Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State – Final Report

October 14, 2013

Prepared for:
State of Washington
Climate Legislative and Executive Workgroup (CLEW)

Prepared by:

leidos

Contents

Acronyms

AFV	Alternative Fuel Vehicles
B&O	Business and Occupation
CA	California
CAFE	Corporate Average Fuel Economy Standards
CLEW	Washington State Climate Legislative and Executive Workgroup
CO_2	Carbon Dioxide
EIA	U.S. Energy Information Administration
EPS	Emissions Performance Standard
EU ETS	European Union Emission Trading Scheme
EV	Electric Vehicles
FIT	Feed in Tariff
GHG	Greenhouse Gas
GMA	Growth Management Act
I-937	Energy Independence Act
LCFS	Low Carbon Fuel Standard
LEV	Low Emissions Vehicle
MACC	Marginal Abatement Cost Curve
mmBtu	One Million British Thermal Units
$MMTCO_2e$	Million Metric Tons of Carbon Dioxide Equivalent
$mtCO_2e$	Metric Ton of Carbon Dioxide Equivalent
MW	Megawatt
NEMS	National Energy Modeling System
OFM	Office of Financial Management
PACE	Property Assessed Clean Energy
PBF	Public Benefits Fund
RCI	Residential, Commercial and Industrial
RD&D	Research, Development, and Deployment
RFS	Renewable Fuels Standard
RGGI	Regional Greenhouse Gas Initiative
RPS	Renewable Portfolio Standard
SAIC	Science Applications International Corporation
SBC	Systems Benefit Charge
SEDS	State Energy Data System

SOW	Statement of Work
TZEV	Transitional Zero Emissions Vehicle
U.S.	United States
WSEC	Washington State Energy Code
ZEV	Zero Emissions Vehicles

Executive Summary

The Washington State Climate Legislative and Executive Workgroup (CLEW), through the Office of Financial Management (OFM), selected Leidos (formerly Science Applications International Corporation or SAIC) to prepare an evaluation of approaches to reduce greenhouse gas (GHG) emissions in Washington State. The CLEW members include Governor Jay Inslee, Senator Doug Ericksen (42nd District), Senator Kevin Ranker (40th District), Representative Joe Fitzgibbon (34th District), and Representative Shelly Short (7th District). The purpose of the CLEW, as defined by Senate Bill 5802, is to recommend a State program of actions and policies to reduce GHG emissions, that if implemented would ensure achievement of the state's emissions targets set in RCW 70.235.020. 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 purpose of this project is to evaluate approaches to reduce GHG emissions and achieve the State's emission targets set in statute (RCW 70.235.020). This project is required under Engrossed Second Substitute Senate Bill 5802, Chapter 6, Laws of 2013. This Final Report summarizes the results of the evaluation of GHG emission reduction programs adopted in other jurisdictions, including reduction strategies being implemented in the Pacific Northwest, on the West Coast, in neighboring provinces in Canada, and in other regions of the country. The evaluation also analyzes Washington State's emissions and related energy consumption and current GHG reduction policies adopted by the State, and summarizes local government initiatives. In addition, this report also includes a summary of federal policies and the modeling results of their contributions to Washington's GHG emission reduction targets.

The Washington State Legislature in 2008, through E2SSHB 2815, adopted targets requiring the State to limit GHG emissions to achieve the following reductions (RCW 70.235.020):

- By 2020, reduce overall emissions of GHGs in the State to 1990 levels;
- By 2035, reduce overall emissions of GHGs in the State to 25% below 1990 levels;
- By 2050, reduce overall emissions to 50% below 1990 levels, or 70% below the State's expected emissions that year.

Key Findings

The results of this project indicate that the State will not meet its statutory reductions for 2020, 2035 and 2050 with current state and federal policies. However, the State can meet its statutory 2020 target if near-term action is taken to implement a new comprehensive emission reduction program. In 2020, for example, it is likely that Washington would meet its target if a new cap and trade policy is implemented. The evaluation found, however, that any combination of the policies summarized in this report, *at the implementation levels evaluated*, will likely be insufficient to meet Washington's targets in 2035 and 2050. However, decisive actions taken today can set Washington squarely on a long-term path that can be strengthened and modified in the coming years to achieve the emission reductions required for 2035 and 2050.

Progress Through Existing Policy

Washington's GHG emissions are dominated by three sectors. In 2010, transportation contributed 44 percent of emissions, electricity was responsible for 22 percent of emissions, and the residential, commercial and industrial sector accounted for 21 percent of emissions.[1] To date, Washington has implemented a variety of policies that reduce emissions in these sectors. In addition, out of the many existing federal policies evaluated, there is one that is expected to contribute additional[2] reductions toward Washington's GHG targets.

Table 1: Summary of Existing Washington State and Federal Policies

Existing Policy	GHG Emission Reductions ($MMTCO_2e$)			Sector Addressed
	2020	2035	2050	
State Renewable Fuel (Diesel) Standard	0.03	0.04	0.05	Transportation
Washington State Energy Code	0.9	5.1	11.0	Electricity, RCI
GHG Emissions Performance Standards	0.0	2.9	2.9	Electricity
Energy Independence Act (I-937)	7.9	10.9	10.9	Electricity
Energy Efficiency and Energy Consumption Programs for Public Buildings	0.03	0.04	0.04	Electricity, RCI
Conversion of Public Fleet to Clean Fuels	0.03	0.04	0.05	Transportation
Purchasing of Clean Cars	5.5	10.0	11.7	Transportation
Growth Management Act	1.6	2.4	2.6	Transportation
Federal RFS	1.4	1.6	1.6	Transportation
Interactive Sum of Reductions from Existing policies	**17.2**	**30.6**	**38.1**	

[1] The State GHG inventory followed the consumption-based approach for accounting for GHG emissions from the electricity sector. The rationale for using the consumption-based approach is that it better reflects the emissions (and emissions reductions) associated with activities occurring in the state, and it is particularly useful for policy-makers seeking to evaluate the impacts of state-based policy actions on overall GHG emissions. The goal of this effort has been to evaluate whether the State will meet statutory targets in light of existing and potential policies, as measured by the State's emissions inventory. Leidos evaluated policies using a framework consistent with the approach used for calculating Washington's statutory baseline inventory (1990) and subsequent inventories.

[2] Additional reductions after accounting for overlap and interactions with existing State policies.

Reductions from these existing state policies, as well as the federal renewable fuel standard, are summarized in Table 8. Together, these policies are estimated to reduce Washington's emissions by 17.2, 30.6, and 38.1 million metric tons carbon dioxide equivalent ($MMTCO_2e$) in 2020, 2035, and 2050, respectively.

Washington GHG Goals and the Challenge Ahead

Despite Washington's significant progress in reducing GHG emissions and establishing policies to generate future emission reductions, meeting the statutory emission targets are projected to require additional action. At the completion of the policy evaluations and the baseline projection, the results show that even with the significant contributions of existing state and federal policies, Washington is projected to fall short of meeting its statutory targets, as illustrated in Table 6.

Table 2. Washington's Baseline Emissions, Reductions from Existing Policies, Emission Targets, and Target Year Gaps

	GHG Emissions ($MMTCO_2e$)		
	2020	2035	2050
Projected GHG emissions *without* federal and state policy (BAU)	115.1	128.1	138.2
Estimated reductions from existing state policies[a]	-15.8	-29.0	-36.5
Estimated reductions from existing federal policies[a]	-1.4	-1.6	-1.6
Projected GHG emissions *with* federal and state policy	97.9	97.5	100.1
GHG emissions target	88.4	66.3	44.2
Additional reductions required to meet target (Gap)	**9.5**	**31.2**	**55.9**

[a] Accounts for interactions between policies (e.g., where policies target the same sources and reductions overlap)

To fill this gap, Washington will need to pursue a combination of additional policies to reduce GHGs, and strengthening existing policies to attain greater GHG reduction benefits. These additional policies may range from economy-wide cap and trade or carbon tax regimes, to targeted programs focusing on portions of the transportation or electricity sectors. Out of a large pool of potential policies nine new policies were selected for analysis and quantification,[3] based

[3] As a result of the bounds of Tasks 1, 2, and 3 of this project, not all programs with GHG reduction benefits currently underway in Washington are presented within this report. This project's Statement of Work (SOW) specified the existing state and federal policies to be evaluated, in Task 1 and Task 3, respectively. In addition to the existing policies evaluated, there are many other programs planned or underway within the State, from transportation pricing to urban composting, which are generating emission reductions, but were not identified in the SOW and therefore not evaluated as an *existing* policy. The evaluation of policies *outside of Washington*, which was executed under Task 2, focused on comprehensive emission reduction strategies that do not exist or are substantially different than programs already underway in Washington. Consistent with the Task 2 SOW, a list of potential programs was run through a technical screen to determine the final list of programs to analyze.

on criteria such as applicability, cost effectiveness, and potential magnitude of GHG impacts. Washington may consider these potential policies in isolation or in combination. Table 7 presents these nine policies, their emission reductions, and the cost effectiveness associated with each. Additionally, Table 7 provides a sum of the reductions, accounting for interactions between policies. The interactive sum represents what would be expected from a State strategy with either cap and trade or a carbon tax as its centerpiece and the implementation of all seven of the additional policies.

Table 3. Summary of Potential GHG Emission Reduction Policies in Washington

Policy	Potential GHG Reductions ($MMTCO_2e$)			Cost Effectiveness ($\$/mtCO_2e$)[a]	Sector Addressed
	2020	2035	2050		
Cap and Trade	12.1	22.1	35.9	Not quantified	Electricity, RCI, Transportation
Carbon Tax	0.4 – 1.7	0.6 – 5.0	Not quantified	$5 – $23	Electricity, RCI, Transportation
Low Carbon Fuel Standard	1.0	3.9	4.0	$103 – $131	Transportation
Zero Emissions Vehicle Mandate	0.1	2.0	2.6	($70) – $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) – $146	Electricity, RCI
Property Assessed Clean Energy[d]	0.02	0.05	0.6	$(171)	Electricity, RCI
Appliance Standards[e]	0.4	0.6	0.6	Not quantified	Electricity, RCI
Feed-in-Tariff, 375 MW Cap[f]	0.5	0.5	0.5	$30 – $500	Electricity
Interactive Sum of Reductions with Cap and Trade	**12.1**	**22.1**	**35.9**		
Interactive Sum of Reductions with Carbon Tax	**3.3**	**8.8**	**9.5**		

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

[b] This policy applies to diesel fuel because the federal renewable fuel standard subsumes the State ethanol requirement. Evaluated as an existing state policy in Task 1, found to be unenforceable. Estimates presented here represent the net gain in emission reductions of a 5 percent RFS relative to Washington's current 0.5 percent RFS attainment

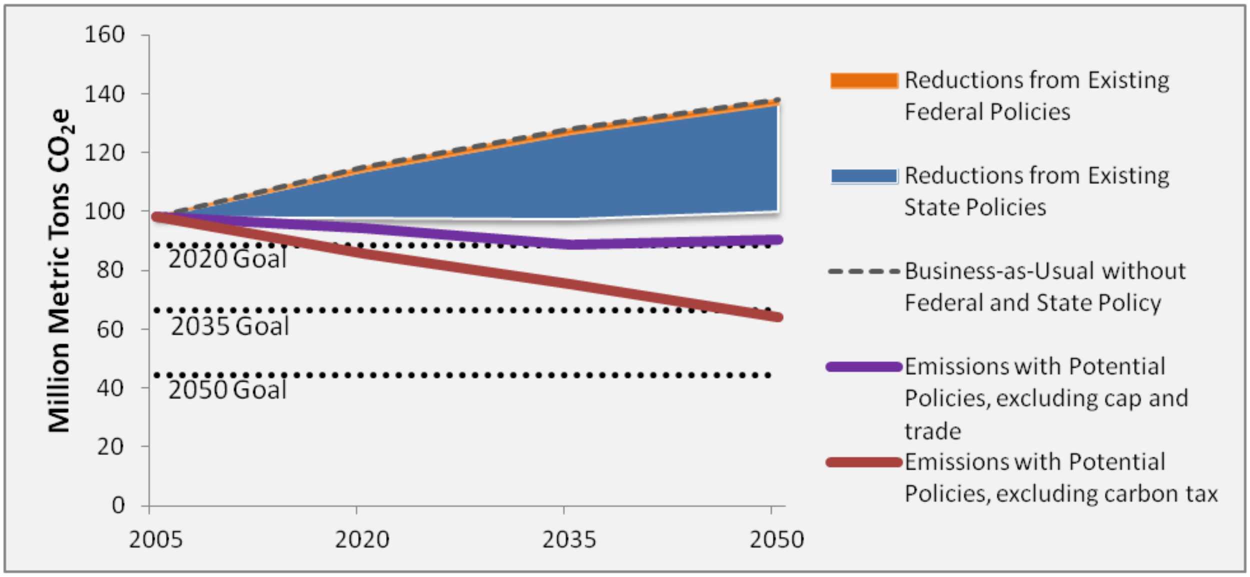
[c] Assumes extending I-937 utility requirements to utilities under 25,000 customers. Two additional options were considered in the analysis as well. Results are highly dependent on funding levels.

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

[e] Evaluated as an existing state policy in Task 1, found to be subsumed by federal appliance standards. Estimates presented here as quantified under Task 1 and reflect potential additional appliance standards not yet covered by existing state or federal standards.
[f] All Feed-in-Tariff reductions would contribute to I-937 goals.

The results illustrated in Figure 1 below, show Washington's projected emissions without state or federal policy, the projected contributions to future emission reductions attributed to existing state and federal policy, and the reductions estimated for the suite of potential policies with either cap and trade or a carbon tax at the center. The implementation levels modeled reflect the relative stringency of these policies as they have been implemented in other jurisdictions and do not consider continued strengthening or other changes. As such, the emission reductions flatten out after approximately 2025, at which point most modeled policies are fully implemented. The modeling for this analysis assumed new policy start dates ranging from 2016 to 2018 based on estimated time needed to pass and implement new legislation. Slower or more rapid adoption and implementation of these policies would result in achieving fewer or greater emission reductions in earlier years as these programs ramp up. Therefore, the scale of the policies as implemented and the timeline until the policies are implemented are two factors that will significantly affect Washington's attainment of its goals. In summary, the policy *mechanisms* analyzed in this report may be sufficient to achieve future targets, but the success will be dependent on design and implementation of compliance parameters.

Figure 1. Emission Reductions from Potential Policies Relative to Washington's Projected Emissions



1 Introduction

The Washington State Climate Legislative and Executive Workgroup (CLEW), through the Office of Financial Management (OFM), tasked Leidos (formerly Science Applications International Corporation or SAIC) to prepare an evaluation of approaches to reduce greenhouse gas (GHG) emissions in Washington State. This Final Report summarizes the results of the evaluation of GHG emission reduction programs adopted in other states and countries, including reduction strategies being implemented in the Pacific Northwest, on the west coast, in neighboring provinces in Canada, and in other regions of the country. This report also summarizes an evaluation of Washington State's emissions and related energy consumption and current GHG reduction policies adopted by the State, including local government initiatives. In addition, this final report also includes a summary of Federal policies and the results of the modeling of their contributions to Washington's GHG emission reduction targets.[4]

The purpose of this project is to evaluate approaches to reduce GHG emissions and achieve the state's limits set in statute (RCW 70.235.020). This project is required under Engrossed Second Substitute Senate Bill 5802, Chapter 6, Laws of 2013.

In 2008, the Washington State legislature enacted E2SSHB 2815, an Act creating a framework for reducing greenhouse gas emissions in Washington. The legislation sets statewide GHG targets requiring the state to limit emissions. The Legislature has also enacted a range of policies that seek to track and reduce GHG emissions in Washington. While substantial progress has been made, recent analysis demonstrates that the state will likely not meet its 2020 emissions limits. Governor Inslee introduced SB 5802 calling for an open discussion with the legislature on what tools the state should use to achieve the GHG limits set in state law. On April 2, 2013 the Governor signed E2SSB 5802 into law, which created the CLEW, and required OFM to contract with an independent and objective consultant to prepare a credible evaluation of approaches to reducing GHG emissions. In June 2013, the CLEW selected Leidos as its consultant. Leidos completed the evaluation in October 2013 and prepared this final report to represent the results.

The evaluation will be used by the CLEW, whose members include Governor Jay Inslee, Senator Doug Ericksen (42nd District), Senator Kevin Ranker (40th District), Representative Joe Fitzgibbon (34th District), and Representative Shelly Short (7th District). The purpose of the CLEW is to recommend a State program of actions and policies to reduce GHG emissions, that if implemented would ensure achievement of the state's emissions targets set in RCW 70.235.020 (E2SSB 5802). The recommendations must be prioritized to ensure the greatest amount of

[4] This final report, which represents Task 4 of this project, summarizes Tasks 1, 2, and 3. The project Statement of Work (SOW) identifies the Tasks as follows: Task 1 – analyze Washington State emissions and related energy consumption (this includes the evaluation of the State's existing GHG emissions reduction policies); Task 2 – evaluate GHG emissions reduction programs outside of Washington; Task 3 – quantify contribution to State's emissions reduction from federal policies; Task 4 – final evaluation report, summarizing Tasks 1-3; and Task 5 – technical support to the CLEW.

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 CLEW report is due to the State Legislature by December 31, 2013.

2 Background –Washington State Energy Use, Expenditures, and Emissions

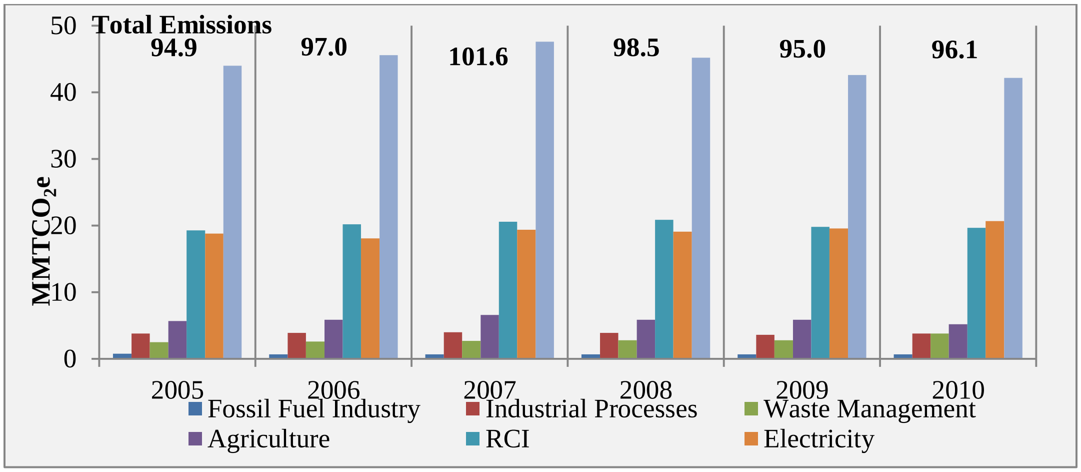
The CLEW through the OFM, as part of its Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State, tasked Leidos to provide an analysis of historical Washington State energy use, expenditures and emissions, and non-energy sources of GHG emissions, such as cement production and agricultural sources. The results, presented in the Task 1 Final Report (Appendix A), set the stage for further identification and evaluation of potential policies, by identifying the GHG drivers and trends.

Total emissions in Washington State in 2010 were 96.1 million metric tons of carbon dioxide equivalent ($MMTCO_2e$),[5] as shown in Figure 1. Despite declines in recent years, the transportation sector remains the largest source of emissions and in 2010 accounted for 44 percent of total GHG emissions in the State. Within this sector the consumption of gasoline in vehicles is the largest single source of emissions in Washington, as illustrated in Figure 2, accounting for over 23 percent of total emissions in 2010. The State projects that on-road gasoline consumption and associated emissions are currently at their peak and will decrease from 2015 through 2050, although relative rankings of high-emitting sources are not expected to change greatly.[6]

[5] Washington State Greenhouse Gas Emissions Inventory, 2012 (includes data from 1990 to 2010). See Task 1 Final Report for more information.

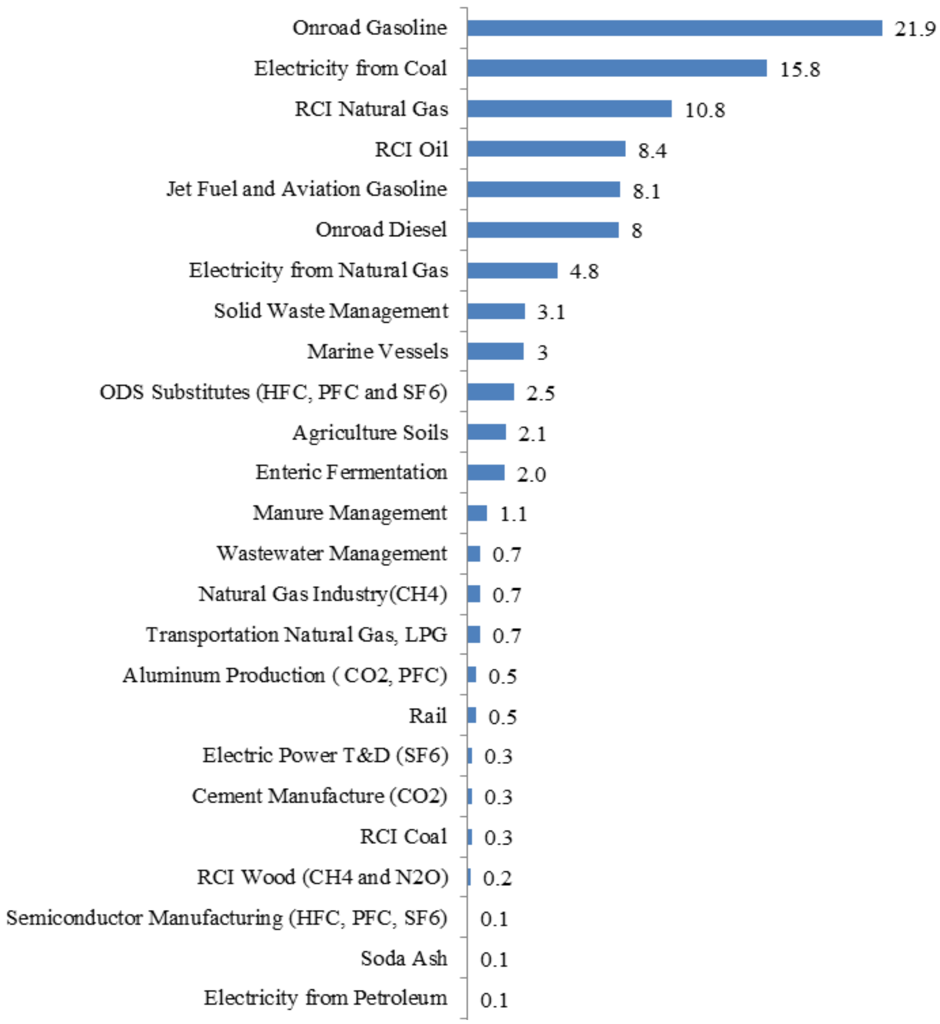
[6] Washington State's GHG Emissions - Historical and Projected Through 2050, as updated in September 2013 by the Department of Ecology (see Appendix D). Projected using WSDOT June 2010 VMT forecast, normalized for fuel efficiency improvements and federal RFS implementation.

Figure 2. Emissions by Sector in Washington, 2005 – 2010 ($MMTCO_2e$)



Source: Washington State Greenhouse Gas Emissions Inventory 1990 - 2010

Figure 3. Washington State GHG Emissions by Source in 2010



3 Washington's GHG Goals and the Challenge Ahead

3.1 Washington's GHG Goals

The Washington State legislature, through E2SSHB 2815, adopted targets requiring the state to limit GHG emissions to achieve the following reductions (RCW 70.235.020):

- By 2020, reduce overall emissions of GHGs in the state to 1990 levels;
- By 2035, reduce overall emissions of GHGs in the state to 25% below 1990 levels;
- By 2050, reduce overall emissions to 50% below 1990 levels, or 70% below the state's expected emissions that year.

Table 4 below presents Washington's historical (1990 and 2010) emissions, and the State's emission levels in the target years (2020, 2035, and 2050) if the State achieves its goals established in RCW 70.235.020.[7]

Table 4: Historical and Target GHG Emissions ($MMTCO_2e$)

Historical Emissions		Emission Targets		
1990	2010	2020 (1990 levels)	2035 (25 percent below 1990 levels)	2050 (50 percent below 1990 levels)
88.4	96.1	88.4	66.3	44.2

3.2 A Challenge Remains

Washington State has made significant progress in reducing GHG emissions. Reductions from the existing state and federal policies analyzed under this project, which are described in detail below in *Section 4 – Progress through Existing Policy*, together, are estimated to reduce Washington's emissions by 17.2, 30.6, and 38.1 million metric tons carbon dioxide equivalent ($MMTCO_2e$) in 2020, 2035, and 2050, respectively, as illustrated in Figure 3 and Table 2. The evaluation conducted under Task 1 analyzed existing state policies, and quantified the contribution of GHG emission reductions in each target year (Section 4.1). The evaluation

[7]The State GHG inventory followed the consumption-based approach for accounting for GHG emissions from the electricity sector. The rationale for using the consumption-based approach is that it better reflects the emissions and reductions associated with activities occurring in the state, and it is particularly useful for policy-makers seeking to evaluate the impacts of state-based policy actions on overall GHG emissions. The goal of this effort has been to evaluate how the State can or will meet statutory targets in light of existing and potential policies, as measured by the State's emissions inventory. Leidos evaluated policies using a framework consistent with the approach used for calculating Washington's statutory baseline inventory (1990) and subsequent inventories.

.

prepared under Task 3 modeled federal policies and quantified the contribution of each toward State goals (Section 4.2). However, before the combined impact on reductions from all policies could be estimated, the interactions and overlaps among the existing state and federal policies were identified and quantified.

Figure 4. Washington's Business-As-Usual Emissions, Reductions from Existing State and Federal Policies, and GHG Emissions Targets

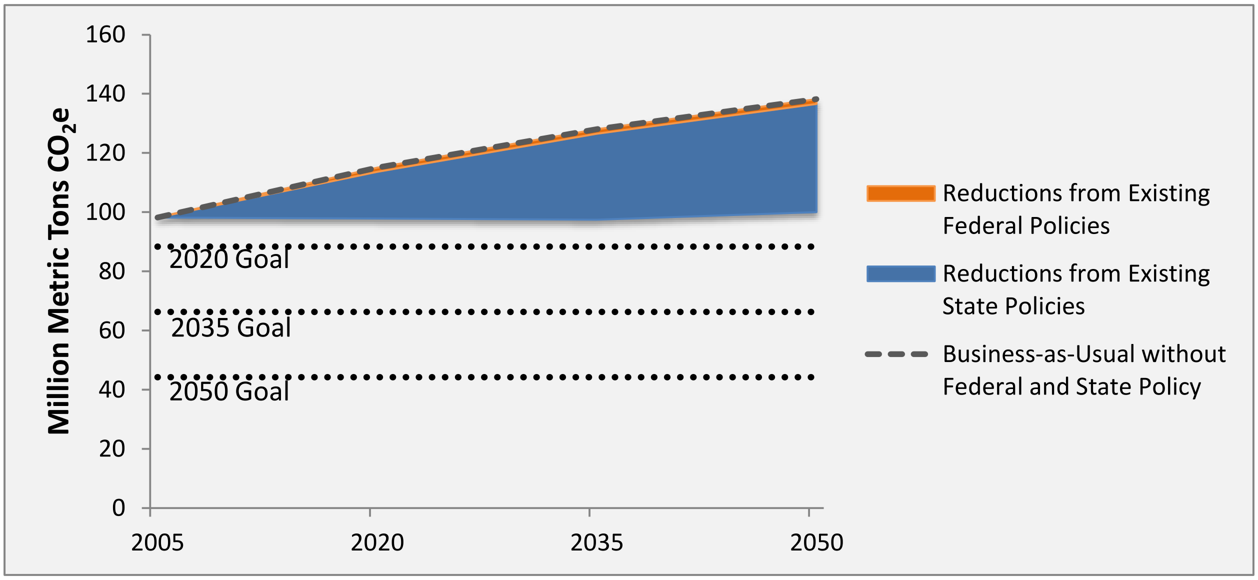


Table 5: Summary of Existing Washington State and Federal Policies and their Interactive Sum of Reductions

Existing Policy	GHG Emission Reductions ($MMTCO_2e$)		
	2020	2035	2050
Simple Sum of State Policy Reductions	15.9	31.4	39.2
Federal Policy Reductions	1.4	1.6	1.6
Percent Diminishment due to Policy Interactions	**1%**	**7%**	**7%**
Interactive Sum of Reductions from Existing policies	**17.2**	**30.6**	**38.1**

Despite Washington's significant progress in reducing GHG emissions and establishing policies to generate future emission reductions, meeting the statutory emission targets are projected to require additional action. Table 6 compares the emission levels required by the statutory targets to the adjusted State baseline projections in 2020 to 2035, and 2050.

The emission projections were developed from the recent GHG inventory forecast prepared by the Washington Department of Ecology,[8] adjusted to exclude the policy impacts implicitly embedded in the data. Specifically, because Ecology's emission projections incorporate some but not all existing State and Federal policy, adjustments were made to Ecology's estimates to generate a forecast that excludes State and federal GHG policies. This provided a clean unconstrained trajectory of emissions from which to evaluate the impact of all existing State and federal GHG reduction policies. Appendix D presents Washington State's GHG Emissions - Historical and Projected Through 2050, as updated in October 2013, and provides additional details on the methodology used for the projection adjustment. At the completion of the policy evaluations and the projection adjustment, the results show that even with the significant contributions of existing state and federal policies, Washington's is projected to fall short of meeting its statutory targets, as illustrated in Table 3.

Table 6. Washington GHG baseline, reductions from existing policies, targets, and resulting gap in 2020, 2035, and 2050 (MMTCO$_2$e)

	2020	2035	2050
Projected GHG emissions *without* federal and state policy (BAU)	115.1	128.1	138.2
Estimated reductions from existing state policies[a]	-15.8	-29.0	-36.5
Estimated reductions from existing federal policies[a]	-1.4	-1.6	-1.6
Projected GHG emissions *with* federal and state policy	97.9	97.5	100.1
GHG emissions target	88.4	66.3	44.2
Additional reductions required to meet target	**9.5**	**31.2**	**55.9**

[a] Accounts for interactions between policies (i.e. where policies target the same sources and reductions overlap)

To fill this gap, Washington will likely need to implement some combination of additional policies to reduce GHGs, and/or leverage its successes to date by strengthening existing policies to attain greater GHG benefits. These additional policies may range from economy-wide cap and trade or carbon tax regimes, to targeted programs focusing on portions of the transportation or electricity sectors. These and other potential policies were evaluated and described in detail in the Task 2 Final Report (Appendix B). Out of a large pool of potential policies, nine new policies were selected for analysis and quantification,[9] based on criteria such as applicability, cost

[8] Washington State Department of Ecology, Updated Washington State's GHG Emissions – Historical and Projected to 2020, 2035 and 2050, October 8, 2013.

[9] As a result of the bounds of Tasks 1, 2, and 3 of this project, not all programs with GHG reduction benefits currently underway in Washington are presented within this report. This project's Statement of Work (SOW) specified the existing state and federal policies to be evaluated, in Task 1 and Task 3, respectively. In addition to the existing policies evaluated, other State programs are generating emission reductions, but were not identified in the SOW and therefore not evaluated as an *existing* policy. The evaluation of policies *outside of Washington*, which was

effectiveness, and potential magnitude of GHG impacts. These nine that were quantified for this project may be considered in isolation or in combination with other policies, such as those summarized in Section 5 – Policy Options. Table 7 presents the nine quantified policies and their respective emission reductions and cost effectiveness. Details on the assumptions, including implementation dates, used to generate the emissions estimates in Table 7 are documented in the Task 2 Final Report, along with a more expansive discussion of the research findings. Additionally, Table 7 provides a sum of reductions that would be expected if all policies were implemented as part of a broader program with either cap and trade or a carbon tax at the center, accounting for the interactions between policies that target the same sectors.

Table 7. Summary of potential GHG emission reduction policies in Washington

Policy	GHG Reductions ($MMTCO_2e$)			Cost effectiveness ($\$/mtCO_2e$)[a]	Source of Emissions Addressed
	2020	2035	2050		
Cap and Trade	13.4	26.0	42.6	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) – $70	Transportation
5% Renewable Fuel (Diesel) 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	0.06	$(171)	Electricity, RCI
Appliance Standards[e]	0.4	0.6	0.6	Not quantified	Electricity, RCI
Feed-in-Tariff, 375 MW Cap[f]	0.5	0.5	0.5	$30 to $500	Electricity
Interactive Sum of Reductions, Excluding Carbon Tax	**13.4**	**26.0**	**42.6**		
Interactive Sum of Reductions, Excluding	**3.3**	**8.8**	**9.5**		

executed under Task 2, focused on comprehensive emission reduction strategies that do not exist or are substantially different than programs already underway in Washington. Consistent with the Task 2 SOW, a list of potential programs was run through a technical screen to determine the final list of programs to analyze.

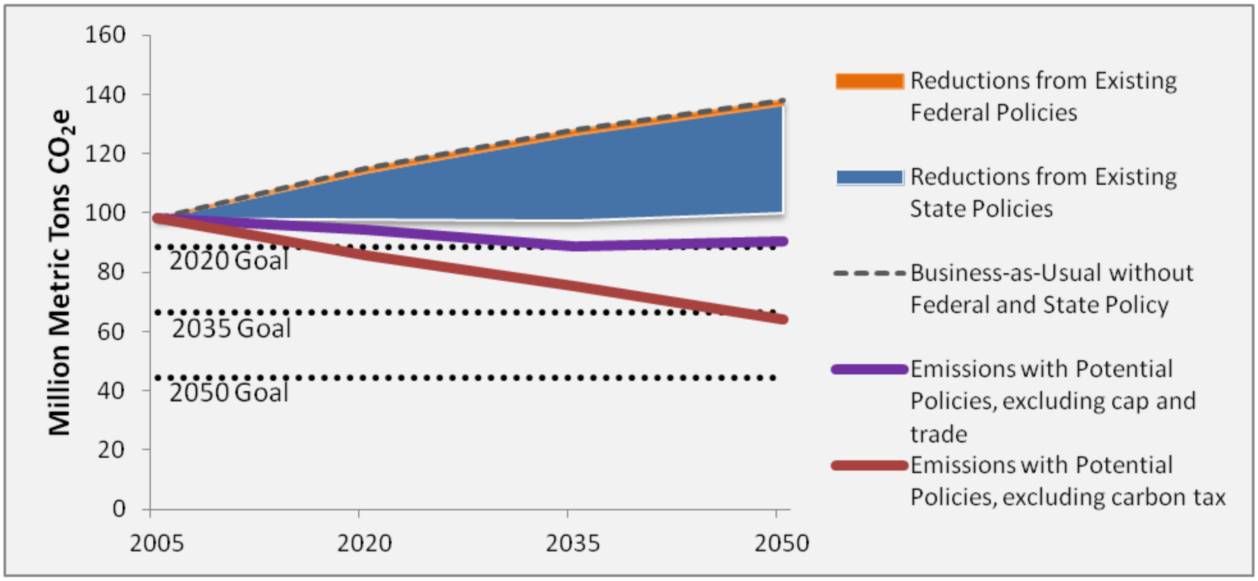
Cap and Trade					

[a] NPV 2013 of emission reductions through 2035, 5 percent discount rate
[b] Evaluated as an existing state policy in Task 1, found to be unenforceable. Estimates presented here represent 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] Evaluated as an existing state policy in Task 1, found to be subsumed by Federal appliance standards. Estimates presented here as quantified under Task 1 and reflect potential additional appliance standards not yet covered by existing State or Federal standards.
[f] All Feed-in-Tariff reductions would contribute to I-937 goals.

The results of this project indicate that Washington State can meet its statutory 2020 target if near term action is taken to implement a new comprehensive emission reduction program at the levels contemplated. It is likely that Washington would meet its 2020 target if a new cap and trade policy is implemented. The evaluation found, however, that any combination of the policies quantified, at the implementation levels evaluated in this project, will likely be insufficient to meet Washington's targets in 2035 and 2050. However, decisive actions taken today can set Washington squarely on a long-term path that can be strengthened and modified in the coming years to achieve the emission reductions required for 2035 and 2050. To cost-effectively meet the 2035 and 2050 targets, the state likely will need to move forward with a diverse set of strategies from among the policies researched for this project. A state plan to meet the targets may include a comprehensive carbon tax or cap and trade program that the legislature strengthens over time, electric vehicle support, investment in fuel conservation and research and development for advanced biofuels and energy technologies. In addition, the state would need to continue to build on its existing programs, which range from transportation system pricing and trip reduction efforts to local government land-use planning and initiatives in weatherization. The policies reviewed in this report and its appendices offer an opportunity to build on the state's successes in existing policies, while maintaining flexibility to allow new policies to emerge alongside advancements. Indeed, environmental goals with long lead times allow both policymakers and the regulated community to adapt to new economic and technological developments at least cost while spurring innovation.

The results illustrated in Figure 5 show Washington's projected emissions without State or federal policy, the contributions of future emission reductions that may be attributed to existing State and federal policy, and the reductions estimated for a suite of policies with either cap and trade or a carbon tax at the center (but not both). The implementation levels modeled reflect the relative stringency of these policies as they have been implemented in other jurisdictions and not considering continued strengthening or tightening of standards. As such, the emission reductions level-off after approximately 2025, at which point most modeled policies are fully implemented. One reason that even with new policies attainment remains unclear, however, is that modeling has assumed policy start dates ranging from 2016 to 2018 based on estimated time needed to pass and implement new legislation.[10] Slower or more rapid adoption and implementation of these policies would result in achieving fewer or greater emission reductions in earlier years as these programs ramp up. Therefore, the level of stringency of the policies as implemented and the timeline until the policies are implemented are two factors that will significantly affect Washington's attainment of its goals. In summary, the policy *mechanisms* contemplated in this report may be sufficient to meet future goals, but that success is somewhat dependent on program design and implementation of compliance parameters.

Figure 5. Emission Reductions from Existing and Potential Policies.



4 Progress through Existing Policy

Washington's achievement of its GHG emissions targets will depend on many factors, including federal, state, and local actions. Existing State policies and local government initiatives were analyzed in Task 1 (see Task 1 Final Report), and Federal policies were analyzed in Task 3 (see Task 3 Final Report). The following sections summarize the results from each of these evaluations.

4.1 Existing State Policies

Washington has adopted a set of coordinated policies that serve to grow the state's economy and help meet the established GHG reduction targets. As part of Task 1, Leidos conducted an analysis of eight existing policies and examined their contribution to reducing GHG emissions in

[10] Specific policy assumptions including implementation dates are documented in the Task 2 final report (Appendix B)

the state. The purpose of the analysis was to estimate GHG emission reductions from each policy, independent of all other policies, for each target year (2020, 2035, and 2050). The Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State project Statement of Work (SOW) identified the following policies for analysis:

- Renewable Fuel Standard
- Washington State Energy Code
- GHG Emissions Performance Standards
- Appliance Standards
- Energy Independence Act (I-937)
- Energy Efficiency and Energy Consumption Programs for Public Buildings
- Conversion of Public Fleet to Clean Fuels
- Purchasing of Clean Cars
- Growth Management Act

The existing policy evaluations incorporated available data and resources to develop an estimate of emission reductions for each policy in the target years. The results of the analysis show that the largest reductions are likely to come from the following three policies, representing each of the three largest emitting sectors of transportation, RCI, and electricity.

- In the **transportation sector**, the purchasing of clean cars policy,[11] which is analyzed as Washington's adoption of two stages of the California Low Emissions Vehicle (LEV) program: LEV II (Pavley) standards that establish fleet average GHG emissions standards for vehicle model years 2009 through 2016, and LEV III (Advanced Clean Cars) standards that apply to vehicle model years 2017 through 2025, which have been harmonized with the federal Corporate Average Fuel Economy Standards (CAFE).[12]
- In the **RCI sector**, the required updates to building energy codes under the Washington State Energy Code (WSEC) produce the largest reductions. The State has required that WSECs adopted from 2013 through 2031 must achieve a 70 percent reduction in annual net energy consumption for new residential and commercial buildings by 2031.[13]
- In the **electricity sector**, the Energy Independence Act[14], also known as I-937, produced the largest reductions. I-937 reductions come from two aspects of the Act: the renewable portfolio standard component and cost-effective energy conservation.

[11] RCW 70.120A.010. http://apps.leg.wa.gov/rcw/default.aspx?cite=70.120A.010
[12] Washington did not adopt the zero emission vehicle requirements.
[13] RCW 19.27A.160. http://apps.leg.wa.gov/rcw/default.aspx?cite=19.27A.160
[14] RCW 19.285 http://apps.leg.wa.gov/rcw/default.aspx?cite=19.285

Other key findings:

- Certain state policies that are not projected to achieve large reductions may provide other important benefits, such as the Energy Efficiency and Energy Consumption Programs for Public Buildings. This policy demonstrates leadership and supports market transformation and capacity building that introduces new methods and products to the marketplace.
- Reductions from the Emission Performance Standard (EPS), which is associated with the phase-out of the state's only coal-fired power plant, the Centralia plant owned by TransAlta, are based on the electricity that is ultimately consumed in Washington.[15]
- The Renewable Fuel (Diesel) Standard[16] analysis demonstrates that the policy is not effective as currently adopted. As an existing policy, the RFS evaluation reflects the current level of biodiesel in Washington. Separately, as a Policy Option discussed in Section 5 of this report, we present the GHG emissions reductions that would be achieved if future legislative action is taken to overcome its current implementation challenges.
- The existing state appliance standards have been subsumed by Federal Standards, and have been acknowledged for their role in influencing the adoption of this associated Federal policy. Additional appliance standards currently not included under State or Federal policy were identified, and their associated GHG emission reductions were quantified. These estimates are presented in the context of Policy Options (Section 5).

The existing policies in Task 1 were evaluated independently of all other policies, and therefore do not take into account any interactions that may occur between policies that may impact reductions. A discussion and quantification of interactions between policies is included in Section 6 of this report. Table 8, below, provides a summary of the analysis for each policy, including the sector affected, and the estimated GHG reductions in the target years. The Task 1 Final Report, contained in Appendix A, provides a detailed discussion of the methodology, assumptions, data sources, and GHG emission reduction estimates for each existing state policy analyzed.

[1515] The consumption-based approach for accounting for GHG emissions from the electricity sector was used to estimate reductions attributable to the EPS to be consistent with the State's GHG emission inventory approach. The rationale for using the consumption-based approach is that it better reflects the emissions and reductions associated with activities occurring in the state, and it is particularly useful for policy-makers seeking to evaluate the impacts of state-based policy actions on overall GHG emissions.

[16] This policy applies to diesel fuel because the federal renewable fuel standard subsumes the State ethanol requirement.

Table 8: Summary of Existing Washington State Policies

Existing Policy	GHG Emission Reductions ($MMTCO_2e$)			Sector Addressed
	2020	2035	2050	
State Renewable Fuel Standard	0.03	0.04	0.05	Transportation
Washington State Energy Code	0.9	5.1	11.0	Electricity, RCI
GHG Emissions Performance Standards	0.0	2.9	2.9[a]	Electricity
Energy Independence Act (I-937)	7.9	10.9	10.9[a]	Electricity
Energy Efficiency and Energy Consumption Programs for Public Buildings	0.03	0.04	0.04	Electricity, RCI
Conversion of Public Fleet to Clean Fuels	0.03	0.04	0.05	Transportation
Purchasing of Clean Cars	5.5	10.0	11.7	Transportation
Growth Management Act	1.6	2.4	2.6	Transportation
Percent Overlap due to State Policy Interactions	**1%**	**8%**	**7%**	
Interactive Sum of Reductions from Existing policies	**15.8**	**29.0**	**36.5**	

[a] In Task 1, this policy was forecasted only to 2035. For this analysis, reductions have been assumed constant to 2050.

4.2 Federal Policies

The Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State project SOW identified the following five categories of federal policies that may contribute to meeting the state's GHG emissions targets. These include:

- 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

Existing Federal policies that fall into these categories, and several potential policies that may also contribute to meeting Washington's GHG emissions targets, are described in the Task 3 Final Report, contained in Appendix C, along with details of the Federal policy evaluation approach and results.

The U.S. Energy Information Administration's (EIA) National Energy Modeling System (NEMS) has been employed to forecast the impacts of these policies on future GHG emission levels. Leidos selected NEMS as the principal tool for evaluating the effects of federal energy and environmental policies. NEMS was developed by the U.S. 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 model is deterministic, providing single point estimates of carbon emissions and other outputs for any given set of input assumptions. For this analysis, the NEMS version developed to support the *Annual Energy Outlook 2012* was used.

NEMS performs its analysis at the national and regional levels. Results of the analysis 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[17], the Western Electricity Coordinating Council / Northwest Power Pool[18]. Leidos employed post-processing techniques to apply relevant policies specifically to Washington state. Specifically, post processing multiplied 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 were obtained from the SEDS and State CO_2 Emissions database maintained by the U.S. EIA. These values were averaged for 2006 through 2010 to estimate Washington State's typical share or weight in the region.

Results of NEMS analysis found that 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 percent) higher in 2035 than current emissions levels (Figure 6). However, Federal policies are likely to have an even more limited impact on the ability of Washington to meet its GHG emission reduction goals, after interactions and overlap with State policies are considered. After removing the policies from the combined case that overlap, we are left with only the Federal Renewables Standard and its total contribution to Washington's reduction targets of 1.4 $MMTCO_2e$ in 2020 The individual assessment for each policy removed from the combined case is presented below, grouped by sector. Ultimately, it is important to note that although NEMS is a deterministic model that generates point estimates, forecasts are more valuable for magnitude, trends and cross-comparisons.

Transport

- Benefits of CAFE are generally captured by Washington's Clean Cars policy, which represents Washington's adoption of California's Low Emission Vehicle (LEV) II (also

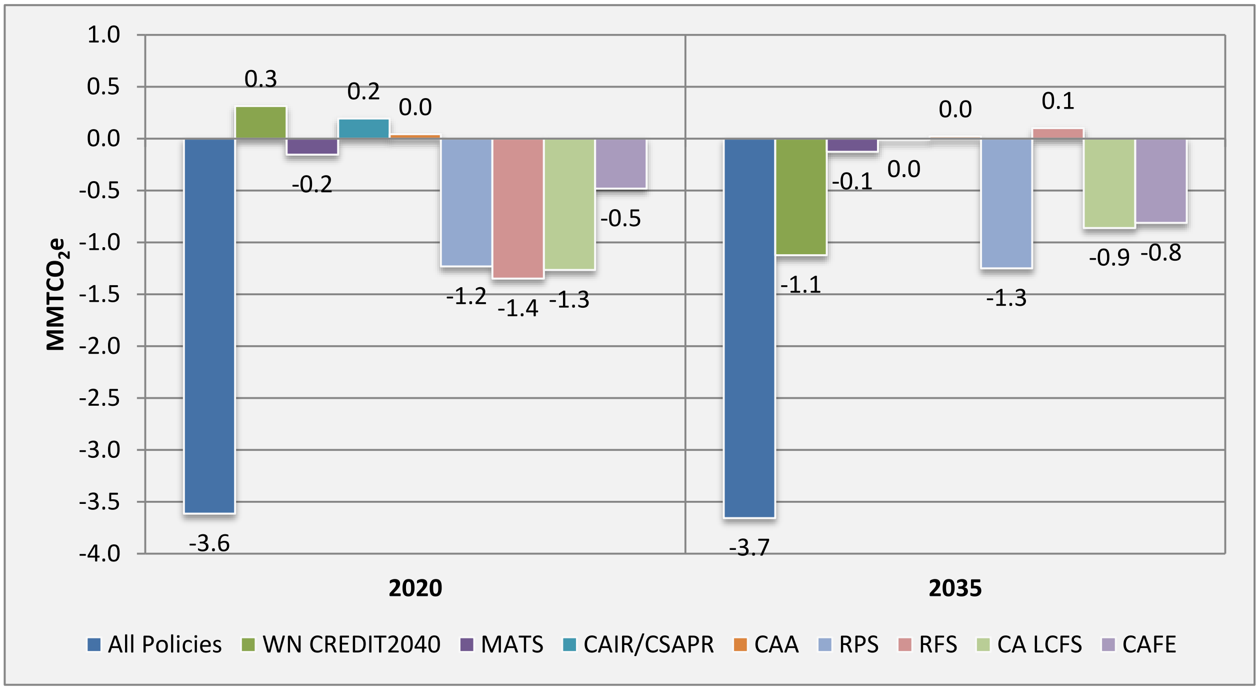
[17] See Appendix A for a map of U.S. Census divisions.
[18] See Appendix B for a map of NEMS Electricity Market Module regions.

referred to as Pavley) and LEV III standards in Washington, as a result of the harmonization of California's program with the Federal CAFE program compliance requirements
- Benefits of CA LCFS were 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) are likely to have little impact on Washington due to limited coal-fired generation
- Existing federal appliance standards are captured in the forecast baseline. Proposed revisions to federal appliance standards are unlikely to pass Congress in the near term
- Impacts for Washington of out of state RPS in surrounding regions may be overestimated due to apportionment of savings

Figure 6: Change in Total Energy Related Carbon Dioxide Emissions in Washington State from Federal Policies



Note: As discussed in the Task 3 Final Report, individual policy results cannot be summed to combined cases.

4.3 Local Government Initiatives

The CLEW through the OFM, as part of its Evaluation of Approaches to Reduce Greenhouse Gas Emissions in Washington State, asked the Washington Association of Cities and the Washington Association of Counties to provide information about how cities and counties respectively work to reduce GHG emissions and to provide examples of significant GHG emission reduction programs undertaken. Table 9 presents a summary of the local initiatives reported by the cities and counties.

Table 9 does not provide an exhaustive list of actions and initiatives occurring at the local level. However it does highlight the existing programs from different counties, and through these examples, it is apparent that a number of counties have undertaken significant GHG emission reduction policies to help support State goals as well as improve operating efficiencies. Efforts are underway at both the county and city level to assist the State in reaching its GHG reduction targets as well as additional jurisdictional-level goals. Initiatives range from passing ordinances pursuant to state-level policy to creating climate action plans and associated greenhouse gas inventories.

Table 9: Summary of Washington State Counties' and the City of Seattle's GHG Reduction Initiatives – Data Call Results

	CAP	GHG Inventory	Sustaina-bility Report	Land use strategies	Traffic Mgmt.	Alt. fuel/ EVs	CTR[19]	Weathe-rization	Energy Eff.	Green Purchasing	Waste Red.	Ded. Staff	Member-ships	Data Available/ Reporting
Benton/ Franklin					✓	✓	✓	✓						
Clallam	✓	✓		✓		✓		✓	✓		✓	✓	✓	
Clark		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Cowlitz								✓	✓					
Island	✓	✓			✓	✓	✓	✓	✓				✓	
King	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kitsap							✓	✓				✓		
Klickitat				✓				✓	✓					✓
Pacific				✓	✓	✓	✓	✓	✓	✓	✓			
Pierce		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓
San Juan				✓	✓	✓	✓	✓	✓	✓	✓			✓
Seattle	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Skagit	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Snohomish	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Stevens				✓			✓	✓	✓		✓			
Thurston	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Walla Walla				✓	✓		✓	✓	✓	✓				
Whatcom	✓	✓			✓	✓	✓	✓	✓		✓		✓	✓

This Table summarizes the local GHG reduction initiatives currently underway in Washington State Counties as well as the City of Seattle. More information about the specific programs undertaken by each County can be found in the Task 1 Final Report and its Appendix. Please note that this is not an exhaustive list of current initiatives and the information illustrated is based on the information provided by County representatives and information available on the County webpage.

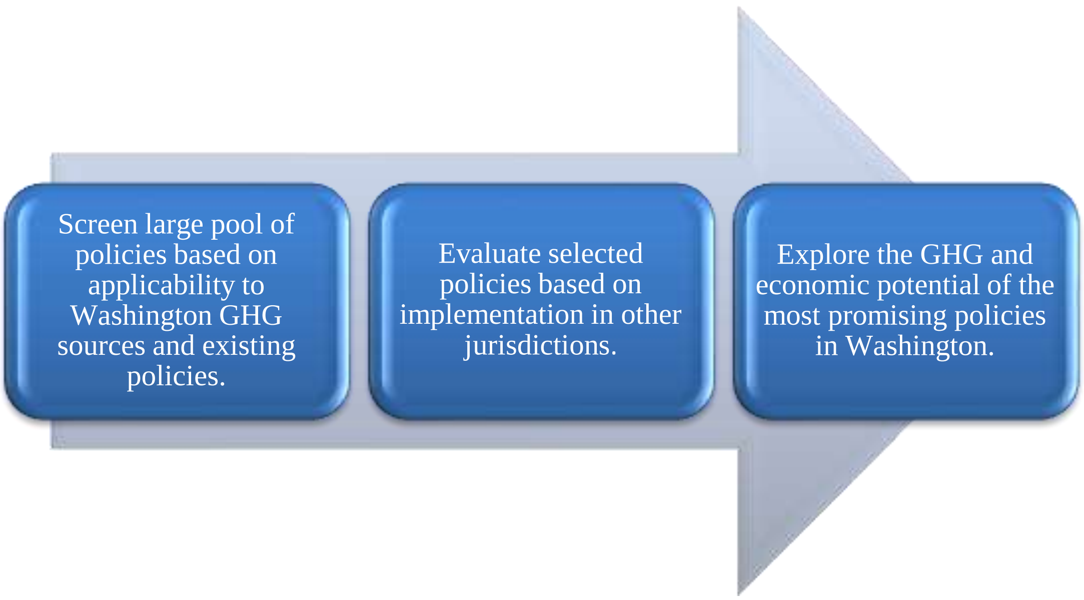
[19] Commute Trip Reduction (CTR)

5 Policy Options

5.1 Policy Screening and Evaluation Process

Virtually unlimited policies exist that either directly or indirectly, positively or negatively, intentionally or unintentionally, impact GHG emissions. An iterative screening process was applied, consistent with the Task 2 SOW, to limit the list of policies for which the evaluation of GHG emission reduction programs adopted in other states and countries was conducted under Task 2 of this project (see Appendix B - Task 2 Final Report).[20] A graphical representation and summary is provided in Figure 7.

Figure 7. 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.

[20] As a result of the bounds of Tasks 1, 2, and 3 of this project, not all programs with GHG reduction benefits currently underway in Washington are presented within this report. This project's Statement of Work (SOW) specified the existing state and federal policies to be evaluated, in Task 1 and Task 3, respectively. In addition to the existing policies evaluated, there are many other programs planned or underway within the State, from transportation pricing to urban composting, which could generate significant emission reductions, but were not identified in the SOW and therefore not evaluated as an *existing* policy. The evaluation of policies *outside of Washington*, which was executed under Task 2, focused on comprehensive emission reduction strategies that do not exist or are substantially different than programs already underway in Washington. Consistent with the Task 2 SOW, A list of potential programs was run through a technical screen to determine the final list of programs to analyze.

Potential targeted programs were identified through several channels. First, policies and sectors recommended by members of the Washington State 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 was reviewed, and all sources were considered on the combined basis of their magnitude in 2010, and their growth since 1990. 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)

A list of policies that have been researched for this project is provided in Table 10. For each of these reviewed policies, the Task 2 report (Appendix B) 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 the Task 2 report (Appendix B), but were not subjected to original quantification.

Table 10. Policies with potential GHG emission reduction benefits assessed.

Economy-wide GHG Reduction Policies	
✓	Cap and Trade
✓	Carbon Tax
Transportation and Land Use Policies	
✓	Low Carbon Fuel Standard
✓	Zero Emissions Vehicle Mandate
✓	Renewable Fuel Standard and Biofuel Support
✓	Pricing Policies
✓	Investment in Public Transit
Energy Conservation Policies	
✓	Public Benefit Fund
✓	Property Assessed Clean Energy
✓	Marine Fuel Conservation
Renewable Energy Policies	
✓	Feed-in-Tariff
✓	Offshore Wind and Ocean Power

Waste Sector Policies	
✓	Landfill Methane Capture
Agriculture and Forestry	
✓	Previous CAT materials reviewed[21]
✓	Researched and GHG reductions quantified
✓	Researched, but not quantified

5.2 Summary Findings

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. Information on design options is provided in this report and its appendices, and ultimately will be determined by state policy makers. Appendix B provides additional details on economic impacts to Washington consumers, households, and various sectors of the economy based on the review of literature and original calculations.

Understanding the cost effectiveness of emissions reductions measures is an important factor in making decisions on policy implementation. Table 11 presents a comparison of the cost per metric ton of carbon dioxide equivalent ($mtCO_2e$) of various emissions reduction 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[22] analysis and four nationally recognized marginal abatement cost curves (MACC) authored by researchers at McKinsey[23], Bloomberg[24], Johns Hopkins University[25], and Stanford University[26]. 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.

---

[21] Washington 2008 Climate Action Team

[22] 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

[23] 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

[24] 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/

[25] 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

[26] 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.

Table 11. 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 ($2010/mtCO$_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

For the quantified policies the Task 2 evaluation included original analysis and calculations on a sub-set of promising policies to understand the emissions reduction opportunities and costs in Washington. Table 12 summarizes this analysis for the eight policies for which quantification was performed, as well as the appliance standards evaluated in Task 1 (Appendix A). 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 12. Estimated GHG Emission Reduction Potential of Policies when Independently Implemented. (Interactions may decrease emissions when policies are implemented together**)**

Policy	GHG Reductions ($MMTCO_2e$)			Cost effectiveness ($\$/mtCO_2e$)[a]	Source of Emissions Addressed
	2020	2035	2050		
Cap and Trade	12.1	22.1	35.9	Not quantified	Electricity, RCI, Transportation
Carbon Tax	0.4 – 1.7	0.6 – 5.0	0.6 – 5.0[27]	$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) – $70	Transportation
5% Renewable Fuel Standard[b]	0.2	0.4	0.4	Not quantified	Transportation
Public Benefit Fund[c]	0.6	2.9	2.9[28]	$(103) to $146	Electricity, RCI
Property Assessed Clean Energy[d]	0.02	0.05	0.06	$(171)	Electricity, RCI
Appliance Standards[e]	0.4	0.6	0.6	Not quantified	Electricity
Feed-in-Tariff, 375 MW Cap[f]	0.5	0.5	0.5	$30 to $500	Electricity

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

[b] Evaluated as an existing state policy in Task 1, found to be unenforceable. Estimates presented here represent 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.

[27] Model did not extend to 2050, therefore 2035 results used as proxy.

[28] Model did not extend to 2050, therefore 2035 results used as proxy.

[d] Based on assumed PACE funding of $50 million over 5 years. Results are scalable.
[e] Evaluated as an existing state policy in Task 1, found to be subsumed by Federal appliance standards. Estimates presented here as quantified under Task 1 and reflect potential additional appliance standards not yet covered by existing State or Federal standards.
[f] All Feed-in-Tariff reductions would contribute to I-937 goals.

The estimates in Table 12 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. Table 13 summarizes the total potential emission reductions that would be expected after accounting for interactions. Two scenarios are presented, one in which cap and trade is implemented with the other policies but without a carbon tax, and a second where a carbon tax is implemented with the other policies without a cap and trade program.

Table 13. Total emission reductions based on accounting for interaction between policies

	2020	2035	2050
Cap and Trade Scenario			
Percent Overlap due to Policy Interactions	19%	32%	24%
Interactive Sum of Reductions ($MMTCO_2e$)	12.1	22.1	35.9
Carbon Tax Scenario			
Percent Overlap due to Policy Interactions	24%	33%	34%
Interactive Sum of Reductions ($MMTCO_2e$)	3.3	8.8	9.5

The potential contributions of these policies, at contemplated stringency and investment levels, towards meeting Washington's GHG targets are illustrated above in Figure 5 and discussed in Section 3.2 – A Challenge Remains. These policies can supply sufficient reductions to meet the 2020 target, but as would be expected, they will be insufficient to meet the 2035 and 2050 targets without further strengthening or additional policies over the next 37 years. For this analysis, the policies were quantified based on design parameters that have already been implemented in other jurisdictions, typically with compliance levels specified only until approximately 2025. These policies therefore do not reflect increased stringency beyond this first phase, which is something that often occurs with policies as current goals are met but further progress is desired. As such, the policy *mechanisms* contemplated in this report may be sufficient to meet future goals, but the design and compliance parameters would need to be tightened.

The following sections (5.3 through 5.10) provide summary information on these policies, including GHG reductions, costs and benefits, implementation issues, and lessons learned. Further detailed information and analysis for each policy, including additional policies that were not part of the analysis summarized in Table 12, are reported in the Task 2 Final Report, included in this document as Appendix B.

5.3 Cap and Trade

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.

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 ($MMTCO_2e$)[29]	73.6	55.2	36.8
GHG Reductions from Cap ($MMTCO_2e$)	12.1	22.1	35.9
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 Emission Trading Scheme (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			

[29] Cap is set relative to the 1990 level for the transportation, electricity, and residential, commercial and industrial sector, equal to 1990 in 2020, 25% below 1990 level in 2035, and 50% below 1990 level in 2050.

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.

5.4 Carbon Tax

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 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.

Potential Action for Consideration			
• Implement a tax on carbon emissions in the state of Washington			
GHGs and Costs in Washington[30]	**GHG Reductions ($MMTCO_2e$)**		**Cost ($/mt$CO_2$e)**[31]
	2020	**2035**	
$10 per mt$CO_2$e tax	0.4	0.6	$5
$10, escalating to $30 per mt$CO_2$e tax	1.5	2.8	$15
$10, escalating to $50 per mt$CO_2$e 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,			

[30] 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.

[31] 5 percent discount rate, NPV 2013

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 (for each \$10/mtCO2e tax, approximately \$0.09 per gallon gasoline, and \$0.67 per mmBTU natural gas) • 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 or other state taxes

5.5 Low Carbon Fuel Standard

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.

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)[32]
	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. The California LCFS has been challenged based on its potential impact on interstate commerce. • Sector exemptions should be carefully considered, such as those included in the California LCFS

[32] 5 percent discount rate, NPV 2013

program. The California LCFS does not cover military activity, the racing industry, the aviation industry, marine fuels, or locomotive fuels.[33] 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 • Electric vehicles (EV) and alternative fuel vehicles (AFV) 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.[34]	• 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

5.6 Zero Emissions Vehicle Goal

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. Even when accounting for upstream emissions from electricity generation, the use of ZEVs results in GHG reductions and reductions in smog forming criteria pollutants.

Potential Action for Consideration
• Consider implementing a ZEV mandate in conjunction with adopting the California LEV III Standard to realize benefits from a coordinated package of transportation policies.

[33] 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

[34] 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

<table>
<tr><th rowspan="2">GHGs and Costs in Washington</th><th colspan="3">GHG Reductions ($MMTCO_2e$)</th><th rowspan="2">Cost ($/mtCO_2e)[35]</th></tr>
<tr><th>2020</th><th>2035</th><th>2050</th></tr>
<tr><td>22 percent ZEV credit requirement by 2025</td><td>0.1</td><td>2.0</td><td>2.6</td><td>($70) - $70</td></tr>
<tr><th colspan="5">Implementation Issues and Lessons Learned</th></tr>
<tr><td colspan="5">• 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.
• Leverage state and regional leadership and infrastructure installed to date; additional support needed to overcome barriers</td></tr>
<tr><th>Potential Costs and Benefits to WA Consumers</th><th colspan="4">Potential Costs and Benefits to WA Businesses</th></tr>
<tr><td>• 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.[36]
• 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.[37]
• Replacing single occupancy gasoline vehicles with single occupancy ZEV/TZEVs will reduce emissions overall, but does not address congestion, which has emissions impacts and costs on consumers and businesses.</td><td colspan="4">• Opportunities for engineering and manufacturing jobs within the State of Washington.[38]
• 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.</td></tr>
</table>

5.7 Renewable Fuel Standard[39] and Supporting Policies

Renewable fuels generally have lower lifecycle emissions than their fossil fuel counterparts, and present an opportunity to reduce transportation sector 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

[35] 5 percent discount rate, NPV 2013
[36] (p.147 of the CARB study: http://www.arb.ca.gov/regact/2012/leviiighg2012/levisor.pdf).
[37] (CARB Study page 209).
[38] (governor's plan page 5: http://opr.ca.gov/docs/Governor's_Office_ZEV_Action_Plan_(02-13).pdf)
[39] This policy applies to diesel fuel because the federal renewable fuel standard subsumes the State ethanol requirement.

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.

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 AFVs, 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.[40,41] • 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.			

[40] 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

[41] 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

5.8 Public Benefit Fund

A public benefits fund (PBF) is a policy mechanism intended to provide long-term, stable funding to support a variety of 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.[42] This is achieved by levying a systems benefit charge (SBC), which is a small surcharge to all ratepayers on electricity and/or gas consumption that produces revenue to fund the PBF. 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.

<table>
<tr><th colspan="2">Potential Action for Consideration</th></tr>
<tr><td colspan="2">• 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</td></tr>
<tr><th colspan="2">GHGs and Costs in Washington</th></tr>
<tr><td colspan="2">Three potential program designs are separately considered and quantified</td></tr>
<tr><th colspan="2">Implementation Issues and Lessons Learned</th></tr>
<tr><td colspan="2">• 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.</td></tr>
<tr><th>Potential Costs and Benefits to WA Consumers</th><th>Potential Costs and Benefits to WA Businesses</th></tr>
<tr><td>• 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), 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.</td><td>• 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.</td></tr>
</table>

[42] DSIRE. 2013. Public Benefit Funds. Accessed August 2013 at: http://www.dsireusa.org/solar/solarpolicyguide/?id=22

• Increased access to energy conservation and distributed renewable technology incentives and financing. • Improved grid reliability and emissions rates.	• 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.

5.9 Property Assessed Clean Energy (PACE) Programs

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 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[43], this feature is critical for building owners to invest in efficiency measures with payback periods of four years or more.

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 ($MMTCO_2e$)**			**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				

[43] Johnson Controls. 2010, An Awakening in Energy Efficiency: Financing Private Sector Building Retrofits. Accessed September 2013 at: http://www.johnsoncontrols.com/content/dam/WWW/jci/be/solutions_for_your/private_sector/Financing_PrivateSector_whitepaper_FINAL.pdf

• 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	Potential Costs and Benefits to WA Businesses
• 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.[44]	• 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.[45]

5.10 Feed-in-Tariff

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.[46] For example, by 2020 Germany has set a goal to have 14% of total energy sourced from renewables, which will be achieved by using renewables. The renewable energy source

[44] 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/
[45] 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/
[46] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

goals increase incrementally each decade thereafter until 2050 when renewables are expected to provide 80% of the electricity. [47]

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 ($/$mtCO_2e$)[48]
	2020	2035	2050	
Program cap of 375 MW (scalable)[49]	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.[50] • 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.[51] • 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.[52] • Complexities include interconnection codes, standards and practices, metering requirements and the siting process for renewable energy systems.[53] • Must consider contract length, interconnection rules and agreements, program and project caps, tariff revisions, payment differentiation and bonus payments.[54]				
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.[55] • 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.			

[47] 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
[48] 5 percent discount rate, NPV 2013
[49] Represents half of the program cap implemented in California.
[50] 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
[51] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[52] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[53] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[54] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.
[55] 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.[56]

6 Policy Interactions Analysis

Analysis of policy interactions is critical to accurately quantifying GHG reductions. Analytical methods were developed and applied to identify and quantify the overlap between the existing state and federal policies and potential new programs for Washington. Three types of interactions were qualitatively identified between policies including complete negations, partial diminishments and synergies. Partial diminishments and synergies were quantified where data were sufficient for the use of simplified methods. The interactions between policies are more complex than the available methods can capture completely, without the use of modeling that is outside the scope of this project. For example, the more complex aspects of the interactions such as price changes, economic impacts, and elasticity curves were not incorporated. However, the approaches used are sufficient to demonstrate the order of magnitude of the interactions and the results provide a solid foundation for understanding how the interactions of these policies will affect the overall GHG emission reduction levels and Washington's ability to meet its targets in the years 2020, 2035 and 2050.

6.1 Interaction Analysis Results

The purpose of the interactions analysis is to provide an integrated view of Washington's current state in relation to their GHG reduction goals. This requires an analysis that considers all existing policies and their combined impact on the State's GHG emissions. Based on this analysis, Washington State is likely to fall short of meeting its 2035 and 2050 targets. Reductions towards Washington's goals are achieved primarily from a single federal policy, the federal RFS, and six[57] existing state policies including;

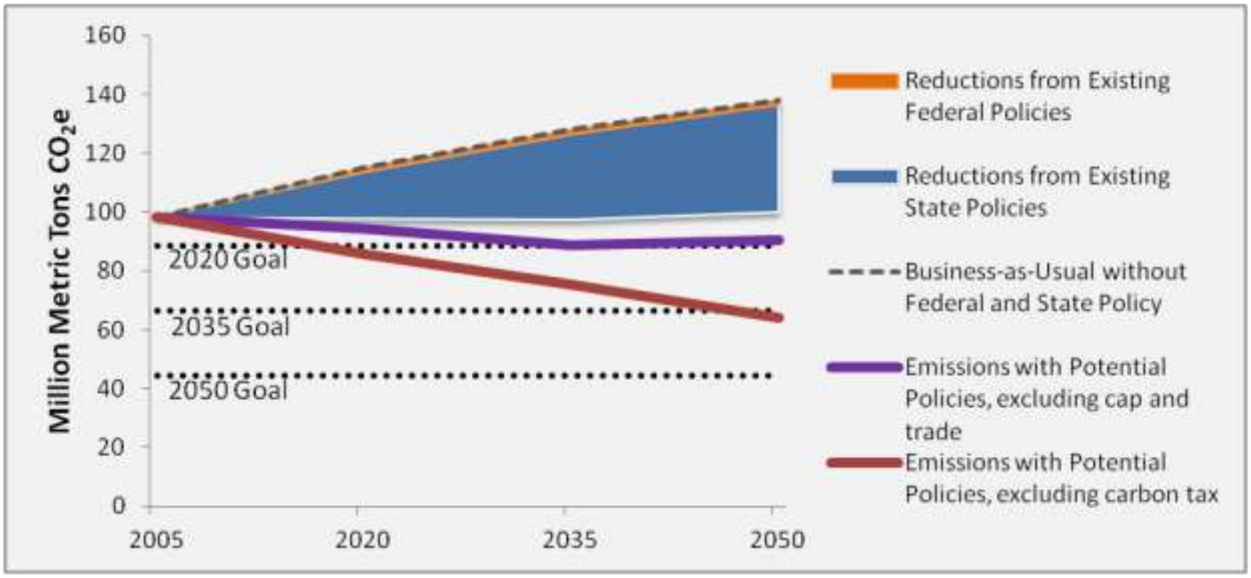
- Washington State Energy Code
- GHG Emissions Performance Standards
- Energy Independence Act (I-937)
- Purchasing of Clean Cars
- Growth Management Act

[56] NARUC. *Feed-in Tariffs: Frequently Asked Questions for State Utility Commissions*. June 2010.

[57] Several of the nine policies identified in the Task 1 SOW were found to have limited contributions to achieving Washington's goals. For example, in Task 1, the state RFS was found to be unenforceable as adopted, and the state's existing Appliance Standards were found to be subsumed by federal standards but reductions were estimated separately for new additional standards; each of these is presented in this report as a Policy Option (Section 5).

A number of potential new reduction policies were reviewed to provide a potential compliance pathway for meeting the 2035 and 2050 goals, which include the policies listed below in Table 17. Two scenarios were examined that assumed implementation of all the potential polices described in the previous section with either a carbon tax or a cap and trade program (but not both) implemented to determine how much additional progress towards the 2035 and 2050 goals could be made. The analysis indicates that if Washington pursued the cap and trade scenario, the State would likely achieve the 2020 target, but fall short of the 2035 and 2050 targets. If Washington pursued a carbon tax at the level modeled without a cap and trade regime, it is unlikely that the state will meet its 2020, 2035, and 2050 targets. It must be noted that all the reduction estimates for these policies were done using assumptions that are outlined throughout the report and generally assume full compliance with the policy and maximum program participation. These estimates represent a potential outcome but as with any forecast there is uncertainty. Figure 8 (also shown above as Figure 3) summarizes the results of the interactions analysis and Washington State's current and potential future progress in achieving the mandated GHG emission targets.

Figure 8: Washington's Potential GHG Emission Reductions – Policy Interactions Analysis



It is important to note that this is a snap shot of progress and forecasts will change and adjust over time. In consideration of the general uncertainties inherent in all projections and emission inventories, the most reasonable conclusions to draw from this analysis are:

1. Washington State will approach but likely fall short of its 2020 target with the existing policies in place, even assuming full compliance.
2. The policies presented in this report provide the tools to meet the 2020 target, but at analyzed levels of stringency and investment will likely not be sufficient to meet 2035 or 2050 goals.

3. To meet 2035 and 2050 targets, policies strengthened beyond the levels contemplated in this analysis will be required; it will require the enhancement or expansion of current polices and the inclusion of additional polices not yet identified to meet the 2050 target.

The sections below describe the assumptions and methods used to quantify interactions among existing state and federal policies, as well as, between existing and potential new policies.

6.2 Existing Policies

Eight existing state polices and one existing federal policy were included in the interactions analysis and are presented in Table 9. These policies were reviewed first to determine which policies would interact, and then how those interactions would impact emission reductions. In all cases, the interactions of existing policies were determined to either partially diminish or completely negate reductions.

As described in Table 9, two primary areas of interaction were identified and contribute to the diminishment of emissions reductions due to interactions. First, a policy interaction occurs between the Washington State Energy Code, the GHG Emissions Performance Standard, and I-937. Both the Washington State Energy Code and the conservation portion of I-937 result in decreased electricity demand (or a decrease in the growth in electricity demand, depending on the year), while the GHG Emission Performance Standard and the renewable energy portion of I-937 decrease the GHG emissions intensity of the electricity used. The result of this is that as the GHG intensity (lbs CO2e/MWh) of the electricity mix decreases due to the GHG Emission Performance Standard and I-937, so too does the benefit of avoiding a unit (MWh) of electricity consumption through the Washington State Energy Code and I-937 conservation requirement. This occurred in both 2035 and 2050 as the decrease in new marginal demand from the conservation measures resulted in less electricity from a relatively cleaner new energy mix comprised of natural gas and renewables rather than coal and other non-renewable resources that would have been used in the absence of the supply-side measures. However, in 2020, these policies actually produced a synergy. In 2020, the conservation measures are estimated to be sufficient to not only reduce the growth in demand for new electricity resources, but to actually degrade existing demand to a point where existing fossil fuel generation, including from coal, may be reduced. As a result, in 2020 the avoided emissions include some portion of existing coal-generated electricity, rather than a decrease in new natural gas and renewable generation that would have been expected otherwise.

The second primary area of interaction occurs between the Growth Management Act and the Purchasing of Clean Cars policies. While the Growth Management Act achieves emission reductions through reduced VMTs, the Purchasing of Clean Cars measure decreases emissions by making each VMT traveled relatively less GHG intensive. As with the electricity policies, when these policies are combined the total is less than the simple sum. This is because each VMT avoided by the Growth Management Act achieves fewer GHG reductions due to the lower per-mile GHG emissions achieved from the Purchasing of Clean Cars. Conversely, the impact of

Purchasing of Clean Cars is reduced because of the decreased VMTs from the Growth Management Act.

Finally, the last area of interaction occurs between the state and federal RFS. As the federal RFS is more stringent than the state RFS or level of attainment, the total of both policies is simply equal to the emission reductions from the federal RFS.

Table 14: Summary of Existing Policy Interactions

Existing Policy	Interaction with Other Existing Policies
State RFS	Completely negated by federal RFS
Washington State Energy Code	Natural Gas emissions savings do not overlap with other existing policies; Electricity emission savings increase in the presence of I-937 because electricity savings are assumed to erode demand fulfilled by existing natural gas and coal-fired generation, whereas without I-937, electricity savings are assumed to avoid the need for new gas-fired generation which is characterized by a lower emission factor.
Emissions Performance Standard	Emission reductions due to improved fossil generation emission performance are diminished because a portion of the impacted fossil is displaced by increased renewable generation and conservation due to I-937.
Energy Independence Act (I-937)	Emission reductions from displaced fossil generation due to I-937 are diminished because the emission performance of fossil generation is improving due to the EPS. I-937 reductions are also diminished because Energy Code policy decreases demand, which decreases the amount of renewable generation required to meet the percentage based RPS targets.
Energy Efficiency and Energy Consumption Programs for Public Buildings	Negligible reductions and overlap with other existing policies
Conversion of Public Fleet to Clean Fuels	Negligible reductions and overlap with other existing policies
Purchasing of Clean Cars	Diminished by GMA as a result of reduced annual VMT over time (in the Task 1 analysis of reductions from Purchasing of Clean Cars, diminishment is implicitly captured and reductions are presented exclusive of interaction with GMA)
Growth Management Act (GMA)	Diminished by the Purchasing of Clean Cars improvement of emission performance on a per mile basis across the vehicle fleet.
Federal RFS	Completely subsumes state RFS; no overlap with other existing policies

Table 15 below provides the results of the interactions analysis on existing state and federal policies.

Table 15: Summary of Interactions Analysis on Existing State and Federal Policies

Existing Policy	GHG Emission Reductions ($MMTCO_2e$)			Sector Addressed
	2020	2035	2050	
State Renewable Fuel Standard	0.03	0.04	0.05	Transportation
Washington State Energy Code	0.9	5.1	11.0	Electricity, RCI
GHG Emissions Performance Standards	0.0	2.9	2.9	Electricity
Energy Independence Act (I-937)	7.9	10.9	10.9	Electricity
Energy Efficiency and Energy Consumption Programs for Public Buildings	0.03	0.04	0.04	Electricity, RCI
Conversion of Public Fleet to Clean Fuels	0.03	0.04	0.05	Transportation
Purchasing of Clean Cars	5.5	10.0	11.7	Transportation
Growth Management Act	1.6	2.4	2.6	Transportation
Federal RFS	1.4	1.6	1.6	Transportation
Percent Overlap due to Policy Interactions	**1%**	**7%**	**7%**	
Interactive Sum of Reductions from Existing policies	**17.2**	**30.6**	**38.1**	

6.3 Potential Policies

This section describes the interactions expected between potential policies evaluated for this report with one another, and with existing state and federal policies. In some instances, federal or state policies were built into the baseline assumptions of the potential policy quantifications, and as a result, no additional discount for interaction is required. The process employed for this interactions analysis consisted of layering in the interactions beginning with an accounting of the interactions between each individual policy and the existing state and federal policies, and then quantifying the interaction with other potential policies based on those results.

The first step of the interactions analysis was to consider potential interactions between the potential policies and the suite of existing policies at the state and federal level. Table 16 summarizes the interactions that have been identified between the existing state and federal policies and the potential policies that have been independently quantified. In several cases, including the ZEV Mandate, PBF, and Cap and Trade, the original quantification of the policy includes a base case that reflects the current federal and state policy environment. For example, the ZEV Mandate assumes that the base vehicle replaced by a ZEV meets the current LEV III vehicle emissions standards. As such, the reductions calculated during Task 2 do not need to be further discounted to reflect interactions with existing policy. Other policies, such as the Feed in Tariff (FIT), were quantified and presented in Task 2 as a policy tool to help achieve the goals of I-937 and extend some of those benefits to non-covered utilities. Therefore, it is assumed that 80 percent of the FIT reductions are subsumed by I-937 covered utilities RPS requirements. Finally, policies like the LCFS and state RFS will be partially diminished by the existing state and federal RFS, which have been quantified as existing policies.

Table 16: Summary of Potential Policy Interactions with Existing state and Federal Policies

Potential Policy	Interaction with Existing Policies
Cap and Trade	Emission reductions attributed to cap and trade exclude all reductions from existing policies
Carbon Tax	Existing policy and energy forecast incorporated in model base case
Low Carbon Fuel Standard	Partially diminished by Federal and State renewable fuel standard
Zero Emissions Vehicle Mandate	LEV III vehicle emission standards incorporated into baseline in quantification of potential
5% Renewable Fuel Standard	Partially diminished by Federal and State renewable fuel standard
Public Benefit Fund	Quantified as applying to the approximately 20% of electric demand not met by I-937 covered utilities.
Property Assessed Clean Energy	Policy quantification assumed to apply only to conservation and renewables not covered by I-937.
Feed-in-Tariff, 375 MW Cap	80% subsumed by I-937. FIT serves as a mechanism to meet I-937 goals for covered utilities, and is additional for non-covered utilities (approximately 20% of state energy consumption).

Next, two separate scenarios were constructed to reflect the likelihood that at most one economy-wide policy would be implemented. The two scenarios assume that *either* a cap and trade policy would be implemented in conjunction with the other proposed policies, *or* that a carbon tax would be, *but not both*. The interactions that occur between policies vary depending on whether the cap and trade or carbon tax is included. For example, under the carbon tax scenario, all energy and transportation related policies are subsumed as complementary. However, under the carbon tax scenario, this is not the case. Policies were assumed to interact with the carbon tax if their calculated cost effectiveness was estimated to be lower than that of the carbon tax. For these policies, the additional price signal from a carbon tax should be sufficient to achieve the interacting policy's emissions reductions. Policies that had a higher cost of abatement than that calculated for the carbon tax, are assumed to occur as additional to those achieved as a result of the carbon tax. Further, there are several interactions among other policies that are noted in the carbon tax scenario. Most notably, the LCFS subsumes all of the emissions reductions from the ZEV mandate and the RFS. The ZEVs simply provide the vehicles that utilize the LCFS fuels with lower carbon intensity, and the RFS provides a stream of low carbon fuels that contributes to meeting the LCFS target.

Table 17: Summary of Interactions of Potential Policies Under Estimation Scenarios

Potential Policy	Cap and Trade Scenario	Carbon Tax Scenario
Cap and Trade	Excludes reductions from existing policies in covered sectors	Excluded
Carbon Tax	Excluded	Price signal achieves reductions additional to existing policy
Low Carbon Fuel Standard	Emission reductions are subsumed by cap	Partial diminishment: LCFS has a higher cost than the carbon tax, and interacts with ZEV and RFS
Zero Emissions Vehicle Mandate	Emission reductions are subsumed by cap	Partial diminishment: ZEV has a higher cost than the carbon tax; and ZEV emission reductions interact with LCFS
5% Renewable Fuel Standard	Emission reductions are subsumed by cap	Partial diminishment: RFS emission reductions interact with LCFS
Public Benefit Fund	Emission reductions are subsumed by cap	Partial diminishment: PBF costs range from higher, to lower than cost of tax , and may interact with PACE and FIT
Property Assessed Clean Energy	Emission reductions are subsumed by cap	No additional interaction with *potential* policies
Feed-in-Tariff, 375 MW Cap	Emission reductions are subsumed by cap	No additional interaction with *potential* policies

Based on these interactions, an interactive sum of emissions reductions from the potential policies under the two scenarios was calculated. Accounting for interactions decreases the sum of emissions reductions in the cap and trade scenario by 19 percent in 2020, 32 percent in 2035, and 24 percent by 2050. In the carbon tax scenario, interactions reduce the simple sum by 24 percent in 2020, 33 percent in 2035, and 35 percent in 2050. These values are reported in Table 18.

Table 18: Summary of Interactive Sum of Potential Scenarios

	2020	2035	2050
Cap and Trade Scenario			
Reduction due to Interactions	12.1	22.1	35.9
Interactive Sum of Reductions ($MMTCO_2e$)	19%	32%	24%
Carbon Tax Scenario			
Reduction due to Interactions	24%	33%	34%
Interactive Sum of Reductions ($MMTCO_2e$)	3.3	8.8	9.5

Appendix A –Task 1 Final Report

The Task 1 Final Report is the final deliverable for Task 1, provided in two separate documents – Task 1 Final Report Part 1and Task 1 Final Report Part 2.

Appendix B –Task 2 Final Report

The Task 2 Final Report is the final deliverable for Task 2, provided in a separate document.

Appendix C –Task 3 Final Report

The final deliverable for Task 3 is provided in a separate document.

Appendix D - Washington State's GHG Emissions - Historical and Projected Through 2050, and Adjustment Approach

The table below presents Washington State's GHG Emissions - Historical and Projected Through 2050, as updated on October 9, 2013 by the Department of Ecology.

To develop an unconstrained baseline GHG projection exclusive of reductions from existing state and federal policies, this analysis built upon the state's GHG projection presented below. Through analysis of documentation of methods, assumptions, and data sources used in the Ecology projection, it was determined that some reductions attributable to existing state and federal policies are implicitly captured in the projection. Ultimately, the Ecology projection below was adjusted to exclude reductions from the federal RFS, the Pavley/LEV II component of the Purchasing of Clean Cars program, and I-937. The result was a "clean" unconstrained baseline GHG projection without reductions from existing policies, with the effect of increasing projected emissions. Subsequently, reductions from these three policies, and other existing policies determined *not* to be captured in the Ecology projection, were credited to Washington to forecast GHG emissions with existing state and federal policies.

Washington State's GHG Emissions - Historical and Projected Through 2050

Million Metric Tons CO_2e	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/ Commercial/ Industrial	**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 (CH_4 and N_2O)	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**	**44.9**	**42.2**	**43.6**	**43.6**	**42.9**	**42.5**	**43.5**	**45.2**	**47.1**	**49.1**
Onroad Gasoline	20.4	23.0	24.7	24.2	21.9	22.3	21.2	19.7	18.5	17.5	16.5	15.6	14.8

Million Metric Tons CO_2e	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Onroad Diesel	4.1	5.3	7.6	7.0	8.0	8.9	9.5	9.7	9.9	10.2	10.5	10.9	11.1
Marine Vessels	2.6	4.0	3.7	3.9	3.0	3.3	3.3	3.4	3.4	3.4	3.5	3.5	3.5
Jet Fuel and Aviation Gasoline	9.1	9.3	10.0	7.8	8.1	7.8	8.0	8.3	8.5	8.7	9.0	9.3	9.5
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	2.8	4.7	6.9	9.1
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(CH_4)	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 (CH_4)	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 (CH_4)	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**	**4.1**	**3.8**	**4.7**	**5.6**	**6.6**	**7.6**	**8.6**	**9.5**	**10.2**	**10.9**
Cement Manufacture (CO_2)	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 (CO_2, 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 (CO_2)	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 SF_6)	0.0	0.5	1.6	2.1	2.5	3.4	4.5	5.5	6.6	7.5	8.4	9.2	9.8
Semiconductor Manufacturing (HFC, PFC, SF_6)	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 (SF_6)	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**	**3.7**	**3.8**	**4.1**	**4.4**	**4.7**	**5.0**	**5.4**	**5.7**	**6.0**	**6.3**
Solid Waste Management	2.1	2.3	2.6	3.0	3.1	3.3	3.6	3.8	4.1	4.4	4.7	4.9	5.1
Wastewater Management	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.9	0.9	1.0	1.0	1.1	1.2
Agriculture	**6.4**	**6.4**	**6.1**	**6.3**	**5.2**	**5.2**	**5.3**	**5.3**	**5.4**	**5.5**	**5.5**	**5.6**	**5.7**
Enteric Fermentation	2.0	2.4	2.2	2.1	2.0	2.0	2.0	2.0	2.0	1.9	1.9	1.9	1.9
Manure Management	0.7	0.8	1.0	1.0	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.9	2.0
Agriculture Soils	3.7	3.2	2.9	3.1	2.1	2.1	2.0	2.0	1.9	1.9	1.8	1.8	1.8
Total Gross Emissions	**88.4**	**100.7**	**110.6**	**98.2**	**96.1**	**99.1**	**99.6**	**100.2**	**102.0**	**104.9**	**108.2**	**111.7**	**115.0**
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 CO_2e)	18	18	19	16	14	14	13	13	12	12	12		

Million Metric Tons CO_2e	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
USA Per Capita Gross Emissions (metric tons CO_2e)					22								

Note: The GHG emissions reductions 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.
Source: Washington State Dept of Ecology. Updated October 9, 2013. Does not reflect adjustments to get to the clean, unconstrained projection conducted in October 2013 under Task 4 of this project.