (for example, some households may be able to reduce the total number of cars or save money on maintenance for vehicles used less frequently).

Public transit includes any means of mass transportation for the general public, which can include buses, trolleys, trains, metro systems, and ferries, among others. Ideally, public transit moves a larger number of people on less fuel, and often cleaner fuel, than traditional passenger motor vehicle travel, reducing fossil fuel consumption, and therefore GHG emissions. GHG reductions from expansion of public transit systems are achievable only when riders are taken off of the road at high enough levels to offset the GHG emissions from the operation of the transit system itself. Optimal reductions are achieved when systems are operating at or near ridership capacity. Therefore, it is important to increase ridership on existing infrastructure (which can be done by increasing frequency and reliability of service, among other alternatives) in addition to planning for system expansion.

Public transit infrastructure in Washington State was given a "D+" (poor) grade by the Seattle Section of the American Society of Civil Engineers (ASCE) in their 2013 Report Card for Washington's Infrastructure, largely due to lack of maintenance, funding, and public transit options not keeping pace with population expansion.[400] While Washington has made investments in public transit and the State's grade is higher than the national average for transit, this still indicates an area for improvement that would contribute to emission reductions, with the co-benefit of increased options for mobility and potentially quality-of-life for Washington residents. In 2008, the Washington State Climate Advisory Team quantified expected cumulative GHG savings of development and expansion of "Transit, Ridesharing, and Commuter Choice Programs" to be 23.6 $MMTCO_2e$ for the State of Washington from 2008-2020 (cost was not quantified). This policy included reducing statewide per capita VMT and working with local governments and regional planning organizations to achieve state targets.[401]

The ASCE gave the United States a "D" (poor) grade for transit, due to lack of access, funding, and maintenance. ASCE noted that 45 percent of Americans do not have access to public transit, and those that do have access have increased ridership by 9.1 percent in the past ten years, meaning interest in public transit has increased, indicating an area for potential improvement in

[400] American Society of Civil Engineers (ASCE) Seattle Section. 2013 Report Card for Washington's Infrastructure. Page 65. Accessed July 2013 at: http://www.seattleasce.org/reportcard/2013ReportCardWA.pdf; and ACSE 2013 Report Card for America's Infrastructure State Facts: Washington. Accessed July 2013 at: http://www.infrastructurereportcard.org/a/#p/state-facts/washington

[401] Washington Climate Advisory Team. Leading the Way: A Comprehensive Approach to Reducing Greenhouse Gases in Washington State. January 25, 2008. Table 4.1. Page 76. Accessed September 2013 at: https://fortress.wa.gov/ecy/publications/publications/0801008b.pdf

emission reduction.[402] Given these factors, successful public transit programs in other countries may serve as the best programs to analyze.
In terms of the policy tools available to the State of Washington for influencing or supporting local transit authorities, the following are activities that WSDOT and the State legislature can undertake:

- WSDOT:
    - Setting state-level goals for transit and communicating and coordinating with transit authorities to ensure implementation of goals (for example, WSDOT's mobility objective of expanding and improving the effectiveness of existing planning and grant programs that support intercity, rural and special needs transportation)[403]
    - Providing grants and technical assistance to transit authorities
    - Providing planning assistance and direction on the types of projects in which investments should be made
    - Providing a centralized view of the transportation system as a whole (including cross-jurisdictional travel between transit authorities, freeway travel, and other modes of travel)

- State of Washington Legislative authority:
    - Approve "local option" sales tax rate that allows transit authorities to raise revenue
    - Review the classification of public transit as it pertains to the 18th amendment to the Washington State Constitution, potentially allowing gas tax revenues to be used for transit purposes

13.1 Existing Policies

This section analyzes existing policies implemented in other jurisdictions to support public transit infrastructure. California is analyzed because of its comparatively aggressive public transit policies at the state level and its proximity to Washington, and Germany and the United Kingdom are examined because of their successful use of various policies to develop public transit as an economic development tool, their focus on environmental sustainability, and their balance with personal automobile usage.[404] Vancouver, British Columbia, is included because of its proximity to Washington and similarities to the city of Seattle.

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[402] ACSE 2013 Report Card for America's Infrastructure: Transit. Accessed July 2013 at: http://www.infrastructurereportcard.org/transit/
[403] Hammond, P. WSDOT Strategic Plan 2011-2017. Strategic Goal: Mobility (Congestion Relief). September 2010. Objective 3.9. Page 26. Accessed September 2013 at: http://www.wsdot.wa.gov/NR/rdonlyres/533F8188-9F2B-4DAD-BF91-7590086A7904/0/StrategicPlan1117.pdf
[404] Akoto, E. *Public Transportation Policies in United States: Drawing Upon Lessons from Germany and United Kingdom*. Global Awareness Society International 21st Annual Conference. New York City, May 2012. Page 2. Accessed

California: The state of California has maintained a Public Transportation Account (PTA) since 1971, of which about half of the funds go to public transit in the State Transit Assistance Program for mass transit operations and capital projects.[405] Revenue for the PTA comes from State taxes on diesel and gasoline and truck weight fees. California also attracts federal matching funds from the Federal Highway Trust Fund (HTF), which collects funds from Federal fuel excise tax, with 85 percent of funds being allocated by the Federal Highway Administration (FHWA) amongst states as Federal matching funds for state highway system (SHS) projects.[406]

California has a biennially-updated five-year State Transportation Improvement Plan (STIP), which allocates State funds for highway improvements, intercity rail, and regional highway and transit improvements.[407] In addition, the 2008 Sustainable Communities and Climate Protection Law (SB 375) requires the 18 Metropolitan Planning Organizations (MPOs) in California to establish "sustainable communities strategies" on how to meet GHG reduction targets. As part of their obligations under that law, the cities of San Diego, Sacramento and Southern California regions have formally adopted transportation plans to reduce GHG emissions.[408]

Germany:[409] In Germany, the public transportation sector market share is five times higher than in the United States, with 8 percent of all German citizens' trips being made on public transportation, as compared with 1.6 percent of all American citizens' trips.[410] Germany is smaller and more populated per square mile than the U.S., which suits the country for the development and use of public transit systems. In Germany, the federal government provides a high percentage of the funding for transit systems, and transfers large amounts of money to local governments to fund public transit projects.[411] The German federalism reform of 2007 gave full responsibility of public transit systems, including budget management and planning decisions, to state governments.[412]

August 2013 at: http://orgs.bloomu.edu/gasi/2012%20Proceedings%20PDFs/Eunice%20Akoto-GASI-2012-%20Proceedings%20final-3.pdf

[405] California Budget Project. *How is Transportation Funded in California?* (September 2006). Page 3. Accessed July 2013 at: http://www.cbp.org/pdfs/2006/0609_transportationprimer.pdf

[406] California Department of Transportation. Transportation Funding in California. 2011 Page iii-iv. Accessed August 2013 at: http://www.dot.ca.gov/hq/tpp/offices/eab/fundchrt_files/Transportation_Funding_in_California_2011.pdf

[407] California Transportation Commission. State Transportation Improvement Program (STIP). Accessed July 2013 at: http://www.catc.ca.gov/programs/stip.htm

[408] Gazettenet. *California implements new transportation plans to cut greenhouse gas emissions*. (July 26, 2013). Accessed August 2013 at: http://www.gazettenet.com/home/7745999-95/california-implements-new-transportation-plans-to-cut-greenhouse-gas-emissions

[409] Buehler, R. and J. Pucher. *Demand for Public Transport in Germany and the USA: An Analysis of Rider Characteristics*. Transport Review. Vol. 32, No. 5, 541–567. (September 2012) Accessed July 2013 at: http://policy.rutgers.edu/faculty/pucher/PublicTransport_TRV_2012_BuehlerPucher_FINAL.pdf

[410] Buehler, R. and J. Pucher. *Making Public Transport Financially Sustainable*. Transport Policy, Volume 18, in press. Page 4. Accessed July 2013 at: http://policy.rutgers.edu/faculty/pucher/Sustainable.pdf

[411] Victoria Transport Policy Institute and Stantec Consulting Ltd. National Strategies on Public Transit Policy Framework – Final Report. May 2011. Page iv. Accessed August 2013 at: http://www.cutaactu.ca/en/publicaffairs/resources/FianlReport-G8.pdf

[412] Victoria Transport Policy Institute and Stantec Consulting Ltd. May 2011. Page 72.

United Kingdom:[413] The U.K. public transit system is among the best in Europe, and, the U.K.'s small but populous geography lends itself well to the development and use of public transit systems, specifically in systems with the potential to maximize ridership and reduce GHGs. The U.K. passed Transport Acts in 1980[414] and 1985[415] which limited regulation of the transit industry, and provided opportunities for private transit expansion by providing opportunities for privatization and limiting regulations on the transit industry.[416] In the U.K., 68 percent of transit system funding is obtained through commercial revenues, while 32 percent is from government subsidies.[417]

As part of the UK's Climate Change Act of 2008, and the associated Carbon Plan released in December of 2011, the government is funding specific public transit infrastructure improvement projects, including setting up the Local Sustainable Transport Fund to fund local-level transit projects aimed at economic growth and GHG reduction, the electrification of the North Transpennine route from Manchester to York (a rail transit project), and funding the fourth installment of the Green Bus fund, which supports the purchase of low carbon emission buses.[418]

Vancouver, British Columbia: TransLink is metropolitan Vancouver's central transit authority, which provides planning and services for transit, roadways, and walking. Since 2006, TransLink has operated with a stated Emissions Policy, which notes its commitment to reducing regional GHGs through decreased car ridership, using a variety of broad policies, along with its commitment to reduce its own organizational GHG emissions from the transit fleet.

TransLink has a 10-Year Transportation and Financial Plan, which involves the first integrated public transportation system in North America to be responsible for planning, financing, and managing the transit system along with major roads, bridges and modes of transportation.[419] The Plan involves three fully-funded years and an additional seven-year outlook. The Plan notes an expected revenue shortfall of $472 million from 2015 to 2015, due to increased prices of fuel, lack of new revenue sources, a declined request to the transportation commissioner to increase fares and lower toll revenues than forecast.[420] This will be partially offset by $98 million per year in cost savings measures (reducing overtime and administrative costs) and revenue

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413 United Kingdom Department for Transport. Accessed July 2013 at: https://www.gov.uk/government/organisations/department-for-transport
414 United Kingdom Legislation. Transport Act of 1980. Accessed July 2013 at: http://www.legislation.gov.uk/ukpga/1980/34/contents
415 United Kingdom Legislation. Transport Act of 1985. Accessed July 2013 at: http://www.legislation.gov.uk/ukpga/1985/67/contents
416 Akoto, E. (May 2012). Page 9. Accessed August 2013.
417 Akoto, E. (May 2012). Page 11. Accessed August 2013.
418 United Kingdom Department for Transport. *Reducing greenhouse gases and other emissions from transport*. October 3, 2012. Accessed August 2013 at: https://www.gov.uk/government/policies/reducing-greenhouse-gases-and-other-emissions-from-transport
419 TransLink. The 10-Year Transportation and Financial Plan. Accessed September 2013 at: http://www.translink.ca/en/Plans-and-Projects/10-Year-Plan.aspx
420 TransLink. 2013 Base Plan and Outlook. Financial Challenge. Accessed September 2013 at: http://www.translink.ca/en/Plans-and-Projects/10-Year-Plan/Base-Plan-and-Outlook.aspx

increasing (service optimization, reduced fare evasion and increased ridership with no new service).[421]

Annual trips per capita in Vancouver were 56 bus, 33 light rail, and 1 commuter rail in 2010, compared with Seattle's 43 bus, 3 light rail and 1 commuter rail trips in 2010.[422] In Vancouver, 61.4 percent of metropolitan residents and jobs are within walking distance from public transit, as compared with Seattle's 35.2 percent.[423]

13.2 GHG Impacts

GHG emission reductions directly attributable to public transit infrastructure development are difficult to quantify due to the high number of variables involved. GHG reductions come primarily from passenger vehicle riders changing modes of transportation to take more trips on public transit systems, increasing the efficiency of the public transit systems by increasing ridership on existing infrastructure, and from increasing the efficiency of public transit systems by electrification or cleaner running technologies, such as low emission bus fleets.

Table 36 below, summarizes the available GHG-related information for California, Germany and United Kingdom public transit infrastructure programs.

Table 36: GHG Costs and Benefits of Example Public Transit Infrastructure Programs

California	
Cost of Reductions	The 2014 STIP estimates that California will spend the following amounts for the 2013 – 2014 year:[424] • **$28.5 million on Rail and Mass Transportation support** • **$125.7 million on Intercity Rail support** • **$32 million capital outlay for STIP Rail and Mass Transportation projects** • **$3 million on the Bay Area Ferry**
Volume of Reductions	None noted.
Programmatic Status	The state-level policies for public transit development in California are among the most aggressive in the United States.
Emissions Leakage	None noted.
Germany	

[421] TransLink. 2013 Base Plan and Outlook. Efficiencies. Accessed September 2013 at: http://www.translink.ca/en/Plans-and-Projects/10-Year-Plan/Base-Plan-and-Outlook.aspx
[422] Williams-Derry, C. Transit Smackdown: Seattle vs. Portland vs. Vancouver. Sightline Daily. July 18, 2012. Accessed September 2013 at: http://daily.sightline.org/2012/07/18/transit-smackdown-seattle-vs-portland-vs-vancouver/ Note that these did not include ferry trips in the total trip count, which are significant for the city of Seattle.
[423] Scheurer, J. Spatial Network Analysis in Vancouver: Are we a Best-Practice Model for Land Use-Transport Integration? July 2, 2013. (PowerPoint Presentation) Slide 12. Accessed September 2013 at: http://www.sfu.ca/content/dam/sfu/continuing-studies/forms-docs/city/vancouver-salon-presentation-020713.pdf
[424] California Transportation Commission. *DRAFT 2014 STIP Fund Estimate*. June 11, 2013. Page 3. Accessed August 2013 at: http://www.catc.ca.gov/programs/STIP/2014_STIP/2014_draft_FundEstimates.pdf

Cost of Reductions	Through the Entflechtungsgesetz program, Germany provides around €1.6 billion (about US$2.1 billion) every year to capital investment projects for urban transportation.[425] Of note, Federal funds do not go to the railway operators (Deutsche Bahn) as the railways are expected to be economically viable without government assistance once operational.[426] Through the RegG program, Germany provides funds for public transit operation. In 2008, this amounted to €6.7 billion (about US$8.8 billion). State governments in Germany also contribute to funding, though this accounts for less than 10 percent of the total government contributions. In 2008, State government contributions were €907.2 million (about US$1.2 billion)[427]
Volume of Reductions	None noted.
Programmatic Status	The successes of the German program are attributed to:[428] • Expanded and improved service • Attractive Fares • Regional and Intermodal Coordination • Car Restrictions • Land-use Policies
Emissions Leakage	None noted.
United Kingdom	
Cost of Reductions	The UK's Climate Change Act of 2008 and associated Carbon Plan, as released in December 2011 include the following transit funding actions:[429] • £600 million (about US$930 million) from the Local Sustainable Transport Fund between 2011 and 2015 for 96 local transport projects across England to promote economic growth and cut carbon emissions. • Providing a further £20 million (about US$30 million) for the purchase of low carbon emission buses through the fourth round of the Green Bus fund, bringing the total support for this initiative to £95 million (about US$145 million) since its launch.
Volume of Reductions	The Carbon Plan released In December 2011 includes public transit as part of transport emissions reduction policies. By 2027, transport emissions should be between 17 and 28 percent lower than 2009 levels, according to the Plan. However, the majority of the decrease is expected to come from increases in personal vehicle efficiencies, not public transit investments.[430] This is estimated to be a decrease of about 21 $MMTCO_2e$.[431]

[425] Victoria Transport Policy Institute and Stantec Consulting Ltd. May 2011. Page 72.
[426] Victoria Transport Policy Institute and Stantec Consulting Ltd. May 2011. Page 73.
[427] Victoria Transport Policy Institute and Stantec Consulting Ltd. May 2011. Page 74.
[428] Jaffe, E. *5 Reasons Germans Ride 5 Times More Mass Transit Than Americans*. The Atlantic. (October 5, 2012). Accessed July 2013 at: http://www.theatlanticcities.com/commute/2012/10/5-reasons-germans-ride-5-times-more-transit-americans/3510/
[429] United Kingdom Department for Transport. *Reducing greenhouse gases and other emissions from transport*. October 3, 2012. Accessed August 2013 at: https://www.gov.uk/government/policies/reducing-greenhouse-gases-and-other-emissions-from-transport
[430] United Kingdom Department for Transport. *The Carbon Plan: Delivering our Low Carbon Future. December 2011*. Page 8. Accessed August 2013 at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47614/3751-carbon-plan-executive-summary-dec-2011.pdf

Programmatic Status	The UK's public transit system is considered among the best in Europe. The success of the Climate Change Act of 2008 and associated Carbon Plan will be better understood as the program evolves.
Emissions Leakage	None noted.
Vancouver, BC (TransLink)	
Cost of Reductions	Translink has seen its cost per revenue passenger decline from $3.85 in 2008 to $3.76 in 2012. Total expenditures in 2012 were $1.43 billion, broken down as follows:[432] • 60 percent Transit Operations • 13 percent Interest Expense • 12 percent Amoritization of Capital Assets • 8 percent Roads and Bridges • 4 percent Administration • 2 percent Transit Police • 1 percent AirCare
Volume of Reductions	In 2011, TransLink acheied Gold Level Status under APTA's Sustainability commitment for GHG progress (making TransLink the first transportation authority in North America to achieve this status).[433] Vancouver's AirCare Program, a mandatory vehicle emissions testing program operated by TransLink's wholly-owned subsidiary Pacific Vehicle Testing Technologies, Ltd., has reduced vehicle emissions by 33 percent since 1992.[434]
Programmatic Status	As noted in a study by the Victoria Transport Policy Institute, Vancouver has seen a decline in the number of registered automobiles and a reduction in downtown automobile trips, which has been attributed to increased transit services.[435]
Emissions Leakage	None noted.

13.3 Energy and Economic Impacts

The specific energy and economic impacts of focus for this analysis are not discussed in detail in analysis documents for the programs reviewed, as there are too many interacting variables and no specific data. As such, Table 37, below, summarizes the conceptual energy and economic impacts of implementing public transit infrastructure programs.

[431] United Kingdom Department for Transport. *The Carbon Plan: Delivering our Low Carbon Future. December 2011*. Page 47. Accessed August 2013 at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47615/3752-carbon-plan-parts-13-dec-2011.pdf
[432] TransLink 2012 Annual Report Highlights. Accessed September 2013 at: http://www.translink.ca/en/About-Us/Corporate-Overview/Corporate-Reports/Annual-Report.aspx
[433] TransLink 2012 Annual Report. Page 51. Accessed September 2013 at: http://www.translink.ca/~/media/documents/about_translink/corporate_overview/annual_reports/2012/translink_2012_annual_report.ashx
[434] TransLink 2012 Annual Report. Page 31. Accessed September 2013 at: http://www.translink.ca/~/media/documents/about_translink/corporate_overview/annual_reports/2012/translink_2012_annual_report.ashx
[435] Page 16. Accessed September 2013 at: http://www.vtpi.org/tranben.pdf

Table 37: Energy and Economic Impacts of Example Public Transit Infrastructure Programs

Conceptual Analysis	
Independence from Fossil Fuels, and Economic Impact	Depending on the type of transit system that is implemented and the adoption of travelers who were formally using personal vehicles, public transit can increase independence from fossil fuels. For example, large-scale implementation of electric rail transit in a state like Washington, where a large portion of the electricity is generated from hydro power, can aid in reducing the amount of fossil fuel consumed from personal vehicle trips.
Impacts on Fuel Choice	The availability of public transit does not affect the consumer fuel choice of travelers using personal vehicles. However, the fuel used for public transit may be different than the fuel used for personal vehicles (for example, lower emissions fuels such as CNG or biodiesel may be used in public transit buses, while gasoline or diesel may be used in personal vehicles).
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Public transit systems are infrastructure-intensive. Transit-related investments can be made in clean energy and energy efficient technologies; for example, low emitting buses and electric rail systems. The American Public Transportation Association (APTA) estimates that every dollar invested in public transportation results in four dollars of economic returns to the community.[436]
Impact on Different Sectors of the Economy	Construction and transportation sectors will be directly benefitted from investments in public transit.

13.4 Household Impacts and Co-Benefits

The specific household impacts of focus for this analysis are not discussed in detail in analysis documents for the programs reviewed. Generally, investments in public transit improve personal wellbeing, with increased access to mobility and transportation, and can enhance a jurisdictions' economy through additional job opportunities.[437] Table 38 below, summarizes the available information on impacts and co-benefits for implementing public transit infrastructure programs.

Table 38: Household Impacts and Co-Benefits of Example Public Transit Infrastructure Programs

California	
Effect on Household Consumption and Spending	None noted.

[436] American Public Transportation Association. Public Transportation Benefits. Accessed August 2013 at: http://www.apta.com/mediacenter/ptbenefits/Pages/default.aspx
[437] American Public Transportation Association. Public Transportation Benefits. Accessed August 2013 at: http://www.apta.com/mediacenter/ptbenefits/Pages/default.aspx

Measures to Mitigate to Low-income Populations, or Economic Impact	The State of California's Department of General Services offers transit vouchers to State employees who use public transportation to and from work, covering up to 75 percent of the cost per month (to a maximum of $65 per month).[438] Vouchers are provided by local and regional transit authorities (for example, Inglewood has a taxi voucher for customers 60 years or older with demonstrated need, or 18 years or older with a proof of disability).[439]
Significant Co-benefits	Reduced congestion from fewer personal vehicles, access to travel options for passengers who do not otherwise have access to personal vehicles. Benefits also include improved mobility and accessibility to transportation to those who cannot afford private vehicles or those who prefer to use public transportation in lieu of personal vehicles (providing a reliable and cost-saving alternative), and improved community and environment. For consumers using public transit, reduced fuel consumption costs transportation expenditures (for example, some households may be able to reduce the total number of cars or save money on maintenance for vehicles used less frequently).
Germany	
Effect on Household Consumption and Spending	None noted.
Measures to Mitigate to Low-income Populations, or Economic Impact	There are two types of subsidies that are provided nationally to German transit users:[440] • The SuperGold Card: provides seniors aged 65 years and older and veterans free • rides on transit during non-peak hours • Discounted taxi services are available for people with disabilities. Taxi vouchers provide a 50 percent discount off normal taxi fares
Significant Co-benefits	Reduced congestion from fewer personal vehicles, access to travel options for passengers who do not otherwise have access to personal vehicles. Benefits also include improved mobility and accessibility to transportation to those who can not afford private vehicles or those who prefer to use public transportation in lieu of personal vehicles (providing a reliable and cost-saving alternative), and improved community and environment. For consumers using public transit, reduced fuel consumption costs transportation expenditures (for example, some households may be able to reduce the total number of cars or save money on maintenance for vehicles used less frequently).
United Kingdom	
Effect on Household Consumption and Spending	None noted.
Measures to Mitigate to Low-income Populations, or Economic Impact	No national-level public transit voucher system was noted in the United Kingdom.

[438] California Department of General Services. Transit Vouchers. Accessed August 2013 at: http://www.dgs.ca.gov/ofam/Programs/Parking/TransitVouchers.aspx
[439] http://www.cityofinglewood.org/depts/rec/human_services/transportation/taxi_coupon_vouchers.asp
[440] Victoria Transport Policy Institute and Stantec Consulting Ltd. May 2011. Page 34.

Significant Co-benefits	Reduced congestion from fewer personal vehicles, access to travel options for passengers who do not otherwise have access to personal vehicles. Benefits also include improved mobility and accessibility to transportation to those who can not afford private vehicles or those who prefer to use public transportation in lieu of personal vehicles (providing a reliable and cost-saving alternative), and improved community and environment. For consumers using public transit, reduced fuel consumption costs transportation expenditures (for example, some households may be able to reduce the total number of cars or save money on maintenance for vehicles used less frequently).
Vancouver, BC (TransLink)	
Effect on Household Consumption and Spending	None noted.
Measures to Mitigate to Low-income Populations, or Economic Impact	In July of 2013, it was announced that TransLink's "FareSavers" program for low-income customers would be phased out as early as January 2014.[441] The "Compass" program will be introduced, which will allow for discounts over standard cash fees. TransLink notes that details will be forthcoming on additional programs to aid low-income customers.
Significant Co-benefits	Reduced congestion from fewer personal vehicles, access to travel options for passengers who do not otherwise have access to personal vehicles. Benefits also include improved mobility and accessibility to transportation to those who cannot afford private vehicles or those who prefer to use public transportation in lieu of personal vehicles (providing a reliable and cost-saving alternative), and improved community and environment. For consumers using public transit, reduced fuel consumption costs transportation expenditures (for example, some households may be able to reduce the total number of cars or save money on maintenance for vehicles used less frequently). Vancouver region traffic crash data have shown that automobile crash rates decline significantly with: bus stop density, percentage of transit-km traveled relative to total vehicle-kms traveled, and walking, biking, and transit commute mode share.[442]

[441] TransLink. Tariff Changes – July 2013. Accessed September 2013 at: http://www.translink.ca/en/About-Us/Governance-and-Board/Bylaws/Tariff-Changes.aspx
[442] Page 45 Accessed September 2013 at: http://www.vtpi.org/tranben.pdf

14 Public Benefit Fund

<table>
<tr><th colspan="2">Policy Definition</th><th>Targeted Sector or Emissions</th></tr>
<tr><td colspan="2">A funding mechanism often used to support programs related to energy efficiency, renewable energy, clean energy research and development, low-income assistance, and other programs that benefit the public at large. Funds are typically collected from electricity and natural gas ratepayers through a system benefits charge on their monthly utility bills.</td><td>Electricity and natural gas consumption in RCI sector</td></tr>
<tr><th colspan="3">GHGs and Costs</th></tr>
<tr><td colspan="3">• GHG reductions and reduction costs vary widely depending on the portfolio of PBF-funded programs.
• GHG reduction costs range from $29/mtCO$_2$ to $99/mtCO$_2$ for jurisdictions analyzed in this study.
• Cumulative lifetime GHG reductions from PBF-fund programs are typically in the tens of millions of metric tons CO_2
• System benefit charges range from about $0.0002/kWh to $0.0085/kWh depending on the state.</td></tr>
<tr><th colspan="3">Implementation Issues and Lessons Learned</th></tr>
<tr><td colspan="3">• Utility companies with coupled profits and sales may be opposed to a PBF because the energy efficiency and renewable energy programs funded by a PBF may reduce sales, revenue, and profit.
• Large energy consumers may oppose a PBF policy due to concerns about added energy costs.</td></tr>
<tr><th>Costs and Benefits to Consumers</th><th colspan="2">Costs and Benefits to Businesses</th></tr>
<tr><td>• Electricity rates will increase on a per kilowatt-hour basis as a result of the SBC, thus, higher energy consumers will pay more on an annual basis. These increased costs may be offset by the availability of resources for energy efficiency improvements.
• Increased access to energy conservation and distributed renewable technology incentives and financing.</td><td colspan="2">• Electricity rates will increase on a per kilowatt-hour basis as a result of the SBC, thus, energy intensive businesses such as is common in the industrial sector will pay more on an annual basis. These increased costs may be offset by the availability of resources for energy efficiency improvements.
• Increased access to energy conservation and distributed renewable technology incentives and financing and R&D funding.
• Expanded clean energy talent pool and job creation.</td></tr>
</table>

A public benefits fund (PBF) is a policy mechanism intended to provide long-term, stable funding to support a variety energy-related programs that benefit the public at large. Specifically, states use PBFs to fund programs related to energy efficiency, investment in renewable energy, reduction of energy usage, environmental concerns, and aid to low-income customers.[443] Through the successful reduction of energy usage, PBFs not only reduce GHG emissions but can save customers millions of dollars in energy costs through financial (for example, rebates, grants, loans and performance-based incentives) and technical efficiency assistance, training programs, education, and investment in renewable energy sources.

PBF revenues are typically collected from ratepayers through a small surcharge (a "system benefits charge") on electricity and/or gas consumption, or through a flat monthly fee. These

[443] DSIRE. 2013. Public Benefit Funds. Accessed August 2013 at: http://www.dsireusa.org/solar/solarpolicyguide/?id=22

charges are typically "non-bypassible," meaning they are assessed to all customers in a nondiscriminatory fashion since customers are charged a PBF fee without regard to where they purchase electricity (the charge is assessed for use of the distribution system rather than based upon the source of the electricity).[444] Alternatively, some PBFs are funded through specified contributions from utilities.[445] Recently, some states have begun to supplement PBFs using alternative compliance payments made by utilities under state renewable portfolio standard (RPS) programs, or the revenue from the sale of carbon emissions allowances in the Regional Greenhouse Gas Initiative (RGGI) auctions.[446]

PBF administration strategies vary by state. State energy offices, state agencies, state public service commissions, quasi-state organizations, nonprofit organizations, and utilities have been tasked in different states to be PBF administrators. A majority of PBF states utilize a hybrid approach, where different entities are responsible for managing separate aspects of the PBF under the direction of one primary oversight body.[447]

As part of a 2006 Ballot Initiative (Initiative 937), utilities in Washington are allowed to recover costs of their RPS mandates through PBF-like charges to customers, though Initiative 937 set up no state-level PBF for use in incentivizing renewable energy or energy efficiency projects.[448]

14.1 Existing Policies

Currently, 30 states and Washington, D.C. have a PBF fund of some sort.[449] The following are some examples of mandatory programs with rigorous state-level oversight and significant funding levels:

California: California created a PBF in 1998 to fund renewable energy, energy efficiency, and research, development and demonstration (RD&D) projects. Originally, the PBF collected a public goods charge (PGC) only on ratepayer electricity use, but a gas surcharge was added in 2001. The California Public Utilities Commission (CPUC) separately collects funds for the California Solar Initiative (CSI), the Self-Generation Incentive Program, the Renewables Portfolio Standard and others programs, but they are not captured in this analysis. In 2011, the state failed to pass legislation authorizing PGC collections in 2012 or later years. However, the Electric Program Investment Charge (EPIC) fund was created to collect funds to continue support for renewable energy and RD&D projects. In addition, a portion of the Procurement

[444] DOE. 2010. Public Benefit Funds: Increasing Renewable Energy & Industrial Energy Efficiency Opportunities. Accessed August 2013 at: http://www1.eere.energy.gov/manufacturing/states/pdfs/publicbenefitfunds.pdf
[445] Center for Climate and Energy Solutions, 2013. Public Benefit Funds. Accessed August 2013 at: http://www.c2es.org/sites/default/modules/usmap/pdf.php?file=5893
[446] DSIRE. 2013. Public Benefit Funds. Accessed August 2013 at: http://www.dsireusa.org/solar/solarpolicyguide/?id=22
[447] DOE. 2010. Public Benefit Funds: Increasing Renewable Energy & Industrial Energy Efficiency Opportunities. Accessed August 2013 at: http://www1.eere.energy.gov/manufacturing/states/pdfs/publicbenefitfunds.pdf
[448] Ibid
[449] Ibid

Energy Efficiency Balancing Account (PEEBA) was used to continue support for EE and low-income assistance programs on an interim basis. Further CPUC action is needed to continue funding of these programs.[450]

The California PGC/EPIC surcharge is non-bypassable, and the CPUC oversees the fund. Generally, the California Energy Commission (CEC) administers the renewable energy and RD&D programs, while utilities administer the energy efficiency and low-income assistance programs. California's surcharges on ratepayer electricity use average $0.0054/kWh for energy efficiency, $0.0016/kWh for renewable energy, and $0.0015/kWh for RD&D. From inception through about 2011, the PGC fund distributed approximately $228 and $62.5 million annually for energy efficiency and RD&D, respectively. Renewables received $135 million annually from 2002 to 2007 and $65.5 million annually from 2008 to 2011. Beginning 2005, natural gas subaccount baseline funding was $12 million with increases of up to $3 million annually to a $24 million cap. According to EPIC investment planning documents, $368.8 million has been budgeted for applied research and development, technology demonstration and deployment, and market facilitation from 2012 to 2014.[451]

Connecticut: Connecticut created separate PBFs to support energy efficiency and renewable energy in 1998. The state's two investor-owned utilities (IOU) began collecting electricity surcharges for the Energy Efficiency Fund and the Clean Energy Fund in 2000 for energy efficiency and renewable energy, respectively. Separately, each municipal electric utility is required to establish a fund for renewable energy, energy efficiency, conservation and load-management programs.[452]

Connecticut Energy Efficiency Fund (CEEF): The CEEF is funded by a surcharge of $0.003/kWh on Connecticut Light and Power and United Illuminating customers' electric bills. Each of the two utilities administers and implements efficiency programs with approval from the Connecticut Department of Public Utility Control. The CEEF also receives funding from the Regional Greenhouse Gas Initiative (RGGI), the ISO New England Forward Capacity Market (FCM), and Class III Renewable Credits. In 2011, the fund collected $154 million ($130.3 million from ratepayer collections; $3.6 million from ARRA/Oil; $17.9 million from the Forward Capacity Market; $5.6 million from Class III Renewables; $5.8 million from RGGI).[453]

Connecticut Clean Energy Fund (CCEF): The CCEF is administered by the Clean Energy Finance and Investment Authority (CEFIA), a quasi-governmental investment organization. In 2000-2001 the IOU ratepayer charge was set at $0.0005/kWh, rising to $0.00075/kWh in 2002-

[450] DSIRE. 2013. California Public Benefits Funds for Renewables and Efficiency. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA05R
[451] DSIRE. 2013. California Incentives/Policies for Renewables & Efficiency: Public Benefits Funds for Renewables and Efficiency. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA05R
[452] DSIRE. 2013. Connecticut Energy Energy Fund. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CT12R
[453] Ibid

2003 and "not less than" $0.001/kWh beginning July 1, 2004. Between 2000 and 2010, the CCEF distributed about $151 million or approximately $20 million annually (in 2010 $4.67 million came from ARRA). Funding from the CCEF is expected to be about $29 million annually from 2011 to 2017. Technologies eligible for funding include solar PV, biomass, hydroelectric, fuel cells, CHP/cogeneration, hydrogen, tidal energy, wave energy, ocean thermal, ethanol, biodiesel, fuel cells using renewable fuels, and other distributed generation technologies.[454]

New Jersey: New Jersey created a Societal Benefits Charge (SBC) to support six programs benefitting residents, businesses and municipalities beginning in 2001.[455]

- New Jersey's Clean Energy Program (NJCEP)
- Social Programs
- Nuclear Decommissioning Trust Fund
- Universal Service Fund
- Remediation Adjustment Clause (RAC) Expenditures
- Consumer Education

This analysis focuses on the NJCEP, a statewide initiative administered by the New Jersey Board of Public Utilities (BPU) that promotes increased energy efficiency and the use of clean, renewable sources of energy (the other SBC-funded programs have limited or no impact on energy and emissions). In 2012, the NJCEP received about 40 percent of total SBC fund distributions. Management of the NJCEP was turned over to third-party program managers Honeywell Utility Solutions and TRC Energy Solutions in 2007 with continued oversight by the BPU.[456]

The SBC is non-bypassable and assessed to all customers of New Jersey's seven investor-owned electric and gas public utilities. The amount collected is determined by the BPU and is currently set to about 3.8 percent of ratepayer energy bills. A total of $482 million was collected during 2001-2004 and a total of $745 million was collected from 2005-2008. In September 2008, the BPU approved a 2009-2012 budget of $1.213 billion, with approximately 80 percent ($950 million) of the budget devoted to energy efficiency programs and 20 percent ($243 million) allocated for renewable energy programs. Any unused funds from previous years are carried into the next year's budget. In November 2012, the BPU approved a six-month extension of funding through June 2013, and is currently considering funding levels for Fiscal Years (FY) 2014-2017. It is important to note that these budget numbers do not account for a variety of factors that may

[454] DSIRE. 2013. Connecticut Clean Energy Fund. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CT03R&re=1&ee=1
[455] NJ Clean Energy Program. 2013. About NJCEP: Societal Benefits Charge. Accessed August 2013 at: http://www.njcleanenergy.com/main/about-njcep/societal-benefits-charge/societal-benefits-charge-sbc
[456] DSIRE. 2013. New Jersey Societal Benefits Charge. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NJ04R

have small or large impacts on the actual annual budget including interest earned on the balance of funds that have already been collected, budget re-allocations between the energy efficiency and renewable energy, supplemental alternative compliance payments (ACPs) made under the state RPS, and transfers of money out of the fund to serve other state purposes.[457]

Oregon: Oregon's electricity IOUs began collecting a three percent public purpose charge (PPC) from their customers to support renewable energy and energy efficiency projects in 2002. In addition, Oregon natural gas customers are assessed a charge of 1.25-1.5 percent depending on their provider. The Energy Trust of Oregon (Energy Trust), an independent non-profit organization overseen by the Oregon Public Utilities Commission, receives about 74 percent of PPC funds. School districts receive about 10 percent of PPC funds for energy efficiency improvements in individual schools. The remaining 16 percent of PPC funds are dedicated to low-income housing development and weatherization assistance programs.[458] This analysis focuses on Energy Trust activities due to data availability.

Energy Trust funding from the PPC was about $83 million in 2012 with an additional $63 million coming from other sources. The Energy Trust's renewable energy programs include financial incentives for projects less than 20 megawatts (MW) that generate energy from solar, wind, hydro, biomass and geothermal resources. Efficiency programs include incentives for improvements to residential, commercial and new buildings, retrofit, appliances and manufacturing processes. The Energy Trust accepts applications for funding in response to specific programs, as well as through an open solicitation process. At least 80 percent of the energy conservation expenditures are concentrated in the service territory of the utility where the funds were collected. In 2007, Oregon's RPS legislation extended the program until 2025.[459]

14.2 GHG Impacts

Public benefit funds contribute to GHG reductions by funding energy efficiency and renewable energy programs that reduce energy consumption and replace traditional fossil fuel power generation with renewable sources. Each state administers a unique portfolio of funded programs and tracks slightly different metrics, making these programs difficult to compare to one another. In general, GHG impacts were only estimated for energy efficiency programs. New Jersey maintains an aggressive program with cumulative lifetime GHG reductions of 60.9 $MMTCO_2e$ at a cost of about $29 per $mtCO_2e$ for projects implemented from 2001 to 2012.[460] By contrast, the Energy Trust of Oregon has achieved 8.4 $MMTCO_2e$ of cumulative lifetime reductions at a cost

[457] Ibid

[458] DSIRE. 2013. Energy Trust of Oregon. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=OR05R&re=1&ee=1

[459] Ibid

[460] NJ Clean Energy Program. 2013. NJCEP Cumulative Results 2000-2012. Accessed August 2013 at: http://www.njcleanenergy.com/files/file/2001-2012%20Program%20Results.xls

of about $99 per $mtCO_2e$.[461] California spends significantly more each year on energy efficiency, renewable energy, and research projects than any other state. California's energy efficiency activities during 2010 and 2011 have reduced state emissions by 3.4 $MMTCO_2e$ per year.[462] Table 39 summarizes the available GHG-related information for the California, Connecticut, New Jersey, and Oregon programs.

Table 39: GHG Costs and Benefits of Example Energy Programs Funded by Public Benefit Funds

California Energy Efficiency Program (funded by Public Goods Charge)[463]	
Cost of Reductions	Cumulative lifetime emissions savings not presented. $1.6 billion spent from 2010-2011 for EE programs ($1,460 million for programs that directly reduce emissions).
Volume of Reductions	**3.4 $MMTCO_2e$ per year from 2010-2011 energy efficiency activities**.
Programmatic Status	Yes. The program is cost-effective overall, met savings goals, and made progress in all market sectors to encourage long-term market transformation. The program has achieved a total resource cost (TRC) test benefit to cost ratio of 2.02.
Emissions Leakage	None noted.
California Renewable Energy Program (funded by Public Goods Charge)[464]	
Cost of Reductions	Cumulative lifetime emissions savings not presented. $934 million spent from 1998-2011 for renewable energy programs.
Volume of Reductions	GHG reductions were not estimated.
Programmatic Status	Overall, the program has been considered a success. However, results for individual programs have been mixed.
Emissions Leakage	None noted.
California RD&D Program (funded by Public Goods Charge)[465]	
Cost of Reductions	Cumulative lifetime emissions savings not presented. $840 million spent for RD&D projects from 1997-2012
Volume of Reductions	GHG reductions were not estimated.

[461] Energy Trust of Oregon. 2013. 2012 Annual Report to the Oregon Public Utility Commission. Accessed August 2013 at:
http://energytrust.org/library/reports/2012_ETO_Annual_Report_OPUC1.PDF
[462] California Public Utilities Commission. 2012. 2010 – 2011 Energy Efficiency Annual Progress Evaluation Report. Accessed August 2013 at:
http://www.cpuc.ca.gov/NR/rdonlyres/89718A1B-C3D5-4E30-9A82-74ED155D0485/0/EnergyEfficiencyEvaluationReport.pdf
[463] Ibid
[464] California Energy Commission. 2011. Renewable Energy Program 2011 Annual Report To The Legislature. Accessed August 2013 at:
http://www.energy.ca.gov/2011publications/CEC-300-2011-007/CEC-300-2011-007-CMF.pdf
[465] California Energy Commission. 2013. Public Interest Energy Research 2012 Annual Report. Accessed August 2013 at:
http://www.energy.ca.gov/2013publications/CEC-500-2013-013/CEC-500-2013-013-CMF.pdf

Programmatic Status	Yes. The program is credited with significant job creation and inducing private investment.
Emissions Leakage	None noted.
Connecticut Energy Efficiency Fund[466]	
Cost of Reductions	$69/mtCO$_2$e (cumulative lifetime reductions from 2012 activities).
Volume of Reductions	2012 energy efficiency activities are expected to generate **182,000 mtCO2/yr, and 2.1M mtCO$_2$e cumulatively over their lifetime**.
Programmatic Status	Yes. The program is credited with reduced customer costs, job creation, and making the state's businesses more competitive. Connecticut also climbed to 6th in ACEEE 2012 State Energy Efficiency Scorecard Ranking.
Emissions Leakage	None noted.
Connecticut Clean Energy Fund[467]	
Cost of Reductions	**$12.8 million paid in renewable energy incentives** (associated emissions reductions not estimated)
Volume of Reductions	GHG reductions were not estimated.
Programmatic Status	The program is currently transitioning from the use of grants, rebates and other subsidies toward innovative low-cost financing.
Emissions Leakage	None noted.
New Jersey Clean Energy Program (funded by societal benefits charge)	
Cost of Reductions	**$29/mtCO$_2$e** (cumulative lifetime reductions from 2001-2012 activities).[468]
Volume of Reductions	**60.9 MMTCO$_2$e cumulative lifetime reduction from 2001-2012** activities.[469]
Programmatic Status	Companies that deliver program related services, including Program Managers, contractors, distributors, equipment manufacturers and retailers report overall program success. Most NJCEP programs are cost-effective based on TRC test, and participation goals were exceeded for most programs in 2010-2011. Total spending about 75-80 percent of budget. Areas for improvement include rebate processing time, marketing efforts, program longevity uncertainty.[470]
Emissions Leakage	None noted.

[466] Connecticut Energy Efficiency Board. 2013. Connecticut Energy Efficiency Fund 2012 Programs and Operations Report. Accessed August 2013 at: http://www.ctenergyinfo.com/FINAL%202012%20ALR%20Pages_2_18_13.pdf
[467] Clean Energy Finance and Investment Authority. 2013. Progress Through Partnerships Annual Report Fiscal Year 2012. Accessed August 2013 at: http://www.ctcleanenergy.com/annualreport/files/assets/downloads/publication.pdf
[468] NJ Clean Energy Program. 2013. NJCEP Cumulative Results 2000-2012. Accessed August 2013 at: http://www.njcleanenergy.com/files/file/2001-2012%20Program%20Results.xls
[469] Ibid
[470] Applied Energy Group. 2012. Evaluation of New Jersey's Clean Energy Programs. Accessed August 2013 at: http://www.njcleanenergy.com/files/file/Library/NJ%20Program%20Analysis%20Final%20Report%206-11-12.pdf

Energy Trust of Oregon (funded by Public Purpose Charge)[471]	
Cost of Reductions	**\$99/mtCO_2e** (for cumulative lifetime reductions and total spending of \$830 million from 2002-2012 activities).
Volume of Reductions	**8.4 MMTCO_2e cumulative lifetime savings from 2002-2012.**
Programmatic Status	Energy Trust has a 91 percent overall customer satisfaction rate according to a program survey. Electricity and natural gas energy efficiency savings and costs goals exceeded. Societal benefit to cost ratios range from 1.2-2.5 for various programs, and administrative costs are below program requirements. The program has generated significant positive economic and jobs impact.
Emissions Leakage	None noted.

14.3 Energy and Economic Impacts

Reports suggest significant energy and economic benefits from PBF-funded programs, including reduced electricity and fossil fuel consumption, increased renewable generation, job creation, and a bolstered economy. Annual distributions from California's PBF are many times higher than any other state. California requires the highest PBF surcharge, but this results in the greatest energy savings and job creation. Total electricity surcharges feeding into California's PBF were about \$0.0085/kWh in 2012.[472] California estimates that 2,800 direct and 4,500 indirect full-time jobs were sustained during 2012 as a result of the state's Public Interest Energy Research projects and in the long-term these projects would produce 27,700 direct, indirect, and induced jobs. In addition, CEC RD&D investments over 15 years totaled \$839 million and attracted \$1.35 billion in match funding.[473] Oregon claims substantial economic and job creation benefits as well. Oregon estimates that \$830 million in energy investments from 2002-2012 have added \$2.8 billion to the state's economy and created nearly 23,000 full-time equivalent job-years.[474] Table 40 summarizes the available energy and economic impact information for the California, Connecticut, New Jersey, and Oregon programs.

[471] Energy Trust of Oregon. 2013. 2012 Annual Report to the Oregon Public Utility Commission. Accessed August 2013 at:
http://energytrust.org/library/reports/2012_ETO_Annual_Report_OPUC1.PDF
[472] DSIRE. 2013. California Public Benefits Funds for Renewables and Efficiency. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA05R
[473] California Energy Commission. 2011. Renewable Energy Program 2011 Annual Report To The Legislature. Accessed August 2013 at: http://www.energy.ca.gov/2011publications/CEC-300-2011-007/CEC-300-2011-007-CMF.pdf
[474] Energy Trust of Oregon. 2013. 2012 Annual Report to the Oregon Public Utility Commission. Accessed August 2013 at:
http://energytrust.org/library/reports/2012_ETO_Annual_Report_OPUC1.PDF

Table 40: Energy and Economic Impacts of Example Energy Programs Funded by Public Benefit Funds

California Energy Efficiency Program (funded by Public Goods Charge)[475]	
Independence from Fossil Fuels, and Economic Impact	**84 million therms/yr reduction** in natural gas use from 2010-2011 activities.
Impacts on Fuel Choice	None noted.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	$1.6 billion spent from 2010-2011 for EE programs **($1,460 million for programs that directly reduce emissions**).
Impact on Different Sectors of the Economy	**$0.0054/kWh surcharge on electricity rates.**
California Renewable Energy Program (funded by Public Goods Charge)[476]	
Independence from Fossil Fuels, and Economic Impact	Impact not quantified, but 127 MW and 87,400 GWh of renewable generation replaces what may have otherwise been fossil-based power
Impacts on Fuel Choice	Increased access to distributed renewables.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	None noted.
Impact on Different Sectors of the Economy	$0.0016/kWh surcharge on electricity rates. Emerging Renewables Program: 28,673 systems installed, representing 127 MW of distributed capacity, with total disbursements of $409 million from 1998-2011. Existing Renewable Facilities Program: Production incentives of $326 million for 87,400 GWh (lifetime) of generation from 1998-2011.
California RD&D Program (funded by Public Goods Charge)[477]	
Independence from Fossil Fuels, and Economic Impact	None noted.
Impacts on Fuel Choice	None noted.

[475] California Public Utilities Commission. 2012. 2010 – 2011 Energy Efficiency Annual Progress Evaluation Report. Accessed August 2013 at: http://www.cpuc.ca.gov/NR/rdonlyres/89718A1B-C3D5-4E30-9A82-74ED155D0485/0/EnergyEfficiencyEvaluationReport.pdf
[476] California Energy Commission. 2011. Renewable Energy Program 2011 Annual Report To The Legislature. Accessed August 2013 at: http://www.energy.ca.gov/2011publications/CEC-300-2011-007/CEC-300-2011-007-CMF.pdf
[477] California Energy Commission. 2013. Public Interest Energy Research 2012 Annual Report. Accessed August 2013 at: http://www.energy.ca.gov/2013publications/CEC-500-2013-013/CEC-500-2013-013-CMF.pdf

Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Estimates developed by the California Clean Energy Future[478], suggest that replacing natural gas energy generation with renewable generation will increase employment by 2.5 to 30 times relative to the natural gas generation scenario, depending on the type of renewable generation with energy efficiency measures. Similarly, replacing fossil fuel energy stands to increase the number of jobs 9 times.
Impact on Different Sectors of the Economy	Over 15 years, the CEC invested **$839 million for energy RD&D projects and attracted $1.35 billion in match funding**. Private rate of return on RD&D around 20-30 percent, social return is around 66 percent. In 2012, PIER projects sustained 2,800 direct and 4,500 indirect full-time jobs (27,700 direct, indirect, and induced jobs is projected long-term as a result of these projects). $0.0015/kWh surcharge on electricity rates.
Connecticut Energy Efficiency Fund[479]	
Independence from Fossil Fuels, and Economic Impact	2012 activities resulted in **1.7 million mmBtu/yr savings and 19.8 million mmBtu lifetime savin**gs from natural gas, fuel oil and propane.
Impacts on Fuel Choice	None noted.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	General job creation claimed. No specific information provided.
Impact on Different Sectors of the Economy	**$0.003/kWh surcharge on electricity rates.**
Connecticut Clean Energy Fund[480]	
Independence from Fossil Fuels, and Economic Impact	4,648 kW of distributed solar PV capacity and 799 mmBtu/yr of solar thermal was incentivized and installed during FY 2012.
Impacts on Fuel Choice	Increased customer access to distributed solar PV and solar thermal
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	None noted.
Impact on Different Sectors of the Economy	**$0.001/kWh surcharge on electricity rates.**
New Jersey Clean Energy Program (funded by societal benefits charge)	
Independence from Fossil Fuels, and Economic Impact	**124 million mmBtu of lifetime cumulative natural gas avoided from EE and RE activities during 2001-2012.**[481]

[478] California Clean Energy Future - a collaboration of the California Air Resources Board, California Public Utilities Commission, California Energy Commission, California Environmental Protection Agency, and California Independent System Operator Corporation with the objective to advance carbon cutting innovation and green job creation through new investments in transmission, energy efficiency, smart grid applications, and increased use of renewable resources.

[479] Connecticut Energy Efficiency Board. 2013. Connecticut Energy Efficiency Fund 2012 Programs and Operations Report. Accessed August 2013 at: http://www.ctenergyinfo.com/FINAL%202012%20ALR%20Pages_2_18_13.pdf

[480] Clean Energy Finance and Investment Authority. 2013. Progress Through Partnerships Annual Report Fiscal Year 2012. Accessed August 2013 at: http://www.ctcleanenergy.com/annualreport/files/assets/downloads/publication.pdf

Impacts on Fuel Choice	Very low participation in ground source heat pumps and solar hot water, both of which decrease natural gas consumption.[482]
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Development of contractor and supplier infrastructure, economic development[483], and additional jobs for local construction trades; opportunities for EE and RE businesses (not quantified).[484]
Impact on Different Sectors of the Economy	**Surcharge increases electricity and NG rates by about 3.8 percent,** [485]
Energy Trust of Oregon (funded by Public Purpose Charge)[486]	
Independence from Fossil Fuels, and Economic Impact	From **2002 to2012, cumulative savings reached 3,224 GWh/yr for electricity and 28.2 million therms/yr for natural gas.** Cumulatively, renewable generation reached 964 GWh from 2002 to 2012.
Impacts on Fuel Choice	Support for large and small scale solar, small wind, hydro, and geothermal plus investments in dairy gas, wastewater treatment, and wood waste gasifier biopower.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Wood waste gasification demonstration; Anaerobic digestion for electricity production at wastewater treatment plants; Small wind on farmland.
Impact on Different Sectors of the Economy	**Since 2002, cumulatively added $2.7 billion to local economy, including $793 million in wages, $155 million in small business income and 22,400 FTE job-years.** Electricity surcharge increases rate by about 3%. Natural Gas surcharge increases rate by 1.25-1.5 percent. 74 percent of surcharge collections feed into Energy Trust.

14.4 Household Impacts and Co-Benefits

Energy efficiency and renewable programs funded by PBFs result in significant energy and energy cost savings for state residents. 2010-2011 energy efficiency activities in California saved nearly 600 GWh of electricity and about 21 million therms of natural gas per year.[487] By comparison, Connecticut and Oregon each reduced annual electricity by about 140 GWh and

[481] NJ Clean Energy Program. 2013. NJCEP Cumulative Results 2000-2012. Accessed August 2013 at: http://www.njcleanenergy.com/files/file/2001-2012%20Program%20Results.xls
[482] Applied Energy Group. 2012. Evaluation of New Jersey's Clean Energy Programs. Accessed August 2013 at: http://www.njcleanenergy.com/files/file/Library/NJ%20Program%20Analysis%20Final%20Report%206-11-12.pdf
[483] Ibid
[484] NJ Clean Energy Program. 2013. About NJCEP: Societal Benefits Charge. Accessed August 2013 at: http://www.njcleanenergy.com/main/about-njcep/societal-benefits-charge/societal-benefits-charge-sbc
[485] Ibid
[486] Energy Trust of Oregon. 2013. 2012 Annual Report to the Oregon Public Utility Commission. Accessed August 2013 at:
http://energytrust.org/library/reports/2012_ETO_Annual_Report_OPUC1.PDF
[487] California Public Utilities Commission. 2012. 2010 – 2011 Energy Efficiency Annual Progress Evaluation Report. Accessed August 2013 at: http://www.cpuc.ca.gov/NR/rdonlyres/89718A1B-C3D5-4E30-9A82-74ED155D0485/0/EnergyEfficiencyEvaluationReport.pdf

natural gas by 8 million and 2.5 million therms, respectively from 2012 programs.[488, 489] California strongly emphasizes the importance of energy innovation claiming that $27.6 million invested in energy research from 1999 to 2008 will result in over $10 billion in energy cost savings for state residents between 2005 and 2025.[490] California and several other states also acknowledge air pollution co-benefits of energy efficiency and renewable energy programs. Specifically, these programs note reductions in NOx, SOx, particulate matter, and mercury emissions. Table 41 summarizes the available household impact and co-benefit information for the California, Connecticut, New Jersey, and Oregon programs.

Table 41: Household Impacts and Co-Benefits of Example Energy Programs Funded by Public Benefit Funds

California Energy Efficiency Program (funded by Public Goods Charge)[491]	
Effect on Household Consumption and Spending	**2010-2011 activities resulted in annual savings of 132 MW, 595 GWh, and 21 million therms in the residential sector.**
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted.
Significant Co-benefits	Reduction in pollutant emissions including NOx, and PM10
California Renewable Energy Program (funded by Public Goods Charge)[492]	
Effect on Household Consumption and Spending	None noted
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted
Significant Co-benefits	None noted
California RD&D Program (funded by Public Goods Charge)[493]	

[488] Connecticut Energy Efficiency Board. 2013. Connecticut Energy Efficiency Fund 2012 Programs and Operations Report. Accessed August 2013 at: http://www.ctenergyinfo.com/FINAL%202012%20ALR%20Pages_2_18_13.pdf
[489] Energy Trust of Oregon. 2013. 2012 Annual Report to the Oregon Public Utility Commission. Accessed August 2013 at:
http://energytrust.org/library/reports/2012_ETO_Annual_Report_OPUC1.PDF
[490] California Energy Commission. 2013. Public Interest Energy Research 2012 Annual Report. Accessed August 2013 at: http://www.energy.ca.gov/2013publications/CEC-500-2013-013/CEC-500-2013-013-CMF.pdf
[491] California Public Utilities Commission. 2012. 2010 – 2011 Energy Efficiency Annual Progress Evaluation Report. Accessed August 2013 at: http://www.cpuc.ca.gov/NR/rdonlyres/89718A1B-C3D5-4E30-9A82-74ED155D0485/0/EnergyEfficiencyEvaluationReport.pdf
[492] California Energy Commission. 2011. Renewable Energy Program 2011 Annual Report To The Legislature. Accessed August 2013 at: http://www.energy.ca.gov/2011publications/CEC-300-2011-007/CEC-300-2011-007-CMF.pdf
[493] California Energy Commission. 2013. Public Interest Energy Research 2012 Annual Report. Accessed August 2013 at: http://www.energy.ca.gov/2013publications/CEC-500-2013-013/CEC-500-2013-013-CMF.pdf

Effect on Household Consumption and Spending	$27.6 million invested in efficiency research from 1999-2008 is estimated to result in $10.1 billion in benefits to ratepayers between 2005 and 2025 from 122,600 GWh of electricity savings and 1.1B therms of natural gas savings. PIER-funded demand response technologies are avoiding 260 MW of peak load annually and saved California electricity ratepayers an estimated $16.5 million in 2012. By 2020, the effects of PIER synchrophasor research and related applications will save Californians an estimated $210-$360 million annually by improving reliability and avoiding costly outages and will provide $90 million per year in other economic benefits.
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted
Significant Co-benefits	None noted
Connecticut Energy Efficiency Fund[494]	
Effect on Household Consumption and Spending	The 2012 Residential Program served 500,836 customers, generating $27.9M, 137 GWh, and 8 million therms of annual savings. Over the lifetime of these measures, savings are estimated to total $276.4 million, 965.9 GWh, and 93M therms.
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted.
Significant Co-benefits	2012 activities will result in lifetime air emissions reductions of 144 metric tons SOx and 288 metric tons NOx.
Connecticut Clean Energy Fund[495]	
Effect on Household Consumption and Spending	None noted.
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted.
Significant Co-benefits	None noted.
New Jersey Clean Energy Program (funded by societal benefits charge)	
Effect on Household Consumption and Spending	Every dollar invested in the energy efficiency program returns $4.00 in savings for the residential customer and $11.00 in savings for the commercial and industrial customer.[496]

[494] Connecticut Energy Efficiency Board. 2013. Connecticut Energy Efficiency Fund 2012 Programs and Operations Report. Accessed August 2013 at: http://www.ctenergyinfo.com/FINAL%202012%20ALR%20Pages_2_18_13.pdf
[495] Clean Energy Finance and Investment Authority. 2013. Progress Through Partnerships Annual Report Fiscal Year 2012. Accessed August 2013 at: http://www.ctcleanenergy.com/annualreport/files/assets/downloads/publication.pdf
[496] Applied Energy Group. 2012. Evaluation of New Jersey's Clean Energy Programs. Accessed August 2013 at: http://www.njcleanenergy.com/files/file/Library/NJ%20Program%20Analysis%20Final%20Report%206-11-12.pdf

Measures to Mitigate to Low-income Populations, or Economic Impact	NJCEP offers EE home improvements, energy education, weatherization assistance; NJCEP spent $256 million during 2001-2012 with lifetime cumulative savings of 1.3 million MWh and 13.4 million mmBtu. Low-income energy bill payment assistance (at least $292 million in 2012 separate from NJCEP).[497]
Significant Co-benefits	Overall reduction in pollutant emissions including NOx, SO_2, and mercury.[498]
Energy Trust of Oregon (funded by Public Purpose Charge)[499]	
Effect on Household Consumption and Spending	141 GWh and 2.5 million therms saved at nearly 17,000 new and existing homes that received Energy Trust services in 2012.
Measures to Mitigate to Low-income Populations, or Economic Impact	4.5 percent of public purpose charge dedicated to low-income housing plus $10 million for electric-bill paying assistance; Program distributes energy-saver kits and offers increased incentive levels for low and moderate-income ratepayers.
Significant Co-benefits	None noted.

[497] NJ Clean Energy Program. 2013. NJCEP Cumulative Results 2000-2012. Accessed August 2013 at: http://www.njcleanenergy.com/files/file/2001-2012%20Program%20Results.xls
[498] Ibid
[499] Energy Trust of Oregon. 2013. 2012 Annual Report to the Oregon Public Utility Commission. Accessed August 2013 at:
http://energytrust.org/library/reports/2012_ETO_Annual_Report_OPUC1.PDF

15 Property Assessed Clean Energy (PACE) Programs

<table>
<tr><th>Policy Definition</th><th>Targeted Sector or Emissions</th></tr>
<tr><td>PACE programs provide or arrange for financing for home and/or building owners to install energy conservation or renewable energy measures. The loans are repaid through a property tax-like assessment with a term length of up to 20-years. These loans allow owners to pay for energy improvements over time, avoiding the barrier of upfront investment costs.</td><td>Electricity and natural gas consumption in RCI sector</td></tr>
<tr><th colspan="2">GHGs and Costs</th></tr>
<tr><td colspan="2">• GHG reductions from existing programs are modest but may not reflect the full potential of PACE since these programs are in their infancy and often have limited funding.
• Unlike utility energy programs funded through a system benefits charge or cost recovery rate adjustments assessed to all ratepayers, participation in PACE is voluntary.
• PACE programs are typically authorized by state law but administered at the city or county level. This means that PACE programs limited costs at the state level once state legislation has been passed. Municipalities may be able to recover some or all administrative costs through application or project fees, increased interest rates, or other sources such as grants.[500]</td></tr>
<tr><th colspan="2">Implementation Issues and Lessons Learned</th></tr>
<tr><td colspan="2">• The Federal Housing Finance Agency currently prevents Fannie Mae and Freddy Mac from purchasing PACE encumbered mortgages which has essentially stalled residential PACE.
• One of the primary challenges state and local programs face when launching a PACE program is acquiring seed funding, or a pool of funding dollars from which lending can occur.</td></tr>
<tr><th>Costs and Benefits to Consumers</th><th>Costs and Benefits to Businesses</th></tr>
<tr><td>• Increased access to energy conservation and distributed renewable technology incentives and financing.
• Improved grid reliability and emissions rates.</td><td>• Increased access to energy conservation and distributed renewable technology incentives and financing.
• Increased access to energy research, development, deployment, and other business development funding.
• Improved grid reliability and emissions rates.
• Expanded clean energy talent pool and job creation.</td></tr>
</table>

Property assessed clean energy (PACE) programs operate by providing a unique loan mechanism to property owners for the deployment of energy efficient technologies and renewable energy at residential, commercial and industrial facilities. These loans allow owners to pay for energy improvements over time, avoiding the barrier of upfront investment costs.

The underlying PACE mechanism is and common to all programs: a local government provides or arranges for financing that is repaid with a property tax-like assessment with a term length of up to 20-years. PACE loans are different from other loans, since they typically stay with the

[500] Sustainable Cities Institute. Property Assessed Clean Energy Program Overview. Accessed August 2013 online at: http://www.sustainablecitiesinstitute.org/view/page.basic/class/feature.class/Lesson_PACE_Financing

property. If a homeowner sells their home before the loan is paid off, the loan can either be paid off at the time of sale or transferred with the property to the new owner. Each program is unique and will reflect different enabling acts, budgetary resources, program administration strategies, and level of community and local government support[501]. By promoting energy conservation and renewable power generation, PACE programs capture energy cost savings and realize environmental co-benefits including reduced emissions from fossil energy consumption, water conservation and improved air quality.

Although PACE programs are often conducted at the local level, they must be authorized by state law. Today, 30 states and the District of Columbia can implement PACE programs. Early interest in PACE focused on the residential sector from 2008 through 2010. However, shortly after that the Federal Housing Finance Agency (FHFA) ordered Fannie Mae and Freddie Mac to stop buying PACE encumbered mortgages in July 2010 due to concerns regarding the structure of loans used to finance residential PACE programs. Specifically, the FHFA raised concerns regarding PACE loans that acquire a priority lien over existing mortgages. Unlike routine tax assessments, these priority liens pose risk management challenges for lenders, servicers and mortgage securities investors, but are not essential for PACE programs to spur fossil energy conservation.[502] As a result, state legislative efforts to enable PACE slowed in 2010. A few law suits have been filed in response to the FHFA's position on residential PACE but all have been unsuccessful. In March 2013, the Ninth Circuit ruled that the courts have no jurisdiction to interfere with FHFA's decision because the agency acted as a "conservator" of Fannie and Freddie, rather than as a regulator. Despite this challenge, some residential programs have continued to move forward with PACE loans receiving a subordinate lien position relative to existing mortgages. One drawback of this strategy is that the resulting increased risk to private investors significantly inhibits their interest in investing in PACE programs. The FHFA limitations do not affect commercial PACE. As more commercial PACE programs have launched and achieved early stage success in the last two years, interest in passing or amending flawed legislation has increased[503].

One of the primary challenges states and municipalities face when launching PACE programs is acquiring seed funding. Many active PACE programs launched with seed funding provided by federal grants through the American Recovery and Reinvestment Act of 2009 (ARRA). However, ARRA funds and other potential federal funding sources have essentially dried up as a result of cuts to federal spending. Likewise, the recent economic recession in the U.S. has led to budgetary issues at the state and local government levels as well. Banks and private investment

[501] PACENow. 2013. Annual Report. Accessed August 2013 at: http://pacenow.org/wp-content/uploads/2013/06/Annual-report-6.18.13.pdf
[502] Federal Housing Finance Agency (FHFA). FHFA Statement on Certain Energy Retrofit Loan Programs. (July 6, 2010). Accessed July 2013 at: http://www.fhfa.gov/webfiles/15884/PACESTMT7610.pdf
[503] PACENow. 2013. Annual Report. Accessed August 2013 at: http://pacenow.org/wp-content/uploads/2013/06/Annual-report-6.18.13.pdf

firms have the potential to kick-start these programs, but currently stand on the sidelines pending the issuance of the FHFA's final rule regarding residential PACE.

Research conducted by ECONorthwest in April 2011 suggests that PACE programs have the potential to generate significant economic and fiscal impacts. Specifically, modeling of hypothetical PACE programs in Columbus, Ohio, Long Island, New York, Santa Barbara, California, and San Antonio, Texas indicates that $4 million in total PACE project spending across the four cities ($1 million in spending in each city) will generate $10 million in gross economic output, $1 million in combined federal, state and local tax revenue, and 60 jobs (about $67,000 per job), on average.[504]

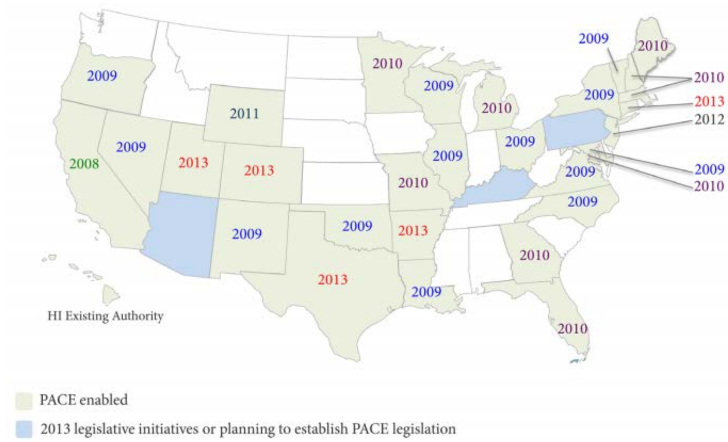
Household energy and energy cost savings achieved from this hypothetical PACE spending were not quantified; however, ECONorthwest did model the impacts of increased consumer spending for a single household achieving energy cost savings of $1,000 per year for 25 years. It should be noted that the results of this modeling effort do not account for any utility revenue losses that would partially offset impacts of increased consumer spending, but ECONorthwest calculated gross spending effects at the local level of about $21,000 in gross economic output, $7,000 in personal income, $3,000 in combined federal, state and local tax revenue, and 0.2 local jobs on average.[505]

15.1 Existing Policies

Currently, 30 states and the District of Columbia have legislation in place that allows municipalities to establish PACE funding programs to finance energy efficiency and renewable energy programs (see Figure 6). Collectively, these pieces of legislation encompass 80 percent of the U.S. population[506]. Many PACE programs are in their infancy and lack a significant portfolio of financed projects from which to gather data. In addition, many programs employ extremely lean operational strategies and avoid onerous reporting requirements as much as possible in an effort to maximize the utilization of available PACE financing for energy improvements. As a result, limited program performance data are available for PACE programs.

[504] ECONorthwest. 2011. Economic Impact Analysis of Property Assessed Clean Energy Programs (PACE). Accessed August 2013 at: http://pacenow.org/wp-content/uploads/2012/08/Economic-Impact-Analysis-of-Property-Assessed-Clean-Energy-Programs-PACE.pdf
[505] Ibid
[506] PACENow. 2013. Annual Report. Accessed August 2013 at: http://pacenow.org/wp-content/uploads/2013/06/Annual-report-6.18.13.pdf

Figure 6: PACE Legislative History in the U.S. [507]



The following list includes some example programs with published performance data:

- Maine PACE Loan Program[508]
- Boulder County, Colorado, ClimateSmart Loan Program (CSLP)[509]
- Sonoma County, California, Sonoma County Energy Independence Program (SCEIP)[510]

Maine PACE Loan Program: Launched in April 2011, the Maine PACE Loan Program provides $6,500 to $15,000 loans to Maine homeowners to finance the cost of eligible energy saving improvements and offers repayment periods of 5, 10, or 15 years at a fixed interest rate of 4.99 percent APR, with no processing fees.[511] PACE loans are available for residential buildings with one to four units that meet a set of minimum underwriting requirements and are located in municipalities that have passed a PACE ordinance. In addition, energy efficiency improvements packages must generate savings of at least 20 percent of home energy usage or 25 percent of heating and hot water energy usage to qualify for a PACE loan. PACE-eligible energy improvements include, but are not limited to: insulation, air sealing, energy efficient heating systems, lighting and appliances, windows and doors, and solar energy systems. Maine's PACE law dictates that loans do not have a senior priority over a primary home mortgage.[512]

As of February 2013, a total of 158 Maine municipalities had passed PACE ordinances and entered into an agreement with Efficiency Maine to administer the loan program on their behalf. Residents of these towns comprise about three quarters of the state population and have

507 Ibid
508 Efficiency Maine. Accessed July 2013 at: http://www.efficiencymaine.com/
509 Boulder County ClimateSmart Loan Program. Accessed August 2013 at: http://www.bouldercounty.org/env/sustainability/pages/cslp.aspx
510 Sonoma County Energy Independence Program. Accessed August 2013 at: http://www.sonomacountyenergy.org/
511 DSIRE. 2013. Maine PACE Loans. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=ME20F
512 Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: http://www.efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf

submitted a total of more than 1,800 loan applications[513]. Efficiency Maine has established a $20.4 million revolving loan fund for the PACE and PowerSaver Loan Program[514] primarily using Federal grant money through the DOE BetterBuildings Program. As homeowners pay back the loans, the loan fund will be replenished for the next round of homeowner applicants[515].

Boulder County, Colorado, ClimateSmart Loan Program (CSLP): The ClimateSmart Loan Program offered loans to Boulder County property owners who wanted to make energy efficiency and renewable energy improvements to their property. In June 2010, residential financing was cancelled and the loan program was put on-hold until issues with the FHFA and federal mortgage regulators, Fannie Mae and Freddie Mac, could be resolved. Subsequently, the commercial loan program was also suspended.[516]

The Boulder County, Colorado, CLSP was the first test of PACE financing on a multi-jurisdictional level (involving individual cities as well as the county government). It was also the first PACE program to comprehensively address energy efficiency measures and renewable energy, and it was the first funded by a public offering of both taxable and tax-exempt bonds. Initiated in 2009, the first phase of the CSLP included two rounds of residential project financing and resulted in about $9.8 million in project loans. Associated program costs and fees and funding of a reserve account for the bonds added $3.2 million, for a total of about $13 million in Phase 1 program spending.[517]

The minimum borrowing level for the first phase of the CLSP was $3,000 per home. The maximum borrowing limit for open loans (using taxable bonds), was the lesser of 20 percent of actual property value, or $50,000. For income-qualified loans (using tax-exempt bonds), the maximum borrowing limit was set to $15,000 per home. Interest rates on PACE loans ranged from 5.2 percent to 6.8 percent depending on the type of bond and the issue. PACE loans were repaid through a 15-year assessment on each participant's property taxes (senior lien). If a property owner sells a PACE-assessed home or business, the assessment stays with the property, with responsibility passing to the next owner until the debt is paid.[518]

Sonoma County, California, Sonoma County Energy Independence Program (SCEIP): Sonoma County's Energy Independence Program gives residential and non-residential property

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[513] Ibid

[514] The PowerSaver Loan Program covers the same home energy improvements as PACE, but offers a wider range of loan amounts, is available statewide, and has slightly different eligibility criteria.

[515] Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: http://www.efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf

[516] Boulder County, Colorado Website. Accessed August 2013 at: http://www.bouldercounty.org/env/sustainability/pages/cslp.aspx

[517] National Renewable Energy Laboratory. 2011. Economic Impacts from the Boulder County, Colorado, ClimateSmart Loan Program: Using Property-Assessed Clean Energy (PACE) Financing. Accessed August 2013 at: http://www.nrel.gov/docs/fy11osti/52231.pdf

[518] Ibid

owners the option of financing energy efficiency, water efficiency and renewable energy improvements through a voluntary assessment on their property tax bills. The property tax assessments are attached to the property, not the property owner, meaning that if the property is sold, the assessment stays with the property. In 2010, Sonoma County's PACE program was temporarily suspended in response to the FHFA's statement of concerns regarding residential PACE financing on July 10, 2010 but was immediately re-opened by the Sonoma County Board of Supervisors on July 13, 2010.[519]

The minimum funding level offered by SCEIP is $2,500 and assessments may not exceed 10 percent of the property value[520]. In addition, the sum of all debt associated with the property cannot exceed 100 percent of the value of the property at the time loan is made.[521] This assessment is final regardless of whether or not the property value decreases[522]. The SCEIP can be combined with utility and state rebates, but financing will only be available for the post-incentive cost. Tax credits will not affect the amount of financing available[523]. The repayment period is 10 years for amounts from $2,500 to $4,999 and projects over $5,000 may be repaid over a term of either 10 or 20 years, at the property owner's option. Projects of $60,000 up to $500,000 require approval by the Program Administrator, and projects over $500,000 require specific approval by the Board of Supervisors. The current interest rate for SCEIP assessment contracts is 7 percent simple interest. The interest rate is fixed at the time the assessment contract and implementation agreement are signed and will not rise.[524]

Commercial and industrial properties must first have an energy audit before participating in the program. Energy audits are not required for residential participants, but they are strongly recommended. Beginning March 1, 2011, the SCEIP offers rebates of up to 75 percent for the cost of energy analyses performed by certified raters.[525]

A key SCEIP enhancement effective July 1, 2011, is the requirement of achieving 10 percent energy efficiency improvement on the property prior to (or along with) the financing of

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[519] DSIRE. 2013. Sonoma County – Energy Independence Program. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F
[520] Sonoma County Energy Independence Program FAQs. Accessed August 2013 at: http://residential.sonomacountyenergy.org/lower.php?url=faqs-75
[521] DSIRE. 2013. Sonoma County – Energy Independence Program. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F
[522] University of San Diego Energy Policy Initiatives Center. 2013. Residential and Commercial Property Assessed Clean Energy (PACE) Financing in California. Accessed September 2013 at: http://energycenter.org/sites/default/files/docs/nav/policy/research-and-reports/PACE%20in%20California.pdf
[523] DSIRE. 2013. Sonoma County – Energy Independence Program. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F
[524] Sonoma County Energy Independence Program FAQs. Accessed August 2013 at: http://residential.sonomacountyenergy.org/lower.php?url=faqs-75
[525] DSIRE. 2013. Sonoma County – Energy Independence Program. Accessed August 2013 at: http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA188F

renewable generation upgrade projects. This approach supports SCEIP's regional goal to "reduce and produce," and it strengthens the market position of the SCEIP assessment portfolio.[526]

15.2 GHG Impacts

PACE programs reduce GHGs from fossil energy consumption by providing financing to home and building owners to make energy efficiency improvements and install renewable energy technologies. GHG savings were not reported in published program reports, but were calculated externally for the Maine PACE and ClimateSmart Loan Programs based on reported energy savings and some basic assumptions detailed below. Estimated gross annual GHG reductions achieved by each program are just over 1,000 mtCO_2e per year. Since PACE programs provide "financing" as opposed to "funding," the cost of these reductions is minimal and includes general administrative costs, the development of a risk-management reserve fund, loan fees, and other related costs.

Table 42: GHG Costs and Benefits of Example PACE Programs

Maine PACE Loan Program[527]	
Cost of Reductions	Loan program (no cost other than administrative costs). Administrative costs not presented.
Volume of Reductions	**1,200 mtCO_2e/yr (gross) and 1,300 mtCO_2e/yr (net)** from projects completed April 2011 to September 2012.[528]
Programmatic Status	For FY 2012, the program was cost-effective for the following three tests: Total Resource Cost (TRC)[529] = 1.61, Program Administrator Cost Test (PACT)[530] = 4.80, Participant Cost Test (PCT)[531] = 2.27
Emissions Leakage	None Noted.
ClimateSmart Loan Program, Boulder County, CO[532]	

[526] Ibid
[527] Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: http://www.efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf
[528] Estimates external to study using the following assumptions: all savings are from primary heating fuel (savings by fuel are 90% fuel oil, 5% NG, 5% Propane); 2013 Climate Registry default emission factors for CO_2, CH_4, and N_2O; IPCC Second Assessment Report GWPs.
[529] Total Resource Cost Test - The TRC examines the costs and benefits of an energy efficiency program from a societal perspective. It compares net energy-savings benefits (avoided costs) to the net costs incurred by the program administrator as well as net costs incurred by the participant, such as the incremental cost of purchasing the program measure. The TRC views program incentives/rebates as transfers at the societal level and not as program costs.
[530] Program Administrator Cost Test - The PACT examines the costs and benefits from the perspective of the program administrator. It compares the net benefits to the net costs incurred by the program administrator, including any rebate/incentive costs but excluding any net costs incurred by the participant, such as the actual measure cost.
[531] Participant Cost Test - The PCT examines the costs and benefits from the perspective of the customer installing the energy efficiency measure (homeowner, business, etc.). Benefits include bill savings realized by the customer from reduced energy consumption and the incentives received by the customer, including any applicable tax credits. Costs include the incremental costs of purchasing and installing the efficient equipment, above the cost of standard equipment, that are borne by the customer. In some cases incremental operations and maintenance costs (or savings) are also included.

Cost of Reductions	CLSP financed (lending) $9.8 million in residential energy retrofits. $2.4 million was set aside to serve as a reserve fund. About $0.8 million was used for administrative costs, loan fees, and other costs.
Volume of Reductions	**1,100 mtCO_2e/yr (gross)**[533]
Programmatic Status	The CSLP achieved all key qualitative goals: (1) reducing GHG emissions, (2) improving the environment, (3) saving energy, and (4) providing direct and indirect economic benefits.
Emissions Leakage	None noted.
Sonoma County Energy Independence Program, Sonoma County, CA[534]	
Cost of Reductions	From March 2009 to March 2013, received 2,640 PACE financing applications for $96 million in renewable energy, energy efficiency and water conservation improvements. More than $66 million has been approved, and over $61 million has been disbursed to projects that are completed. Approximately $9.6 million of the assessments have been fully paid off, which has provided a like amount to be made available for additional projects.
Volume of Reductions	An effort by the County to quantify the energy savings and GHG reduction for financed energy efficiency and water conservation projects is currently underway.
Programmatic Status	The program has improved energy efficiency, increased renewable energy generation, GHG reductions, water conservation, and added local jobs. Currently, there are efforts to expand program.
Emissions Leakage	None noted.

15.3 Energy and Economic Impacts

Generally, the low interest rates and relatively long repayment terms mean the PACE programs can create an immediate positive cash flow to building owners. In other words, energy cost savings achieved though PACE-financed energy improvements can exceed loan repayment costs on an annual basis resulting in net savings even during repayment years. These benefits will continue to accrue after loan repayment is complete.

All three PACE programs analyzed here generated positive economic output, added jobs, and reduced energy consumption or added renewable energy capacity. The Maine PACE Loan

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[532] National Renewable Energy Laboratory. 2011. Economic Impacts from the Boulder County, Colorado, ClimateSmart Loan Program: Using Property-Assessed Clean Energy (PACE) Financing. Accessed August 2013 at: http://www.nrel.gov/docs/fy11osti/52231.pdf

[533] Estimate external to study using the following assumptions: average participant savings of 1,786 kWh/yr for electricity and 74.9 therms/yr for natural gas; eGRID2012 electricity CO_2e emission factor for WECC Rockies subregion; 2013 Climate Registry default natural gas emission factors for CO_2, CH_4, and N_2O, IPCC Second Assessment Report GWPs.

[534] Sonoma County Energy Independence Program. 2013. Sonoma County Energy Independence Program Activity Update. Accessed August 2013 at: http://www.drivecms.com/uploads/sonomacountyenergy.org/Reports/032613_GSD%20SCEIPupdate_attA.pdf

Program achieved verified gross energy savings of over 16,000 mmBtu predominantly through reduced fuel oil consumption. ClimateSmart program participants realized gross first-year electricity and natural gas savings of 1.1 GWh and 4,500 mmBtu, respectively. An effort to quantify the energy savings for PACE-financed energy efficiency and water conservation projects is currently underway in Sonoma County, California but the program did report financing over 1,100 solar installations that generate about 8.3 kW annually.

Table 43: Energy and Economic Impacts of Example PACE Programs

Maine PACE Loan Program[535]	
Independence from Fossil Fuels, and Economic Impact	Verified first-year, annual gross savings for the PACE/PowerSaver Program are **16,332 mmBtu for the 284 projects** completed April 2011 through September 2012.
Impacts on Fuel Choice	None noted.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Total PACE/PowerSaver FY2012 program spending of $3.4 million (excluding adjustments for early retirement, economic cost of lending, and evaluation costs) resulted in the creation of an estimated 238 FTE job-years.
Impact on Different Sectors of the Economy	Total PACE/PowerSaver FY2012 **program spending of $3.4 million** (excluding adjustments for early retirement, economic cost of lending, and evaluation costs) resulted in an estimated $15.6 million increase in Gross State Product.
ClimateSmart Loan Program, Boulder County, CO[536]	
Independence from Fossil Fuels, and Economic Impact	Gross first-year electricity and NG **savings of 1.1 GWh/yr and 4,500 mmBtu/yr**,respectively.
Impacts on Fuel Choice	Increased access to residential solar PV.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	**$13 million spent in financing and program costs supported 85 jobs** (57 percent were solar PV-related jobs) in Boulder County (about 6.5 jobs/$1 million of investment) and 126 jobs in the state as a whole (about 9.7 jobs/$1 million of investment). Wage and salary earnings increased by $5.1 million in Boulder County and $7.1 million for the state as a whole in the short term.
Impact on Different Sectors of the Economy	Economic activity increased by almost $14 million in Boulder County and almost $20 million for the state as a whole. The study claims cash spending and alternatively financed spending probably increased the total of all program-related spending by 20 percent or more.
Sonoma County Energy Independence Program, Sonoma County, CA[537]	

[535] Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: http://www.efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf

[536] National Renewable Energy Laboratory. 2011. Economic Impacts from the Boulder County, Colorado, ClimateSmart Loan Program: Using Property-Assessed Clean Energy (PACE) Financing. Accessed August 2013 at: http://www.nrel.gov/docs/fy11osti/52231.pdf

Independence from Fossil Fuels, and Economic Impact	The program currently is serving 1,841 participating property owners, completing over 1,800 energy efficiency projects and 1,100 solar installations, and generating 8.3kW of energy annually. An effort to quantify the energy savings and GHG reduction for financed energy efficiency and water conservation projects is currently underway.
Impacts on Fuel Choice	Increased access to distributed renewable generation.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	The **$61 million invested locally has energized the creation of an active energy efficiency and renewable energy construction market**. Opportunity exists for collaboration and partnership with private PACE program providers to expand the options that could be used to secure funds and increase Program funding capacity.
Impact on Different Sectors of the Economy	**86 percent of PACE-financed projects have been installed by local contractors**. This has led to the creation of approximately 77 local jobs within the related industry sectors that are engaged with program.

15.4 Household Impacts and Co-Benefits

Households that took advantage of PACE financing in Maine were reported to have saved over 28 percent of whole-house energy usage on average. Program participants in Boulder, Colorado were reported to have saved nearly 1,800 kWh of electricity and 75 mmBtu of natural gas per year on average, resulting in annual energy cost savings of about $208 per participant. Boulder and Sonoma Counties also report (but do not quantify) program co-benefits that include water conservation and improved air quality.

Table 44: Household Impacts and Co-Benefits of Example PACE Programs

Maine PACE Loan Program[538]	
Effect on Household Consumption and Spending	**57.5 mmBtu gross savings for each of the 284 projects completed** April 2011 through September 2012. On average, these savings represent 28.6 percent of pre-project whole-house energy usage.
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted.
Significant Co-benefits	None noted.
ClimateSmart Loan Program, Boulder County, CO[539]	

[537] Sonoma County Energy Independence Program. 2013. Sonoma County Energy Independence Program Activity Update. Accessed August 2013 at: http://www.drivecms.com/uploads/sonomacountyenergy.org/Reports/032613_GSD%20SCEIPupdate_attA.pdf
[538] Opinion Dynamics Corporation. 2013. Evaluation Of The Efficiency Maine Trust Pace Loan Program: Interim Impact Report. Accessed August 2013 at: http://www.efficiencymaine.com/wp-content/uploads/2012/04/PACE-Interim-Impact-Report-FINAL.pdf
[539] National Renewable Energy Laboratory. 2011. Economic Impacts from the Boulder County, Colorado, ClimateSmart Loan Program: Using Property-Assessed Clean Energy (PACE) Financing. Accessed August 2013 at: http://www.nrel.gov/docs/fy11osti/52231.pdf

Effect on Household Consumption and Spending	Reduced **energy use saved participants a combined total of about $124k/yr ($208/yr per participant)** during the first year on their electric and gas utility bills. Average participant savings were 1,786 kWh/yr for electricity and 74.9 therms/yr for NG.
Measures to Mitigate to Low-income Populations, or Economic Impact	2008 ballot measure that funded the CSLP authorized Boulder County to issue up to $40 million in bonds, including $14 million in tax-exempt bonds intended for low-income-qualified projects.
Significant Co-benefits	Reduced environmental impacts, such as air pollution and water use.
Sonoma County Energy Independence Program, Sonoma County, CA[540]	
Effect on Household Consumption and Spending	An effort to quantify the energy savings and GHG reduction for financed energy efficiency and water conservation projects is currently underway.
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted.
Significant Co-benefits	Water conservation (not quantified).

[540] Sonoma County Energy Independence Program. 2013. Sonoma County Energy Independence Program Activity Update. Accessed August 2013 at: http://www.drivecms.com/uploads/sonomacountyenergy.org/Reports/032613_GSD%20SCEIPupdate_attA.pdf

16 Feed-in-Tariffs

Policy Definition	Targeted Sector or Emissions
A FiT is a policy mechanism designed to accelerate investment in and deployment of renewable energy technologies by offering long-term contracts with a set price to renewable energy producers. The FiT provides certainty to potential energy producers by establishing guaranteed price schedules and eliminating the need for contractual negotiations with utilities, for eligible projects.	Electricity Generation

GHGs and Costs

- Cost of reductions in Germany for solar in 2010 was €537 or ($714)/mt$CO_2$e while the cost of reductions for wind in 2010 was €44 or ($58.5)/ mt$CO_2$e.[541]
- In Germany, 2010 reductions from solar was 7 million tCO_2e while the volume of reductions for wind in 2010 was 27 millions tCO_2e.[542]
- In California in 2012, FiT rates ranged from $0.77/kWh to $0.93/kWh depending on the contract period.[543]

Implementation Issues and Lessons Learned

- The success of a FIT policy depends on many variables, including existing renewable energy generation, community acceptance of renewable energy and associated costs, and interconnection codes and standards.[544]
- A 2010 World Future Council study found that FITs with the following attributes are more successful in deploying renewable energy; notably programs without program caps or project-size caps, with longer contract terms, with more technologies, with tariffs based on the cost of generation rather than avoided cost, with more differentiation in the tariffs and with sufficient inflation indexing.[545]
- Program caps serve to moderate the potential cost to ratepayers and system integration impacts of introducing a large number of FIT-funded renewable resources, while project caps can serve to moderate the number of large projects and/or broaden the type of technologies.[546]
- A focus on small-scale projects can lead to big-scale achievements; for example almost all Ontario solar projects are 10 MW and smaller (a third are 10 kW and smaller) and yet Ontario's installed capacity ranks #4 in North America, behind California, Arizona, and New Jersey.[547]
- Setting payment schedules has proved challenging as payments need to be high enough to attract investors without resulting in windfall profits and undue burden on ratepayers.[548]

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[541] Marcantonini and Ellerman. The Cost of Abating CO2 Emissions by Renewable Energy Incentives in Germany. Accessed August 2013 at: http://cadmus.eui.eu/bitstream/handle/1814/25842/RSCAS_2013_05rev.pdf?sequence=1
[542] Ibid.
[543] California Public Utilities Commission, http://www.cpuc.ca.gov/PUC/energy/Renewables/Feed-in+Tariff+Price.htm accessed 8/12/13
[544] The National Association of Regulatory Utility Commissioners (NARUC). *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions.* June 2010. Report accessed August 2013 at http://www.naruc.org/Publications/NARUC%20Feed%20in%20Tariff%20FAQ.pdf
[545] The World Future Council. *Grading North American Feed-in Tariffs.* May 2010. Report accessed August 2013 at http://www.worldfuturecouncil.org/fileadmin/user_upload/PDF/Grading_N.Am._FITs_Report.pdf
[546] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[547] Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013. Report accessed August 2013 at http://www.ilsr.org/wp-content/uploads/2013/05/expect-delays-ontario-fit-ilsr-2013.pdf
[548] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

• Incentives for distributed generation and commitment to local ownership can spur economic development; notably by attracting private sector investment, drawing clean energy companies and associated industries and creating jobs. • Policy areas often identified as complicating the development of renewable energy resources affecting the effectiveness of a FIT include interconnection codes, standards and practices, metering requirements and the siting process for renewable energy systems.[549] • A 2010 report by the The National Association of Regulatory Utility Commissioners found that the key elements of a successful FiT include longer contract length, interconnection rules and agreements, program and project caps, tariff revisions, payment differentiation and bonus payments.[550]	
Costs and Benefits to Consumers	**Costs and Benefits to Businesses**
• As FIT programs are **s**upported by ratepayers through above-market costs, electricity rates are likely to increase. • The resulting impact to the average household electricity bill is undetermined in the U.S., as FIT programs are still in their infancy.[551] • Germany's FIT cost consumers a 3% rate increase in the lifetime of the program, with a 5% increase in 2008 alone, averaging $2.66 to $8.00 per month.[552]	• As FIT programs are supported by ratepayers through above-market costs, electricity rates are likely to increase. • As FIT programs are still in their infancy in the US, the impact to businesses is still undetermined.

A feed-in tariff (FIT) is a policy mechanism designed to accelerate investment in and deployment of renewable energy technologies by offering long-term contracts with a set price to renewable energy producers. The FIT provides certainty to potential energy providers by establishing guaranteed price schedules and eliminating the need for contractual negotiations with utilities, for eligible projects.

16.1 Existing Policies

FITs are used to a limited extent around the United States, but they are more common internationally. Historically, FITs have been associated with a German model in which the government mandates that utilities enter into long-term contracts with generators at specified rates, typically well above the retail price of electricity. In the United States, where FITs are comparatively new, FITs or similarly structured programs are mandated to varying degrees in a limited number of states. However, a different model has also emerged in which utilities independently establish a utility-level FIT, either voluntarily or in response to state or local

[549] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[550] NARUC. Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions. June 2010.
[551] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[552] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

government mandates[553]. This section reviews FIT programs in Germany, Ontario, and California.

Germany

The Renewable Energy Sources Act, also known as EEG (Erneuebare-Energien-Gesetz) law, has enabled renewable energy investments in large scale throughout Germany through the use of FITs. In 2011, the FIT program rates were significantly enhanced as part of a government policy, called "Energiewende", to accelerate the phase out of eight nuclear plants totaling 20.9 GW of electric power generation capacity.[554] Amendments in 2012 increased the term of the FIT guaranteed rate from 15 years to 20 years for some installations, designed to spur new projects and investments in Germany, particularly smaller ones. FIT rates vary based on source fuels, such as hydropower, land fill gas, sewage gas, mine gas, biomass (bio waste and small manure biogas), geothermal, on-shore wind, off-shore wind, and solar. There is also a lower tariff provided for self-consumption at certain sites.

Germany has established fixed FIT rates for 2012 to 2021, providing clear long term investment protection and guidance for developers, though these rates fluctuate based on technology, installation size, and are based on levelized project costs. With the new amended and enhanced rates, Solar Photovoltaic (PV) has become a very attractive technology. Renewable energy accounted for total investment of €22.9 Billion in 2011, with PVs accounting for €15.0 Billion. The total economic output of German based renewable energy manufactures and installers was €24.94 Billion, including exports.[555]

By 2020, the goal is to have 14% of total energy sourced from renewables, which will be achieved by using renewables to provide 35% of electricity, 18% of thermal energy and 10% in transportation sector, leading to a 40% reduction in greenhouse gases when compared to 1990 standards. The renewable energy source goals increase incrementally each decade thereafter until 2050 when renewables are expected to provide 80% of the electricity, 60% of thermal energy. With 25% reduction through efficiency, the overall reduction in GHG is anticipated to be 80% to 95% by 2050. [556]

Ontario

In November 2006, the Ontario Power Authority (OPA) launched the Renewable Energy Standard Offer Program (RESOP) to develop distributed (10 MW and smaller) renewable energy

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[553] EIA. May 2013. Feed-in tariff: A policy tool encouraging deployment of renewable electricity technologies. Accessed August 2013 at: http://www.eia.gov/todayinenergy/detail.cfm?id=11471

[554] http://energytransition.de/

[555] Sullivan et al. Gross employment from renewable energy in Germany in 2011. March 2012. Accessed August 13, 2013. http://www.erneuerbare-energien.de/fileadmin/ee-import/files/english/pdf/application/pdf/ee_bruttobeschaeftigung_en_bf.pdf

[556] AGEE-Stat 2013. Renewable Energy Sources in Germany – Key information 2012 at a glance. February 2013. http://www.erneuerbare-energien.de/fileadmin/Daten_EE/Dokumente__PDFs_/20130328_hgp_e_tischvorlage_2012_bf.pdf

projects by using a standardized, fixed price, long-term contract. While RESOP attracted investment in renewable energy, contracting nearly 1,400 MW of wind (56%), solar (34%), bioenergy and hydropower power projects, execution was problematic largely and after 18 months only 34 MW out of 1,400 MW reached operation. [557]

In early 2009, advocates of expanding and improving the RESOP program won passage of the Green Energy & Green Economy Act, establishing Ontario's FIT program designed to create new clean energy industries and jobs, boost economic activity and the development of renewable energy technologies, and improve air quality by phasing out coal-fired electricity generation by 2014.[558] Qualifying renewable technologies include biogas, renewable biomass, landfill gas, solar photovoltaic (PV), hydro power and wind power.[559] The Ontario Power Authority (OPA) is responsible for implementing the FiT Program. Within two years OPA signed about 2,000 small and large FIT contracts with clean energy producers totaling approximately 4,600 MW.[560] Ontario's FIT program has played a significant role in jumpstarting renewable energy, ranking #4 and #11 in North America for solar and wind deployment. It has also enabled widespread participation in renewable energy generation with 1 in 7 Ontario farmers participating and earning a return on their investment.[561]

FIT Program has been key to making Ontario a leader in clean energy production and manufacturing. FIT attracted more than $20 billion in private sector investment to Ontario during challenging economic times, welcomed more than 30 clean energy companies to the province as of 2011[562] and created more than 31,000 jobs as of 2013.[563] By the end of 2014, Ontario will be the first jurisdiction in North America to replace coal-fired generation with cleaner sources of power.[564] Ontario has shut down 10 of 19 coal units and reduced the use of coal by nearly 90 per cent since 2003.[565] Moreover, Ontario is on track to procure 10,700 MW of non-hydro renewable energy generation by 2015.[566] To support the long-term sustainability of the FiT Program, OPA

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[557] Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013. Report accessed August 2013 at http://www.ilsr.org/wp-content/uploads/2013/05/expect-delays-ontario-fit-ilsr-2013.pdf
[558] http://www.energy.gov.on.ca/en/fit-and-microfit-program/2-year-fit-review/
[559] Ontario Power Authority. Feed-In Tariff (FIT) Program, FAQs. Accessed August 12, 2013. http://fit.powerauthority.on.ca/faqs
[560] Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report.* March 2012. http://www.energy.gov.on.ca/docs/en/FIT-Review-Report-en.pdf
[561] Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.
[562] http://www.energy.gov.on.ca/en/fit-and-microfit-program/2-year-fit-review/
[563] http://www.energymanagertoday.com/ontarios-buy-local-feed-in-tariff-stuck-in-a-rut-after-initial-success-092031/
[564] Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report.* March 2012.
[565] Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report.* March 2012.
[566] Ontario. *Ontario's Feed-in Tariff Program Building Ontario's Clean Energy Future - Two-Year Review Report.* March 2012.

has set annual procurement targets of 150 megawatts for small FiT and 50 megawatts for microFiT for each of the next four years, beginning in 2014.

The biggest challenge for the FIT program is the overwhelming demand. Signed contracts for nearly 5,000 megawatts of new renewable energy capacity will allow the province to meet most of its 2030 renewable energy target, 12 years early.[567] While Ontario's FIT program has stumbled with less than 10 percent of its contracted capacity deployed, it remains competitive with leading U.S. states.[568]

In addition, the revision of tariffs may have affected investors and created some instability in the policy environment. In late 2010, the OPA lowered contract price to reflect better economics. While tariff revisions may ensure probability and program sustainability, they should be clearly communicated to investors to maintain a stable policy environment.[569]

California

On February 14, 2008, the California Public Utilities Commission (CPUC) authorized the purchase of up to 480 MW of renewable generating capacity from renewable facilities smaller than 1.5 MW. The FiT provides a mechanism for small renewable generators to sell power to the utility at predefined terms and conditions, without contract negotiations, setting the price paid to small generators at the level of the Market Price Referent (MPR). In 2009, eligible project size was increased to 3 MW.[570] The original FiT program closed on July 24, 2013, and was replaced by a renewable market adjusting tariff (ReMAT).

In May 2012, the CPUC implemented a new pricing mechanism and program rules for the FiT program, the ReMAT, in response to stakeholders' petitions for modification.[571] The ReMAT allows the FiT price to adjust in real-time based on market conditions. ReMAT is being implemented by IOUs to comply with the IOU's portion of the 750 MW state-wide feed-in tariff program mandated by SB 32.[572] ReMAT includes two principle components: First, the starting price increases or decreases for each product type based on the market's participation in the

[567] Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.

[568] Institute for Self Reliance. *Expect Delays - Reviewing Ontario's "Buy Local" Renewable Energy Program*. May 2013.

[569] The National Association of Regulatory Utility Commissioners (NARUC). *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions.* June 2010. Report accessed August 2013 at http://www.naruc.org/Publications/NARUC%20Feed%20in%20Tariff%20FAQ.pdf

[570] California Public Utilities Commission. *Feed-in Tariffs Legislative History*. Accessed August 2013 at: http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/fit_legislativeHistory.htm

[571] WSGR. *California Public Utilities Commission Adopts Terms of Standard FIT Contract and Revised Tariffs.* June 2013. Article access August 2013 at http://www.wsgr.com/WSGR/Display.aspx?SectionName=publications/PDFSearch/wsgralert-standard-FIT-contract.htm

[572] http://www.pge.com/includes/docs/pdfs/b2b/energysupply/wholesaleelectricsuppliersolicitation/standardcontractsforpurchase/ReMAT_Webinar1_Overview.pdf

program and applies to three FiT product types (ie. baseload, peaking as-available, and non-peaking as-available). Second, a two-month price adjustment mechanism may increase or decrease the price for each product type every two months based on the market response. The IOU-share of MWs under the revised FiT program is 493.6 MW.[573]

16.2 GHG Impacts

Like any renewable power source, the GHG impacts from FiT programs depend largely on the source of power being replaced. Generally, specific quantification of GHG reduction benefits associated with FiT programs reviewed was not available. **Table 45** summarizes findings of available GHG-related information for select FiT programs.

Table 45: GHG Costs and Benefits of FiT Programs

Germany	
Cost of Reductions	**Cost of reductions for solar in 2010 was €537 or ($714)/mtCO2e while the cost of reductions for wind in 2010 was €44 or ($58.5)/ mtCO2e**.[574]
Volume of Reductions	2010 reductions from solar was 7 million tCO2e while the volume of reductions for wind in 2010 was 27 million tCO2e.[575]
Programmatic Status	The program has provided a strong market for German based manufactures and the country was a net exporter of renewable energy technologies and services.
Emissions Leakage	Data not readily available.
Ontario	
Cost of Reductions	Data not readily available.
Volume of Reductions	Data not readily available.
Programmatic Status	As of March 2013, OPA executed 1,706 micro,[576] small and large FIT contracts for 4,541 MW in renewable energy projects, with another 882 contracts for an additional 10,577 MW in the pipeline.[577]
Emissions Leakage	Data not readily available.
California	
Cost of Reductions	2012 FiT rates range from $0.77/kWh to $0.93/kWh depending on the

[573] WSGR. *California Public Utilities Commission Adopts Terms of Standard FIT Contract and Revised Tariffs.* June 2013.
[574]Marcantonini and Ellerman. The Cost of Abating CO2 Emissions by Renewable Energy Incentives in Germany. Accessed August 2013 at: http://cadmus.eui.eu/bitstream/handle/1814/25842/RSCAS_2013_05rev.pdf?sequence=1
[575] Ibid.
[576] Micro FIT applies to systems less than 10 kW, and is meant to encourage homeowners, farmers and small business owners to build more distributed energy systems, particularly wind and solar. It offers special incentives and assistance, including fast tracked applications, no connection test required, automatic contract eligibility and higher payments. "Feed-In Tariffs: Frequently Asked Questions for State Utility Commissions", NARUC, June 2010. http://www.naruc.org/Publications/NARUC%20Feed%20in%20Tariff%20FAQ.pdf
[577] Power Authority FIT Program Website, "March 2013 Quarterly Program Report," June 24, 2013. Accessed August 2013. http://fit.powerauthority.on.ca/fit-program

	contract period[578]
Volume of Reductions	Data not readily available.
Programmatic Status	Data not readily available.
Emissions Leakage	FiT is targeted to local generators in utility territories.

16.3 Energy and Economic Impacts

FiT programs increase renewable energy generation sources, create direct and indirect clean energy jobs, and attract private sector investment. For example, the German FiT program is extensive and, in conjunction with Germany's pledge to reduce GHG emissions by 40% by 2020, has significantly impacted the deployment and growth of renewable energy sources. In 2012, 12.6% of the total energy produced in Germany was generated from renewable energy sources as follows: Biomass (8.2%); Wind energy (1.8%), Photovoltaic (1.1%) Hydropower: 0.8% and Solar thermal and geothermal (0.5%).[579] The renewable energy based electric energy supply had a total production of 136.1 TWH accounting for 22.9% of total electricity produced. The major sources are Wind (33.8%), Photovoltaic (20.6%); Hydropower (15.6%) and Biomass (30%).[580]

The Ontario program has taken special steps to encourage participation in certain sectors. To further municipal and public entity participation in new renewable installations, special incentives will be provided to eligible entities including municipalities, publicly funded schools, public colleges and universities, hospitals, publicly owned long term care homes, public transit services and Metrolinx (transportation authority). Special incentives will include a "price adder" to the standard FiT pricing, the provision of priority points during the application process, and the creation of capacity set-asides. In addition, municipalities and other public sector entities noted above will have access to funding for costs associated with design and development of the small FIT projects.[581]

Table 46 summarizes the available energy and economic impact information for select FiT programs.

Table 46: Energy and Economic Impacts of FiT Programs

Germany	
Independence from Fossil	The program costs are passed on to rate payers as an EEG levy, which has

[578] California Public Utilities Commission, http://www.cpuc.ca.gov/PUC/energy/Renewables/Feed-in+Tariff+Price.htm accessed 8/12/13

[579] AGEE-Stat 2013, Renewable Energy Sources in Germany – Key information 2012 at a glance, Published by AGEE-Stat, February 2013. Accessed August 2013 at: http://www.bmu.de/fileadmin/bmu-import/files/english/pdf/application/pdf/ee_in_zahlen_tischvorlage_en.pdf

[580] Ibid. - AGEE-Stat 2013

[581] Borden Ladner Gervais, "A New Path for Renewables: Major Changes to Ontario's Renewable Procurement and Feed-In Tariff (FIT) Program, *Martindale.com*, June 20, 2013. Accessed on August 12, 2013. http://www.martindale.com/energy-law/article_Borden-Ladner-Gervais-LLP_1846884.htm

Fuels, and Economic Impact	resulted in high costs for electricity. Germany has the second highest power cost in the European Union. The average cost of electricity is €0.26/kWh and this represents a significant premium when compared to retail market prices for electricity. This issue has become a significant economic and political concern.[582]
Impacts on Fuel Choice	Movement towards renewable power.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	**The growth in renewable energy investments by 2016 is anticipated to be €23.7 Billion.**[583] Germany leads the world in renewable energy investment, capturing 13 percent of global investment.[584]
Impact on Different Sectors of the Economy	**Renewable energy accounted for total investment of €22.9 Billion in 2011, with PVs accounting for €15.0 Billion.** [585] The total economic output of German based renewable energy manufactures and installers in 2011 was €24.94 Billion, including exports. This sector supported 381,600 jobs. [586]
Ontario	
Independence from Fossil Fuels, and Economic Impact	**As of March 2013, OPA had executed 1,706 micro,[587] small and large FIT contracts for 4,541 MW in renewable energy projects, with another 882 contracts for an additional 10,577 MW in the pipeline.**
Impacts on Fuel Choice	Phasing out coal-fired electricity generation by 2014.[588] To prepare for the coal phaseout, the aggressive energy law in 2009 established energy efficiency programs and a feed-in tariff providing generous financial benefits to renewable developers. Those efficiency programs have helped make Ontario one of the few jurisdictions where energy demand is declining, rather than increasing.[589]
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	**Over $27 billion in private sector investment to Ontario. The program has created 20,000 jobs and is expected to create 50,000 jobs.**[590]
Impact on Different Sectors	The program has increased the amount of clean energy in Ontario's supply

[582] The growing cost of Germany's feed-in tariffs. Web Article from business spectator.com, Feb, 2013. Accessed Aug. 13, 2013. http://www.businessspectator.com.au/article/2013/2/21/policy-politics/growing-cost-germanys-feed-tariffs
[583] The growing cost of Germany's feed-in tariffs. Web Article from business spectator.com, Feb, 2013. Accessed Aug. 13, 2013. http://www.businessspectator.com.au/article/2013/2/21/policy-politics/growing-cost-germanys-feed-tariffs
[584] http://www.edf.org/sites/default/files/EU_ETS_Lessons_Learned_Report_EDF.pdf
[585] Sullivan et al - RE investment estimate published in research report "Gross employment from renewable energy in Germany in 2011" by Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, March 14, 2012, Accessed August 13, 2013. http://www.erneuerbare-energien.de/fileadmin/ee-import/files/english/pdf/application/pdf/ee_bruttobeschaeftigung_en_bf.pdf
[586] Ibid.
[587] Micro FIT applies to systems less than 10 kW, and is meant to encourage homeowners, farmers and small business owners to build more distributed energy systems, particularly wind and solar. It offers special incentives and assistance, including fast tracked applications, no connection test required, automatic contract eligibility and higher payments. "Feed-In Tariffs: Frequently Asked Questions for State Utility Commissions", NARUC, June 2010.
[588] Ontario's Feed-in Tariff Program Two-Year Review Report, Fareed Amin, Ontario Deputy Minister Of Energy, March 19, 2012. Accessed August 12, 2013. http://www.energy.gov.on.ca/docs/en/FIT-Review-Report.pdf
[589] http://www.scientificamerican.com/article.cfm?id=ontario-phases-out-coal-fired-power
[590] http://www.energy.gov.on.ca/docs/en/FIT-Review-Report.pdf

of the Economy	mix, created over 20, 000 jobs, and attracted over $20 billion in private sector investment to Ontario during challenging economic times.[591]
California	
Independence from Fossil Fuels, and Economic Impact	Data not readily available.
Impacts on Fuel Choice	Data not readily available.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	**Projected $50 billion in total new investment in CA**[592]
Impact on Different Sectors of the Economy	**Projected 28,000 direct jobs per year, and 27,000 indirect jobs per year on average, and increase direct state revenue by $1.7 billion.**[593]

Household Impacts and Co-Benefits

Table 47 highlights that little data on household impact and co-benefit information for FiT programs was readily available.

Table 47: Household Impacts and Co-Benefits of FiT Programs

Germany	
Effect on Household Consumption and Spending	Germany FIT is regressive where higher income households stand to gain more than lower income households. However, this effect is small. The anticipated incremental levy is estimated to be €0.0353/kWh in 2011 to €0.0458/kWh in 2015. The increased levy will impact disposable income ranging from €21.06 for the lowest economic bracket with a monthly disposable income less than €500 to €50.10 for the highest bracket with a monthly disposable income in excess of €4,500.[594] Germany's feed-in tariff is likely to be regressive, i.e. redistributing income shares from the lower to the upper part of the income distribution. Poorer households spend a higher share of their income on electricity than wealthy households, and a levy raised proportionally to electricity consumption emphasizes this differential. Moreover, the collected

[591] Ontario's Feed-in Tariff Program Two-Year Review Report, Fareed Amin, Ontario Deputy Minister Of Energy, March 19, 2012. Accessed August 12, 2013. http://www.energy.gov.on.ca/docs/en/FIT-Review-Report.pdf
[592] Wei, Max, Daniel Kammen. 2010. Economic Benefits of a Comprehensive Feed-In Tariff: An Analysis of the REESA in California. Renewable and Appropriate Energy Laboratory, University of California, Berkeley.
[593] Ibid.
[594] Grösche et al (2011), on the redistributive effects of Germany's Feed in Tariff, published by Department of Economics, Christian-Albrechts-Universiitat zu Keil. June 2011, Accessed August 14, 2013. http://www.econstor.eu/bitstream/10419/49291/1/66579133X.pdf

	revenues are used for subsidizing renewable energy installations, investments typically undertaken by wealthier households.[595]
Measures to Mitigate to Low-income Populations, or Economic Impact	Data not readily available.
Significant Co-benefits	The program provides flexibility and accommodates a wide variety of technologies, and encourages small and large producers to participate. The program is geographically neutral, which encourages project development and is also promoted as a local economic stimulus program.
Ontario	
Effect on Household Consumption and Spending	Data not readily available.
Measures to Mitigate to Low-income Populations, or Economic Impact	Priority consideration, project design/development funding, and "price adders" are given to projects that have a minimum of 15% participation level from Community or Aboriginal groups.[596]
Significant Co-benefits	The program has increased the amount of clean energy in Ontario's supply mix, created thousands of direct and indirect clean energy jobs, and attracted over $20 billion in private sector investment to Ontario during challenging economic times. [597]
California	
Effect on Household Consumption and Spending	Data not readily available.
Measures to Mitigate to Low-income Populations, or Economic Impact	Data not readily available.
Any significant co-benefits to the jurisdiction	Data not readily available.

[595] Gröscheet al (2011), on the redistributive effects of Germany's Feed in Tariff, published by Department of Economics, Christian-Albrechts-Universiitat zu Keil. June 2011, Accessed August 14, 2013. http://www.econstor.eu/bitstream/10419/49291/1/66579133X.pdf
[596] Ibid. Program Overview
[597] Ontario Power Authority FIT Program Website, "March 2013 Quarterly Program Report," June 24, 2013. Accessed August 12, 2013. http://fit.powerauthority.on.ca/fit-program

17 Shore Power

Policy Definition	Targeted Sector or Emissions
Shore power, also known as port electrification or cold ironing, is the process of transferring the electrical generation needs for Ocean Going Vessels (OGV) while at berth (docked) from onboard diesel auxiliary engines to cleaner shore-side power grids.	Transportation
GHGs and Costs	
California saw 2,400 mtCO2e reduction in 2011, with an expected 200,000 mtCO2e reduction in 2020. Canada saw 1,521 mt CO2e reduction from April to October 2010.	
Implementation Issues and Lessons Learned	
• The shore power approach is generally best suited for vessels that make multiple calls at the same terminal for multiple years. • The best candidates for shore power are large container ships, cruise ships, reefer (refrigerated) ships, and specially-designed crude tankers that have diesel-electric engines. • Shore power requires extensive infrastructure improvements both on the terminal side for supplying the appropriate level of conditioned electrical power and on-board the vessels that will use the system.[598]	
Costs and Benefits to Consumers	**Costs and Benefits to Businesses**
• No consumer costs from shore power projects have been identified • Improved air quality through reduction in emissions rates.	• Increased costs for vessel construction or retrofit • Increased competitiveness as more global ports equip vessels with shore power capabilities • Reduced energy costs while vessels call at port • Shore power infrastructure requires investment from ports and companies to design, build, and install shore power technology both on land and vessels. These projects represent opportunities for engineering and construction jobs within the State of Washington • Shipping companies will see a reduction in costs associated with reduced fuel consumption • Shore power at ports in Washington has the potential to increase the demand on local jurisdictions' electric power supply

Shore power, also known as port electrification or cold ironing, is the process of transferring the electrical generation needs for Ocean Going Vessels (OGV) while at berth (docked) from onboard diesel auxiliary engines to cleaner shore-side power grids.

The fuel use and emissions from maritime port sources can be significant, with OGVs and harbor craft being major contributors to air pollution and GHG emissions in and around ports. For example, a 2004 study showed that the Port of Los Angeles alone released average daily air pollution and GHG emissions exceeding that of 500,000 vehicles. A 2013 Sandia National

[598] San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Pages 89-90. Access August 2013 at: http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485

Laboratories report on vessel cold-ironing states that "approximately one-third to one-half of emissions attributed to OGVs come from their auxiliary diesel engines, which are run while the vessel is at berth and require electrical power for everything from lighting to loading and discharging equipment." Reducing the use of diesel auxiliary engines while OGVs are at port reduces GHG emissions and improves air quality by reducing emissions of particulate matter and nitrogen oxides (NO_x).[599] The Puget Sound Clean Air Agency (PSCAA) calculates that just eight hours of shore power cuts on-board oil burning by 2.85 metric tons of fuel. Although the Electrify Transportation in Washington report does not give specific reductions estimates, air emissions are reported to be reduced by about 30 percent per eight-hour port call for cruise ships.[600]

The shore power approach is generally best suited for vessels that make multiple calls at the same terminal for multiple years. The best candidates for shore power are large container ships, cruise ships, reefer (refrigerated) ships, and specially-designed crude tankers that have diesel-electric engines. Shore power requires extensive infrastructure improvements both on the terminal side for supplying the appropriate level of conditioned electrical power and on-board the vessels that will use the system.[601]

California and Canada (primarily British Columbia) have implemented shore power regulation and initiatives, respectively. Washington ports have facilitated private sector infrastructure investments to implement shore power for a cruise terminal at the Port of Seattle and a container ship terminal at the Port of Tacoma. As shore power technology is adopted more broadly at all West Coast ports, shore power will become more feasible for container and cargo ships that call at Washington ports.[602] No federal standards or control requirements have been promulgated addressing emission reductions from at-berth OGV auxiliary engines.[603]

17.1 Existing Policies

This section summarizes shore power programs implemented in other jurisdictions. The following programs are included:

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[599] Pratt and Harris. 2013. Vessel Cold-Ironing Using a Barge Mounted PEM Fuel Cell: Project Scoping and Feasibility. (February 2013). Page 5. Accessed August 2013 at: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/sand2013-0501_barge_mounted_pemfc.pdf

[600] Electrify Transportation in Washington. 2007. Electrify Transportation Briefing Book. (January 2007.) Page 16. Accessed August 2013 at: http://www.plugincenter.net/wp-content/uploads/2010/10/Electrify_Transportation_Briefing_Book.pdf

[601] San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Pages 89-90. Access August 2013 at: http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485

[602] Electrify Transportation in Washington. 2007. Electrify Transportation Briefing Book. (January 2007.) Page 16. Accessed August 2013 at: http://www.plugincenter.net/wp-content/uploads/2010/10/Electrify_Transportation_Briefing_Book.pdf

[603] California Air Resources Board (CARB). Adoption of the Regulation to Reduce Emissions from Diesel Auxiliary Engines on Ocean-going Vessels While at Berth. (October 18, 2008). Accessed August 2013 at: http://www.arb.ca.gov/regact/2007/shorepwr07/uid2007.pdf

The California Air Resources Board At-Berth Regulation: In December 2007, the California Air Resources Board (ARB) approved the "Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean-Going Vessels At-Berth in a California Port" Regulation, commonly referred to as the At-Berth Regulation. The purpose of the At-Berth Regulation is to reduce diesel particulate matter (DPM) and NO_x emissions from diesel auxiliary engines on container ships, passenger ships, and refrigerated-cargo ships while berthing at California Ports. California Ports include the Port of Los Angeles (POLA), Long Beach (POLB), Oakland, San Diego, San Francisco, and Hueneme. The most common method for complying with the At-Berth Regulation is expected to be plugging in to shore power.[604]

The At-Berth Regulation requires a fleet to satisfy auxiliary engine operating limits for a percentage of visits, reduce the percentage of power produced by auxiliary engines in the fleet while at berth, and utilize available shore power if a vessel is equipped with shore power capabilities. OGV fleets are required to achieve compliance on January 1, 2014. The regulation requires 50 percent shore power usage and 50 percent reduction of auxiliary engine power during a fleet's quarterly visits to a port by 2014, 70 percent by 2017, and 80 percent by 2020.[605]

During 2006 through 2009, the POLA and POLB invested a combined $52.1 million to implement shore power programs. The Ports implemented the programs alongside the ARB regulation and expect to have shore power implemented at all major container and cruise terminals and one liquid bulk terminal at the POLA, and at all container terminals, one crude oil terminal, and one liquid bulk terminal at the POLB by 2014. The POLA and POLB expect the use of shore power at berth will reduce OGV emissions of CO_2 by 95 percent per vessel call. The estimate does not account for power plant emissions. The Ports intend to largely recapture the infrastructure costs over time through financial terms in the leases with terminal tenants.[606]

In May 2011, the South Coast Air Quality Management District awarded $58 million dollars from voter approved Proposition 1B for funding of 25 shore power infrastructure projects that will greatly reduce diesel emissions from ships calling at the POLA, POLB, and Port of Hueneme. The award helped fund the projects to accommodate the expected growth in electrified ships visiting the ports because of the CARB's At-Berth Regulation. The shore power projects will be completed at the end of 2013 and are estimated to reduce annual emissions of 762 tons of NO_x and 13 tons of DPM over 10 years.[607]

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[604] CARB. Shore Power for Ocean-going Vessels, Background. Accessed August 2013 at: http://www.arb.ca.gov/ports/shorepower/background/background.htm

[605] CARB. Shore Power for Ocean-going Vessels, FAQs. (February 11, 2013). Accessed August 2013 at: http://www.arb.ca.gov/ports/shorepower/faq/faq.htm#

[606] San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Access August 2013 at: http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485

[607] South Coast Air Quality Management District. AQMD Awards Nearly $60 Million for Ship Electrification, Shore-Side Power Projects. (May 2011). Accessed August 2013 at: http://www.aqmd.gov/news1/2011/bs050611.htm

The Port of San Francisco became the first California port to provide shore power for cruise ships while at berth in October 2010. The project budget was $5.2 million and was funded through contributions from multiple agencies including the Bay Area Air Quality Management District ($1.9 million), San Francisco Public Utilities Commission ($1.3 million), U.S. EPA Diesel Emission Reduction Act Program ($1.0 million), and the Port of San Francisco ($1.0 million). The Port of San Francisco estimates that the reductions in emissions for a 10-hour ship call are approximately 140 pounds of DPM, 1.3 tons of NO_x, 0.87 tons of sulfur oxides (SO_x), and 19.7 $mtCO_2e$.[608] Although there is no data on how often the ships use the shore power at this port, container and reefer ships must comply with California's at-berth regulations if they dock at a port 25 or more times annually while passenger ships must comply if they visit a port 5 or more times per year.[609] Consequently, vessels using this shore power will be making multiple trips to the port.

Transport Canada Marine Shore Power and Shore Power Technology for Ports Programs: Transport Canada, the country's department responsible for developing regulations, policies, and services of transportation, completed the Marine Shore Power Program between 2007 and 2012. The program provided $2 million (CAD) to Port Metro Vancouver to install shore power technology for cruise ships and $1.8 million (CAD) to the Port of Prince Rupert to support installation of shore power for container ships.[610] As part of the Marine Shore Power Program, The Port Metro Vancouver became the first port in Canada and third in the world to install shore power for cruise ships. This 2009 installation for cruise ships represents a $9 million (CAD) initiative by the Government of Canada, the British Columbia Ministry of Transportation and Infrastructure, Holland America Line, Princess Cruises, BC Hydro and Port Metro Vancouver. Between April and October 2010, Port Metro Vancouver completed 44 shore power connections, which reduced GHG emissions by 1,521 $mtCO_2e$. Based on costs at the time of measurement, cruise ships saved an average of $234 (CAD) and 1.78 metric tons of fuel each hour that their engine was shut off while at berth.[611] In 2011, 35 vessels connected to the Ports shore power facilities, reducing GHG emissions by 1,318 $mtCO_2e$.[612]

In January 2012, the Government of Canada approved a $27.2 million (CAD) Shore Power Technology for Ports Program as part of the country's Clean Air Agenda. The Clean Air Agenda

[608] Office of the Mayer, City & County of San Francisco. Mayor Newsom and the Port of San Francisco Inaugurate Cruise Ship Using Shoreside Power. (October 2010). Accessed August 2013 at: http://www.epa.gov/region9/mediacenter/posf-dera/SF-Port-Shore-Power.pdf

[609] California Air Resources Board. 2012. At-berth Regulation Presentation. Accessed September 2013 online at: http://www.arb.ca.gov/ports/shorepower/meetings/10032012/presentation.pdf

[610] Transport Canada. Harper government invests in Canadian ports. (January 25, 2012). Accessed August 2013 at: http://www.tc.gc.ca/eng/mediaroom/release-2012-h004e-6622.htm

[611] Transport Canada. Case Study – Port Metro Vancouver Shore Power Project. (February 2, 2012). Accessed August 2013 at: http://www.tc.gc.ca/eng/programs/environment-sptp-case-study-2690.htm

[612] Port Metro Vancouver. Shore Power at Canada Place. Access August 2013 at: http://www.portmetrovancouver.com/en/about/cruiseandtourism/shorepower.aspx

funds initiatives with an economy-wide target of reducing GHG emissions by 17 percent from 2005 levels by 2020. As part of the program, Seaspan Ferries Corporation will be installing shore power at the Swartz Bay Ferry Terminal in 2013. The project will cost $179,300 (CAD) and will decrease fuel consumption at the Swartz Bay Ferry Terminal by approximately 70,000 litres (18,500 gallons) annually, representing a net savings of about $45,000 (CAD) and an approximate 210 mtCO_2e reduction in GHG emissions.[613] Beginning in 2014, the Port of Halifax will be the first port in Atlantic Canada to implement shore power for cruise ships. The shore power infrastructure project represents a $10 million (CAD) initiative among the Government of Canada, the Province of Nova Scotia, and the Port of Halifax. Once installed, the shore power operation will decrease cruise ship idling by seven percent, representing an annual decrease of approximately 123,000 litres (32,500 gallons) of fuel usage and 370 mtCO_2e of GHG and air pollutant emissions.[614]

Shore Power Projects in Washington State: The Port of Seattle, Princess Cruises, and Holland America Line completed a $7.5 million shore power project at Seattle's Terminal 30 in 2005 and 2006. The cruise lines each contributed approximately $1.5-1.7 million on landside infrastructure and $1.0-1.1 million for retrofitting five vessels (two Princess Cruise vessels and three Holland America Line vessels). The USEPA and Puget Sound Clean Air Agency provided $75,000 in grant funding to assist the projects. Participating vessels are cutting annual CO_2 emissions by up to 29 percent annually, with financial savings on energy costs of up to 26 percent per call.[615] The cruise lines' shore power systems were relocated to Terminal 91 in 2009.[616]

In October 2010, a $2.7 million shore power project was completed at the Port of Tacoma's Totem Ocean Trailer Express, Inc. (TOTE) terminal. The U.S. EPA awarded the Port of Tacoma a $1.5 million grant to construct a shore side connection and power system at the terminal. TOTE contributed approximately $1.2 million to retrofit two Alaska trade ships that make weekly calls at the terminal. The shore power project estimated a reduction of diesel and GHG emissions by up to 90 percent during TOTE's 100 annual ship calls. That translates to about 1.9 tons of diesel particulates and 1,360 mtCO_2e each year. The infrastructure update sustained an estimated 50 manufacturing and local installation jobs. [617]

[613] Transport Canada. Shore power arrives at Swartz Bay Ferry Terminal. (March 6, 2013). Accessed August 2013 at: http://www.tc.gc.ca/eng/mediaroom/releases-2013-h024e-7068.htm
[614] Transport Canada. Shore power arrives at the Port of Halifax. (January 23, 2013). Accessed August 2013 at: http://www.tc.gc.ca/eng/mediaroom/releases-2013-h003e-7035.htm
[615] 40 Cities. Port of Seattle Cuts Vessel Emissions by 29% Annually and Saves 26% on Energy Costs per Call. Access August 2013 at: http://www.c40cities.org/c40cities/seattle/city_case_studies/port-of-seattle-cuts-vessel-emissions-by-29-annually-and-saves-26-on-energy-costs-per-call
[616] Cochran Marine. Seattle – Terminal 91 Shore Power Relocation. Accessed August 2013 at: http://www.cochranmarine.com/current-installations/seattle-shore-power-relocation-terminal-91/
[617] Port of Tacoma. First cargo ship in Pacific Northwest plugs into shore power at Port of Tacoma. (October 27, 2010). Accessed August 2013 at: http://www.portoftacoma.com/Page.aspx?cid=4773

The following sections present results for shore power projects at ports in California and Canada. The programs highlight collaborative efforts between federal, state, and local agencies with private industry to implement shore power infrastructure and vessel retrofits to reduce GHG emissions and improve air quality. In addition, economic impacts from the use of shore power for container ships, cruise ships, or ferry vessels in these jurisdictions are directly applicable to ports in the Puget Sound Region. As a result, these programs were deemed most appropriate for use by Washington.

17.2 GHG Impacts

Table 48 summarizes the available GHG-related information for the California and British Columbia programs. Implementation of California's At-Berth Regulation is estimated to reduce emissions from OGVs by 80 percent in 2020,[618] and POLA and POLB GHG emissions from OGVs will be reduced by 95 percent.[619] The Marine Shore Power Program adopted at Canada Place Terminal in Vancouver, British Columbia has proven to be a reliable and effective solution to reduce large-scale emissions and has been expanded to other ports in Canada in recent years.[620]

Table 48: GHG Costs and Benefits of Example Shore Power Programs

California	
Cost of Reductions	None noted.
Volume of Reductions	**2,400 mtCO_2e (in 2011)** **200,000 mtCO_2e (2020)**[621]
Programmatic Status	The program is in the early stages of implementation. Successes of the program will be realized over time. A better assessment can be made following the **At-Berth Regulation requirement of 50 percent reduction in emissions per fleet by 2014**.[622]
Emissions Leakage	Displacement of emissions from OGVs auxiliary engines to electric power plants. Source of electricity generation at power plants will determine overall emissions reductions. [623]
Canada	

[618] Transport Canada. Case Study – Port Metro Vancouver Shore Power Project. (February 2, 2012). Accessed August 2013 at: http://www.tc.gc.ca/eng/programs/environment-sptp-case-study-2690.htm
[619] Port of Long Beach and Port of Los Angeles. San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Pages 89-90. Accessed August 2013 at: http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485
[620] Transport Canada. Case Study – Port Metro Vancouver Shore Power Project. (February 2, 2012). Accessed August 2013 at: http://www.tc.gc.ca/eng/programs/environment-sptp-case-study-2690.htm
[621] California Climate Change Portal. 2013. January 2013 State Agency Greenhouse Gas Reduction Report Card. (January 2013). Pages 2 and Table 2 page 3. Accessed August 2013 at:http://www.climatechange.ca.gov/climate_action_team/reports/2013_CalEPA_Report_Card.pdf
[622] CARB. Shore Power for Ocean-going Vessels, Background. Accessed August 2013 at: http://www.arb.ca.gov/ports/shorepower/background/background.htm
[623] Pratt and Harris. 2013. Vessel Cold-Ironing Using a Barge Mounted PEM Fuel Cell: Project Scoping and Feasibility. (February 2013). Page 16. Accessed August 2013 at: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/sand2013-0501_barge_mounted_pemfc.pdf

Cost of Reductions	None noted.
Volume of Reductions	**1,521 $mtCO_2e$** (April 2010 to October 2010 at Canada Place Terminal)[624]
Programmatic Status	The Marine Shore Power Program was deemed a success from 2007 to 2012. The Shore Power for Ports Program was passed in 2012 and will build on past successes.
Emissions Leakage	Displacement of emissions from OGVs back to electric power plants. Source of electricity generation at power plants will determine overall emissions reductions. [625]

17.3 Energy and Economic Impacts

Table 49 summarizes the available energy and economic impact information for the California and Canadian shore power programs. The POLA and POLB are examples of significant economic investments for shore power infrastructure. Infrastructure development includes jobs for terminal improvements, engineering services, permitting, and construction management. Ports with shore power capabilities will continue to be competitive economic hubs. For example, the Port of Halifax generated approximately $1.5 billion economic growth and contributed over 11,000 port-related jobs in 2012.[626]

Table 49: Energy and Economic Impacts of Example Shore Power Programs

California	
Independence from Fossil Fuels, and Economic Impact	Independence from fossil fuels will be increased through reduction in diesel fuel consumption to power OGVs while at port. [627]
Impacts on Fuel Choice	Increase in demand on local jurisdictions electricity power supply. [628]

[624] Transport Canada. Case Study – Port Metro Vancouver Shore Power Project. (February 2, 2012). Accessed August 2013 at: http://www.tc.gc.ca/eng/programs/environment-sptp-case-study-2690.htm
[625] Pratt and Harris. 2013. Vessel Cold-Ironing Using a Barge Mounted PEM Fuel Cell: Project Scoping and Feasibility. (February 2013). Page 16. Accessed August 2013 at: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/sand2013-0501_barge_mounted_pemfc.pdf
[626] Transport Canada. Shore power arrives at the Port of Halifax. (January 23, 2013). Accessed August 2013 at: http://www.tc.gc.ca/eng/mediaroom/releases-2013-h003e-7035.htm
[627] Pratt and Harris. 2013. Vessel Cold-Ironing Using a Barge Mounted PEM Fuel Cell: Project Scoping and Feasibility. (February 2013). Page 16. Accessed August 2013 at: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/sand2013-0501_barge_mounted_pemfc.pdf
[628] Pratt and Harris. 2013. Vessel Cold-Ironing Using a Barge Mounted PEM Fuel Cell: Project Scoping and Feasibility. (February 2013). Page 16. Accessed August 2013 at: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/sand2013-0501_barge_mounted_pemfc.pdf

Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Shore power requires extensive infrastructure improvements on-board vessels that would use the system, as well as on the terminal side for supplying appropriate levels of conditioned electrical power. [629] From 2006 to 2009, POLA and POLB invested $52.1 million[630], and in 2011 SCAQMD awarded $58 million to fund shore power infrastructure. [631] A Port of San Francisco project was budgeted at $5.2 million. [632]
Impact on Different Sectors of the Economy	Increased competitiveness as more fleets fit vessels with shore power capabilities.[633]
Canada	
Independence from Fossil Fuels, and Economic Impact	Independence from fossil fuels will be increased through reduction in diesel fuel consumption to power OGVs while at port. Fuel savings of 146,000 gallons at Canada Place Terminal from April 2010 to October 2010.[634]
Impacts on Fuel Choice	Increase in demand on local jurisdictions electricity power supply. [635]
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	Shore power requires extensive infrastructure improvements on-board vessels that would use the system, as well as on the terminal side for supplying appropriate levels of conditioned electrical power.[636] Swartz Bay Ferry Terminal Investment - $179,300 (CAD) Canada Place Cruise Terminal Investment - $9.4 million (CAD) Port of Halifax Cruise Terminal Investment - $10 million (CAD)
Impact on Different Sectors of the Economy	Increased competitiveness as more fleets fit vessels with shore power capabilities.

17.4 Household Impacts and Co-Benefits

Table 50 summarizes the available household impacts and co-benefit information for the California and Canadian programs. Both programs will reduce GHG emissions as well as DPM,

[629] Pratt and Harris. 2013. Vessel Cold-Ironing Using a Barge Mounted PEM Fuel Cell: Project Scoping and Feasibility. (February 2013). Page 16. Accessed August 2013 at: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/sand2013-0501_barge_mounted_pemfc.pdf
[630] San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Access August 2013 at: http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485
[631] South Coast Air Quality Management District. AQMD Awards Nearly $60 Million for Ship Electrification, Shore-Side Power Projects. (May 2011). Accessed August 2013 at: http://www.aqmd.gov/news1/2011/bs050611.htm
[632] Office of the Mayer, City & County of San Francisco. Mayor Newsom and the Port of San Francisco Inaugurate Cruise Ship Using Shoreside Power. (October 2010). Accessed August 2013 at: http://www.epa.gov/region9/mediacenter/posf-dera/SF-Port-Shore-Power.pdf
[633] San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Pages 89-90. Access August 2013 at: http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485
[634] Transport Canada. Case Study – Port Metro Vancouver Shore Power Project. (February 2, 2012). Accessed August 2013 at: http://www.tc.gc.ca/eng/programs/environment-sptp-case-study-2690.htm
[635] Pratt and Harris. 2013. Vessel Cold-Ironing Using a Barge Mounted PEM Fuel Cell: Project Scoping and Feasibility. (February 2013). Page 16. Accessed August 2013 at: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/sand2013-0501_barge_mounted_pemfc.pdf
[636] Pratt and Harris. 2013. Vessel Cold-Ironing Using a Barge Mounted PEM Fuel Cell: Project Scoping and Feasibility. (February 2013). Page 16. Accessed August 2013 at: http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/sand2013-0501_barge_mounted_pemfc.pdf

NO_x, and SO_x to improve air quality in the surrounding area. Significant diesel emissions reductions from electric shore power connection will result in fewer incidences of asthma, cardiopulmonary diseases, lost school and work days, and premature deaths directly linked to diesel pollution.[637] The programs are not expected to impact energy costs or costs of goods for households or low-income populations.

Table 50: Household Impacts and Co-Benefits of Example Shore Power Programs

California	
Effect on Household Consumption and Spending	Drawbacks to the program may include increased power consumption from local power grid causing energy costs to increase.
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted.
Significant Co-benefits	Use of shore power will reduce OGV at-berth emissions of DPM, NO_x, and SO_x by 95 percent per vessel at POLA and POLB.[638] Expected increased health benefits from improved air quality.[639]
Canada	
Effect on Household Consumption and Spending	None noted.
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted.
Significant Co-benefits	Improved air quality through reduction in diesel auxiliary engines.

18 Landfill Methane Capture

Policy Definition	Targeted Sector or Emissions
A requirement that landfills with more than 450 thousand tons of waste-in-place install and operate landfill gas collection and control systems. These systems collect and destroy methane gas, and can be	Landfill methane

[637] Office of the Mayer, City & County of San Francisco. Mayor Newsom and the Port of San Francisco Inaugurate Cruise Ship Using Shoreside Power. (October 2010). Accessed August 2013 at: http://www.epa.gov/region9/mediacenter/posf-dera/SF-Port-Shore-Power.pdf

[638] San Pedro Bay Ports Clean Air Action Plan 2010 Update. (October 2010). Pages 89-90. Access August 2013 at: http://www.cleanairactionplan.org/civica/filebank/blobdload.asp?BlobID=2485

[639] Office of the Mayer, City & County of San Francisco. Mayor Newsom and the Port of San Francisco Inaugurate Cruise Ship Using Shoreside Power. (October 2010). Accessed August 2013 at: http://www.epa.gov/region9/mediacenter/posf-dera/SF-Port-Shore-Power.pdf

used to generate thermal or electric energy.	
GHGs and Costs	
• Estimated by California ARB to cost from $5.50 per $mtCO_2e$ to a high of $11.38 per $mtCO_2e$ over the measure's expected life of 2010-2033, with an average of $8.64 per $mtCO_2e$. • Annual reductions of 1.2 $MMTCO_2e$ in 2010 to an 2.1 $MMTCO_2e$ in 2033. Cumulative 2010-2033 emission reductions are estimated at 38.8 $MMTCO_2e$. • Regulatory costs are estimated to range from $25,000-$1.2 million annually.	
Implementation Issues and Lessons Learned	
• Relatively small source of GHG emissions in Washington, but achievable at a low cost per $mtCO_2e$. • Must be coordinated with the federal New Source Performance Standards (NSPS) which regulates gassy landfills larger than 2.5 million metric tons design capacity.	
Costs and Benefits to Consumers	**Costs and Benefits to Businesses**
• $0.09 per month per Californian • Reduction in NMOC emissions	• Estimated capital investment of over $27 million to design, construct, and install required landfill GCCS, and an additional $6.4-$14 million annually in recurring costs. Total costs for technology, operation, monitoring and maintenance are estimated at approximately $335 million. • Costs to landfill operators may translate into jobs in related sectors.

The anaerobic degradation of organic waste creates methane (CH_4), a potent GHG that is 21 times more heat trapping than carbon dioxide. Modern municipal solid waste (MSW) landfills are managed anaerobically (in the absence of oxygen), and emit CH_4 emissions over time, in varying amounts depending on landfill management practices. Typically, CH_4 comprises approximately 50 percent of landfill gas (LFG). In the U.S., landfills account for 17.5 percent of all CH_4 emissions, or about 1.8 percent of total GHG emissions.[640]

Federally, the New Source Performance Standard (NSPS) regulates large MSW landfills, and requires those with greater than 50 megagrams (Mg) emissions per year of non-methane organic compounds (NMOC) to install gas collection and control systems (GCCS). Although these systems are implemented for the management of NMOC, the management practice of combusting LFG also destroys the CH_4 component of the gas. Landfill GCCS capture and combust CH_4 generated at landfills, preventing it from being released to the atmosphere, or capture it for energy use if it is generated in large enough amounts.

The NSPS applies only to landfills with a design capacity of 2.5 million metric tons or greater.[641] However, many landfills in the U.S. are smaller than this, and there is no federal standard requiring GCCS at those sites. California implemented a Landfill Methane Control Measure as

[640] U.S. Environmental Protection Agency. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2011*. April 12, 2013. Accessed August 2013 at: http://epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf
[641] U.S. Environmental Protection Agency. *Rule and Implementation Information for Standards of Performance for Municipal Solid Waste Landfills*. Accessed July 2013 at: http://www.epa.gov/ttnatw01/landfill/landflpg.html

part of their AB 32 Global Warming Solutions Act to target smaller landfills that still have significant CH_4 emissions.

18.1 Existing Policies

This section analyzes existing policies implemented in other jurisdictions which target landfill methane emissions. The following programs are included:

California Landfill Methane Control Measure: Under California regulation, landfills with greater than 450,000 tons of waste-in-place, a landfill gas heat rate greater than or equal to 3.0 MMBtu per hour, and which received waste after January 1, 1977 must install and operate a landfill GCCS with 99 percent destruction removal efficiency for methane. Hazardous waste landfills, construction and demolition landfills, and landfills regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) are exempt.[642]

18.2 GHG Impacts

At this time, California is the only state in the U.S. that has implemented a landfill methane policy more stringent than the federal rules, and program evaluation data on emissions reductions and costs are unavailable. Table 51 summarizes the costs and reductions from the California program, as presented in the ARB Staff Initial Statement of Reasons.

Table 51: GHG Costs and Benefits of the CA Landfill Methane Control Measure

California	
Cost of Reductions	California ARB estimated total costs of implementation from 2010-2033 at $111 million (2008 USD). The overall cost-effectiveness estimates inclusive of private and public costs of the measure range from a low of **$5.50 per mt$CO_2$e to a high of $11.38 per mt$CO_2$e** over the measure's expected life of 2010-2033, with an average of $8.64 per mt$CO_2$e.[643]
Volume of Reductions	Annual emission reductions range from a **low of 1.2 MMTCO2e in 2010 to an estimated high of 2.1 MMTCO_2e in 2033**. California ARB estimated that cumulative 2010-2033 emission reductions resulting from the measure would be 38,830,509 mtCO_2e.[644]
Programmatic Status	There are currently no data available on the success of the program.
Emissions Leakage	There is no anticipated displacement or leakage of emission sources.

[642] California Air Resources Board. *Implementation Guidance Document for the Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills*. July 2011. Accessed August 2013 at: http://www.arb.ca.gov/cc/landfills/docs/guidance0711.pdf

[643] California Air Resources Board. *Staff Report: Initial Statement of Reasons for the Proposed Regulation to Reduce Methane Emissions from Municipal Solid Waste Landfills*. May 2009. Accessed August 2013 at: http://www.arb.ca.gov/regact/2009/landfills09/isor.pdf

[644] California Air Resources Board. May 2009.

In general, the Landfill Methane Control Measure represents a relatively low cost means of reducing CH_4 emissions according to California modeling. However, several parties commented during the public comment period that the ARB estimates were lower than many individual landfills would experience. For smaller landfills, the costs to mitigate CH_4 will be greater on a per $mtCO_2e$ basis.

18.3 Energy and Economic Impacts

During policy development, the California ARB quantified costs and benefits of the Landfill Methane Control Measure for two sectors of the economy: landfill operators and regulators. As shown in Table 52, the total costs to affected businesses are approximately $111 million. These costs include site monitoring, system installation, operation and maintenance, and reporting, much of which must be conducted on-site or in-state. The annual costs to the government for implementation and compliance monitoring is estimated to range from $24,500 to $1.2 million.[645]

Table 52: Energy and Economic Impacts of the CA Landfill Methane Control Measure

California	
Independence from Fossil Fuels, and Economic Impact	Landfill gas can be converted for use in vehicles as liquefied natural gas (LNG), or upgraded to pipeline quality methane. Additionally, if sufficient gas quantities exist the methane can be combusted for electricity generation. Any of these applications has the potential to displace fossil fuel.
Impacts on Fuel Choice	Other than modest displacement of fossil fuels, no impact on fuel choice is anticipated.
Opportunity for Investments in Infrastructure and Clean Energy/Energy Efficiency	The California ARB estimates a necessary capital investment of over $27 million to design, construct, and install required landfill GCCS, and an additional $6.4-$14 million annually in recurring costs. **Total costs for technology, operation, monitoring and maintenance are estimated at approximately $335 million**.[646]

[645] Ibid.
[646] Ibid.

Impact on Different Sectors of the Economy	California ARB estimated the following costs to affected businesses over the life of the measure: • Capital: $8.1 million • Annual Operations and Maintenance (O&M): $43 million • Monitoring: $60 million • Reporting: $54,200 • TOTAL: $111 million Additionally, California ARB estimated the following costs to affected government agencies which manage landfills: • Capital: $19 million • Annual O&M: $105 million • Monitoring: $101 million • Reporting: $250,000 • TOTAL: $225 million **Regulatory costs are estimated to range from $25,000-$1.2 million annually**.[647]

18.4 Household Impacts and Co-Benefits

Over the life of the measure, the ARB calculated that the Landfill Methane Control Measure would cost the average California household $0.09 per month.[648] This cost would not be expected to significantly impact household consumption and spending.

As noted, the federal NSPS regulation requiring landfill GCCS at large gassy landfills was not developed to manage CH_4. Rather, it targets volatile organic compounds (VOCs) and NMOCs which are harmful to air quality and present health concerns. However, the technology for mitigating these compounds – combustion – also destroys the methane contained in LFG. For landfills regulated under NSPS, the destruction and management of methane could thus be considered a co-benefit. Conversely, a policy that targets methane for destruction will have the co-benefit of mitigating VOCs and NMOCs.[649] Table 53 shows the household impacts and co-benefits associated with the California methane control measure.

647 Ibid.
648 Ibid.
649 Ibid.

Table 53: Household Impacts and Co-Benefits of the CA Landfill Methane Control Measure

California	
Effect on Household Consumption and Spending	Costs associated with the Landfill Methane Control Measure are borne directly by landfill operators and regulating agencies. However, some costs will be passed to consumers in the form of increased waste disposal costs. Over the life of the measure, California ARB calculated that the measure will **cost each California approximately $0.09 per month.**
Measures to Mitigate to Low-income Populations, or Economic Impact	None noted.
Significant Co-benefits	Installation of landfill GCCS reduces toxic NMOCs from landfills. California ARB estimates the following **NMOC reductions**: • 2011: 13,700 tons • 2015: 21,300 tons • 2020: 22,800 tons Conversely, combustion of landfill gas generates nominal levels of criteria pollutants, but the California ARB estimates that NOx and CO are not expected to increase at subject landfills.[650]

[650] Ibid.

19 Agriculture and Forestry Sequestration and Emission Reduction Options

Estimates of emissions from the agriculture sector have increasingly shown its significance to global emissions, while forests have been increasingly used as an emissions mitigation tool through carbon capture and storage. This is highlighted in the 2011 U.S. National Emissions Inventory which shows the agriculture sector to be responsible for around 8% of total U.S. emissions while Land Use, Land Use Change, and Forestry (LULUCF) are a net sink, offsetting about 14% of total U.S. emissions.[651]

Washington State has investigated different ways to incorporate these sources into their policies to both reduce emissions from agriculture and land use changes, and enhance the sequestration and storage of carbon in forests. In 2008 Washington States Forrest Sector Workgroup released a report that identified potential policy options that addressed the LULUCF sector. The recommendations made were incorporated into a joint report by the Washington State Departments of Ecology and Department of Commerce on "Growing Washington's Economy in a Carbon-Constrained World".

The recommendations from these reports were created under the assumption that Washington State would be joining the Western Climate Initiative and its regional cap and trade program. The focus of these recommendations is the development of offset protocols that would be used to incentivize projects that improve agricultural practices and limit deforestation from which offsets could be sold to regulated entities to help meet their emission caps. These recommendations included developing offset protocols under a cap trade program for;

- Avoided Conversion (conserving developable forest lands permanently),
- Urban Forests (urban tree planting programs),
- Forrest Management (improving and ensuring long-term carbon storage through improved management techniques).[652]

The Joint departmental report also included recommendations on Agricultural offset protocols including;

- Improved soil carbon and nitrogen management on both working agricultural and conservation lands.
- Cattle manure management that captures and destroys methane.[653]

Emissions from LULUCF were also addressed in the report with recommendations outside the structure of a cap and trade program. These recommendations were based on following and enhancing the Growth Management Act, which attempts to the balance the need for further development required to accommodate the projected 1.5 million additional state residents by

[651] http://www.epa.gov/climatechange/ghgemissions/sources.html
[652] http://www.ecy.wa.gov/climatechange/2008FAdocs/11241008_forestreportversion2.pdf
[653] https://fortress.wa.gov/ecy/publications/publications/0801025.pdf

2025 while limiting the environmental impacts of that development. These recommendations are made on the principal of limiting development in rural and forest lands and instead directing development to high density multi-use urban areas.[3]

19.1 Examples of Similar Offset Programs

California's Air Resources Board has adopted as part of their cap and trade program an offsets protocol for forestry projects and the Regional Greenhouse Gas Initiative (RGGI) is in the process of adopting a new forestry offset protocol based on California's to replace their existing one[654]. Both of these target similar project types as those identified above. The effectiveness of these cannot be judge currently as California program is too new and RGGI covered entities have thus far not invested in offsets because the emission cap has not been approached and the cost of emission allowances remains far below the cost of developing offset projects.

The Clean Development Mechanism (CDM), which is the offset provider for countries who wish to use offsets as a means to meet their commitments under the UNFCCC's Kyoto Protocol agreement and is a large scale example of this type of system. The CDM has addressed several of the offset requirements such as additionality, and has been used as a reference and guide for the development of other offset program protocols. The CDM expects to issue around 8 million certified emission reduction credits (CERs), each of which is equivalent to 1 metric ton of CO2 reductions, from currently registered LULUCF projects by 2020.[655]

19.2 Lessons Learned

There is still debate over the legitimacy of carbon offsets and whether they are providing real reductions, or if they simply allow cap and trade covered entities to continue emitting at high levels. Offsets for project types such as forest conservation, which provide credits for not cutting down an existing forest under the premise that it would have been cut down in a business as usual baseline, are particularly criticized because essentially no change has actually been made yet an offset credit has been given. The majority of offset protocols are predicated on ensuring "additionality", that the action that is reducing emissions or avoiding emissions wouldn't have been done anyway, that the project is additional to business as usual. This opens up all offsets for criticism because it is very difficult to predict or forecast what would have happened in the absence of the policy.[656]

New Zealand's cap and trade program has come under fire recently as it allowed U.N Emission Reduction Units (ERUs) in uncapped amounts to be used to offset government issued emission allowances (NZUs). The ERUs were much cheaper, at 13 cents due to an overabundance, which

[654] RGGI Program Review News Release: RGGI States Propose Lowering Regional CO2 Emissions Cap 45%,Implementing a More Flexible Cost-Control Mechanism; http://www.rggi.org/docs/PressReleases/PR130207_ModelRule.pdf

[655] http://cdm.unfccc.int/Statistics/Public/CDMinsights/index.html

[656] http://sfpublicpress.org/news/2013-07/californias-market-for-hard-to-verify-carbon-offsets-could-let-industry-pollute-as-usual

dragged the price of NZUs down from $7 to below 2$. This also gave landowners who would be required to surrender 1 NZU or ERU for every 2 tons of emissions an opportunity to cheaply cover the cost of high emissions, which for a landowners who wished to convert their land from forest to another use the opportunity to sell their NZUs on the market and then buy the much cheaper ERUs to cover their emissions, allowing significant profits while drastically increasing emissions[657]. This caused emissions from deforestation to rise to 8.2 million metric tons in one year compared to just 200,000 metric tons a year earlier.[658] This is a cautionary tale not about LULUCF offsets specifically but about what offsets are allowed, from what sources, and in what quantities. Allowing offsets can clearly have unintended consequences under a cap and trade program if not carefully integrated.

[657] Owners of land with forests planted before 1990 are forced to take part in the ETS and are given carbon permits for each tonne of carbon stored in their trees. When they harvest forests they are forced to surrender permits and when new forests are planted they receive additional ones

[658] http://www.pointcarbon.com/polopoly_fs/1.2518903!CMANZ20130816.pdf

Task 3 – Evaluation of Federal Policies

Summary of Federal Policies and Their Contributions to Washington's GHG Emission Reduction Targets

September 20, 2013

Table of Contents

Acronyms

BACT	Best Available Control Technology
BAU	Business-as-Usual
BCG	Boston Consulting Group
Btu	British Thermal Units
CAFE	Corporate Average Fuel Economy
CAIR	Clean Air Interstate Rule
CARB	California Air Resources Board
CD	Census Division
CEA	Consumer Energy Alliance
CEQA	California Environmental Quality Act
CLEW	Climate Legislative and Executive Workgroup
CO_2	Carbon Dioxide
CRS	Congressional Research Service
CSAPR	Cross-state Air Pollution Rule
D.C.	District of Columbia
DOE	U.S. Department of Energy
EIA	U.S. Energy Information Administration
EISA	Energy Independence and Security Act
EPA	U.S. Environmental Protection Agency
EPACT	Energy Policy Act
FERC	Federal Energy Regulatory Commission
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IPM	Integrated Planning Mode
IRS	Internal Revenue Service
ITC	Investment Tax Credit
LCFS	Low Carbon Fuel Standard
LNG	Liquefied Natural Gas
MATS	Mercury and Air Toxic Standards
MLP	Master Limited Partnership
MPG	Miles Per Gallon
NEMS	National Energy Modeling System
NESCAUM	Northeast States for Coordinated Air Use Management
NHTSA	National Highway Transportation Administration
NOx	Nitrogen Oxides
NREL	National Renewable Energy Laboratory
NSPS	New Source Performance Standards

OFM	Office of Financial Management
PSD	Prevention of Significant Deterioration
PTC	Production Tax Credit
PV	Photovoltaic
REITs	Real Estate Investment Trusts
RFS	Renewable Fuels Standards
RIN	Renewable Identification Number
RVO	Renewable Volume Obligation
SAIC	Science Applications International Corporation
SEDS	State Energy Data System
SMU	Southern Methodist University
U.S.	United States
WA	Washington
WECC/NWPP	Western Electricity Coordinating Council / Northwest Power Pool
WSPA	Western States Petroleum Association

1 Overview

As part of its Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State, the Climate Legislative and Executive Workgroup (CLEW), through the Office of Financial Management (OFM), has tasked Science Applications International Corporation (SAIC) with examining and summarizing federal policies that could potentially contribute to meeting the state's greenhouse gas (GHG) emission targets for 2020, 2035, and 2050. On July 26, 2013, SAIC submitted a draft document in fulfillment of those objectives. After receiving comments from the State, SAIC provided an updated document on August 23, 2013 that responded to comments provided by the State and further quantified the potential amount of future GHG emission reductions in Washington State that could be attributable to existing and anticipated federal policies. This document provides additional response to further comments provided by the State and adds greater detail on GHG emission reductions in Washington that are forecast to occur through 2035 due to the impacts of federal policies.

There are a virtually unlimited number of federal policies that can affect national and individual state GHG emission levels. The Kaya identity (eq.1 below) expresses carbon dioxide emissions as a function of: 1) Total economic activity; 2) the energy intensity of economic activity; and 3) the carbon intensity of energy consumed.[1]

$$CO_2 \text{ Emissions} = \text{Population} \times (\text{GDP/Population}) \times (\text{Energy/GDP}) \times (CO_2\text{/Energy}) \quad \text{(equation 1)}$$

Thus, virtually any policy that will affect economic activity, from the Patient Protection and Affordable Care Act to the quantitative easing by the Federal Reserve will affect GHG emissions. However, it is rare that the GHG consequences of such policies have been examined and to do so would require a scope and resources far beyond that of this study. Instead, we will focus on those policies that can be more reasonably expected to impact the last two variables of the Kaya identity, the energy intensity of the economy and the carbon intensity of energy consumed. That said, such policies themselves, will have an impact on economic activity that can be of great consequence, and which we will try to consider in this study.

Although this analysis has been largely limited to existing federal policies, or proposed federal policies that can be plausibly expected to be implemented in the near- or mid-term, a special exception has been made for the inclusion of state-level policies implemented within Washington's region but outside of its borders such as California's Low Carbon Fuel Standard and the Renewable Portfolio Standards in place across the region. A summary of each policy

[1] Kaya, Y., *Impact of Carbon Dioxide Emission Control on GNP Growth: Interpretation of Proposed Scenarios,* paper presented to the IPCC Energy and Industry Subgroup, Response Strategies Working Group, Paris, France, 1990.

analyzed appears directly below accompanied by a brief literature review. The U.S. Energy Information Administration's (EIA) National Energy Modeling System (NEMS) has been employed to perform a forecast of the impacts of these policies on future greenhouse gas emission levels. NEMS performs its analysis at the national and regional levels. Preliminary results provided in Section 4 below include forecasts of impacts on national emissions levels and forecasts of impacts on Census Division 9, which includes California, Oregon, Hawaii, Alaska and Washington and in the case of electricity[2], the Western Electricity Coordinating Council / Northwest Power Pool[3]. SAIC will employ post processing techniques to apply relevant policies specifically to Washington state. Specifically, post processing will multiply Washington's average historic share of fuel, energy, or emissions, as appropriate, by regional NEMS projections to estimate state-level impacts for each policy. Historic data for Washington was obtained from the State Energy Data System (SEDS) and State CO_2 Emissions database maintained by the Energy Information Administration. These values were averaged for 2006 through 2010 to estimate Washington State's typical share or weight in the region. Additional details on state-level calculation methods are provided in Appendix C.

2 Summary of Federal Policies to be Examined

The CLEW has identified five categories of federal policies that may contribute to meeting the states greenhouse gas emissions targets. They are:

- Renewable fuel standards;
- Tax incentives for renewable energy;
- Tailpipe emission standards for vehicles;
- Corporate average fuel economy (CAFE) standards for cars and light trucks; and
- Clean Air Act requirements for emissions from stationary sources and fossil-fueled electric generating units.

This study defines the renewable fuels standards as RFS-1 and RFS-2 as required under the Energy Policy Act (EPACT) of 2005 and Energy Independence and Security Act (EISA) of 2007, respectively. Tax incentives for renewable energy are defined as the Production Tax Credit for Renewable Resources and its subordinate element, the Investment Tax Credit. The CAFE standards are defined as the more stringent requirements implemented subsequent to EISA 2007. The tailpipe emissions standard for carbon dioxide and the most recent update to the CAFE standards are inextricably bound, both via regulation and in the NEMS model and thus are treated jointly. In response to the CLEW mandate to evaluate the impact of applicable emission standards for stationary source and fossil fueled electric generation under the Clean Air Act, this

[2] See Appendix A for a map of U.S. Census divisions.
[3] See Appendix B for a map of NEMS Electricity Market Module regions.

study examines the Mercury and Air Toxic Standards, the Clean Air Interstate Regulations, and the Cross-state Air Pollution Rule which constrain emissions of sulfur dioxide and oxides of nitrogen.

There are several other policies in place, that while not emanating from the federal government, have critical impacts across state borders and in particular, that may affect Washington's ability to meet its GHG emissions targets. Most notable among these are the California Low Carbon Fuel Standard, and state-level renewable portfolio standards. While it is unlikely that the Federal government will pass a renewable portfolio standard in the foreseeable future, we will conduct a regional analysis that captures the impact of surrounding states on the Washington electricity market.

In addition to existing policies, SAIC will also examine several prospective policies that we believe have a reasonable chance of becoming law in the near future and affecting the curve of Washington's future emissions profile.[4] Three of these were identified in President Obama's Climate Action Plan, released on June 25, 2013. They include EPA regulation, under the Clean Air Act, of GHG emissions from current and future electric generation stations, new incentives for renewable power generation on federal lands, and a reduction of tax expenditures for fossil fuels, which SAIC has interpreted as a repeal of the oil and gas depletion allowance.

In addition to those policies proposed by President Obama there are several being considered in Congress and lower down in the executive branch which also may have important impacts. The first is to grant renewable generation projects Master Limited Partnership (MLP) parity with fossil fuel projects as well as to allow renewable energy projects the same tax benefits from Real Estate Investment Trusts (REITs) that fossil-based projects now receive. MLPs and REITs combine the tax benefits of a partnership with the liquidity of a publicly traded stock. Both MLPs and REITS are taxed based on returns to investors but are not taxed at the corporate level, eliminating the "double taxation" generally applied to corporations and their shareholders. Limited partners in an MLP may record a pro-rated share of the MLP's depreciation to reduce tax liability. To qualify for MLP status, a partnership must generate at least 90 percent of its resources from qualifying sources. To date, "inexhaustible" (renewable) energy sources have been excluded as a qualifying source. The MLP Parity Act would allow renewables to be included as a qualifying source. REITs work similarly to MLPs. REITs were initially authorized by Congress in 1960 to give retail investors a way to get into commercial real estate. They are

[4] There are a virtually limitless number of potential policies that have been proposed at the federal level that could, conceivably reduce greenhouse gases. However, given the current legislative environment, absent existing authorities in the executive branch, or inclusion in an unrelated bill such as a continuing resolution or debt ceiling adjustment the prospects for these policies are limited in the near term. For example, S. 761, the Energy Saving and Industrial Competiveness Act may have had relevant impacts on Washington's emission levels but has been subject to considerable delay in the U.S. Senate as unrelated amendments associated with the minority's effort to defund the Patient Protection and Affordable Care Act are considered. Should S.761 pass out of the senate it will be subject to a similar process in the House of Representatives.

required to pay at least 90 percent of their taxable income to shareholders. REITS are now used for funding timber, data centers, mobile phone towers, and natural gas pipelines. All that is required for renewable energy facilities to be eligible for classification as a REIT is a letter ruling by the Internal Revenue Service that renewable facilities are "real property." The IRS has issued case-specific letters ruling in support of renewable REITS, but, has not, to date, issued a generic ruling.

Although it is not a policy determined by Congressional statute or executive order, the potential expansion of Liquefied Natural Gas (LNG) exports may have important effects on domestic gas production and prices. These effects may, in turn, have implications for future GHG reductions in Washington. The Federal Energy Regulatory Commission is currently considering application for the siting and construction of 17 LNG export terminals, with an additional six in the proposal pipeline. Approval of a significant portion of these terminals will likely increase the export of natural gas with important implications for gas production and prices.

2.1 Existing Policies

Renewable Fuels Standards (RFS-1 and RFS-2)

Program Summary: The Renewable Fuels Standard (RFS) was created under EPACT 2005. EPACT required that 7.5 billion gallons of renewable fuels be blended into motor gasoline by 2012. Administered by EPA, the original RFS is often referred to as RFS-1. The Program was expanded under EISA 2007. In addition to motor gasoline, it now includes diesel fuels. The target for renewable fuel to be blended into transportation fuels was raised to 36 billion gallons by 2022. EISA established new categories of renewable fuels including biomass-based diesel, non-cellulosic advanced and cellulosic biofuel, each with its own target within the larger overall target. Together, these advanced biofuels were equal to 21 billion of the overall 36 billion gallons targeted in 2022. EISA also set thresholds for the life-cycle GHG emissions of each of these fuels. To qualify under the program, traditional renewable fuels would need to have life-cycle emissions that are 20 percent lower than the fuel being displaced, advanced biofuel and biomass-based diesel would need to have lifecycle emissions 50 percent below the fuel being displaced, and cellulosic biofuel would need to have life-cycle GHG emissions 60 percent below the gasoline or diesel fuel it displaces. Under this Program (now referred to as RFS-2) the EPA assigns refiners and importers of petroleum-based transportation fuels a Renewable Volume Obligation (RVO). These regulated entities may meet these obligations with Renewable Identification Numbers (RIN), an alphanumeric code assigned to each gallon of renewable fuel either produced or imported into the United States. RINs may be traded so that obligations can be met at least cost.

Results of Preliminary Literature Review: The EPA estimated that RFS-2 will displace approximately 13.6 billion gallons of motor gasoline and diesel fuel in 2022, reducing greenhouse gas emissions by 138 million metric tons, and decreasing the cost of oil imports by

$41.5 billion. At the same time, the program will increase farm income by $13 billion dollars in 2022, but will also increase the annual cost of food by $10 per person in the U.S.[5] In 2011 and 2012, the American Petroleum Institute commissioned a two-phase study to look at the economic impacts of RFS-2. In phase one, Charles River Associates used the NEMS version from *Annual Energy Outlook 2011* to evaluate the market's ability to absorb ethanol into petroleum based fuels. They estimated that by 2013 the U.S. market would no longer be able to absorb the requisite volume of ethanol and would have to begin either reducing production of petroleum based fuels or increasing the portion of production that was exported.[6] Further, Charles River found that by 2015, implementation of the rule would be impossible. In phase two, NERA economic consulting looked at the economic effects of hitting this "blend wall," and concluded thatit would result in a $770 billion decline in GDP in 2015, and a diminution of household consumption of $2,700.[7]

What these studies fail to emphasize is that under EISA, the EPA has considerable discretion to alter the individual standards or provide waivers to fuel producers and exporters. In his June 26, 2013 testimony to the House Committee on Energy and Commerce, Subcommittee on Energy and Power, EIA Administrator Adam Sieminski stated that "the RFS program is not projected to come close to the achievement of the legislative target that calls for 36 billion gallons of renewable motor fuels use by 2022." He went on to state, "EPA will need to decide how to apply its regulatory discretion regarding the advanced and total RFS targets as allowed by law." The U.S. EPA did reduce compliance levels for cellulosic ethanol in 2012 and 2013, setting the 2013 target at 6 million gallons, less than half of the level in February 2013 proposed rulemaking and well below the one billion gallons foreseen in EISA. The final 2013 rulemaking did maintain the advanced biofuel target at statutory levels, with the total renewable fuels target at 16.55 billion gallons. The final does project however, that EPA will need to adjust the total target below the 18.15 billion gallons contained in EISA.[8] The EIA points out that the expectation that cellulosic and advance biofuels could be available in significant volumes at reasonable costs has not been realized and that the general reduction in fuel volumes consumed places additional pressure on biofuel volumes targets.[9]

[5]U.S. EPA, *EPA Finalizes Regulation for the National Renewable Fuel Standard Program for 2010 and Beyond*, Office of Transportation and Air Quality, EPA-420-F-10-007, February 2010.
[6]Charles River Associates, *Impact of the Blend Wall Constraint in Complying with the Renewable Fuel Standard*, H. Foster, R. Baron, P. Bernstein, November 2, 2011, http://www.api.org/news-and-media/news/newsitems/2013/march-2013/~/media/Files/Policy/Alternatives/13-March-RFS/CRA_RSF2_BlendwallConstraints_Final_Report.pdf
[7] http://www.api.org/~/media/Files/Policy/Alternatives/13-March-RFS/NERA_EconomicImpactsResultingfromRFS2Implementation.pdf
[8] U.S. Energy Information Administration, *EPA Finalizes Renewable Standard for 2013; Additional Adjustments Expected in 2014*, August 14, 2103, http://www.eia.gov/todayinenergy/detail.cfm?id=12531
[9] Energy Information Administration, U.S. Department of Energy, statement of Adam Sieminski, Administrator, before the Subcommittee on Energy and Power, Committee on Energy and Commerce, U.S. House of Representatives, June 26, 2013, http://www.eia.gov/pressroom/testimonies/sieminski_06262013.pdf

CAFE Standards and Tailpipe Emission Standards for Carbon Dioxide

Program Summary: The Corporate Average Fuel Economy (CAFE) Standards were first enacted into law by the U.S. Congress in 1975, in response to the 1973 Arab Oil Embargo. The law required a doubling of passenger vehicle fuel efficiency to 27.5 miles per gallon (mpg) by 1985. Fuel efficiency was defined as the sales weighted mean fuel economy expressed as mpg for a manufacturer's fleet of vehicles with a gross vehicle weight less than 8,501 pounds. For every 0.1 mpg that a manufacturer's annual fleet missed the goal, it was required to pay a penalty of $5.50 multiplied by the manufacturer's total vehicle production. The National Highway Transportation Administration (NHTSA) was also authorized to set a separate standard for light trucks, which rose from 11.6 mpg in 1975 to 19.5 mpg in 1985. Between 1986 and 1988, the CAFE standard was lowered to 26 mpg and the light-truck standard stood at 20.5 mpg. In 1989, NHTSA restored the passenger-vehicle standard to 27.5 mpg and lowered the truck standard to 20 mpg. CAFE standards stood unchanged until 2006, when the light truck standard was raised to 24 mpg by 2011. In EISA 2007 Congress raised CAFE standards for cars and light duty trucks significantly, reaching 35 mpg by 2020. In April 2009, NHTSA, together with the U.S. EPA announced plans to accelerate this increase, reaching a combined average of 35.5 mpg by model year 2016, based on passenger cars reaching 39 mpg and light duty trucks meeting a 35 mpg target. EISA 2007 also required fuel efficiency standards for medium- and heavy-duty trucks for the first time. These standards were proposed jointly by NHTSA and EPA in October of 2010 and finalized as the Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles in August 2011.[10] EPA issued minor amendments to this rule in May and August of this year.[11]

On October 15, 2012, NHTSA and EPA jointly issued a final rule for CAFE standards and tailpipe emissions of carbon dioxide for light duty vehicle model years 2017 and beyond. Under the rule, each manufacturer faces a unique combination of carbon dioxide emissions and CAFE standards depending on the numbers of vehicles produced and the footprint of those vehicles. The latter is a change from earlier versions of the CAFE standards that focused on a weight threshold and had a single mpg target above and below that threshold. Instead, the footprint of a vehicle is defined as its wheelbase size (the distance from middle of front axle to middle of rear axle) multiplied by its track width (the distance between the center lines of its tires). The EPA tailpipe emissions standard of 163 grams of carbon dioxide per mile for light-duty vehicles would suggest a fleet wide average of 54.5 mpg in 2025 if the tailpipe emissions standard was reached through fuel economy alone. However, there are other mechanisms that may be used to reach that tailpipe standard. NHTSA has set a minimum CAFE standard for passenger cars of 50.9 mpg by 2025. NHTSA does allow manufacturers some flexibility, including the option to

[10] The Pew Environment Group, *History of Fuel Economy*, April 4, 2011, http://www.pewenvironment.org/uploadedFiles/PEG/Publications/Fact_Sheet/History%20of%20Fuel%20Economy%20Clean%20Energy%20Factsheet.pdf

[11] U.S. Environmental Protection Agency http://www.epa.gov/otaq/climate/regs-heavy-duty.htm

average mpg between passenger cars and light duty trucks, to bank and carry forward credits for earlier over-compliance, to trade among manufacturers, and to improve air conditioning performance to meet carbon dioxide standards.[12]

Results of Preliminary Literature Review: Two primary areas of concern have been raised related to the implementation and ongoing tightening of CAFE standards. First, CAFE standards increase the purchase price of new vehicles, and second, there is ongoing concern that one of the common approaches to improving fuel efficiency, reducing the weight of vehicles, may increase traffic fatalities. The former is fairly straightforward while the latter is much less clear. The EPA estimates the cost of new vehicles will increase by $1,800 from the model year 2016 rule to the model year 2025 rule.[13] There is little controversy over this number, though some report it as $2,000 to $2,800.[14] EPA estimated a payback of these costs, through reduced gasoline consumption, to be between 3.2 and 3.4 years depending on the discount rate applied to the analysis, with total savings between $5,700 and $7,400 over the life of the vehicle.[15],[16] This analysis assumes an average gasoline price of $3.87. Some have taken issue with this price, suggesting that prices are likely to decline over time.[17] Further, even if life-cycle cost estimates promise a return-on-investment, new car buyers will typically act in response to visible sticker prices.

The concern about safety rests largely on a study completed in 1989 by Crandall and Graham that linked higher fuel economy levels to decreased weight, and declines in car weight to increased fatalities.[18] The most oft-cited reference is a 2002 National Academy of Sciences study that concluded that the fuel economy improvements from CAFE had probably resulted in

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[12]CAFE standards are based on tests permed on a dynamometer in EPA labs that simulates city and highway driving based on procedures outlined in the original 1975 legislation. Estimates of real world auto fuel efficiency tend to differ and are reflected on EPA window stickers. These window stickers use a more recent methodology that takes into account hot and cold driving conditions, use of automobile air conditioners, and high speed driving among other condition. Using the more recently developed methodology the 54.5 mpg in the new CAFE standards is likely to be closer to a real world efficiency of 40 mpg.

[13] For the MY 2016 rule, NHTSA and EPA had estimated a cost increase of approximately $950 above Model Year 2011.

[14] Heritage Foundation, *CAFE Standards: Fleet-wide Regulations Costly and Unwarranted*, Diane Kurtz, November 28, 2011, http://www.heritage.org/research/reports/2011/11/cafe-standards-fleet-wide-regulations-costly-and-unwarranted

[15]U.S. EPA, *Regulatory Impact Analysis: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards*, EPA-420-R-12-016, August 2012, http://www.epa.gov/otaq/climate/documents/420r12016.pdf

[16] This estimate is for the price of fuel savings only, it does not incorporate the social cost of carbon. EPA has quantified the benefits from monetizing the avoided damages from carbon dioxide emissions separately.

[17] Congressional Research Service, *Automobile and Truck Fuel Economy (CAFE) and Greenhouse Gas Standards*, B. Yacobbuci, B. Canis, and R. Lattanzio, September 11, 2012, p.7, http://www.fas.org/sgp/crs/misc/R42721.pdf

[18] *The Effect of Fuel Economy Standards on Automobile Safety*, R. Crandall, and D. Graham, Journal of Law and Economics, Vol. 32, 1989, pp. 97-118. http://www.jstor.org/discover/10.2307/725381?uid=3739936&uid=2129&uid=2&uid=70&uid=4&uid=3739256&sid=21102549651477

between 1,300 and 2,600 additional traffic fatalities in 1993,[19] based on a 1997 analysis by NHTSA. It should be noted that the report pointed out that the most important determinant of traffic fatalities was vehicle weight differential, and that a policy focused at reducing weights at the high-end of the scale would improve safety. A series of subsequent analyses have called into question whether CAFE standards decrease vehicle safety at all, some actually observing a positive correlation between higher fuel economy and vehicle safety test crash ratings.[20] The observation about vehicle weight differentials was echoed in a 2011 paper by Anderson and Aufhammer that effectively supports recent measures to expand CAFE standards to medium- and heavy-duty vehicles.[21] The CAFE standards are in place and operational. GHG reduction impacts on Washington will have clear results, and estimates in the literature of anticipated consumer costs are well bounded. However, a full assessment of all impacts including safety considerations would have considerable remaining uncertainty.

EPA Mercury and Air Toxic Standards

Program Summary: The U.S. EPA finalized the Mercury and Air Toxics Standards Rule (also known as the Utility MACT) in December 2011. The rule required existing electric generation units to reduce emissions of hazardous air pollutants to the level of the top 12 percent of existing units by 2015. For new power plants the rule called for a mercury emissions rate limit of 0.002 pounds per gigawatt-hour. Industry contested this level as unachievable and sought remedy prior to implementation of the new source performance standards (NSPS) for greenhouse gas emissions to allow them to begin construction prior to the implementation of the NSPS (see discussion on NSPS below). In July 2012 the agency agreed to reconsider the rule, and in March of 2013 issued a new "final" rule set mercury limits of 0.003 pounds per gigawatt-hour.

Results of Preliminary Literature Review: The U.S. EPA estimates the rule will cost $9.6 billion in 2015, and a total of $89.9 billion between 2015 and 2034, with public health benefits ranging from $110 to $280 billion in the first year alone.[22] An independent analysis by NERA, conducted for the American Coalition of Clean Coal Electricity, found a similar cost beyond that of the Cross State Air Pollution Rule (see below) of $10.4 billion in 2015 and $94.8 billion between 2015 and 2034.[23] EPA estimates health benefits from the rule at between $33 billion

[19] National Research Council, Transportation Research Board, *Effectiveness and Impact of Corporate Average Fuel Efficiency Standards*, 2002, P. 27 www.nhtsa.gov/cars/rules/cafe/docs/162944_web.pdf

[20] Oak Ridge National Laboratory, Effect of Fuel Economy on Automobile Safety: A Reexamination, Center for Transportation Analysis, S. Ahmad and D. Greene, November 2004, http://www-cta.ornl.gov/cta/Publications/Reports/TRB_05_1336_AhmadGreene.pdf

[21] Vehicle Weight, Highway Safety and Energy Policy, M. Anderson, M. Aufhammer, June 5, 2011, http://www.uni-heidelberg.de/md/awi/forschung/auffhammer_researchseminar.pdf

[22] U.S. EPA, *Regulatory Impact Analysis for the Final Mercury and Air Toxics Standard*, EPA-45 2/R-11-011, December 2011, http://www.epa.gov/ttn/ecas/regdata/RIAs/matsriafinal.pdf

[23] NERA Economic Consulting, *An Economic Impact Analysis of EPA's Mercury and Air Toxics Standards Rule*, ,P.Bernstein, S.Bllomberg, S. Mankowski,and S. Tuladhar, March 1, 2012, p. 2, http://www.nera.com/nera-files/PUB_MATS_Rule_0312.pdf

and $90 billion annually, far greater than costs. However, NERA and others have criticized these estimated benefits because 90% of those benefits are associated with reduced premature death from particulates, which are a co-benefit, rather than the focus of the rule.[24]

Clean Air Interstate Rule

Program Summary: The EPA's Clean Air Interstate Rule (CAIR) was designed to address the problem of pollution from power plants in the eastern US that drifts from one state to another. CAIR covers all fossil-fueled power plants in 27 Eastern states and the District of Columbia with a nameplate capacity greater than 25 megawatts. Twenty-two states and the District of Columbia fall under the caps for both sulfur dioxide, oxides of nitrogen (NOx) and ozone season NOx. Three states are controlled for only ozone season NOx, and two states are controlled for only sulfur dioxide and NOx emissions. The cap went into effect for NOx in 2009 and will go into effect for sulfur dioxide in 2015. The program includes allowance trading to lower compliance costs. In December 2008, the U.S. Court of Appeals for the DC Circuit directed the EPA to revise CAIR in what would become the Cross-state Air Pollution Rule (CSAPR). Until CSAPR was implemented, CAIR was to remain the functioning regulation. On August 12, 2012, the U.S. Court of Appeals for the D.C. Circuit announced its intent to vacate the CSAPR. As a result of that decision sulfur dioxide and oxides of nitrogen from power plants in the Eastern U.S. continue to be regulated under CAIR. On June 24, 2013 the U.S. Supreme Court announced that it will review the decision of the appeals court.

Result of Preliminary Literature Review: According to EPA, CAIR will impose annual costs of $3.7 billion beginning in 2015 but will generate some $82.4 billion in annual health benefits.[25] For additional benefit and cost information please see discussion of the Cross-state Air Pollution Rule below. The predominant impacts of both CAIR and CSAPR will be in the Eastern half of the United States. As the NEMS model that we will be using for this analysis provides results at the national and regional level, this study captures the geographic impacts. The regional results are then downscaled to Washington based on its historic share of fuel, energy, or emissions in the region as appropriate. So, if CAIR has little impact on the western region, it will have little impact on Washington.

Cross-state Air Pollution Rule

Program Summary: CSAPR was issued on July 6, 2011 under the "good neighbor" provisions of the Clean Air Act, intended to ensure that emissions from one state's power plants do not cause harmful pollution in other states. This rule was a response to the direction of the U.S. Court of Appeals for the D.C. Circuit, which in 2008 instructed EPA to revise the CAIR. The CSAPR is intended to replace and strengthen the CAIR (see above) by further reducing the

[24] U.S. EPA, *Regulatory Impact Analysis for the Final Mercury and Air Toxics Standard*, EPA-45 2/R-11-011, December 2011, http://www.epa.gov/ttn/ecas/regdata/RIAs/matsriafinal.pdf
[25] http://www.epa.gov/cair/impact.html

sulfur dioxide and oxides of nitrogen pollution from coal-fired power plants across 28 Eastern states. While similar to the CAIR in many ways, CSAPR contains tighter emissions caps, limits to interstate trading, and no carryover of banked allowances from the Acid Rain Budget programs. On August 12, 2012, the U.S. Court of Appeals for the D.C. Circuit announced its intent to vacate the CSAPR. As a result of that decision, sulfur dioxide and oxides of nitrogen form power plants in the Eastern U.S. continue to be regulated under CAIR. On June 24, 2013 the U.S. Supreme Court announced that it will review the decision of the appeals court.

Results of Preliminary Literature Review: According to a study by the Brattle Group, the EPA has estimated costs of the CSAPR at approximately $1 billion annually between 2012 and 2020.[26] The Brattle Group goes on to summarize its own study, and additional studies by the Edison Electric Institute with support of the consultants ICF Incorporated, and the Bipartisan Policy Center. However, none of these studies addressed the costs of CSAPR independently, instead combining CSAPR costs with other EPA regulations, most notably the Mercury and Air Toxic Standards (MATS) discussed above. Estimated costs from the combined rules equaled between $70 billion and $130 billion over the 2008 to 2020 time frame, and each had a central value on the order of $10 billion per year. Most of these costs are attributable to MATS, suggesting independent estimates of the cost of CSAPR in line with EPA's estimates. (See discussion above). The U.S. EPA estimates the public health benefits of the CSAPR at between $110 and $280 billion and public welfare benefits of $4.1 billion in 2014.[27]

The CLEW has tasked SAIC with examining the impact of Clean Air Act requirements for emissions from stationary sources and fossil-fueled electric generating units on Washington State GHG emissions. While it remains uncertain whether the CAIR or CSAPR will be the mechanism EPA uses to regulate sulfur dioxide and oxides of nitrogen emissions from electric generating stations, one of the regulations will be in force. These regulations are likely to increase the cost of coal-fired electric generation, providing a competitive advantage to lower GHG emitting sources such as gas-fired and renewable generation. With the CAIR and CSAPR only applying to generation in the Eastern U.S., it is likely to have little impact on GHG emissions in Washington or its surrounding region. However, because it will affect the overall national generation mix, we examined it as part of this study to confirm these suppositions. As expected the CAIR and CSPR did not show a discernible material impact on Washington emission levels. (see discussion of results below).

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[26]The Brattle Group, *Potential Coal Plant Retirements and Retrofits Under Emerging Environmental Regulations,* Martin Celebi, Presented to Midwest renewable Energy Association, August 10, 2011, http://www.brattle.com/_documents/UploadLibrary/Upload981.pdf

[27]U.S. EPA, *Regulatory Impact Analysis for the Federal Implementation Plans to Reduce Interstate Transport of Fine Particulate Matter and Ozone in 27 states*; Correction of SIP Approvals for 22 States, Docket ID No. EPA-HQ-OAR-2009-0491, U.S. EPA Office of Air and Radiation, June 2011. http://www.epa.gov/airtransport/pdfs/FinalRIA.pdf

Tax Incentives for Renewable Energy (PTC and ITC)

Program Summary: The production tax credit for renewable electricity is equal to $0.023 per kWh of power for the first decade of production from qualifying renewable resources (generally wind, solar, and biomass). Alternatively, a tax credit equal to 30 percent of the investment in qualifying equipment may be taken. The PTC is slated to sunset on December 31, 2013, absent additional action by the U.S. Congress.

Results of Preliminary Literature Review: A recent analysis by the National Research Council, using the NEMS version from the *Annual Energy Outlook 2011*, concluded that the PTC and ITC reduce U.S. national GHG emissions by 0.3 percent at the very high cost of $3.9 billion in foregone revenue to the U.S. Treasury. [28] The U.S. EIA's *Annual Energy Outlook 2013* examines a case where the PTC does not sunset at the end of 2013. The result is an increase in electrical generation from renewables, beyond the reference case, of approximately 5 percent in 2020, 18 percent in 2030, and 38 percent in 2040.[29]

California Low Carbon Fuel Standard

Program Summary: Issued on January 18, 2007, the Low Carbon Fuel Standard (LCFS) calls for a reduction of at least 10 percent in the carbon intensity of California's transportation fuels by 2020. The performance-based regulation was adopted in 2009, and the California Air Resources Board (CARB) began implementing the regulation in 2010. The regulated entities tend to be fuel producers and importers who sell motor gasoline and diesel fuel. The most common method for generating the credits required for compliance is the use of ethanol, followed by, to a lesser extent, natural gas and bio-based gases, biodiesel, and electricity.[30]

There has been a series of court challenges to the LCFS centered on the potential impact of the regulation on agricultural and ethanol production practices in other states. In December 2011, the U.S. District Court for the Eastern Division of California found that the regulation violated the Interstate Commerce Clause of the U.S. Constitution because it: 1) discriminates against the use of out-of-state corn-based ethanol; and 2) seeks to control farming and transportation practices outside of its own borders . In April 2012, the U.S. Ninth District Court of Appeals granted a stay of injunction while CARB appeals the injunction. The stay allowed the program to be enforced until the appeal is resolved. On September 18, 2013, the U.S. Ninth District Court of Appeals ruled two-to-one that the California LCFS did not violate the Interstate Commerce

[28] National Research Council, *Effects of U.S. Tax Policy on Greenhouse Gas Emissions*, Committee on the Effects of Provisions in the Internal Revenue Code on Greenhouse Gas Emissions, W. Nordhaus, S. Merrill, P. Beaton, Eds., June 20, 2013, p. 141

[29] U.S. Energy Information Administration, *Annual Energy Outlook 2013*, Figure 15, http://www.eia.gov/forecasts/aeo/source_renewable_all.cfm#updated_nosunset

[30] UC Davis Institute of Transportation Studies, *Status Review of California's Low Carbon Fuel Standard*, S.Yeh, J. Witcover, J. Kessler, Spring 2013, p. 1

Clause of the U.S. Constitution.[31] On June 6, 2013 California's Fifth Court of Appeals handed down a provisional ruling in a case that argued that the LCFS was implemented without adequate study of general environmental impacts as required by the California Environmental Quality Act (CEQA) and specifically improperly deferred development of mitigation measures for potential increases in NOx emissions that may occur due to the LCFS. The court has allowed CARB to proceed with the existing regulation but has provided formal direction for addressing the concerns raised by the lawsuit.

Results of Preliminary Literature Review: Since the adoption of California's LCFS there has been consideration of similar regulations across multiple U.S. states including Oregon, Washington, and the eleven Northeastern states that comprise the Northeast States for Coordinated Air Use Management (NESCAUM). In August 2011, NESCAUM released an economic analysis of a potential LCFS for the Northeast region. Using the NEMS version that supported the *Annual Energy Outlook 2010*, NESCAUM found reduced transportation related GHG emissions of 5-9%, increased jobs, personal income and gross regional product that could be attributed to the Northeast LCFS. [32] In October 2011, IHS/CERA conducted an assessment of the NESCAUM report under contract to the Consumer Energy Alliance (CEA). The assessment suggested that many of the assumptions used for the NESCAUM report were too optimistic.[33] CEA then went on to perform its own analysis of an LCFS in the Northeast and Mid-Atlantic, using the NEMS version from *the Annual Energy Outlook 2011* and including its own assumptions.[34] The result showed decreases in jobs, and overall GDP, attributable to the Northeast LCFS, of a similar magnitude to the increase found earlier by NESCAUM. Although NESCAUM found gains and IHS/CERA found losses, the magnitude of the changes attributable to the LCFS in both the NESCAUM and CEA studies were quite similar, representing a fraction of one percent of the reference case, regardless of the sign of the impact.

Subsequent to the implementation of the California LCFS, there has been a series of dueling studies on the economic impacts of the regulation. The first, released in June 2012, was prepared by the Boston Consulting Group (BCG) on behalf of the Western States Petroleum Association (WSPA). Using proprietary models, the BCG forecast significant economic consequences from the California LCFS including a loss of 28,000 to 51,000 jobs, a loss of $4.4 billion in tax revenue and between $0.33 and $1.06 in costs per gallon.[35] A review of the BCG report by the

[31] Jacobs, J. Appeals court rejects industry challenge to Calif. low-carbon fuel standard. E&E News PM. September 18, 2013. Accessed September 2013 at: http://www.eenews.net/eenewspm/2013/09/18/stories/1059987472
[32]NESCAUM, *Economic Analysis of a Program to Promote Clean Transportation Fuels in the Northeast/Mid-atlantic Region*, Report Summary, August 18, 2011, http://www.nescaum.org/topics/clean-fuels-standard/
[33] *Assessment of the NESCAUM Economic Analysis of a Clean Transportation Fuels Program for the Northeast/Mid-atlantic Region*, prepared by IHS/CERA for the Consumes Energy Alliance, October 14, 2011,
[34] While the assumptions and findings of the study were the responsibility of CEA, the author of this study, SAIC, was retained to execute the NEMS model runs.
[35] Boston Consulting Group, *Understanding the Impacts of AB 32*, Prepared for the Western State Petroleum Association, June 19, 2012, pp.3-4. http://www.cafuelfacts.com/wp-content/uploads/2012/07/BCG_report.pdf

UC Davis Policy Institute for Energy, Environment and the Economy identified seven critical assumptions and five intermediate conclusions that made significant contributions to the negative outcomes in the BCG study. These include no response in fuels demand to increased price, a limited availability of "bankable" compliance credits and a small number of advanced technology vehicles in the fleet by 2020.[36] The reviewers state that "the report's full set of assumptions is unlikely and have concerns about certain aspects of the methodology." In June 2013, ICF International released the first phase of a two-phase study of the California LCFS to be completed for the California Electric Transportation Coalition. The results of macroeconomic modeling will be contained in the yet-to-be-released second phase of the study, but the first phase sought to develop plausible compliance scenarios. Key findings that differ from the BCG assumptions include that there will be significant over-compliance and banking in the early years of the regulation, the LCFS is driving investment in low-carbon fuels, and natural gas consumption in the transportation sector is poised to expand rapidly.[37]

Oregon authorized a LCFS in 2009 that would cut carbon intensity in cars and trucks by 10 percent per gallon by 2025. However, the authorization included a sunset provision allowing the LCFS to expire in 2015. As of a state Senate vote on July 8, 2013, the LCFS will be allowed to expire in 2015, but the topic may be heard for reconsideration at a short session of the Senate in February 2014.[38] The Oregon Department of Environmental Quality never moved to implement the standards because of the sunset date. A thorough examination of a Washington state LCFS was completed by the consulting firm TIAX in 2011 with follow-up work from Life Cycle associates in 2013. A detailed discussion of the methodology and results of those studies appear in the Task 2 Report of this study but the overall results generally supported LCFS as an economically positive policy option for the state. TIAX examined six scenarios. Under the worst scenario, employment decline by 200 while in all other scenarios it grew by anywhere from 3,600 to 12,000 people. Similarly in the worst scenario personal income declined by $13.8 million, but all other scenarios show personal income growing anywhere from $147 million to $526 million. Gross State Product decline by $36.5 million in the worst scenario but grew by between $164 million and $454 million in all other scenarios. [39]

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[36] University of California, Davis, *Expert Evaluation of the Report: Understanding the Impacts of AB 32*, May 2013, pp. 9-10, http://policyinstitute.ucdavis.edu/files/general/pdf/2013-05-09_Expert-Evaluation-of-BCG-Report.pdf

[37] ICF International, *California's Low Carbon Fuel Standard: Compliance Outlook for 2020*, prepared for the California Electric Transportation Coalition, June 2013, pp.2-3., http://www.caletc.com/wp-content/downloads/LCFSReportJune.pdf

[38] Zheng, Y. The Oregonian. *Oregon Senate rejects 'clean fuels' bill, a top priority for environmental lobby*. (July 6, 2013). Accessed July 2013 at: http://www.oregonlive.com/politics/index.ssf/2013/07/oregon_senate_rejects_clean_fu.html#incart_river; and Greenwire. E&E Publishing. *State Senate rejects clean fuels bill*. (July 8, 2013). Accessed July 2013 at: http://www.eenews.net/greenwire/2013/07/08/stories/1059983987

[39] Pont, J. and J Rosenfeld. TIAX LLC for the State of Washington Department of Ecology. February 18, 2011. Table E-3. Page ix, Table E-3.

Renewable Portfolio Standards

Program Summary: While it has been considered, there is no federal renewable portfolio standard, nor can it be reasonably argued that we can expect one in the near future. However, 30 states and the District of Columbia currently have enforceable renewable portfolio standards including Washington, California, Oregon, Nevada and Montana. Each state determines its own renewable targets, eligible technologies and penalties for non-compliance. Washington State currently has an RPS of 15% by 2020, with solar, wind, biomass, geothermal, landfill gas, and marine sources, plus incremental electricity produced as a result of efficiency improvements made to hydroelectric facilities after March 31, 1999 qualifying under the standard.

Results of Preliminary Literature Review: Washington's Renewable Portfolio Standards will be evaluated under Task 1 of this project. However, because the renewable targets of other states in close proximity to Washington may affect the mix of electricity imported and exported to and from Washington, we will examine the overall impacts of RPS requirements in the Western Electricity Coordinating Council / Northwest Power Pool (WECC/NWPP) area and Census Division 9 and their interaction with Washington's GHG reduction policies, including the State's Renewable Energy Standards. Because it is a regional model, NEMS does not capture fuel-specific provisions at the state level but rather subsumes these targets in an approximation of region-level compliance requirements (voluntary or discretionary targets are not modeled).

2.2 Pending Policies

GHG Regulation for Coal-Fired Power Plants

Program summary: Since January 2011, GHG emissions from large new and modified sources have been subject to regulation under the Prevention of Significant Deterioration (PSD) program, which requires all such sources to adopt the Best Available Control Technology (BACT) for reducing emissions. BACT standards are set by state permitting authorities on a case-by-case basis and often result in equipment and operational efficiency improvements. According to the Congressional Research Service (CRS), EPA and the states have issued fewer than 50 GHG permits to stationary sources in the year following the requirement's implementation[40] because the emission threshold for requiring permits was set at a high level[41] and few new facilities have been built in the aftermath of the recession.[42]

[40] According to then EPA Assistant Administrator Gina McCarthy's testimony to the House Energy and Commerce hearing on June 29, 2012, stating that EPA and the states had issued 44 permits for greenhouse gas emissions. This identical number appears in a September 14, 2012 report by the Clean Air Act Advisory Committee at http://www.epa.gov/nsr/ghgdocs/20120914CAAACPermitStreamlining.pdf

[41] New facilities need to add 100,000 tons per year of carbon dioxide equivalent and modifications must raise emissions by 75,000 tons per year to trigger the requirement.

[42] Congressional Research Service, *EPA Standards for Greenhouse Gas Emissions from Power Plants*, J. McCarthy, June 26, 2013, http://www.fas.org/sgp/crs/misc/R43127.pdf

On March 27, 2012 EPA proposed New Source Performance Standards (NSPS) to regulate GHG emissions from electric generation. The NSPS differs from the PSD in that the NSPS is a federally established performance standard enforced by the states rather than a state adjudicated requirement. This standard covers new fossil-fueled power plants larger than 25 megawatts of capacity, and is set at 1,000 pounds carbon dioxide per megawatt-hour, equivalent to the emissions level of a natural gas combined-cycle unit. Initially scheduled to go final on April 13, 2013, the EPA delayed the final rule after receiving some 2.7 million comments and extended the comment period to June 12, 2013. In contrast to many Clean Air Act standards, when the NSPS goes final, its performance standard is retroactive to the day it was proposed, potentially shutting down new coal plant construction as of March 27, 2012. However, the EPA proposal exempted plants constructed before April 13, 2013. There are some 15 "transitional" electric generating units that fall into this one-year window. Further, the NSPS requires that if EPA regulates new units for a pollutant then it must also regulate existing units for that pollutant. EPA may, however, set less stringent performance standards for the existing units.

President Obama, in his Climate Action Plan announced June 25, 2013, issued a Presidential Memorandum directing the U.S. EPA to work expeditiously to complete carbon pollution standards for both new and existing power plants.[43] The memorandum called for the reissuance of the proposed standards for the new units in September 2013 and for the issuance of final guidelines on existing units by June 1, 2015.

Results of Preliminary Literature Review: Industry has resisted the NSPS for GHG from electric generating units by pointing out that the combination of a stringent performance threshold and the lack of economically competitive carbon capture and sequestration technology effectively ban the building of new coal-fired power plants. The EPA's Regulatory Impact Analysis for the proposal does not necessarily take issue with this conclusion but instead argues that this outcome is no different than that which will result from existing and anticipated economic conditions in the marketplace including the low projected cost of natural gas and the implementation of state renewable portfolio standards. Using the Integrated Planning Mode (IPM) developed by ICF International, the EPA conducted scenario analyses around higher natural gas prices and/or electric demand and found that in the absence of the rule, gas prices would need to reach $10.00 per million Btu to drive new coal-fired generation, an outcome viewed as very unlikely with current gas prices below $4.00 per million Btu. Given these market conditions, it is reasonable that some would question whether the rule is necessary. EPA responds that it is necessary as a "backstop" should market conditions change.[44]

[43] Executive Office of the President, *The President's Climate Action Plan*, June 2013, p.6
[44] U.S. EPA, *Regulatory Impact Analysis for the Proposed Standards of Performance for Greenhouse Gas Emissions for New Stationary Sources: Electric Utility Generating Units*, EPA-452/R-12-001, March 2012, http://www.epa.gov/carbonpollutionstandard/actions.html

Incentives for Renewable Energy on Federal Lands

Program summary: As part of the President's Climate Action Plan, he directed the Department of Interior to permit an additional 10 gigawatts of renewable generation on public lands by 2020.[45] In April, 2013 the Bureau of Land Management issued a Final Rule to protect lands with pending right-of-way applications for wind or solar energy generation from appropriation by mining interests under existing public lands laws. Also, bills have recently been introduced into the U.S. House of Representative (H.R. 596) and U.S. Senate (S. 279) to establish wind and solar energy leasing programs on Federal lands in a similar fashion to oil and gas leasing programs.

Results of Preliminary Literature Review: Since 2011, the Department of Interior has permitted 25 utility-scale solar facilities, nine wind farms, and 11 geothermal plants on federal lands. Many of these projects have been undertaken in 17 solar zones across six Western states – Arizona, California, Colorado, Nevada, New Mexico, and Utah. These projects are not without controversy however, as some residents and environmental groups complain about destroyed vistas and threats to migratory species.[46]

Reduced Tax Expenditures for Fossil Energy (Oil and Gas Depletion Allowances)

Program Summary: Using the depletion allowance, owners of oil and gas wells may deduct from their taxes an amount equal to the decline in the value of their reserves as oil or gas is extracted and sold. For small producers – those companies with less than 1,000 barrels per of oil production per day, or less than six million cubic feet of natural gas production per day – a percentage depletion equal to 15 percent of gross revenues associated with production may be deducted from taxes, even if, in the aggregate, this deduction exceeds the total cost of original investment in the property over the life of the property.

Results of Preliminary Literature Review: A recent analysis by the National Research Council, using the NEMS version from the *Annual Energy Outlook 2011* concluded that the average effect of the depletion allowances on GHG emissions, over time, is too small to accurately estimate, or even determine if the sign of change is negative or positive.[47]

REIT and MLP Parity

Program Summary: While the production tax credit and investment tax credit for renewable technologies have played an important role in the growth of these energy sources, they have three primary shortcomings in addition to their potential costs to the U.S. Treasury. First, they

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[45] Executive Office of the President, *The President's Climate Action Plan*, June 2013, p.7

[46] San Francisco Chronicle, *Anger Over Plans for Energy Plants on Public Lands*, Carolyn Lockhead, July 10, 2013. http://www.sfchronicle.com/science/article/Anger-over-plans-for-energy-plants-on-public-lands-4656189.php

[47] Effects of U.S. Tax Policy on Greenhouse Gas Emissions, Committee on the Effects of Provisions in the Internal Revenue Code on Greenhouse Gas Emissions, National Research Council, W. Nordhaus, S. Merrill, P. Beaton, Eds., June 20, 2013, p. 142

are subject to periodic renewal by Congress and the President and the uncertainty hampers potential investment, creating "lumps" in deal flows that do not necessarily reflect market fundamentals. Second, they only have value as tax equity and the number and diversity of investors with sufficient tax liability that is consistent enough over time to take advantage of this tax equity is very limited. According to the National Renewable Energy Laboratory (NREL), tax-equity based investment in renewables has been limited to some 20 investors and just $3-6 billion annually over the last several years.[48] Finally, these subsidies are cited by opponents of renewable energy investments as a demonstration that renewable energy cannot compete on a level economic playing field with fossil energy and thus should not be undertaken.

Because Real Estate Investment Trusts (REITs) and Master Limited Partnerships (MLPs) already benefit fossil energy, extending these benefits to renewable energy holds the attraction of not only substantially reducing the cost of financing for renewable energy investments but of putting renewable energy on a level playing field with many oil and gas investments that already benefit from this treatment. MLPs and REITs combine the tax benefits of a partnership with the liquidity of a publicly traded stock. Both MLPs and REITS are taxed based on returns to investors but are not taxed at that corporate level, eliminating the "double taxation" generally applied to corporations and their shareholders. REITs were initially authorized by Congress in 1960 to give retail investors a way to get into commercial real estate. They are required to pay at least 90 percent of their taxable income to shareholders. REITS are now used for funding timber, data centers, mobile phone towers, and natural gas pipelines. All that is required for renewable energy facilities to be included is a letter ruling by the Internal Revenue Service (IRS) that renewable facilities are "real property." To date, two firms (Hannon Armstrong Sustainable Infrastructure Capital Inc. and Power REIT) have been granted REIT status by the IRS through private letter rulings, however, neither firm has been forthcoming with the details of their respective rulings. Renewable Energy Trust Capital has asked for a ruling from the IRS on classifying solar farms as real property. This ruling is imminent. Ultimately, clean energy developers hope for a blanket IRS ruling that would expand these private letter rulings to other types of renewable facilities. Failing this result, Congress could take legislative action.

Because current law specifically prohibits MLP investment in "inexhaustible" (renewable) natural resources, extending MLPs to renewable energy requires Congressional action. S. 3275, the Master Limited Partnerships Parity Act (MLP Parity Act), is a bipartisan piece of legislation introduced in June 2012 that would open up MLPs to renewable energy. The MLP Parity Act would amend the Internal Revenue Code to expand the definition of "qualifying income" for MLP treatment to include income gains from renewable and alternative fuels. It was

[48] National Renewable Energy Laboratory, *Financing U.S. Renewable Energy Projects Through Public Capital Vehicles: Qualitative and Quantitative Benefits,* M.Mendelsohn and D. Feldman, April 2013, http://www.nrel.gov/docs/fy13osti/58315.pdf

reintroduced into both the Senate and House of Representatives on April 24, 2013. This legislation is reported to have significant bipartisan and bicameral support and could bring new financing not only to traditional renewable energy projects such as wind and solar, but also to nuclear power, energy storage, energy efficiency, carbon capture, and other less obvious clean energy initiatives.

Results of Preliminary Literature Review: Studies of the additional capital flows for renewable energy projects from the extension of REITs have not been completed, and it may be useful to attempt some generic calculation of such an extension of REITs to renewable energy facilities as this study progresses. More work has been done on MLP parity. According to a 2012 study out of Southern Methodist University (SMU), Cox School of Business, providing MLP parity to renewables could yield an additional $3.2 billion to $5.6 billion of capital inflows to renewable projects between 2013 and 2021.[49] In 2012, installations of new photovoltaic (PV) capacity required financing of some $3.64 billion per gigawatt and installations of new wind capacity required financing of approximately $2.13 billion per gigawatt,[50] suggesting that MLP parity could drive between 1.5 and 2.6 gigawatts of additional capacity by 2021, even assuming no leverage in capital financing from these funds.

Because investors in MLPs and REITs pay taxes on dividends, the budget impact of MLP parity and extending eligibility for REITS is likely to be negligible. The total market capitalization of existing MLPs is approximately $300 billion, and, according to the Joint Committee on Taxation, these MLPs are expected to cost taxpayers about $1.2 billion between 2011 and 2015, or less than 0.1 percent of market capitalization annually. Assuming the high end of investment in renewables projected by SMU would generate an annual cost to taxpayers of under $5 million annually. Further, should we include gains in tax revenue that result from an increase in renewable power deployment and related economic activity in manufacturing, construction, and other areas, the budgetary impact may be net positive. A recent study by the U.S. Partnership for Renewable Energy Finance found that the budgetary burden from investment tax credits for solar energy was more than offset by the tax revenues generated from related leases and power purchase agreements, creating, in effect, a return of 10 percent for the federal government.[51]

[49] *Leveling the Playing Field: The Case for Master Limited Partnerships for* Renewables. Southern Methodist University, Cox School of Business, W.B. Bullock, B.L. Weinstein, and B. Johnson, May 2012. http://www.pressdocs.cox.smu.edu/maguire/AWEA%20final%20report%205-12.pdf

[50] National Renewable Energy Laboratory, *Financing U.S. Renewable Energy Projects Through Public Capital Vehicles: Qualitative and Quantitative Benef*its, M.Mendelsohn and D. Feldman, April 2013, http://www.nrel.gov/docs/fy13osti/58315.pdf

[51] *How to Attract Private Investment in Clean Energy,* Bloomberg, June 10, 2013, http://www.bloomberg.com/news/2013-06-10/how-to-attract-private-investment-in-clean-energy.html

Expanded Natural Gas Exports

Program Summary: Largely as a result of the revolution in extracting natural gas from shale formations using hydraulic fracturing, U.S. production of natural gas rose by more than a third, from 19.0 trillion cubic feet in 2005, to 25.3 trillion cubic feet in 2012. Over the same time frame, the price of natural gas at the wellhead dropped from $9.08 per thousand cubic feet to $3.35 per thousand cubic feet. [52] Concurrently, the share of electric generation generated by combusting coal declined from 49 percent to 37 percent and much of that generation shifted to gas, which grew from 20 percent of total generation to 31 percent of generation. Meanwhile, electric generation from renewable resources, including hydropower grew from 9 percent to 12 percent.[53] In April 2012, the share of electric generation from coal and natural gas were equal for the first time since at least the 1970s.[54] Shortly thereafter, the share of coal increased above 40% and the share of natural gas fired generation dropped to nearly 25%, remaining at those levels from November 2012 through March 2013 due to rising natural gas prices.[55] The share of coal-fired generation once again dropped below 40% between April 2013 and June 2013, as coal experienced incremental price increases. Together, these trends suggest an extreme sensitivity to fuel price within the electric generation sector.

Much of the shift from coal to natural gas is attributable to the large decline in gas prices. Further, the decline in relative prices of natural gas when compared to renewables may have hindered growth in electric generation from renewable sources.

According to the Reference Case forecast in EIA's Annual Energy Outlook 2013, natural gas production is expected to increase at an average rate of 1.3 percent per year, reaching 33.2 trillion cubic feet by 2040. Nearly all of this growth is attributable to increased production of shale gas.[56] Although the reduction in carbon dioxide emissions attributable to the combustion of natural gas when compared to the combustion of coal- or petroleum-based fuels is a simple matter of chemistry and is well known, the GHG impacts associated with fugitive emissions from natural gas production and hence life-cycle use of natural gas is far more uncertain, particularly for shale gas production, whose widespread expansion is a relatively recent phenomena. There is a large and growing literature on methane emissions from shale gas production but its findings are far from consensus, ranging from a slight improvement from

[52] U.S. Energy Information Administration, *Natural Gas: Gross Withdrawals and Production*, http://www.eia.gov/dnav/ng/ng_prod_sum_dcu_NUS_a.htm and U.S. Energy Information Administration, *U.S. Natural Gas Wellhead Prices*, http://www.eia.gov/dnav/ng/hist/n9190us3m.htm

[53] U.S. Energy Information Administration, Electric Power Monthly: Data for May 2013, Table 1.1, July 22, 2013, http://www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_1_1

[54] U.S. Energy Information Administration, *Monthly coal- and natural gas-fired generation equal for first time in April 2012, July 6, 2012*, http://www.eia.gov/todayinenergy/detail.cfm?id=6990#

[55] U.S. Energy Information Administration, *Coal regains some electric generation market share from natural gas*, May 23, 2013, http://www.eia.gov/todayinenergy/detail.cfm?id=11391

[56] U.S. Energy Information Administration, *Annual Energy Outlook 2013*, http://www.eia.gov/forecasts/aeo/source_natural_gas_all.cfm#natgascon

conventional gas production, to a slight increase in emissions, all the way to a substantial increase in emissions. For example in April 2011, the U.S. EPA included a separate emissions factor for methane from unconventional wells in their report, *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 – 2009*, for the first time. This methodological change greatly increased estimates of emissions from the natural gas system. By their April 2013 version of the report, EPA had lowered the emissions factor for wells with hydraulic fracturing substantially, lowering overall emissions from the natural gas system by some 20 percent. EPA also reports that as they collect more data from their Greenhouse Gas Reporting Program, these numbers may be adjusted again.[57] In an effort to address this uncertainty, the University of Texas, in conjunction with the Environmental Defense Fund and nine industry partners launched a comprehensive study of methane leakage rates from hydraulic fracturing wells.[58] They looked at 190 production sites and found that a majority had equipment in place that reduced methane missions by 99 percent suggesting that EPA's estimates of emissions from this source needed to be adjusted downwards.[59] The NEMS model only focuses on carbon dioxide emissions from fuel combustion and thus any consideration of life-cycle fugitive emissions must be conducted off-line.

At the projected rate of increase, production will exceed domestic consumption and the excess production is expected to be exported in the form of liquefied natural gas (LNG).[60] With current spot prices for LNG- at $15.40 per thousand cubic feet in northeast Asia and $11.60 per thousand cubic feet in Southern Europe, U.S. gas producers are anxious to begin exporting LNG. The chief obstacle to these exports is the availability of LNG export terminals.[61] The Federal Energy Regulatory Commission (FERC) maintains jurisdiction over the licensing of LNG export terminals, and FERC is currently considering applications for the siting and construction of 17 LNG export terminals, with an additional six in the proposal pipeline. DOE/FERC is under considerable pressure from some members of Congress to accelerate approvals. After approving its first export terminal in late 2011, the next approval did not come until May 2013. Approvals have since accelerated, with the third export terminal approved on August 7, 2013 and a fourth

[57] U.S. EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990 - 2013*, Chapter 10, Recalculations and Improvements, April 2013, http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Chapter-10-Recalcs.pdf
[58] Industry partners include, Anadarko Petroleum Corporation, BG Group plc, Chevron, Encana Oil & Gas (USA) Inc., Pioneer Natural Resources Company, Shell, Southwestern Energy, Talisman Energy, USA, and XTO Energy, http://www.engr.utexas.edu/news/7416-allenemissionsstudy
[59]http://www.utexas.edu/news/2013/09/16/understanding-methane-emissions/
[60] U.S. Energy Information Administration, *Annual Energy Outlook 2013*, http://www.eia.gov/forecasts/aeo/source_natural_gas_all.cfm#natgascon http://www.eia.gov/forecasts/aeo/source_natural_gas_all.cfm#prodiq.
[61] Bloomberg, *Northeast Asia LNG Rises on Lower Supplies in Pacific, WGI Says*, C.H. Hong, July 2, 2013, http://www.bloomberg.com/news/2013-07-03/northeast-asia-lng-rises-on-lower-supplies-in-pacific-wgi-says.html

approved on September 10, 2013.[62] While others have sought to slow the process because of the impact of higher natural gas prices on U.S. manufacturing, the DOE has pointed to a recent study by NERA Economic Consulting (see discussion below) that found a general increase in national wealth associated with increased natural gas exports.[63] Approval of a significant portion of these terminals will likely increase the export of natural gas with important implications for gas production and prices, which, in turn, are likely to have important impacts on the mix of electric generation in the future. While increased natural gas prices may make cleaner renewables more competitive, they may also moderate or even reverse the shift from coal-fired electric generation to natural gas-fired generation. The balance of these two effects will have important implications for GHG emissions. Further, that balance may interact with new regulations on GHG emissions from electric generation stations (see discussion above), in a manner that should be modeled using the overarching view of the NEMS system.

Results of Preliminary Literature Review: The U.S. Department of Energy has commissioned two studies of the effects of increasing natural gas exports. The first, by the U.S. Energy Information Administration was completed in January 2012, and focused on impacts to domestic gas markets, and in particular on levels of production and domestic wellhead prices. Using the *Annual Energy Outlook 2011* version of NEMS, the EIA found that production would increase and that prices would rise by between $0.70 and $1.58 per thousand cubic feet on a baseline that was already anticipated to escalate over time.[64] The second study, completed by NERA Economic Consulting in December 2012, focused on the macroeconomic effects of the increase in natural gas exports. Not surprisingly, NERA found that overall GDP grew with increased exports. However, increases in national income were dominated by income to resource providers, while overall labor income experienced declines.[65] The NERA study went on to also suggest that the level of exports and price increases anticipated in the EIA study were somewhat overestimated given the likelihood of international competition among suppliers.[66]

[62] Claudia Assis, *And Cove Point Makes Three..LNG Export Terminal Approved, Energy Ticker*, September 11, 2013, http://blogs.marketwatch.com/energy-ticker/2013/09/11/and-cove-point-makes-three-lng-export-terminal-approved/

[63] Wall Street Journal, *Louisiana LNG Export Proposal Approved*, T.Tracy, August 7, 2013, http://online.wsj.com/article/SB10001424127887323477604578654070088855686.html

[64] U.S. Energy Information Administration Independent Statistics and Analysis, *Effect of Increased Natural Gas Exports on Domestic Energy Markets as requested by the Office of Fossil Energy*, January 2012. p. 8, http://energy.gov/fe/downloads/lng-export-study-related-documents

[65] NERA Economic Consulting *Macroeconomic Impacts of LNG Exports from the United States*, p. 8, http://energy.gov/fe/downloads/lng-export-study-related-documents

[66] NERA Economic Consulting, *Macroeconomic Impacts of LNG Exports from the United States*, p. 8, http://energy.gov/fe/downloads/lng-export-study-related-documents

3 Analytical Approach and Methodology

While the overall impact of federal statutes, regulations, and policies on national levels of greenhouse gas emissions is interesting, it is their specific direct impact on GHG levels in Washington, and their interaction with specific state policies and programs to reduce greenhouse gas emissions that is of particular relevance to this study. However, to determine those impacts and consider their interaction with state policies and programs we must first quantify the nationwide effects of the federal actions.

SAIC has selected the National Energy Modeling System (NEMS) as the principal tool for evaluating the effects of federal energy and environmental policies. NEMS was developed by the U.S. Energy Information Administration (EIA), the independent statistical agency within the U.S. Department of Energy, specifically to evaluate the implications of broad federal policies. It is the model that is used by the EIA to produce its Annual Energy Outlook, and to respond to specific requests by the U.S. Congress to evaluate contemplated new energy and environmental laws, such as the Waxman-Markey cap and trade legislation that had been earlier considered. The model is non-proprietary, publically available and scrupulously documented, allowing for a transparent discussion of methods and assumption used. The version supporting the *Annual Energy Outlook 2011* was recently used by Nordhaus et al. in their comprehensive study of the *Effects of U.S. Tax Policy on Greenhouse Gas Emissions*.[67] The model is deterministic, providing single point estimates of carbon emissions and other outputs for any given set of input assumptions. Uncertainty in the model's projections of policy impacts can, to a limited extent, be investigated by varying the model's assumptions on certain macroeconomic variables (e.g., GDP and world crude oil prices), but the required scenario analyses are beyond the scope of this project.

NEMS includes all prominent existing federal energy and environmental laws including *inter alia*, the Mercury and Air Toxic Standards, the Clean Air Interstate Regulations, the Cross State Air Pollution Rule, Clean Air Act restrictions on sulfur dioxide emissions and oxides of nitrogen, the oil and gas depletion allowance, and the production tax credit and investment tax credit for renewable energy. While not federal programs, the model also discretely represents California's Low-Carbon Fuel Standard and the Renewable Portfolio Standards implemented at the state-level. Although they are embedded in NEMS, there are no discrete levers for separating tailpipe emission standards in NEMS. However, the tailpipe emission standards are fully integrated into the new CAFE standards and thus it is appropriate to treat them jointly. Additionally, proposed policies such as REIT and MLP parity and expanded export licenses for liquefied natural gas are not captured within the existing model. However, after an initial literature review to assess the anticipated results of these policies, we may wish to integrate those effects into future model

[67] National Research Council, *Effects of U.S. Tax Policy on Greenhouse Gas Emissions*, Committee on the Effects of Provisions in the Internal Revenue Code on Greenhouse Gas Emissions, W. Nordhaus, S. Merrill, P. Beaton, Eds., June 20, 2013.

runs. Finally, although the exact nature of proposed future restrictions on GHG emissions from electric generating stations is not known, SAIC can represent differing levels of potential restrictions by increasing the risk cost premium for building new coal-fired generation within NEMS. For this analysis, SAIC will be using the NEMS version developed to support the *Annual Energy Outlook 2012.*

The NEMS version used in this analysis is temporally limited to projections out to 2035. This is primarily because uncertainty increases when projections reach the point where model results are no longer useful — in other words, the 2050 estimates are much less certain than the 2035 estimates. This increasing uncertainty over time is largely the result of progressively more unpredictable developments and advances (e.g., technological, social, economic, legislative) that will dramatically impact energy and emissions in the future. One recent example is the developments of hydraulic fracturing technology and its application to shale gas which is changing the energy supply landscape. As a result of model limitations, and the very limited value of extending projections out to 2050 through post-processing and extrapolation of model results, the timeframe for this analysis has been constrained to 2035.

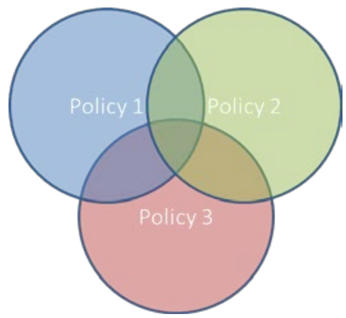
The complex nature and robust characterization of federal policies that makes NEMS the preferred tool of many analysts when conducting this sort of study also creates challenges in representing and interpreting model results, and all conclusions should recognize uncertainty and potentially confounding factors. In some cases, apparently counterintuitive results may be ultimately explained by understanding multiple levels of causation represented in NEMS. For example, while a regulation on coal-fired electric generation such as the Mercury and Air Toxic Standards would be expected to increase the cost of coal-fired generation and favor future natural gas and renewable builds, thus lowering GHG emissions, the parasitic load of emissions control equipment used to meet regulations at existing and new coal-fired power plants will likely increase GHG emissions. The weighted impacts of these countervailing effects may vary over time, altering the emissions profile associated with this regulation. More broadly, because the policies examined in this study have various periods of applicability and differing sunset dates, their interactions will vary over time and alter the trend line for the impacts of any one policy. Thus, a careful, systematic approach to completing this analysis must be undertaken.

Our first step will be an isolated policy analysis—the effect of each federal policy on GHG and emissions will be evaluated exclusive of all interactions with other policies. Our general approach will be to estimate emission reductions as the difference between emissions with and without the policy, as calculated through NEMS modeling. Thus, expected “business-as-usual” (BAU) developments, such as the general trend towards cleaner sources of electricity generation (e.g., natural gas), are captured in all model scenarios. SAIC’s general approach to evaluating the individual and composite contribution of current federal policies is as follows with graphical representations included for clarity (for all model runs, the impacts on Washington will be disaggregated from the rest of the country):

1. The reference case version of the model will be considered the baseline scenario.

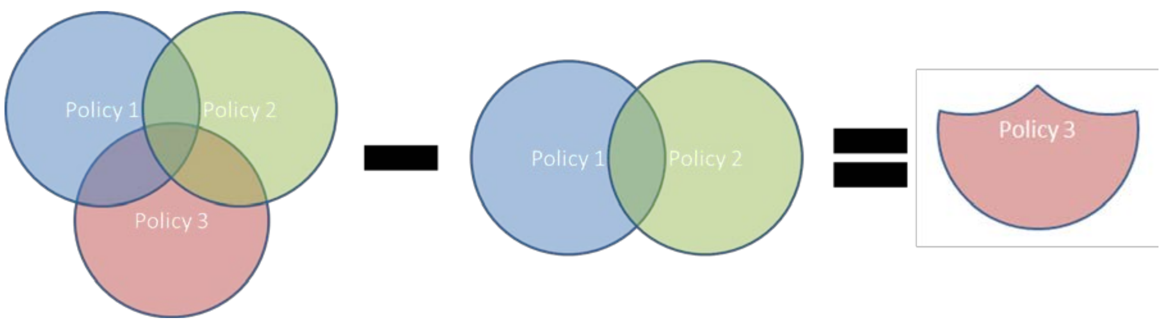
2. Remove all federal policies from the baseline scenario. The difference between this model run and the baseline scenario in step 1 represents the reduction due to all of the federal policies, including interactions.

Figure 1. Graphical representation of the reduction due to all of the federal policies, including interactions



3. Remove each policy separately, and make a run, comparing emissions to the baseline scenario. The difference in emissions represents the reduction due to the policy exclusive of all interactions with other policies.

Figure 2. Graphical representation of the process used to calculate the reduction due to a single federal policy, exclusive of all interactions



4. Any difference between the reduction due to all of the federal policies as calculated in step 2 and the sum of the individual policy emission reductions as calculated in step 3 equals the overlap between the federal policies (i.e., the portion of emissions that cannot be credited to a single policy).

Figure 3. Graphical representation of the sum of reductions due to individual federal policies, exclusive of all interactions

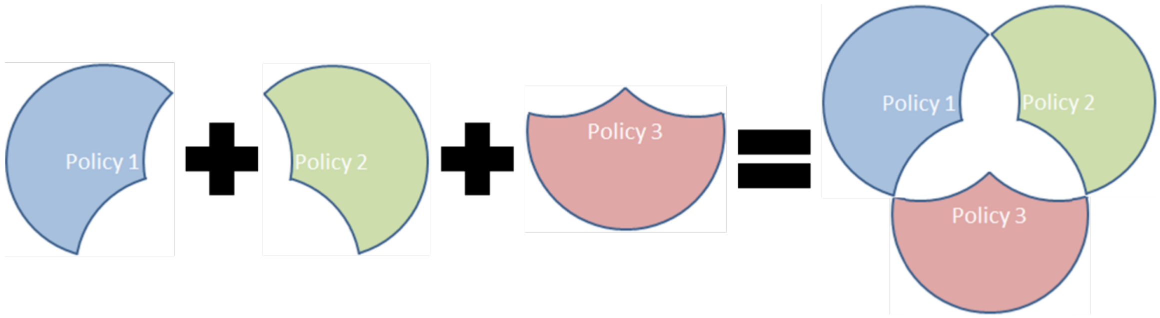
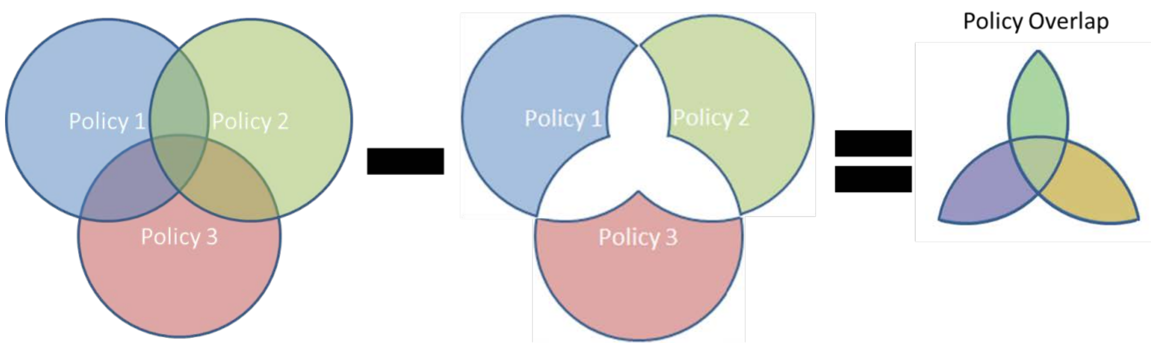


Figure 4. Graphical representation of the difference between the reduction due to all of the federal policies (calculated in step 2) and the sum of the individual emission reductions (calculated in step 3) which equals the overlap between the federal policies



Note that this approach is opposite, in a sense, to the approach used to estimate energy and emissions impacts of existing State policy under Task 1. As mentioned previously, this was done to capture expected BAU developments in all model scenarios. Such precision is only possible with modeling tools such as NEMS, thus, an alternative approach was required for Task 1.

The modeling approach for evaluating the contribution of federal policies towards meeting Washington's GHG emission reduction targets includes an analysis of the interactions between federal policies. However, there will also be interactions between federal policies and the state policies implemented by Washington. Because the federal policies are outside of Washington's control, SAIC will consider these interactions during the analysis of existing and proposed state policies.

To supplement the NEMS modeling exercise outlined above, for each federal policy where the model output raises additional questions, SAIC will review existing policy documentation, data, and implementation history in conjunction with Washington's existing GHG emissions inventory and forecast to develop an understanding of each policy's evolution, requirements, and available data sets.

4 Preliminary Results

We began our analysis by conducting model runs for 10 potential policy cases. The first two cases represented the NEMS baseline condition used for the *Annual Energy Outlook 2012*, with the minor modification of incorporating the California Low Carbon Fuel Standard (LCFS). This case will be referred to as the WA baseline case to differentiate it from the standard EIA reference case for *Annual Energy Outlook 2012*. This does not imply that this case only refers to Washington State. We will derive national level impacts and regional assessment from the WA Baseline case. The name serves to delineate the reference case used for this study from the EIA reference case that may be used for other studies.

The second case differed from the first in that in addition to including the LCFS, the model was adjusted to extend the Production Tax Credit (PTC) out through 2040, unchanged, rather than the current baseline which has the PTC sunset at the end of 2013.[68] Cases three through nine represent the sequential shut down of the policies currently in the baseline, one by one, to isolate their individual impacts on energy production and consumption and GHG emissions. The final case shuts down all policies simultaneously to understand the interactions among them and their overall contribution to altering energy markets and GHG emissions. See Table 1 for a summary description of the policy cases examined. Once cases one through nine were run, results at the national level and for Census Division 9, consisting of California, Oregon, Washington, Hawaii and Alaska or the Western Electricity Coordinating Council, Northwest Power Pool[69] as appropriate, were each examined. As described above at the end of the Overview section above, and detailed in Appendix C, regional results in Census Division 9 (or the Western Electricity Coordinating Council/Northwest Power Pool as applicable) are downscaled to Washington based on its historic share of fuel, energy, or emissions in the region as appropriate.

Recall the general analytical approach described above when examining the results reflected in the figures below. When comparing Case 2, the extension of the Production Tax Credit to Case 1, the reference case, we are quantifying the impact on GHG emissions from adding an extension of the tax credit to all other existing Federal policies captured in NEMS. As a result, the figures show increased renewable generation and decreased carbon dioxide emissions over time associated with this case. The analysis of Case 3 through Case 9 requires some additional processing to develop an intuitive illustration of the results. In each of these cases, we are turning off an existing policy captured in the NEMS reference case. When we turn off policies that generally reduce energy consumption or carbon dioxide emissions, the output from the case will show an increase in energy consumption or carbon dioxide emissions. In order to produce the figures shown below, SAIC multiplies the resulting NEMS output by negative one to capture the impact of the individual policy examined. For example, in Case 9, NEMS forecasts that

[68] The value for the Production Tax Credit is held constant, in 2004 dollars, within NEMS through 2040.
[69] NEMS evaluates electricity impacts at the power pool level but reports out GHG emission levels at the census division level.

shutting off CAFE standards will increase total U.S. energy consumption by nearly 0.9 quadrillion Btu in 2035. Thus, we can deduce (and display in Figure 5) that the existence of CAFE standards decreases U.S. total energy consumption by 0.9 quadrillion Btu in 2035).

In the Case 10, the combined case, all federal policies examined under Case 3 through Case 9 are turned off and the Production Tax Credit is allowed to sunset after 2013. The effect of the combined case is far greater than any individual case that includes shutting off only one policy, and is also greater than the simple sum of the policies evaluated individually. This is because some of the policies have overlapping impacts that generate reductions and the model only reports the effect of each policy exclusive of all interactions when evaluated individually.

Table 1. Case Definitions for Preliminary Analysis of Federal Policies

Case ID	Case Name	Case Description
Case1	WA Baseline	AEO 2012 Reference Case with CA LCFS Incorporated
Case2	WN Credit 2040	AEO 2012 Reference Case with CA LCFS and PTC Extended to 2040
Case3	MATS Off	WA Baseline with Mercury and Air Toxics Standard Turned Off
Case4	CAIR/CSAPR Off	WA Baseline with Clean Air Interstate Rule and Cross-state Air Pollution Rule Turned Off
Case5	CAA Off	WA Baseline with Clean Air Act Turned Off
Case6	RPS Off	WA Baseline with Renewable Portfolio Standards Turned Off
Case7	RFS Off	WA Baseline with Renewable Fuels Standards Turned Off
Case8	CA LCFS Off	WA Baseline with California Low Carbon Fuel Standard Turned Off
Case9	CAFE Off	WA Baseline with CAFE Turned Off
Case10	Combined	WA Baseline with all Policies Turned Off

As shown in Figure 5 below, the federal policy that has the largest impact on total energy consumption is the CAFE standards [70] which reduce total national energy consumption by as much as 0.8% by 2035 or 0.9 quadrillion Btu. By 2035, the new CAFE standards will lower U.S. carbon dioxide emissions by more than one percent or 63 million metric tons (Figure 6).

[70] This adjustment to the model left the passenger vehicle standard at the pre-EISA 2007 level of 27.5 mpg and the light-duty truck standard at the 2011 level of 24.0 mpg.

While the impact of the Production Tax Credit on total energy consumption is less marked, it appears that extending it to 2040 reduces national carbon dioxide emissions by nearly 1.3% in 2035, or an estimated 78 million metric tons. This is likely attributable to the role of the tax credit in making renewable electricity, particularly from wind, more economical than fossil-based alternatives. Once fully implemented, the Renewable Fuel Standards have a smaller, but still important role in reducing national carbon dioxide emissions.

The Renewable Portfolio Standards have an impact similar to the Renewable Fuel Standards through 2025, however, beyond 2025 that impact rapidly dissipates, perhaps because many of the target dates in the standards do not go beyond that year. Although the Clean Air Interstate Rule (CAIR) or Cross-state Air Pollutant Rule (CSAPR) are aimed at criteria pollutants, because they make coal-fired generation more expensive, they are likely to drive a shift toward lower-emitting generation sources, as shown in Figure 6, and will likely also contribute to an overall reduction in US carbon dioxide emissions despite the parasitic load of pollution control equipment at coal-fired power plants. For more detail on the impacts of individual policies, particularly at the regional and state level, please see discussion below. The sequence in which the policies are presented differs slightly from that in Section 2 above so that we can group the analysis of transport-based policies and electric-generation based policies.

Figure 5. Change in Total U.S. Energy Consumption from Federal Policies Modeled

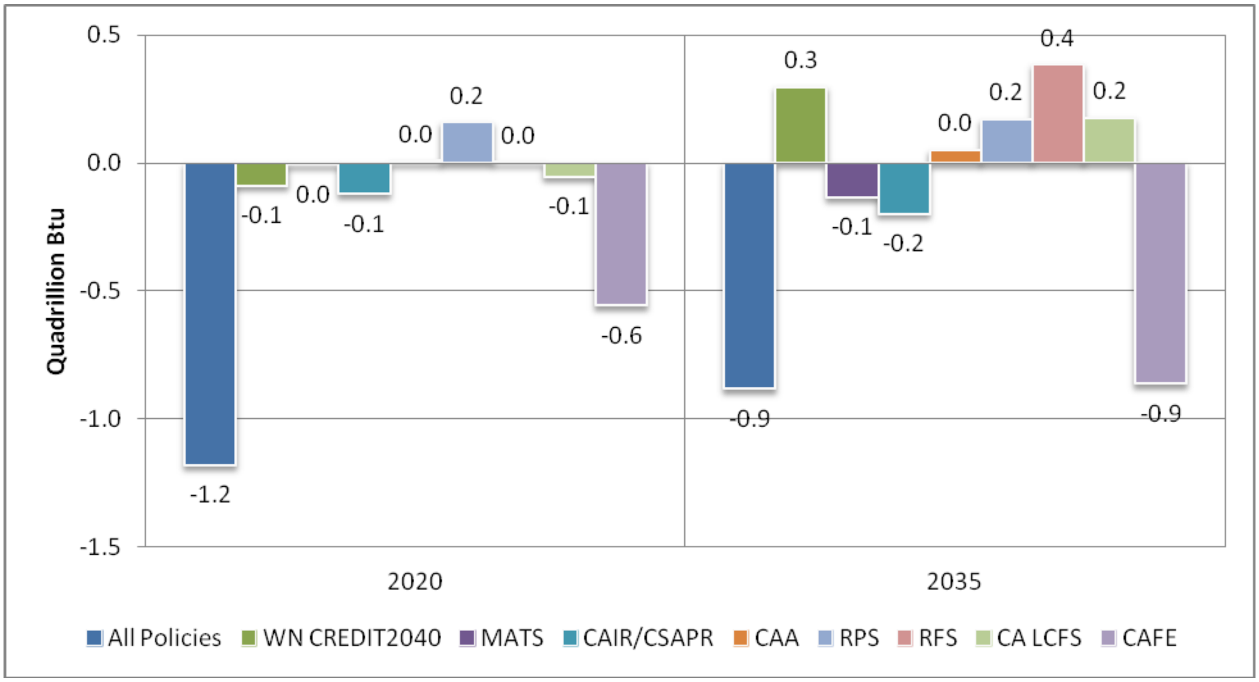
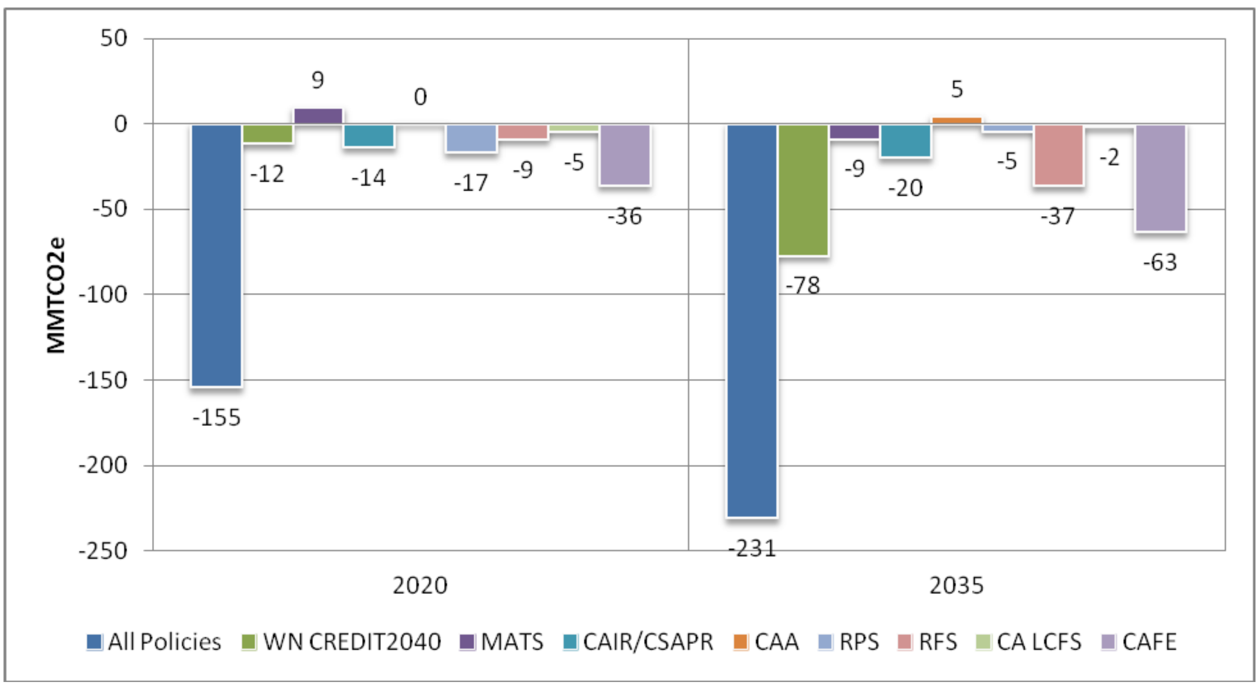


Figure 6. Change in Total U.S. Energy-related Carbon Dioxide Emissions from Federal Policies Modeled



4.1 Transportation-related Policies

In contrast to the distribution of greenhouse gas emissions found in most states, transportation, rather than electric power generation is the largest single source of GHG emissions in Washington. Transportation represented 44.3 percent of Washington's overall greenhouse gas emissions in 2010, and on-road motor fuels represented 31.4 percent of overall greenhouse gas emissions. While these emissions declined between 2007 and 2010, they were still above their 1990 levels.[71] Further, the recent decline is largely attributable to higher gasoline prices and a flattening in vehicle miles travelled due to the recent economic crisis. It is likely that as the U.S. economy returns to more typical growth patterns, transport emissions will resume their escalation absent policy intervention. As shown in Figure 7 and Figure 8 below, CAFE standards have the largest impact on gasoline consumption and GHG emissions at the national level of any transportation-related federal policy. At the national level the Renewable Fuel Standards provide a reduction in carbon dioxide emissions about one-third that of CAFE standards in 2020 and one-half that of the CAFE standards in 2035. In Census Division 9 the LCFS and RFS play a larger role than CAFE in reducing carbon dioxide emissions in 2020. By 2035, reductions from CAFE exceed those from LCFS and the RFS reductions appear to reverse. (Figure 9 and Figure 10). The regional impact of the LCFS is not surprising as the California transportation sector is by far the largest component of transport related emissions in Census Division 9. The reversal in the RFS is more difficult to explain but is likely related to the interactive effects of the RFS with the LCFS and CAFE standards.

[71] State of Washington, Department of Ecology, *Washington State Greenhouse Gas Emissions Inventory, 1990 - 2010*, December 2012, Publication no. 12-02-034

Figure 7. Change in U.S. Motor Gasoline Consumption from Federal Policies Modeled

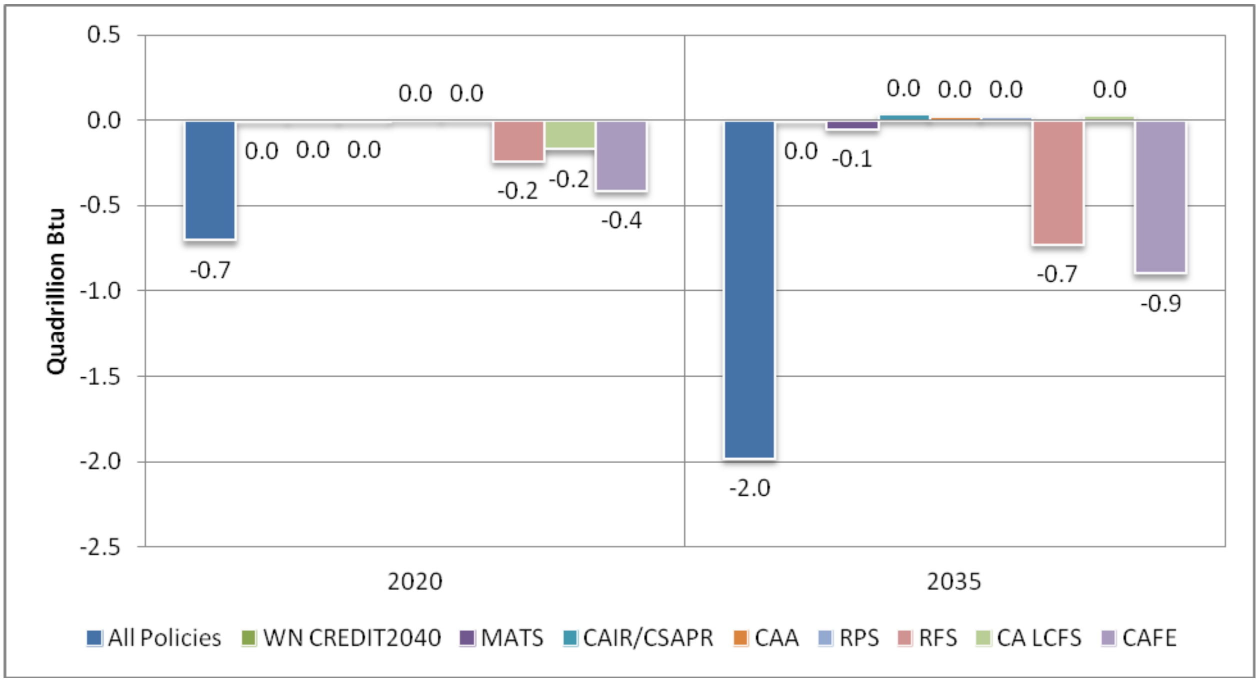


Figure 8. Change in U.S. Carbon Dioxide Emissions from Transportation from Federal Policies Modeled

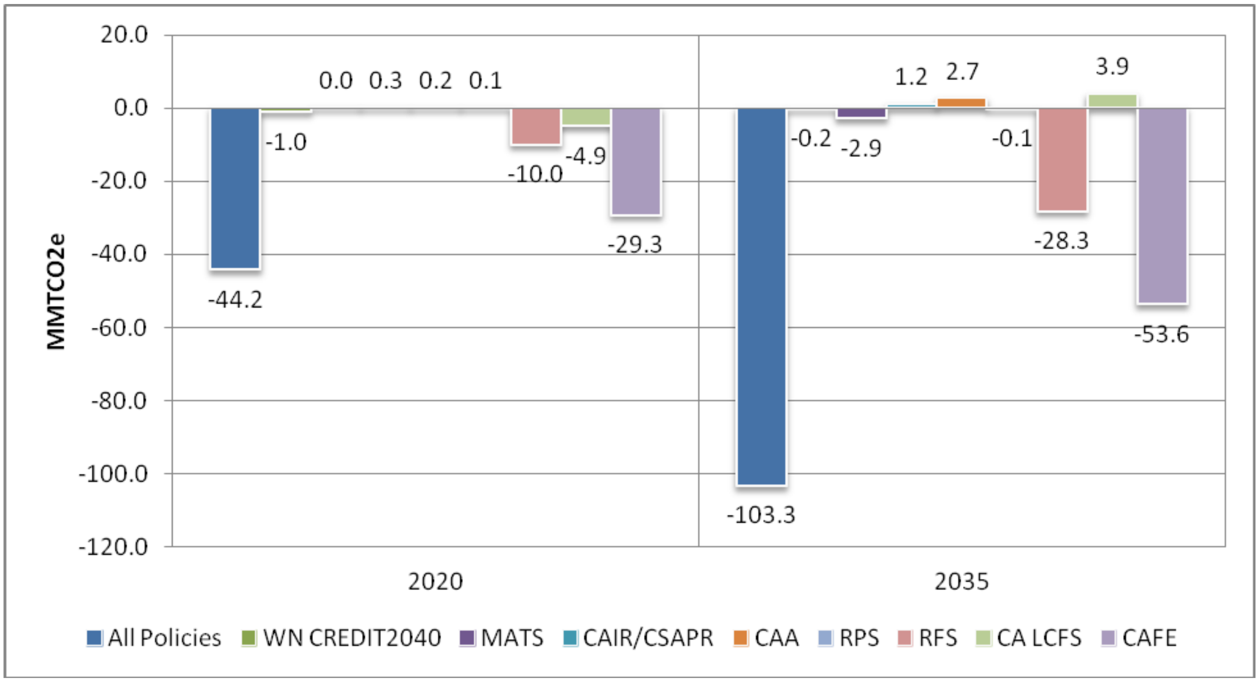


Figure 9. Change in Motor Gasoline Consumption in Census Division 9 from Federal Policies Modeled

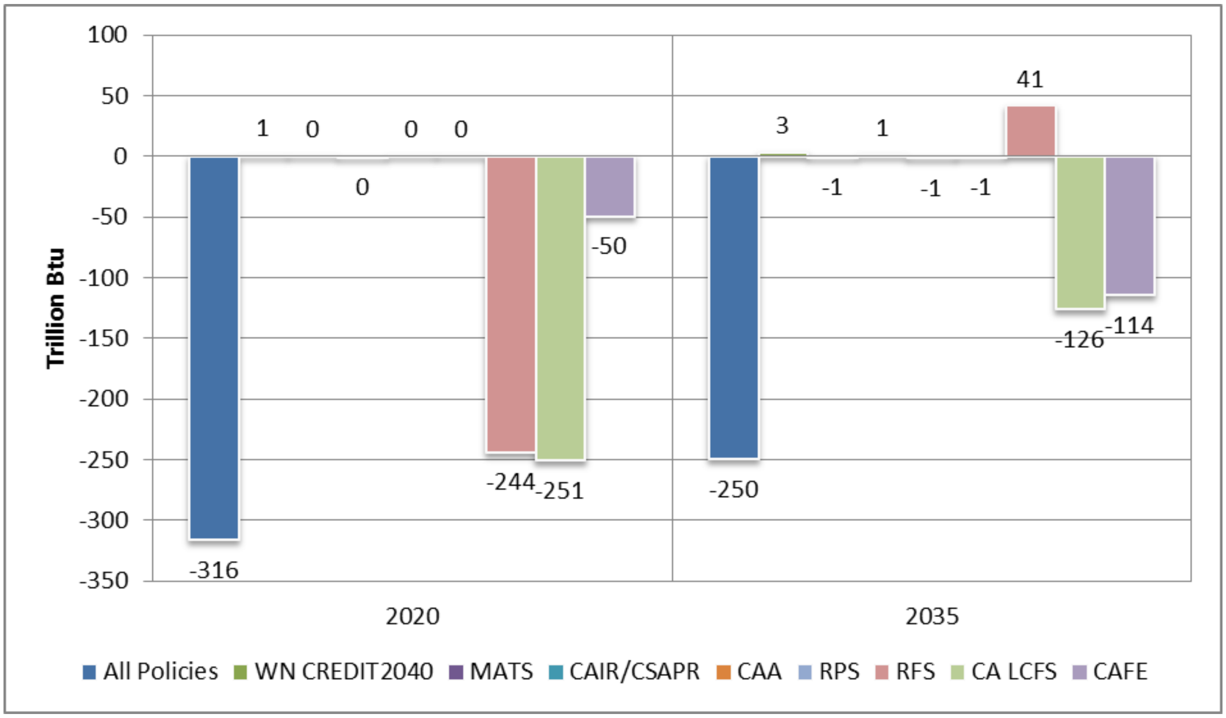


Figure 10. Change in Carbon Dioxide Emissions from Transportation in Census Division 9 from Federal Policies Modeled

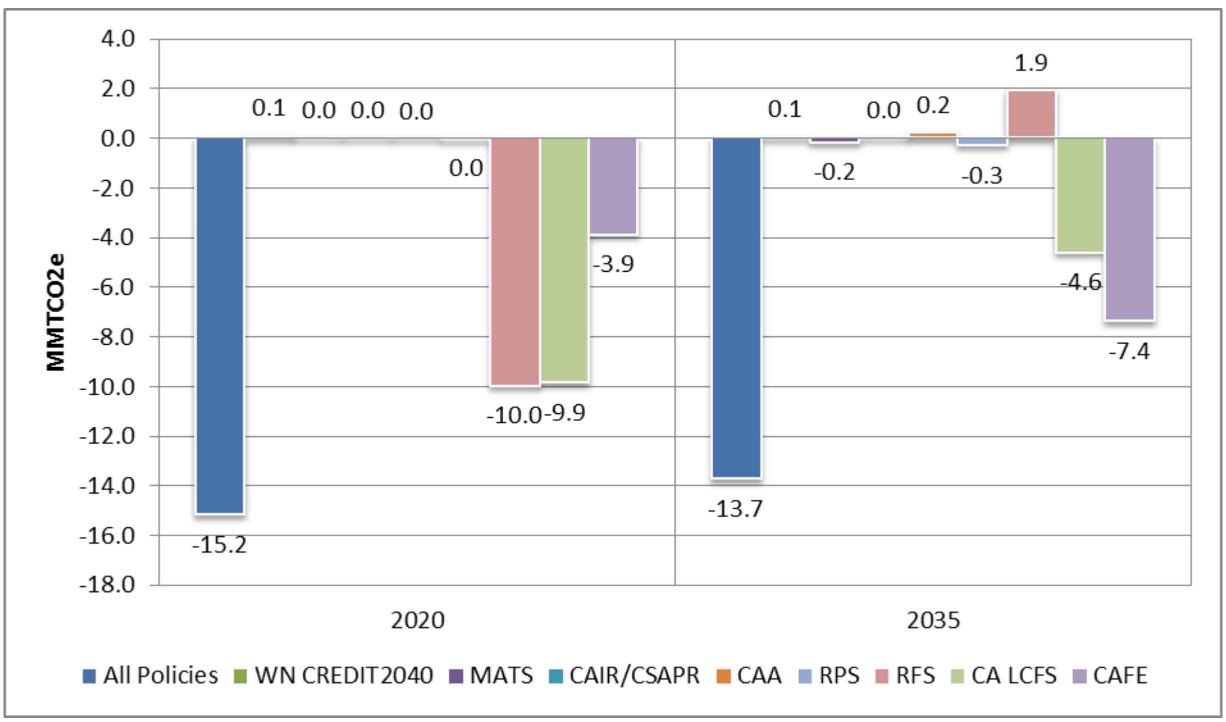


Figure 11. Change in Motor Gasoline Consumption in Washington State from Federal Policies Modeled

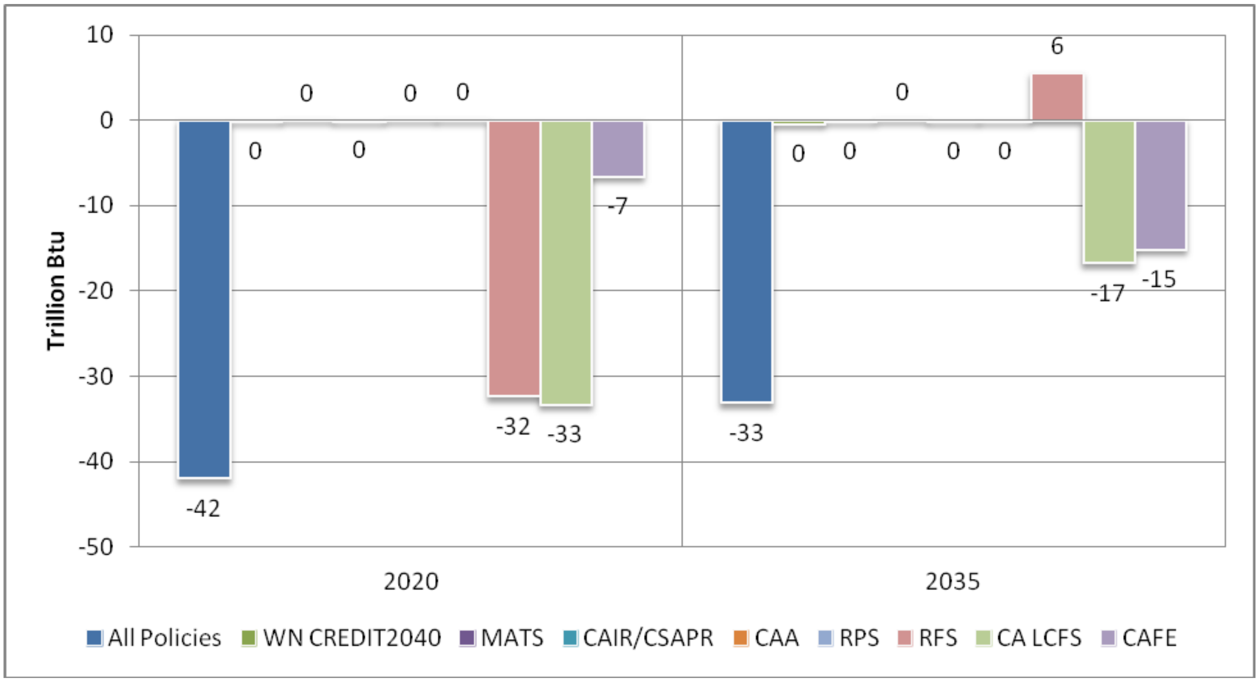
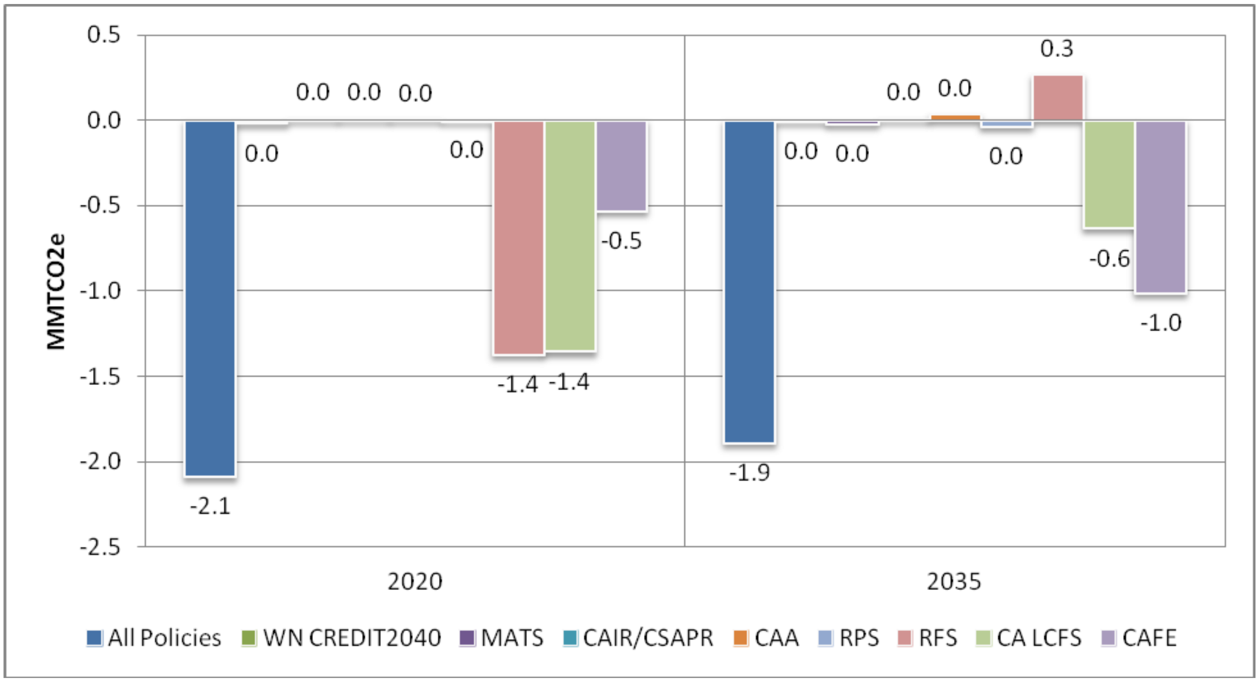


Figure 12. Change in Carbon Dioxide Emissions from Transportation in Washington State from Federal Policies Modeled



Renewable Fuels Standards (RFS-1 and RFS-2)

At the national level, The Renewable Fuels Standards (RFS) is second only to CAFE in reducing carbon dioxide emissions from the transportation sector. As shown in Figure 8 the RFS is projected to reduce carbon dioxide emissions by 28.3 million metric tons across the U.S. in 2035. This differs from the 37 million metric tons of carbon dioxide reductions associated with RFS shown in Figure 6. Because Figure 6 captures total U.S. energy-related carbon dioxide emissions it will capture reductions associated with this policy outside the transportation sector as there are, to some degree, spillover effects in the residential, commercial and industrial sectors. At the census division level, reductions in carbon dioxide emissions exceed those from CAFE standards in 2020 but diminish rapidly by 2035 until it no longer provides additional emissions reduction benefits. For Washington alone, the impacts of the national RFS are nearly three times as large as CAFE in 2020 but similarly dissipate by 2035 (Figure 11 and Figure 12). This is expected as our methodology scales Washington impacts to the broader Census Division results.

Recommendations for Further Analysis: The preliminary results of this analysis point directly at a strong interactive effect between the California LCFS and the RFS. In addition, the RFS and the CAFE standards are likely to also have some interactions. Once all of these interactions are accounted for, it would be worthwhile to investigate potential methods for isolating the impacts of the RFS and LCFS on Washington. NEMS and current post-processing methods do not allow for this level of granularity. Further, a more complete understanding of the reversal in the impacts of the RFS between 2020 and 2035 should be developed.

CAFE Standards and Tailpipe Emission Standards for Carbon Dioxide

As shown in Figure 7 through Figure 10 above, the upward revision in CAFE standards will have important impacts on motor gasoline consumption and greenhouse gas emissions at both the national and census division levels. The revision to CAFE standards is forecast to reduce U.S. motor gasoline consumption six percent in 2035, or 0.9 quadrillion Btu, equivalent to 63 million metric tons of carbon dioxide (53.6 million metric tons in the transportation sector as shown in Figure 8).[72] At the census division level, the increased CAFE standards lower motor gasoline consumption by as much as eight percent in 2027 and by 2035, lower GHG emissions by 7.4 million metric tons of carbon dioxide equivalent. At the state-level, CAFE standards are expected to reduce emissions by a little more than one percent or 1.0 million metric tons of carbon dioxide in 2035, exclusive of all interactions (Figure 12). This reduction coincides with a decrease in motor gasoline consumption within the state of about 15 trillion Btu in 2035 (Figure 11).

[72] As discussed above under the Renewable Fuels Standards, the overall reduction in total U.S. energy related emissions will exceed those in the transportation sector due to relatively small spillover effects in the residential, commercial and industrial sectors.

Recommendations for Further Analysis: Over time**,** CAFE standards grow to the most important non-state-level policy mechanism for reducing consumption and GHG emissions in the transportation sector as the RFS and California LCFS sunset and diminish in impact. This importance justifies considerable further analysis. CAFE standards are likely to have interactions with the Renewable Fuels Standards and California LCFS, which should be disentangled. Once that is completed, the results should be incorporated into our assessment of state-level policies and WA specific impacts.

California Low Carbon Fuel Standards (LCFS)

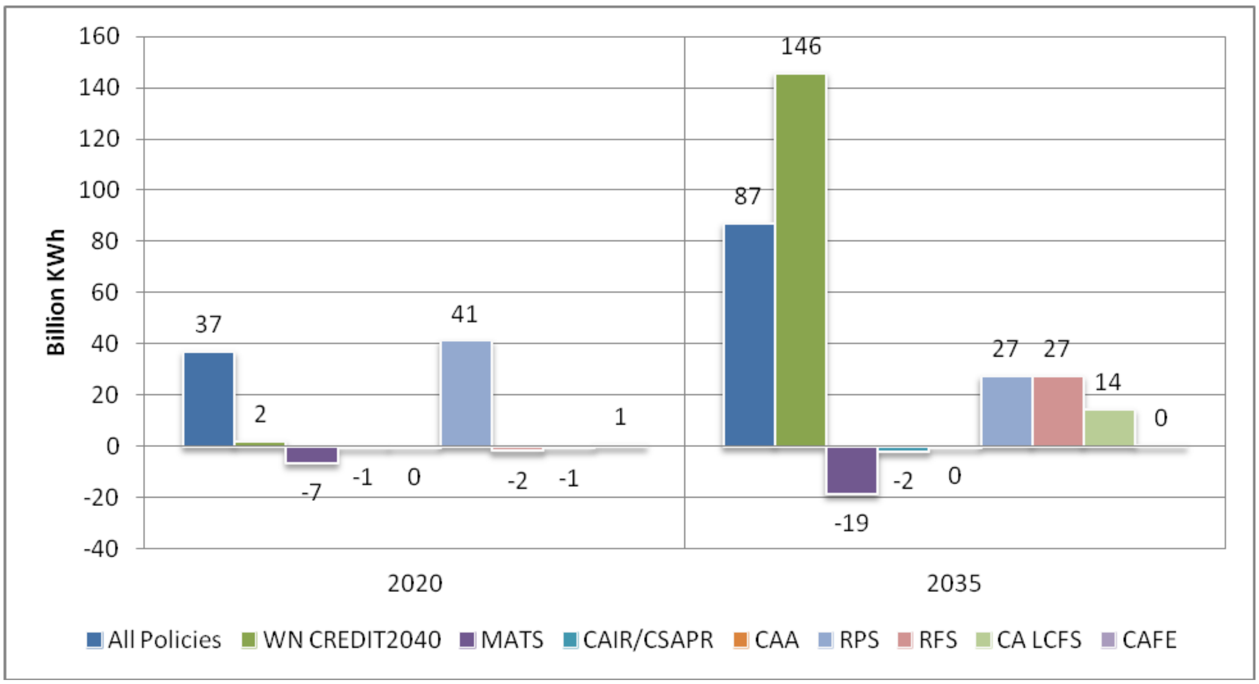
Although the LCFS is not a federal policy, the prominent role it plays in California's efforts to reduce greenhouse gas emissions, and the proximity and influence of California's fuel markets on Washington persuaded SAIC to model the impacts of this policy. SAIC added the California LCFS to the NEMS version used for the *Annual Energy Outlook 2012*, to establish the WA Baseline case, and then turned the LCFS off to gauge its impact on carbon dioxide emissions. As one might expect, and reflected in Figure 9 and Figure 10 above, because of California's prominent role in the Census Division 9 transportation economy, the LCFS shows important impacts on GHG emissions in Census Division 9. The LCFS reduces carbon dioxide emissions in Census Division 9 by 9.9 million metric tons in 2020 and 4.6 million metric tons in 2035. The state-level results reflect similar magnitude and trends of results as Census Division 9 due to the apportioning methodology used and may not be an appropriate measure of California LCFS impacts in Washington. The state-level results are likely overestimated since California is most impacted by the LCFS in Census Division 9 and Washington is only impacted by spillover effects.

Recommendation for Further Analysis: The impact of the California LCFS on GHG emissions in Census Division 9 should be explored further. As a start, it is not clear what the LCFS will provide in GHG reductions that are not provided by the Federal RFS. The interactions of the LCFS with CAFE standards and the Renewable Fuel Standards should be examined in detail. In addition, while the preliminary literature showed considerable uncertainty regarding the economic impacts of the LCFS in the northeast and California, there is sufficient evidence that the LCFS in these locations would reduce GHG emissions within their geographic boundaries. Accordingly, the analysis of a state-level LCFS within Washington is justified. SAIC is examining the previous literature on the potential of a Washington LCFS to reduce emissions at reasonable cost within the Task 2 Report part of the broader study under this project.

4.2 Electric-generation Related Policies

In 2010, almost two-thirds (66 percent) of Washington's in-state electricity generation was hydroelectric. This yielded some of the nation's lowest electricity rates and total emissions from net consumption of electricity of just 20.7 million metric tons of carbon dioxide equivalent. This was equal to about 21.8 percent of total state emissions. Low electricity rates and low aggregate emissions creates challenges in achieving GHG reductions through typical electricity supply and demand mechanisms, with the possible exception of an electricity GHG performance standard to mitigate the higher carbon content of imported electricity. As revealed in Figure 13 through Figure 16 below, the aggregate impact of the 30-state Renewable Portfolio Standards (RPS) seems to have its greatest effect prior to 2025 on the portion of electric generation attributable to renewables and the reduction of GHG emissions at both the federal and census division or Western Electricity Coordinating Council, Northwest Power Pool[73] (WECC/NWPP) levels. The diminished impacts of the RPS after 2025 are likely the result of the target dates for most RPS being set at 2025 or earlier, with only Hawaii (2030), Delaware and Illinois (2026) having later dates. Of course, it is unlikely at that point that existing generation capacity will be removed or that states will dramatically scale back their expectations of the portion of generation they expect from renewable resources. From the model's perspective though, this generation capacity is now part of the reference case and the policy will not drive further variance from that reference case. By 2035, in the absence of the RPS, increases in renewable generation are driven by the extension of the Production Tax Credit.

Figure 13. Change in U.S. Renewable Source Generation from Federal Policies Modeled



[73] The WECC/NWPP is characterized as Electricity Market Module 21 in NEMS.

Figure 14. Change in U.S. Carbon Dioxide Emissions from Electric Power from Federal Policies Modeled

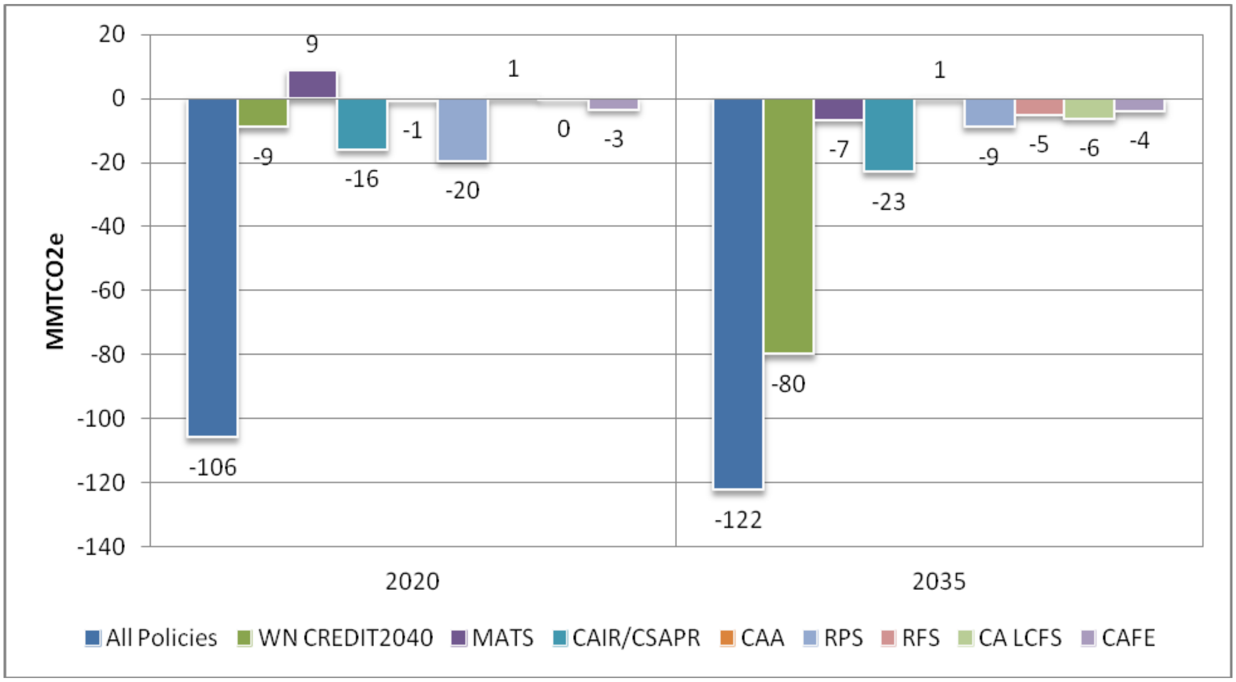


Figure 15. Change in WECC/NWPP Renewable Source Generation in WECC/NWPP from Federal Policies Modeled

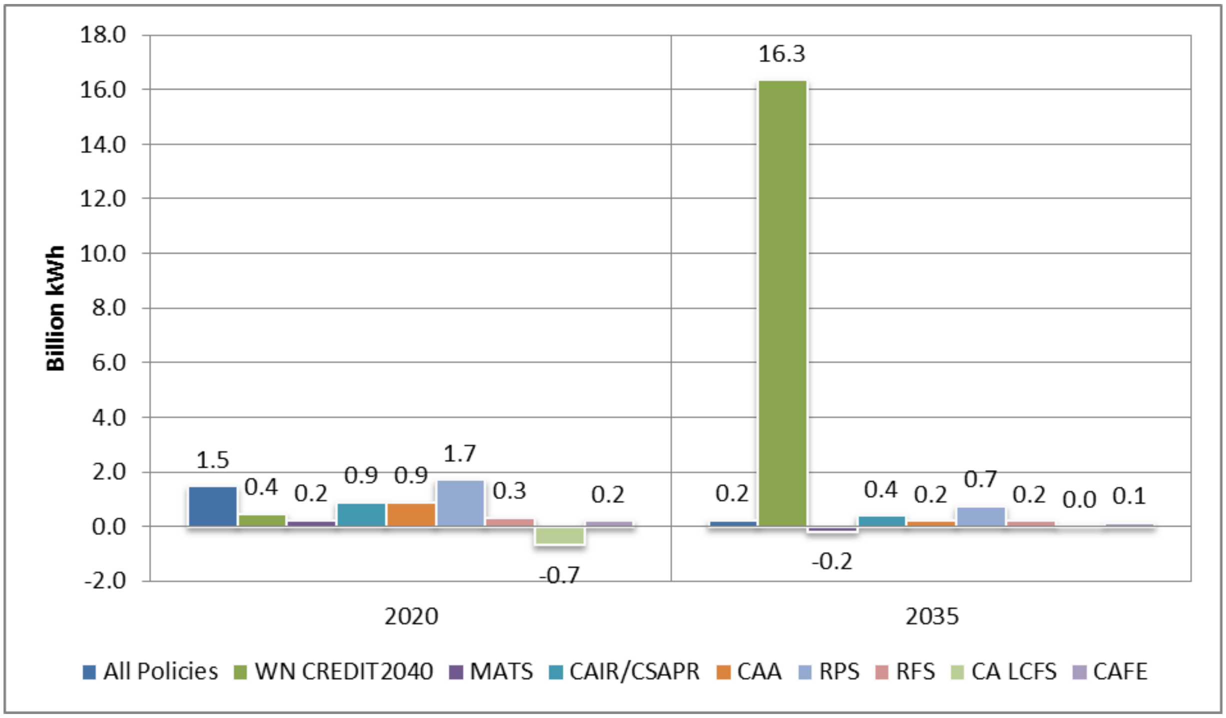


Figure 16. Change in Carbon Dioxide Emissions from Electric Power Generation in Census Division 9 from Federal Policies Modeled

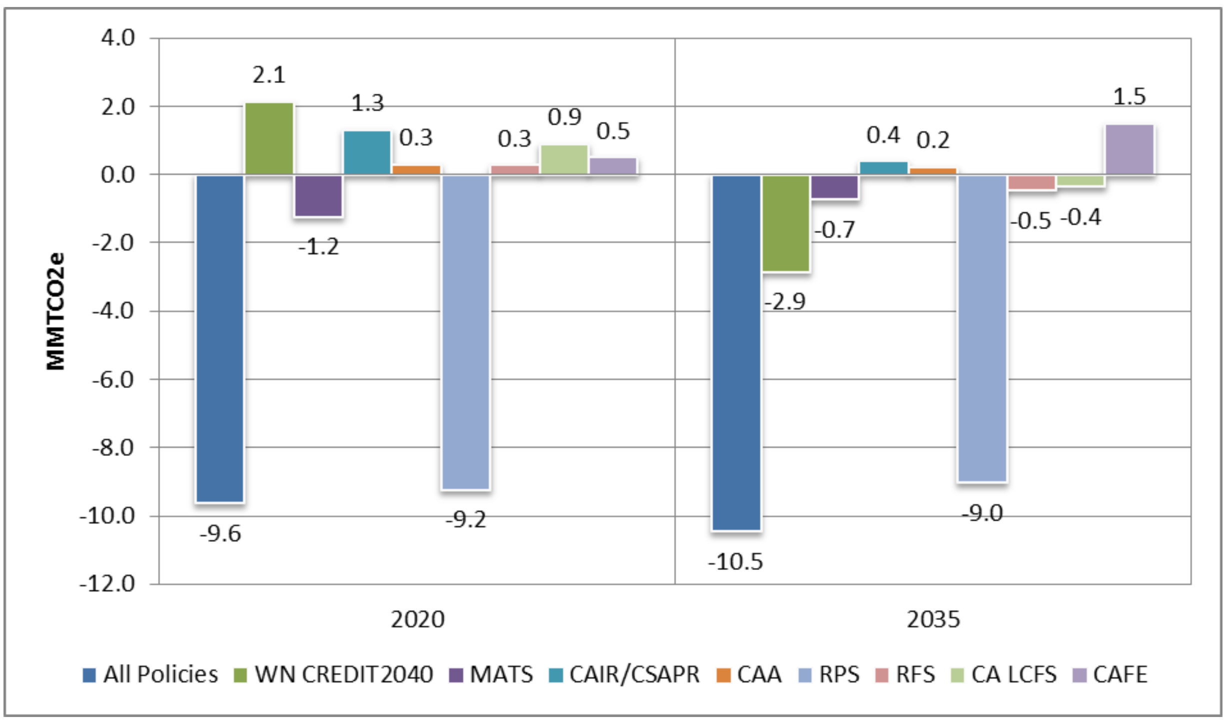


Figure 17. Change in Washington State Renewable Source Generation from Federal Policies

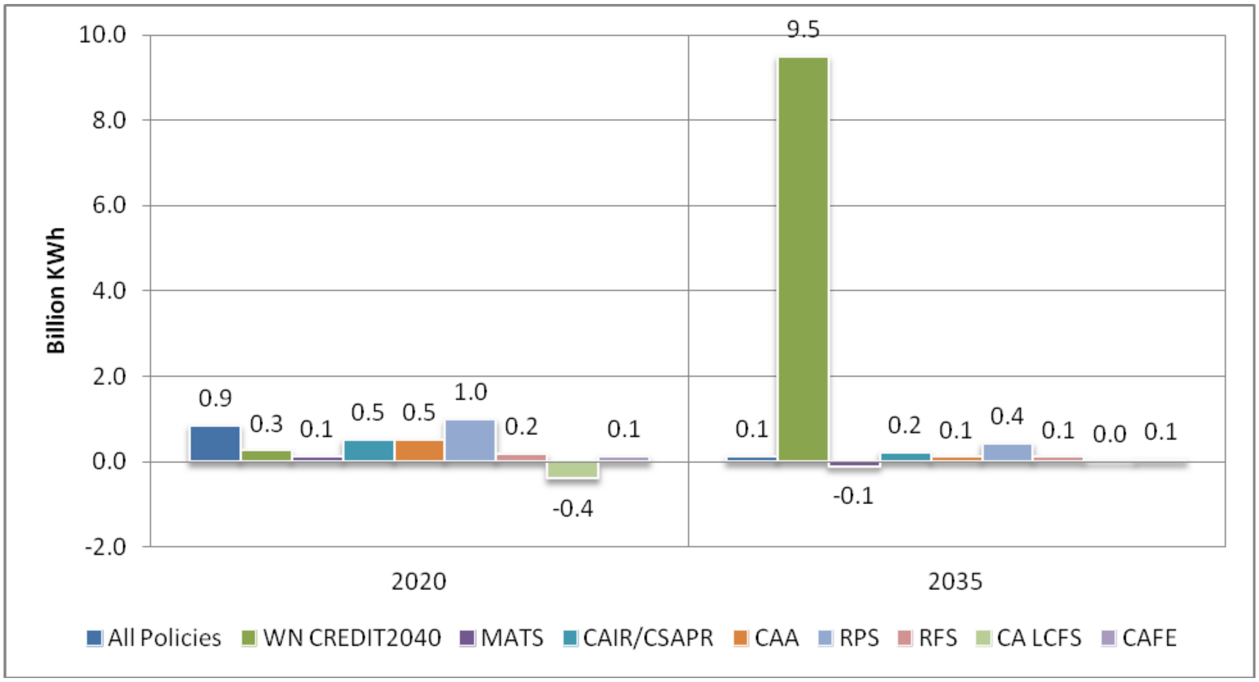
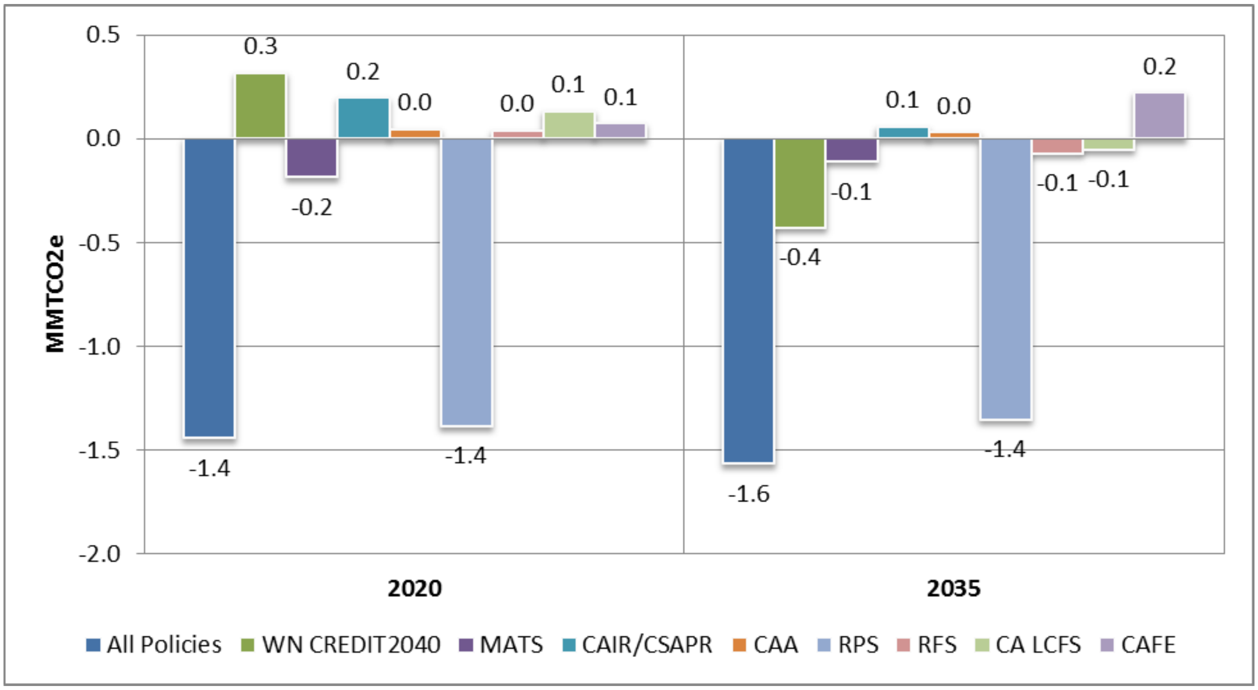


Figure 18. Change in Washington State Carbon Dioxide Emissions from Electric Power from Federal Policies Modeled



EPA Mercury and Air Toxic Standards

Initial modeling of the Mercury and Air Toxics Standards (MATS) shows that these standards will yield less renewable generation and higher emission levels at the national level in 2020 (Figure 13 and Figure 14). While the decrease in renewable generation persists to 2035, the effect on emission levels reverses, likely due to the displacement of coal-fired electric generation capacity with natural gas-fired generation. The near term increase in carbon dioxide emissions is not particularly surprising as pollution control technology for mercury and air toxics removal increase ancillary power requirements increasing the amount of coal that needs to be consumed to satisfy electricity demand and effectively increasing carbon dioxide emissions per kilowatt-hour generated. Over time, this impact is overcome as the fleet shifts away from coal-fired generation.

Recommendations for Further Analysis: The renewable electric generation results for this policy are somewhat counterintuitive as MATS should increase the costs of new coal-fired generation, favoring increased renewable builds. Further investigation to understand this outcome at the national and regional level is underway. That said, the overall impact of MATS is relatively small and is likely to be muted to a large degree in Washington State given the absence of significant coal-fired generation. Further inquiry into the apparently counter-intuitive result is may yield some insights but it remains likely that MATS will not have sufficient impact on Washington to justify further state-level analysis.

Clean Air Interstate Rule and Cross-State Air Pollution Rule

Figure 14 shows that in 2020, the Clean Air Interstate Rule (CAIR) or the Cross-state Air Pollution Rule (CSAPR) would reduce national carbon dioxide emissions from electricity generation by 16 million metric tons carbon dioxide equivalent, with reductions growing to 23 million metric tons carbon dioxide equivalent in 2035. Figure 13 does not show a concurrent increase in national level renewable generation from CAIR/CSAPR suggesting that the rules are forecast to cause a shift from coal-fired generation to natural gas-fired generation. There are no similar reductions in emissions in Census Division 9, again likely attributable to the reduced level of existing coal-fired generation there. Similarly, at the state-level, the impacts of CAIR/CSAPR on energy consumption, renewable generation, and carbon dioxide emissions are estimated to be marginal across the study time horizon.

Recommendations for Further Analysis: Like MATS, the CAIR/CSAPR is likely to have a non-material impact on Washington given the relatively limited role of coal-fired electricity in Washington's energy mix and the regulation's focus on units in the Eastern half of the U.S. Thus it is difficult to argue for the allocation of additional study resources for further analysis of this policy. At the national level, there are several interesting questions that may warrant investigation within a different forum, such as does the change in GHG emissions results from a shift from coal-fired generation to gas-fired generation. Additionally, as many previous studies have conflated the costs of MATS and CAIR/CSAPR, an effort to disaggregate those costs may be worthwhile, particularly given the apparently highly diverse effects on GHG emission levels of the two policies.

Renewable Portfolio Standards (RPS)

We have examined the impacts of the 30 state (plus District of Columbia) RPS to understand their national impact and potential spillover effects in Washington. NEMS subsumes individual state targets in an approximation of region-level compliance requirements (voluntary or discretionary targets are not modeled). While it does not have the granularity to examine the direct impacts of Washington's own RPS, it does provide useful insight into the impact of the region's aggregate RPS requirements on electric generation and carbon dioxide emissions across the region and within Washington. Figure 13 and Figure 14 demonstrate that, in the aggregate, these RPS will increase total U.S. renewable electric generation and reduce carbon dioxide emissions by 20 million metric tons carbon dioxide in 2020. The national impact of the RPS diminishes subsequently over time as many of the State RPS have target dates set for 2025 or earlier, dropping the reduction in carbon dioxide to nine million metric tons by 2035. These impacts are similar in WECC/NWPP and Census Division 9 (Figure 15 and Figure 16), though the percentage change in renewable power generation in WECC/NWPP is lower – likely due to a relatively much larger installed base of renewable generation – and the RPS plays a larger role in the reduction of carbon dioxide emissions in Census Division 9, on the order of nine million metric tons in 2020 and 2035.. In the Washington State electric power sector, carbon dioxide emissions reductions attributable to the RPS in states across the surrounding region are expected to be approximately 1.4 million metric tons in both 2020 and 2035. Overall, these reductions represent an improvement of about 1.5 percent.

Recommendations for Further Analysis: Although NEMS is not the right tool to examine the specific impacts of Washington's own RPS on the state's energy economy, that analysis will be conducted with off-line tools as a part of other tasks under this study. The substantial impacts of the RPS at the national and Census Division levels justifies further investment to determine the impact of the RPS in surrounding states, most notably California's very aggressive target of 33% by 2020, on Washington. SAIC will seek additional granularity on the impact of multiple state RPS, to determine to what extent such policies need to be added to an interactions analysis with other state policies.

Tax Incentives for Renewable Energy (PTC and ITC)

After showing almost no impact on the amount of electric generation from renewable energy in 2020 (Figure 13), the effect of the PTC on renewable electric generation grows substantially through 2035, when total U.S. renewable electric generation is 20% higher than it otherwise would be in the absence of the PTC. Figure 14 shows a similar effect on total U.S. carbon dioxide emissions from electricity generation in 2035, with emissions some 80 million metric tons carbon dioxide lower than in the absence of the PTC. Figure 15 represents a similar trend in the PTCs impact on renewable generation in WECC/NWPP, but the absence of an accompanying reduction in carbon dioxide emissions from electric generation in Census Division 9, as captured in Figure 16 is somewhat confounding, though likely the result of comparing the WECC/NWPP region to Census Division 9 which is not an apples-to-apples comparison. To understand the geographical differences between these regions, maps are provided in Appendix A and B. In Washington, the PTC has a marginal impact on renewable generation while RPS targets are still active (through 2025), then increases renewable generation dramatically out to 2035. The PTC is projected to increase renewable generation in Washington by about nine percent, or 9.5 billion kilowatt-hours (Figure 17).

Recommendations for Further Analysis: The rapid escalation in the impacts of the PTC after 2025 is concurrent with the rapid decrease in effects of the RPS after 2025. This suggests potential interactions between these two policies that need to be resolved. Each has robust influence on renewable generation and carbon dioxide emissions across the country, somewhat less so in WECC/NWPP and Census Division 9. Our first step will be to resolve the apparent conflict between levels of renewable generation in WECC/NWPP and carbon dioxide emission levels in Census Division 9. At this juncture, resolution of the potential interactions, followed by a review of potential methods to resolve comparison issues between the WECC/NWPP and Census Division 9 regions is warranted.

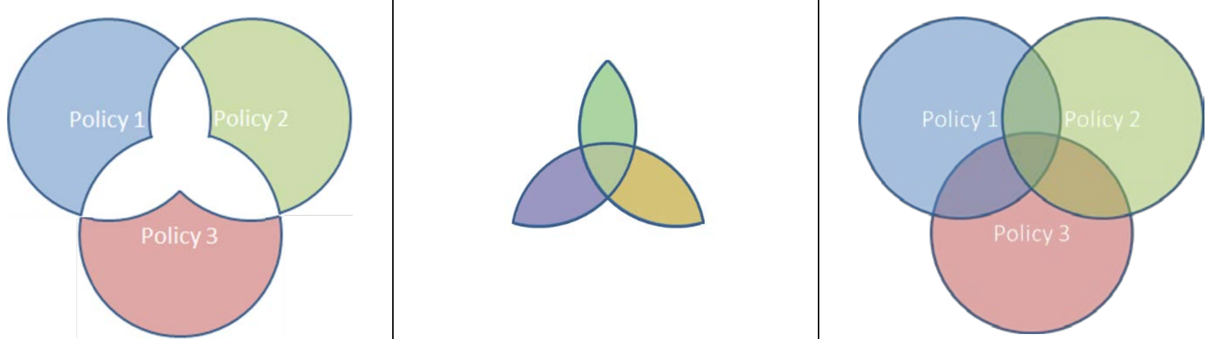
4.3 Combined Case

The final case examined combines all of the adjustments to the WA baseline reference case previously analyzed individually in Case 3 through Case 9. In the combined case, all federal policies described above are turned off and the Production Tax Credit is allowed to sunset after 2013. This combined case shows that together, the federal policies modeled decrease total U.S carbon dioxide emission by 155 million metric tons in 2020 and 231 million metric tons in 2035. **(**Figure 6**)**. About half of that decrease is attributable to declines in motor gasoline consumption driven by CAFE, Renewable Fuel Standards and Low Carbon Fuel Standards. The bulk of the remaining decreases are attributable to increased generation of electricity from renewable resources associated with extending the Production Tax Credit to 2040 and, in the years prior to 2025, the Renewable Portfolio Standards **(**Figure 13**).** These trends were consistent with the Washington state-level results. Holding all else equal if all of the federal policies evaluated were to be eliminated, carbon dioxide emissions in Washington would be projected to be approximately 3.7 million metric tons (4.5%) higher in 2035 than current emissions levels (Figure 20).

When the individual impacts of each of Case 3 through Case 9 are summed they equal far less than the overall impact of the combined case. There are interactions between multiple policies such as CAFE standards, Renewable Fuel Standards, and the Low Carbon Fuel Standard or the Renewable Portfolio Standards and the Production tax Credit and the individual results of each policy represent only the portion of reductions that are exclusive of interactions with other policies. Some of these interactions will completely negate the impact of one or more of the identified policies in certain years, some may merely diminish the impact of one or more of the identified policies and some may even have synergistic effects, which, when combined, result in a greater impact than when assessed independently. The sum of the individual impacts on carbon dioxide emissions of the policies studied, exclusive of all policy interactions, is some 10 percent less than the impact of the combined case at the national level and 50 percent less at the Census Division and Washington State levels in 2035. This means that without additional analysis, approximately 50 percent of anticipated carbon dioxide reductions in Washington during 2035 can be credited to a specific federal policy and 50 percent cannot. These carbon dioxide emissions reductions in 2035 are illustrated graphically below at the state level.

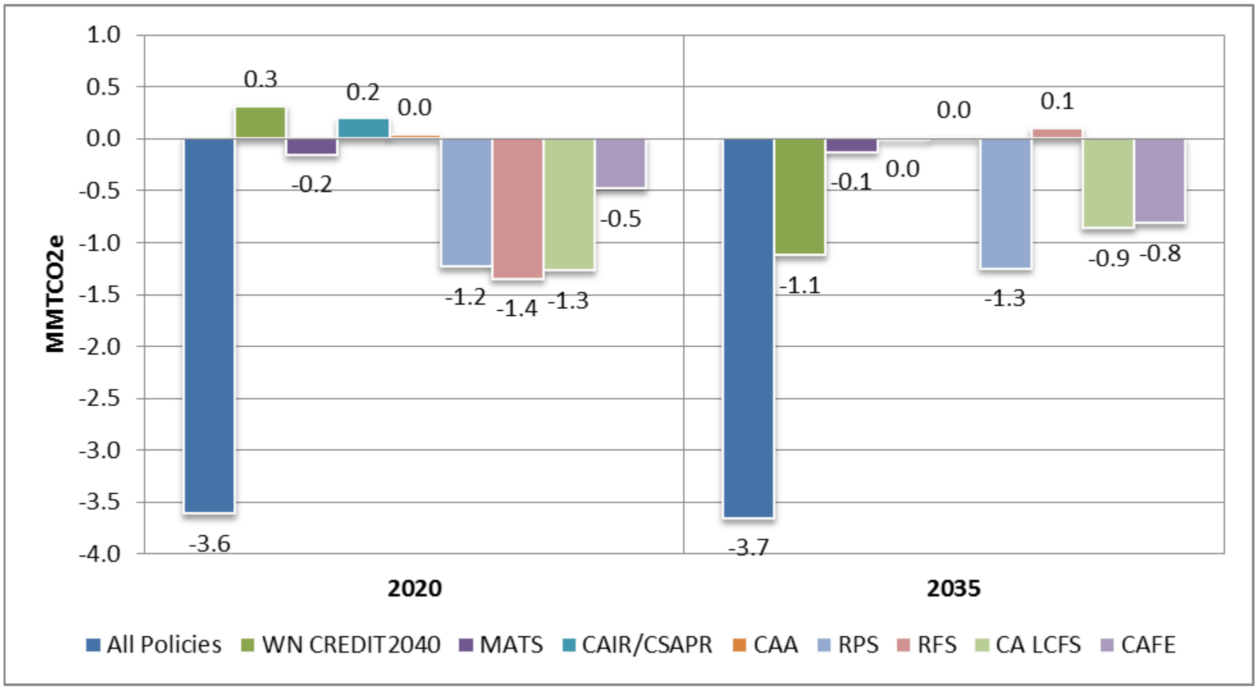
Figure 19. Projected Washington State Carbon Dioxide Emissions Reductions in 2035; (1) Exclusive of Policy Interactions, (2) Isolated for Policy Overlap, and (3) Overall Reductions.

CO_2 Reductions Exclusive of Policy Interactions	Policy Overlap CO_2 Reductions	Total CO_2 Reductions
1.8M mtCO$_2$	***1.8M mtCO$_2$***	***3.7M mtCO$_2$***



Recommendations for Further Analysis: The effect of the combined case is far greater than any individual case that includes shutting off only one policy, and is also larger than the sum of the individual policies since some of those policies will completely negate or diminish the impacts of one another. Our intuition suggests there are two groupings with large interactive effects. For transportation related consumption and emissions, the CAFE standards, Renewable Fuels Standard, and the California Low Carbon Fuel Standard are likely to have strong interactions. For the electricity sector, Renewable Portfolio Standards and the Production Tax Credit are likely to have interactive effects. Further modeling to disaggregate the share of the combined case attributable to each of these policies is likely to yield interesting and valuable results if authorized by the CLEW.

Figure 20. Change in Total Energy Related Carbon Dioxide Emissions in Washington State from Federal Policies



4.4 Pending Policies

The policies that follow have been proposed but do not exist in current law or regulation. However, it is plausible that they will be implemented by statute, regulation or executive order in the next several years. They have been selected for their likely relevance to Washington's efforts to reduce GHG emissions. The determination of whether we should conduct further quantitative analysis was made based on their applicability to the Washington energy economy and the results of the preliminary literature review described above.

GHG Regulation for New and Existing Coal-Fired Power Plants

While a re-issued NSPS for electric generating units is likely to be subjected to multiple lawsuits and other potential delays, the recent urgency expressed by the President suggests that this rule will likely go final in the next several years. Similarly, it is likely that the EPA will subsequently move forward with performance standards for existing generating units, though the design and level of those thresholds is impossible to predict.

Recommendations for Further Analysis: It is a relatively manageable task to model the impact of the NSPS on new generating units by placing a technology constraint on a case. However, it is likely that a NEMS modeling case using the *Annual Energy Outlook 2012* version will show very similar results to the EPA's analysis of no additional coal-fired units with or without the regulation. Yet, it may be informative to test the proposition by running a case with increased natural gas exports and hence prices, as this is also a plausible scenario (see discussion of natural gas exports below). Similarly, it may be interesting to test the impact of the NSPS on new units when the RPS is shut off since the EPA has cited interactions with those state policies.

While it is impossible to predict the exact nature of the NSPS for existing electric generation units post-2015, we can model a proxy effect by increasing the regulatory cost risk in the model incrementally for two or three possible cases.

Incentives for Renewable Energy on Federal Lands

Although more than one-quarter of all land in Washington is owned by the Federal Government, little of it is owned by the Bureau of Land Management (BLM). Rather, most of it is owned by the U.S. Forest Service or is part of the National Park System. Further, according to NREL, those BLM lands contain no viable concentrated Solar, PV, or wind resources. The BLM has identified some viable biomass and geothermal resources on their lands in the state.[74]

Recommendations for Further Analysis: Given the relatively limited availability of viable renewable resources on public lands in Washington it is unlikely to be a critical portion of our analysis of potential state GHG reduction policies. Additional renewable builds on public lands in WECC/NWPP will be captured elsewhere in the existing NEMS case runs we have, or will complete. Off-line discussions with a representative of the Governor's Office of Regulatory Assistance to determine opportunities for permitting renewable projects on public lands in the states will be pursued.

Reduced Tax Expenditures for Fossil Energy (Oil and Gas Depletion Allowances)

In his Climate Action Plan, President Obama called for the elimination of all U.S. fossil fuel tax subsidies in his Fiscal Year 2014 budget. While there are other policies that arguably subsidize fossil fuel consumption, the largest tax subsidy is the oil and gas depletion allowance, estimated to equal about $1 billion annually. A recent National Research Council study, performed using NEMS found that the average effect on GHG emissions over the time horizon of the model is too small to accurately estimate, or even determine if the sign of the change is positive or negative.[75]

Recommendation for Further Analysis: Since Washington does not have any oil and gas production of consequence it is unlikely that the removal of this tax expenditure would have any effect on the state. Combined with the inability of previous researchers to detect any material

[74] U.S. Department of Interior, U.S. Department of Energy, *Assessing the Potential for Renewable Energy on Public Lands*, February 2003, http://www.nrel.gov/docs/fy03osti/33530.pdf

[75] National Research Council, Effects of U.S. Tax Policy on Greenhouse Gas Emissions, Committee on the Effects of *Provisions in the Internal Revenue Code on Greenhouse Gas Emissions*, W. Nordhaus, S. Merrill, P. Beaton, Eds., June 20, 2013, p. 142

change in GHG emissions at the national level attributable to this tax expenditure makes it clear that no further analysis of this policy is needed.

REIT and MLP Parity

REIT and MLP parity are policies that are gaining momentum, with two renewable energy firms having been granted REIT status through private IRS rulings and the reintroduction of the MLP Parity Act in both the U.S. House of Representatives and U.S. Senate. It is likely that REIT and MLP parity would have interactions with both the Production Tax Credit (PTC) and Renewable Portfolio Standards. REIT and MLP parity are often championed as a method for achieving the same objectives as the PTC at lower cost to the U.S. Treasury.

Recommendation for Further Analysis: REIT and MLP Parity may play an important role in further greening the electric sector in Washington (and throughout the U.S.) but it is unlikely during the duration of this project that it can be accurately represented in NEMS. Instead, we will undertake a qualitative analysis in an attempt to assess the opportunity to take advantage of these policies within Washington.

Expanded Natural Gas Exports

Although Washington produces almost no natural gas, it is a significant consumer of natural gas and has a well-developed infrastructure to take advantage of low-cost natural gas supply.[76] There is some uncertainty over the impact of low-cost natural gas on greenhouse gas emissions with some parties fearful that low-cost natural gas is crowding out new investment in renewable energy. Others have argued that natural gas and renewables are complementary energy sources, with renewables offering a price hedge against potential volatility in natural gas prices and natural gas providing capacity to firm up otherwise intermittent renewable generation.[77]

A considerable amount of modeling has been conducted on potential increased natural gas exports that one might expect should FERC license a majority of the 17 liquefied natural gas expert terminals currently proposed. While the authors of these studies differ on the magnitude of exports, the ultimate price and the allocation of costs and benefits, they all foresee a change in price significant enough that it may alter the relationship between, coal, natural gas, and renewable fuels in the marketplace.

Recommendation for Further Analysis Program: Additional cases of NEMS should be run that reflect a low and a high range of natural gas prices assumed to increase under an increased export scenario. Impacts of the initial cases should be evaluated to determine if further adjustment to additional cases is necessary. In particular, the effect of variation in the natural gas

[76] Washington Department of Commerce, *2013 Biennial Energy Report: Issues, Analysis and Updates*, R. Weed, Report to Legislature, Dec 2012, p.36
[77] Washington Department of Commerce, 2013 *Biennial Energy Report: Issues, Analysis and Updates*, R. Weed, Report to Legislature, Dec 2012, p.52

price on RPS and PTC should be examined in cases where the GHG NSPS are in place and where the GHG NSPS is turned off.

The NEMS model only focuses on carbon dioxide emissions from fuel combustion. It does not consider the contribution of fugitive emissions to life-cycle GHG emissions. Although the reduction in carbon dioxide attributable to the combustion of natural gas when compared to the combustion of coal or petroleum-based fuels is a simple matter of chemistry and is well known, the GHG impacts associated with fugitive emissions from natural gas production and hence life-cycle use of natural gas is far more uncertain, particularly for shale gas production, whose widespread expansion is a relatively recent phenomena. There is a large and growing literature on methane emissions from shale gas production but its findings are far from consensus, ranging from a slight improvement from conventional gas production, to a slight increase in emissions, all the way to a substantial increase in emissions. Since most of the recent growth in U.S. gas supply and nearly all of the future growth is attributed to the exploitation of shale gas, if this study determines that a large portion of emission reductions will be achieved by switching from coal to natural gas fired generation or by shifting a large portion of the transportation sector to natural gas fuel in the future, additional consideration of life-cycle fugitive emissions should be conducted using off-line analysis and tools.

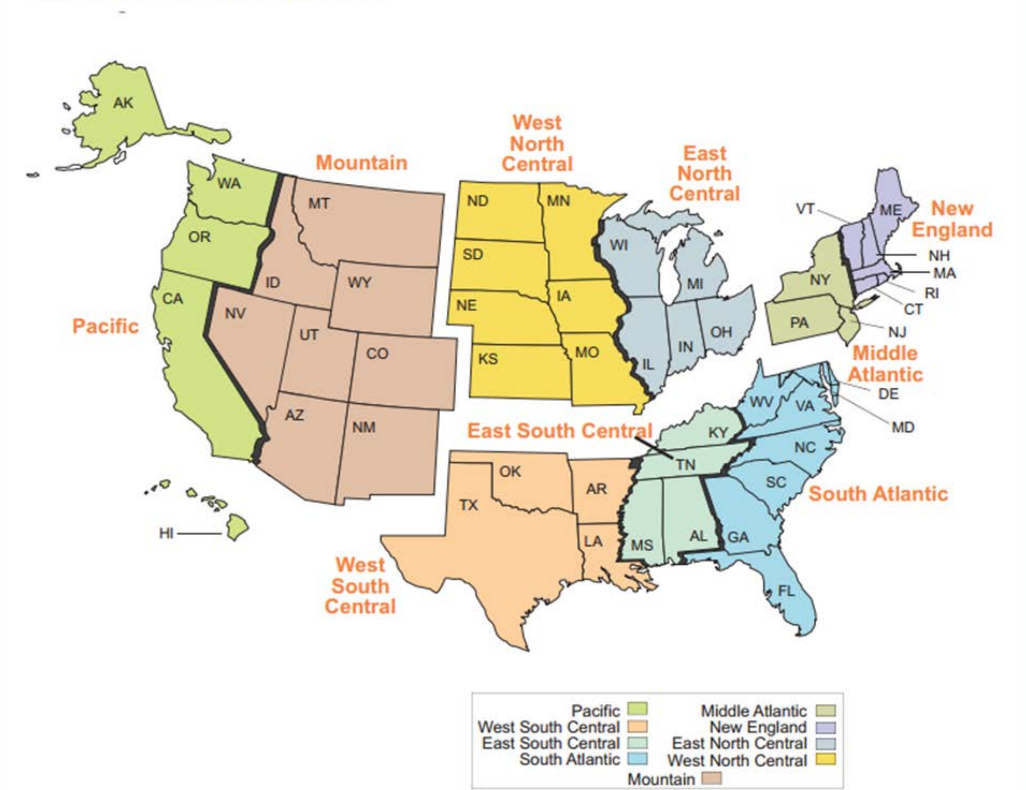
5 Appendices

These appendices include a U.S. Census Division Map, a NEMS Electricity Market Module Regional Map, and details on the methodology used to estimate state-level impacts from regional NEMS results.

5.1 Appendix A – U.S. Census Division Map

Washington is one of five states included in Census Division 9 (CD9), otherwise known as the Pacific division.

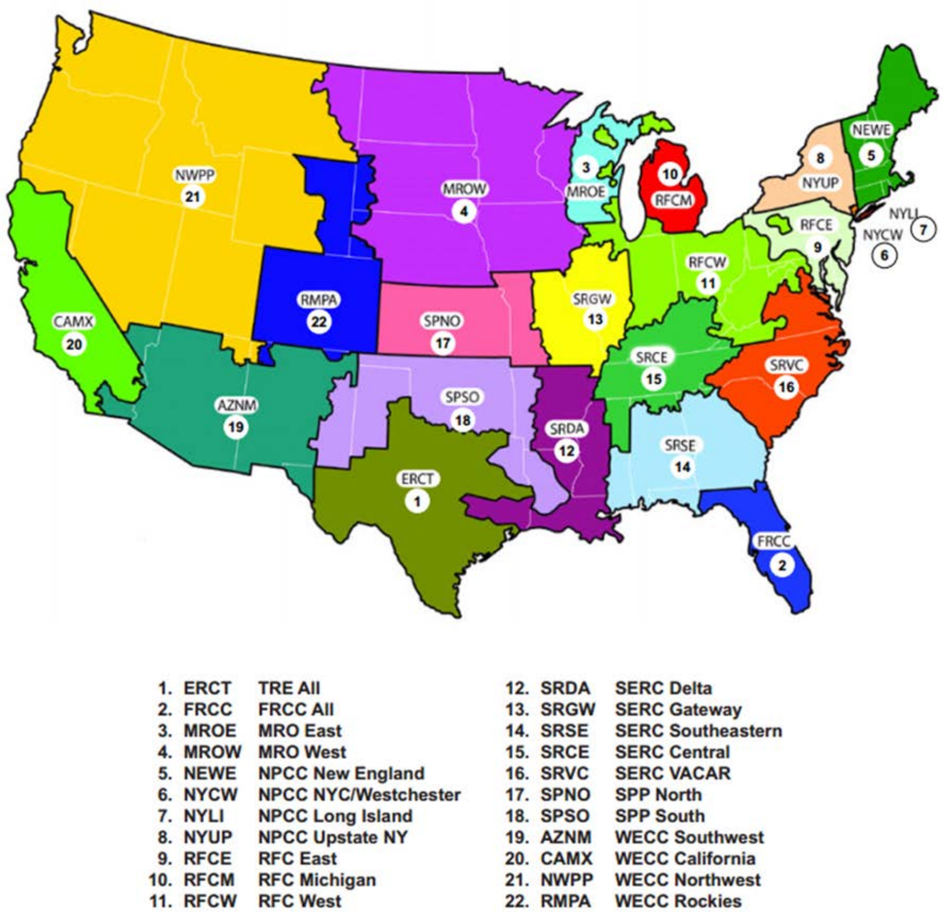
Figure F1. United States Census Divisions



5.2 Appendix B – NEMS Electricity Market Module Regional Map

Washington is located entirely within the Western Electricity Coordinating Council / Northwest Power Pool region.

Figure F2. Electricity market module regions



5.3 Appendix C - Methodology for Washington State Projection

SAIC applied the historic share of energy and fuel consumption and CO_2 emissions, as appropriate, to regional NEMS projection to arrive at state-level results. SAIC first used averaged historic data from 2006 through 2010 obtained from State Energy Data System (SEDS)[78] and State CO_2 Emissions database[79] (both sources are maintained by the Energy Information Administration) to estimate Washington State's share or weight in the region where it is located, then multiplied this share or weight to the region's projection produced by NEMS. Specific equations used to calculation state-level results for each metric are provided below:

State Total Energy Consumption = WA Total Energy Consumption Share in CD9 (calculated using SEDS historic data) x CD9 Total Energy Consumption

State Total Energy CO_2 Emissions = WA Total Energy CO_2 Emissions Share/weight in CD9 Total Energy CO_2 Emissions (calculated using EIA state CO_2 emissions historic data) x CD9 Total Energy CO_2 Emissions

State Motor Gasoline = WA Gasoline Consumption Share/weight in CD9 (calculated using SEDS historic data) x CD9 Gasoline Consumption

State CO_2 Emissions by Transportation = WA Transportation CO_2 Share/weight in CD9 Transportation CO_2 emissions (calculated using EIA state CO_2 emissions historic data) x CD9 Transportation CO_2 Emissions

State Renewable Source Electricity Generation = WA Renewable Generation Share/weight in EMM21 (calculated using SEDS historic data and NEMS EMM21 calibration data) x EMM21 Renewable Generation

State CO_2 Emissions by Electric Power = WA Electricity Generation CO_2 Share/weight in CD9 Electricity Generation CO_2 Emissions (calculated using EIA state Electricity generation CO_2 emissions historic data) x CD9 Electricity Generation CO_2 Emissions

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[78] EIA. 2013. State Energy Data System. Accessed August 2013 at: http://www.eia.gov/state/seds/
[79] EIA. 2013. State CO_2 Emissions. Accessed August 2013 at: http://www.eia.gov/environment/emissions/state/state_emissions.cfm