NERA
ECONOMIC CONSULTING

Analysis of Economic and CO_2 Emissions Impacts of Washington Initiative 1631

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EXECUTIVE SUMMARY

Washington state's Initiative Measure No. 1631 (I-1631 or the Initiative) is a ballot initiative that will be voted on by the registered voters of Washington state on November 6, 2018.[1] I-1631 would enact a "pollution fee" (hereafter referred to as the "I-1631 fee") beginning on January 1, 2020 on the carbon content of (i) fossil fuels sold or used in the state (with several sectoral exemptions) and (ii) electricity generated or imported into the state (with some exemptions for planned coal generator retirements).[2]

The I-1631 fee would begin at $15 per metric ton of carbon dioxide equivalent (CO_2e) in 2020 and increase by $2 per metric ton per year plus an adjustment for inflation. If and when the State's greenhouse gas (GHG) emission reduction goal for 2035 is attained,[3] the I-1631 fee would continue to increase each year at the rate of inflation but the additional increment of $2 per metric ton per year would be discontinued. However, our projections of GHG emission reductions through 2035 indicate that the State's goal will not be attained. The Initiative specifies three areas in which the carbon pollution funds should be spent (after accounting for administrative fees). These include the categories referred to as "clean air and clean energy investments," "clean water and healthy forests investments," and "healthy communities investments."

NERA Economic Consulting (NERA) conducted a macroeconomic analysis of implementation of I-1631 that includes both the I-1631 fee and the spending of the revenues and credits raised by the fee. Given that the Initiative defines I-1631 as a price per metric ton of carbon content, the fee is functionally equivalent to a carbon tax for modeling purposes. This report provides the results of that analysis regarding net energy and economic impacts in Washington state, as well as impacts on Washington state GHG emissions, for the years 2020 through 2035, and documents the methodology and key assumptions used in the analysis.

A. Summary of Major Results

Net Energy Price Impacts in Washington State

I-1631 is projected to have the following key energy price impacts (relative to a baseline without I-1631, with dollar impacts stated in current dollars).[4]

- **It would impose I-1631 fees on the carbon content of non-exempt fossil fuels and electricity in Washington state:** The I-1631 fees would be $15 per metric ton of CO_2e in 2020, increasing

[1] The full text of the Initiative is available at: https://www.sos.wa.gov/_assets/elections/initiatives/finaltext_1482.pdf.

[2] "Carbon content" is defined in I-1631 as the "carbon dioxide equivalent" that is released through the combustion or oxidation of a fossil fuel, or that is associated with the combustion or oxidation of a fossil fuel, used to generate electricity. I-1631 references RCW 70.235.010 for its definition of "carbon dioxide equivalent," which is "a metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential."

[3] Per RCW 70.235.020, the State's GHG emission reduction goal for 2035 is to reduce GHG levels by 25% below 1990 levels. The state's inventory reports its 1990 emissions were 88.4 million metric tons ("Report to the Legislature on Washington Greenhouse Gas Emissions Inventory: 2010 – 2013," Washington Department of Ecology, October 2016), implying this goal would be attained if statewide emissions in 2035 were 66.3 million metric tons CO_2e or less.

[4] Appendix III provides all dollar results in constant (year 2020) dollars.

by $2 per metric ton per year plus an adjustment for inflation, to about $66 per metric ton by 2035.

- Total I-1631 fees collected (including fees calculated for light and power companies and natural gas distribution companies) would be approximately $790 million in 2020, rising to $3.1 billion by 2035. Through 2035, the fees collected would total about $30 billion.

- Consistent with the provisions of the Initiative, our analysis assumes that all fees would be spent on various projects and causes, as called for in the Initiative. The analysis results presented below reflect the net effect of that spending as well as the impacts of the I-1631 fees on energy prices and prices of other goods and services.

- **We project the Initiative will increase household energy prices in Washington state as follows:**
  - Gasoline prices up 13¢ per gallon in 2020, 59¢ per gallon by 2035.
  - Diesel prices up 15¢ per gallon in 2020, 66¢ per gallon by 2035.
  - Natural gas prices up $0.76 per MMBtu in 2020, $3.54 per MMBtu by 2035.
  - Electricity rates up 0.03¢ per kWh in 2020, 1.7¢ per kWh by 2035.

Table 1 shows the energy impacts described above for the years that were modeled between 2020 and 2035.

Table 1: Net Energy Price Impacts of I-1631 in Washington State (Current Dollars)

	2020	2023	2026	2029	2032	2035
I-1631 Fee ($/metric ton)	$15.00	$22.82	$31.78	$41.90	$53.39	$66.48
Total I-1631 Fee Collections (in millions $)	$786	$1,169	$1,601	$2,058	$2,571	$3,147
Increase in Gasoline Pump Price (¢/gallon)	13¢	19¢	27¢	36¢	47¢	59¢
Increase in Diesel Pump Price (¢/gallon)	15¢	23¢	32¢	43¢	55¢	66¢
Increase in Delivered Price of Natural Gas to Households ($/Mcf)	$0.76	$1.16	$1.64	$2.18	$2.82	$3.54
Increase in Delivered Price of Electricity to Households (¢/kWh)	0.03¢	0.3¢	1.0¢	1.2¢	1.1¢	1.7¢

Sources: I-1631 and NERA calculations as described in report.

Net Economic Impacts in Washington State

I-1631 is projected to have the following net impacts on Washington state households and the Washington state economy (relative to a baseline without I-1631, with dollar impacts in current dollars).

- **Total net cost per household:** I-1631 is projected to lead to total net costs for the average Washington household of $440 in 2020, increasing to $990 by 2035.

- These estimates reflect the net effects on Washington state household income due to the overall macroeconomic impacts of the Initiative.
- These impacts reflect the net effects combining the negative effects of the I-1631 fees and the positive effects of I-1631 fee spending.
- These net costs reflect all the macroeconomic impacts of the Initiative, not just the simple estimates of added spending due to the I-1631 fee; these other effects include impacts on Washington state household income due to changes in economic productivity as well as to increased economic distortions due to the I-1631 fee (*e.g.*, tax-interaction effects).

- **Gross State Product (GSP):** Washington state's GSP is projected to be reduced (relative to baseline levels) by 0.4% ($2.2 billion) in 2020 and 0.5% ($5.3 billion) by 2035.
    - These reductions also reflect the macroeconomic net effects of the combination of negative effects of the I-1631 fees and positive effects of I-1631 fee spending.
- **Labor income to workers:** I-1631 is projected to reduce Washington state workers' annual income (after accounting for the offsetting effects of worker financial assistance provided for in I-1631) by $800 million in 2020, rising to $3.2 billion in 2035. These reductions are equivalent to the income from approximately 9,000 jobs in 2020 and 21,300 jobs in 2035, respectively.[5]
    - Most of the projected labor income losses are in the portions of the State's economy that are not associated with most of the large emitters.
        - 80% of the projected labor income losses are in the modeled sector that contains services/commercial businesses such as retailers, health care, hospitality, and personal care services. In our model, this sector accounts for less than 5% of Washington GHG emissions in 2020.
    - Like the other macroeconomic measures reported above, these reductions in worker income reflect the net macroeconomic effects of the I-1631 fees and the I-1631 fee spending.

Table 2 shows the economic impacts described above for the years that were modeled from 2020 through 2035.

[5] A change in "job-equivalents" is defined as the change in total labor income divided by the average annual income per job in a given year and sector. This measure does not represent a projection of the numbers of job positions that would be lost, since losses in household income reflect the possibilities of less income per worker as well as fewer workers in the Washington state economy. They also do not reflect an estimate of potential layoffs that might occur during transition to a new economic equilibrium; our analysis considers only the net changes that last after any transitional disruptions.

Table 2: Net Economic Impacts of I-1631 in Washington State (Current Dollars)

		2020	2023	2026	2029	2032	2035
Average Total Cost per Washington State Household ($/Household)		$440	$550	$660	$760	$830	$990
Change in Gross State Product (%)		-0.4%	-0.4%	-0.5%	-0.4%	-0.5%	-0.5%
Change in Worker Income	Billions $	-$0.8	-$1.3	-$1.6	-$2.0	-$2.2	-$3.2
	Job-Equivalents	9,000	-12,300	-14,000	-16,000	-15,900	-21,300

Notes: A change in "job-equivalents" is defined as the change in total labor income divided by the average annual income per job in a given year and sector.
Sources: I-1631 and NERA calculations as described in report.

GHG Emission Impacts in Washington State

Our analysis of GHG emissions data from the U.S. Energy Information Administration (EIA) and from the state of Washington indicates that 59% of Washington state GHG emissions in 2020 would be covered by the provisions of the Initiative because some sectors are exempt. (This covered percentage would be lower if "biogenic" GHG emissions are included in the total.) Note that spending of I-1631 fee revenues assumed in our analysis results in some GHG emission reductions in exempted sectors.

Our analysis estimated total reductions in GHG emissions in Washington state over time due to the Initiative, relative to baseline emissions in each year without I-1631. These are "total" reductions because they reflect the combined macroeconomic effects of (a) reductions made in response to the incentives created by the I-1631 fee and (b) additional reductions from spending of the fee collections (and credits) on projects that lower carbon-intensity or improve energy efficiency.

The analysis found a 12 million metric ton decline in baseline GHG emissions from 2020 to 2035. This decline reflects the projected effects of changes over time that are unrelated to I-1631, including effects of other GHG emission reduction programs, and are projected to occur with or without the Initiative.

- **Total GHG emission reductions in Washington state in 2035 due to the Initiative are estimated to be about 7.2 million metric tons.**
    - Reductions in GHG emissions reflect the total combined macroeconomic effects of the I-1631 fees and the spending of I-1631 fees.
    - Our analysis finds that of the 7.2 million metric ton reduction in GHG emissions in 2035, 4.6 million metric tons is due to the incentives created by the I-1631 fee and 2.6 million metric tons is due to use of the revenues (and credits) for GHG reduction projects. Note that this second element (the 2.6 million metric tons) would be a smaller reduction if the spending was not as extensively targeted on GHG reduction projects as our analysis has assumed.

Our analysis has not considered how the Initiative might affect GHG emissions occurring outside of Washington state, as it was not possible to evaluate the complexities of international leakage within the time available to conduct this study.

B. Study Objectives and Methodology

The principal study objectives were to estimate the potential *net* macroeconomic impacts and GHG emission reductions in Washington state from implementation of I-1631 over the period from 2020 (its first implementation year) through 2035. By "net" impacts, we mean that the macroeconomic modeling includes the economic and emission impacts from both the I-1631 fee itself as well as from spending the revenues (and credits) from the I-1631 fee.

Our analysis assumed that all the I-1631 fee funds (whether collected by the government or spent by utilities to obtain credits against their share of the fees) would be spent on types of investments representative of those that the ballot initiative allows. The text of I-1631 allows for many potential uses of the collected I-1631 fees, but requires very few actually be funded, making it impossible to know how such funds will actually be spent if I-1631 is implemented. The uses of the I-1631 fees assumed in this analysis are representative of the many allowable ways the funds could be spent, including investments in various types of energy efficiency, renewable generation, and lower-emitting forms of transportation services as well as worker assistance, forestry programs, and education. The resulting net impacts thus indicate the potential size of economic impacts and GHG emission reductions due to the Initiative, although the precise results would vary if different assumptions were made about how the revenues would be spent.

The I-1631 fee and the spending of the revenues generally work in opposite directions in terms of economic impacts; that is, imposition of the I-1631 fee leads to negative macroeconomic impacts while spending the associated revenues leads to positive macroeconomic impacts, thereby offsetting each other. In contrast, the two elements generally work in the same direction in terms of reducing GHG emissions. We emphasize that a complete macroeconomic analysis of the Initiative requires modeling both the positive and the negative economic impacts of the Initiative.

We performed the analysis using NERA's proprietary energy-economic model called N_{ew}ERA, which allowed us to estimate both the net macroeconomic and total GHG emission impacts in Washington state of the Initiative. The baseline macroeconomic conditions assumed for the analysis match publicly-available projections that have been developed by the U.S. government and by Washington state. We estimated the net economic and GHG emission impacts of the Initiative on Washington state by comparing the modeled economic and energy market outcomes that are projected to occur in Washington under a scenario that includes the provisions of I-1631 to their respective values in the baseline projection. Again, the provisions that define the policy scenario include the assessment of the I-1631 fees on covered fossil fuels and electricity and the spending of all the I-1631 fee funds (including utility credits).

N_{ew}ERA Model

The NewERA model is a U.S. regional economy-wide integrated energy and economic model that includes a bottom-up unit-specific representation of the U.S. electricity sector and a top-down macroeconomic representation of all other sectors of the economy including households and governments. It has substantial detail for all the energy sources used by the economy, with separate sectors for electricity, coal, natural gas, crude oil, and refined petroleum products. For this analysis, Washington state was established as a separate region in the model, interconnected with other states via trade in goods and services, so that impacts to the state's economy and emissions could be estimated directly. NewERA is a long-term model that includes the assumption that households and firms make optimal decisions over the entire modeling period, within regulatory constraints, and with full knowledge of future policies.

The baseline for this study matches the U.S. Energy Administration's (EIA's) *Annual Energy Outlook* (*AEO*) *2018* Reference Case (No Clean Power Plan) projections. This baseline case reflects current energy and environmental rules and regulations (*e.g.*, state renewable energy standards and Federal fuel economy standards), as well as the EIA's most recent projections of energy and economic activity, and CO_2 emissions for the U.S.[6] Washington-specific economic assumptions are based on data from the Washington State Office of Financial Management. The baseline also includes Washington state's renewable portfolio standard for electricity generation (as well as those in other states).

Overview of Methodology

We modeled the macroeconomic impacts of I-1631 fees starting in 2020 at $15 per metric ton of carbon content, rising at $2 per metric ton per year, plus an adjustment for inflation that increases the fee by 2035 to $45 per metric ton in year 2020 constant dollars or about $66 per metric ton in current dollars.[7] The I-1631 fee was applied to the carbon content of non-exempt fossil fuels and in-state electricity consumption, while exempting a range of sectors and fuels within sectors, as specified in the Initiative (*e.g.*, the energy-intensive trade-exposed sectors, diesel fuel in the agriculture sector, jet fuel, and marine fuel were exempted). As provided for in the Initiative, the I-1631 fees were only applied to fossil fuel CO_2e emissions, thereby exempting non-fossil fuel CO_2e.[8] These I-1631 fees would increase energy prices to Washington state households and businesses—and introduce negative multiplier and other market effects—and thus negatively impact the Washington state economy. However, consumer and business reactions to these fees would be expected to lead to some reductions in Washington state GHG emissions.

[6] According to EIA data, Washington's 2016 carbon intensity in the electric sector (lbs CO_2 per MWh) was the lowest in the U.S. See Washington Electricity Profile 2016, available at: https://www.eia.gov/electricity/state/washington/.

[7] All dollar values in the Executive Summary are presented in current dollars, having been converted from year 2020 constant dollars based on the U.S. Energy Information Administration's *Annual Energy Outlook 2018's* projection of the consumer price index for all urban wage earners and clerical workers for the U.S. The average annual rate of increase from 2020 through 2035 is 2.6%. Results stated in constant (year 2020) dollars are provided in Appendix III.

[8] For purposes of this analysis, we assume that non-fossil GHGs are equal to the average of these emissions from 2010 through 2013 (source: "Report to the Legislature on Washington Greenhouse Gas Emissions Inventory: 2010 – 2013," Washington Department of Ecology, Oct. 2016), and remain constant throughout the modeling horizon.

This macroeconomic analysis also included the positive effects of spending the I-1631 fee revenues (and credits). Although there is considerable uncertainty on how the funds would be used, we selected actions and market interventions that represent the types of additional economic activities called for in the Initiative to yield additional GHG emission reductions. These include the following: (a) increased electric and natural gas efficiency, (b) incremental builds of solar photovoltaic power plants, and (c) reduced carbon-intensity of personal transportation. Our analysis also provided for funds to be used to assist low-income households with credits on their electricity and natural gas bills and for worker support. Finally, the analysis included the use of funds to provide additional government spending on allowable projects in the water/sewage, forestry/fisheries sectors, and on allowable education programs. Note that while I-1631 does not prevent I-1631 fee funds from being spent outside of Washington state, our analysis assumed that *all* direct spending of the I-1631 fees would be on in-state investments or directed to Washington state households, which would tend to increase the estimated positive impacts of the Initiative.

Pass-Through of I-1631 Fees

In our methodology, the added costs due to the I-1631 fees are passed through to consumers in the form of higher prices (*e.g.*, higher prices for fossil fuels and increased prices of other goods and services they consume). Cost pass-through is to be expected for several reasons. With respect to electricity and natural gas, utilities in the state base their energy rates on their total cost of service, and regulators traditionally treat costs of compliance with environmental regulations as an allowable cost to be passed along in customer rates. Regarding petroleum products, the I-1631 fee would be assessed on the carbon content embodied in the refined products, either as they enter the state or after having been refined by an in-state refinery. Given that sellers of refined products can choose to sell their product outside of Washington without bearing the cost of the fee, competition dictates that they will pass the fee through to the consumer as a precondition to serving any Washington consumers.[9]

It is important to note that this pass-through of I-1631 fees is not just a likely outcome of market forces, it is also an essential element to achieve the objectives of the Initiative. If the I-1631 fees were not passed through to consumers, the incentives to reduce *use* of the refined petroleum products (either by conservation or by switching to lower-carbon technologies to provide the energy services) would be eliminated and the GHG reductions would be much smaller than we have estimated. In other words, lack of pass-through would defeat the intention of I-1631 (to reduce GHG emissions), particularly with respect to reductions in usage of gasoline and diesel.

[9] The overwhelming majority of GHG emissions associated with petroleum consumption occurs at the point of combustion (*e.g.*, when cars are driven by consumers), while GHG emissions emitted at refineries are about 2% of the total GHG emissions associated with refined petroleum products. Thus, even if Washington's refineries were *not* to pass the costs of the fee on their refining emissions through to consumers, there would be little change in our analysis results, because about 98% of the cost associated with the I-1631 fees for refined petroleum products is tied to the CO_2 emitted by the consumers of the fuels and not by the refiners.

I. INTRODUCTION

Washington state's Initiative Measure No. 1631 (I-1631 or the Initiative) is a ballot initiative that will be voted on by the registered voters of Washington state on November 6, 2018.[10] NERA conducted a macroeconomic analysis of implementation of the provisions of I-1631, including both the "pollution fee" on the carbon content of fossil fuels ("pollution fee" is the specific language used in the Initiative – hereafter we refer to it as the "I-1631 fee") and the spending of the revenues and credits raised by the fee. This report provides estimates of the net energy and economic impacts in Washington state of the Initiative over the period from 2020 to 2035 as well as its impacts on Washington greenhouse gas (GHG) emissions.

A. Study Objectives

The principal study objectives were to estimate the potential *net* macroeconomic impacts and GHG emission reductions in Washington state from implementation of I-1631 over the period from 2020 (first implementation year) through 2035. By "net" impacts, we mean that the macroeconomic modeling includes the economic and emission impacts from spending the revenues (and credits) from the I-1631 fee *as well as* the economic and emission impacts of the I-1631 fee itself.[11] These two elements of the policy generally work in opposite directions in terms of economic impacts; that is, imposition of the I-1631 fee leads to negative macroeconomic impacts while spending the associated revenues leads to positive macroeconomic impacts, thereby offsetting each other. In contrast, the two elements generally work in the same direction in terms of reducing GHG emissions. We emphasize that a complete macroeconomic analysis of the Initiative requires modeling both the positive and the negative economic impacts of the Initiative.

We performed the analysis using NERA's proprietary energy-economic model called N_{ew}ERA, which allows us to estimate both the net macroeconomic and total GHG emission impacts in Washington state of the Initiative. The baseline macroeconomic conditions assumed for the analysis match publicly-available projections that have been developed by the U.S. government and by Washington state. We estimated the net economic and GHG emission impacts of the Initiative on Washington state by comparing the modeled economic and energy market outcomes that are projected to occur in Washington under a scenario that includes the provisions of I-1631 to their respective values in the baseline projection. Again, the provisions that define the policy scenario include the assessment of the I-1631 fees on covered fossil fuels and electricity and the spending of all the I-1631 fee funds (or utility credits).

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[10] The full text of the Initiative is available at: https://www.sos.wa.gov/_assets/elections/initiatives/finaltext_1482.pdf.

[11] For our analysis, we have assumed all the I-1631 fee funds (whether collected by the government or spent by utilities to obtain credits against their share of the fees) are spent on types of investments representative of those that the ballot initiative allows. The uses of the I-1631 fees in this analysis are representative of the many allowable ways the funds could be spent, including investments in various types of energy efficiency, renewable generation, and lower-emitting forms of transportation services as well as worker assistance, forestry programs, and education.

B. Report Organization

Section II provides a summary of the Initiative, including information on exemptions from the I-1631 fee and the allowed uses of the I-1631 fees raised by the Initiative. Section III includes information on our modeling methodology, including a description of the proprietary $N_{ew}ERA$ energy-economic model that has been used in this analysis. This section also provides information on how we have modeled the implementation of the Initiative, including the I-1631 fees, exemptions, and the spending of the I-1631 fee collections. Section IV includes our estimates of net energy, economic, and GHG emissions impacts in Washington state that are estimated to result from implementation of I-1631 over the period from 2020 to 2035. Appendix I includes additional details on the $N_{ew}ERA$ model; Appendix II includes additional information on assumptions regarding the spending of the I-1631 fee revenues; and Appendix III includes all results in year 2020 constant dollars (the main body of the report includes results reported in current dollars, *i.e.*, dollars that include the effects of future inflation).

II. OVERVIEW OF INITIATIVE 1631

I-1631 is a measure proposed for Washington's statewide ballot in November 2018 that would enact a "pollution fee" beginning January 1, 2020 on the carbon content of (i) fossil fuels sold or used in the state (with some sectoral exemptions), and (ii) electricity generated or imported into the state (with some exemptions for planned coal generator retirements).

A. Schedule of I-1631 Fees

The I-1631 fee would begin at $15 per metric ton of CO_2-equivalent (CO_2e) in 2020 and increase by $2 per metric ton per year plus an adjustment for inflation. The I-1631 fee would continue to be increased in this manner until the State's 2035 greenhouse gas (GHG) emission reduction goal is met.[12] If and when the goal were to be met, the fee would then increase by adjustments for inflation without the additional $2 per year adder. This analysis, however, does not project sufficient GHG emissions reductions to attain the State's 2035 goal by 2035.

B. Exemptions from the I-1631 Fee

Section 9 of I-1631 describes exemptions from the I-1631 fee for various sectors. These exemptions include:

- Fossil fuels brought into the state in the fuel supply tank of a motor vehicle, aircraft, vessel, or locomotive;
- Exports of fossil fuels outside of Washington state (excluding to Federally-recognized Indian tribal reservations located within the state);
- Motor vehicle fuels to government entities;
- Fossil fuels used by energy-intensive, trade-exposed (EITE) sectors;
- Electricity sold to EITE;
- Aircraft fuels and maritime fuels;
- Activities of Federally-recognized tribes that are exempt from state taxation;
- Diesel fuel, biodiesel fuel, or aircraft fuel used for agricultural purposes;
- Emissions from "Coal Closure Facilities"; and

[12] The State's GHG emission reduction goal for 2035 is to reduce GHG levels by 25% below 1990 levels, which would set 2035 GHG emissions at or below 66.3 million metric tons of CO_2e (RCW 70.235.020).

- Electricity generated in Washington and sold to other jurisdiction with a similar carbon fee.

GHG emissions from non-fossil sources are also not covered by I-1631.

C. Uses of I-1631 Fee Revenues

Section 3 of I-1631 sets up the "Clean Up Pollution Fund" in which pollution fee revenues would be deposited and from which expenditures would be made. In addition, the Initiative provides that light and power companies and natural gas distribution companies would be able to claim credits of up to 100% of their I-1631 fees to the extent they make allowable and approved clean energy investments on their own, and thus fees from those emissions would not go to the Clean Up Pollution Fund.

Section 3 of the Initiative identifies the following allowed types of spending of carbon fee revenues and rough allocations among the major types.

- Administrative costs (no specific allocation).
- Clean air and clean energy investments (70% of the funds within the Clean Up Pollution Fund after accounting for administrative costs).
    - Clean air and clean energy investments could include additions of renewables, increases to efficiency, projects to reduce transportation-related carbon emissions, deployment of zero-emission vehicles, increases in public transportation, demand-side management, distributed generation, and sequestration of carbon.
    - A minimum balance of $50 million must be set aside by four years after the effective date, and replenished annually, with the funds used to support workers "affected by the transition away from fossil fuels to a clean energy economy."
- Light and power companies and natural gas distribution companies would be able to claim credit for up to 100% of their pollution fees to be used for a range of clean energy investments.
    - Investment options for light and power companies could include: renewables, energy efficiency, transportation-related carbon emission reductions, public transit, demand-side management, synthetic fuels, distributed generation, energy storage, sequestration of carbon, as well as customer education/outreach, and accelerated depreciation of fossil generators.
    - Investment options for natural gas distribution companies could also include purchases of "alternative carbon reduction units" for up to ten percent of the I-1631 fee owed by a company in a given year.
- "Clean water and healthy forests" investments (25% of the funds within the Clean Up Pollution Fund after accounting for administrative costs).
    - Clean water and health forests investments could include restoring and protecting estuaries/fisheries/marine shoreline habitats, reducing flood risks, improving stormwater infrastructure, and increasing resiliency to wildfires.

- Healthy community investments (5% of the funds within the Clean Up Pollution Fund after accounting for administrative costs).
    - Healthy community investments could include support related to preparedness and awareness for wildfires, relocation due to flooding/sea level rise, and educational programs at public schools.

III. MODELING METHODOLOGY

This section describes the modeling methodology used in this study. The first two parts of this section describe the integrated energy-and-economy model used in the analysis (called N_{ew}ERA) and the nature of the baseline conditions used in the modeling. The third part of this section provides specifics regarding the I-1631 fee and the uses of I-1631 fee revenues that are assumed to estimate the effects of the Initiative.

A. N_{ew}ERA Model for This Study

NERA's N_{ew}ERA modeling system is an energy and economic modeling framework that integrates a bottom-up representation of the electricity sector with a top-down representation of the production and consumption decisions across the rest of the economy, including household decisions that affect overall energy use and related GHG emissions. The model produces integrated projections of energy sector and other economic activities for future years, and allows the energy and macroeconomic impacts of a potential policy to be estimated by comparing projections of the future with and without the policy's requirements included in the model's input assumptions.

A regional macroeconomic model is produced by tailoring the framework to reflect the specific U.S. regions, sectors, and time period of concern. For this analysis, a model of the Washington state economy was constructed with a sectoral detail that would allow for the various exemptions in I-1631 to be reasonably represented. The modeling for this study was for the period from 2020 through 2035 with modeling inputs and results for every third year in that period. The model results include the following types of information:

- *Macroeconomic results* – gross domestic product (and gross regional/state product for each macroeconomic region), changes in household consumption, changes in labor income and wage rates (used to estimate labor market changes in terms of an equivalent number of jobs), economy-wide energy usages, and wholesale and retail fuel prices.

- *Unit-level dispatch decisions in the electric sector* – changes in unit dispatch in response to different operating constraints (*e.g.*, emission rate limits or fees).

- *CO_2 emissions* – CO_2 emissions by sector, based on projected energy uses to meet demand for in-region production. Power sector CO_2 emissions are based on unit dispatch by fuel type. To estimate Washington state electricity sector emissions as they would be accounted for under I-1631, the model addresses in-state emissions and emissions associated with power flows from outside of the state. Our analysis has not considered how the Initiative might affect GHG emissions occurring outside of Washington state, as it was not possible to evaluate the complexities of international leakage within the time available to conduct this study.

Additional information about the N_{ew}ERA modeling framework is included in Appendix I.

B. Baseline Conditions

The N_{ew}ERA baseline conditions were calibrated to match projections developed by Federal government agencies, notably those of the EIA as defined in its *Annual Energy Outlook 2018* (*AEO 2018*) Reference (No CPP) case. This baseline includes the effects of continuing implementation of energy and environmental regulations that have already been promulgated (*e.g.*, the Regional Greenhouse Gas Initiative (RGGI), the California GHG cap-and-trade program, federal vehicle fuel economy standards, federal appliance energy efficiency standards, and state renewable portfolio standards) as well as other factors that lead to changes over time in the U.S. economy and the various sectors. Key assumptions drawn from *AEO 2018* include natural gas and crude oil prices, regional electricity demand, capital costs for new electric generators, GDP growth, and non-electric sector fuel use and emissions.

Baseline assumptions specific to Washington state are sourced from state-specific databases. These inputs include:

- Non-agricultural employment forecast by industry;[13]
- Agricultural employment forecast;[14]
- State population forecast;[15]
- Housing unit estimates;[16] and
- Vehicles miles traveled (VMT) forecast.[17]

Other baseline assumptions are taken from other publicly-available government sources, including the U.S. EPA and the Washington State Energy Office's Carbon Tax Assessment Model (CTAM).[18] These sources are summarized in the following table, along with a broad summary of the key inputs adjusted to develop the scenario representing I-1631.

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13 Long-term economic forecast, Office of Financial Management, State of Washington, 2018. Available at: https://www.ofm.wa.gov/washington-data-research/economy-and-labor-force/long-term-economic-forecast.

14 Long-term employment projections, Employment Security Department, State of Washington, 2018. Available at: https://esd.wa.gov/labormarketinfo/projections.

15 State population forecast, Office of Financial Management, State of Washington, 2017. Available at: https://www.ofm.wa.gov/washington-data-research/population-demographics/population-forecasts-and-projections/state-population-forecast.

16 April 1 postcensal estimates of housing: 1980, 1990 – present, Office of Financial Management, State of Washington, 2018. Available at: https://www.ofm.wa.gov/washington-data-research/population-demographics/population-estimates/historical-estimates-april-1-population-and-housing-state-counties-and-cities.

17 Vehicle miles traveled forecast, Transportation Revenue Forecast Council September 2017 Transportation Economic and Revenue Forecasts, Office of Financial Management, State of Washington, 2017. Available at: https://www.ofm.wa.gov/budget/budget-instructions/transportation-revenue-information.

18 Carbon Tax Assessment Model (CTAM) version 3.5 Base, July 12, 2018. Department of Commerce, State of Washington. Available at: http://www.commerce.wa.gov/wp-content/uploads/2018/08/Energy-CTAM-3-5-EIA-Ref-2018-July-12.xlsx.

Figure 1: Baseline Scenario and Overview of Initiative Scenario (I-1631)

Baseline Scenario	Initiative Scenario (I-1631)
• Projected fuel prices, emissions, and economic output consistent with U.S. Energy Information Administration's (EIA's) *Annual Energy Outlook 2018* (*AEO 2018*) reference case (includes existing national and state rules and regulations) • Includes Washington's existing renewable energy standard • Washington state economic information from Washington State Office of Financial Management	• Includes all baseline policies • I-1631 fee starting in 2020 • Coverage and exemptions per I-1631 • Use of collected I-1631 fees consistent with I-1631

For both the baseline and Initiative scenario, modeling of the period 2020 through 2035 involved explicit simulation of every third year during that period (2020, 2023, 2026, 2029, 2032, and 2035).

C. Information on Projected Implementation of I-1631

This section provides information on how various elements of I-1631 were modeled in this study.

1. I-1631 Fees

Table 3 shows the values for I-1631 fees by year (in year 2020 constant dollars and in current dollars) used in the study, based on the starting price of $15 per metric ton of carbon content, the $2 per metric ton increase per year, and the assumed inflation adjustment (to show the annual fees in current dollars).[19]

[19] The I-1631 fee is a price per metric ton of CO_2e at levels set by the Initiative. In our modeling, the fee is equivalent to a tax per metric ton of CO_2e.

Table 3: Estimated Annual Carbon Fees Per Metric Ton of Carbon Content (Year 2020 Constant Dollars and Current Dollars)

Year	Fee (2020$/ metric ton)	CPI-U[(*)]	Fee (Current$/ metric ton)
2020	$15.00	2.634	$15.00
2021	$17.00	2.711	$17.49
2022	$19.00	2.784	$20.08
2023	$21.00	2.862	$22.82
2024	$23.00	2.942	$25.68
2025	$25.00	3.021	$28.68
2026	$27.00	3.101	$31.78
2027	$29.00	3.181	$35.02
2028	$31.00	3.262	$38.39
2029	$33.00	3.345	$41.90
2030	$35.00	3.429	$45.56
2031	$37.00	3.517	$49.40
2032	$39.00	3.606	$53.39
2033	$41.00	3.699	$57.57
2034	$43.00	3.794	$61.93
2035	$45.00	3.892	$66.48

[(*)] Inflation is defined in I-1631 as the consumer price index for all urban wage earners and clerical workers for the United States (CPI-U). As was done in the State's Fiscal Impact Statement, we use a forecast of CPI-U. Our forecast is from the EIA, released as part of its *AEO 2018*. The average annual rate of inflation from 2020 through 2035 using the CPI-U index is 2.6%.

2. Emissions Covered by the I-1631 Fee

The I-1631 fee is applied to the carbon content, defined as the CO_2e released through the combustion or oxidation of fossil fuels, of fossil fuels (coal, natural gas, crude oil, and refined petroleum products) sold or used in Washington and of electricity generated within Washington or imported for use in Washington. This dollar-per-ton of CO_2e structure is equivalent to how carbon taxes are represented in N_{ew}ERA. Our modeling of the Initiative captures the CO_2e associated with combustion/oxidation of fossil fuels but does not account for non-CO_2 GHG emissions from the combustion/oxidation of fossil fuels.[20]

With respect to coverage in the electricity sector, state imports of power from other regions would be subject to the I-1631 fee, unless such imports are explicitly exempted (as discussed in Section III.C.3). Imports associated with directly-imported power use the CO_2e emission rate of the specific generator. Other imports are assumed to have a CO_2e emission rate of 0.428 metric tons per megawatt-hour (MWh), which is based on the rate that California applies to imports under its carbon policy.[21]

[20] We note that the "Fiscal Impact Statement" released by the State's Office of Financial Management, also did not evaluate non-CO_2 GHGs, and estimated that this exclusion understated I-1631 fee revenues by about 1%.

[21] Emission rate for unspecified electricity imports, see https://www.arb.ca.gov/cc/reporting/ghg-rep/regulation/mrr-2016-unofficial-2017-10-10.pdf?_ga=2.38149792.2074598499.1535745137-1154581668.1535722864.

3. Exemptions from the I-1631 Fee

Section 9 of I-1631 provides details on exemptions from the I-1631 fee. These exemptions, and the treatment of each exemption in our analysis, are summarized in Table 4.

Table 4: I-1631 Exemptions and Proposed Treatment in Analysis

Exemption	Treatment in NERA Analysis
Fossil fuels brought into the state in a fuel supply tank for a motor vehicle, aircraft, vessel, or locomotive	All residential motor vehicle fuel purchases will be subject to the I-1631 fee Aircraft and maritime fuels are separately exempt
Exports of fossil fuels outside of Washington state	The I-1631 fee is applied on carbon emissions, so exports will not be subject to the fee
Motor vehicle fuels to government entities	Emissions from refined petroleum products consumed in the government sector will be exempt[22]
Fossil fuels used by energy-intensive, trade-exposed (EITE)	All direct emissions from entities in the 23 EITE sectors will be exempt from paying the I-1631 fee
Electricity sold to EITE	Not implemented in the modeling; if electricity sold to EITE were to be exempt this would shift costs to other electricity customers
Aircraft fuels and maritime fuels	All direct emissions from the combustion of refined petroleum products in the commercial air and water transportation sectors will be exempt from paying the I-1631 fee
Activities of Federally-recognized Indian Tribes	We do not exempt any emissions associated with Federally-recognized tribal activities as we could not accurately identify such emissions
Diesel fuel used in agriculture	All direct emissions from the combustion of refined petroleum products in the agriculture sector will be exempt from paying the I-1631 fee
Emissions from "Coal Closure Facilities"	All emissions from Centralia units 1 and 2 (located in Washington and scheduled to retire by the ends of 2020 and 2025, respectively) and emissions associated with imports from Colstrip units 1 and 2 (located in Montana, but partially owned by Washington utilities, and scheduled to retire no later than 2022) will be exempt from paying the I-1631 fee
Electricity generated in WA sold to other jurisdiction with similar carbon fee/electricity generated in another region and subject to similar fee	Emissions associated with electricity imports from British Columbia (Canada) will not be subject to any I-1631 fees since those emissions are assumed to be subject to BC's carbon tax

Notes: (1) Fossil fuels supplied for purposes of generating electricity are also exempt. Electricity generators are subject to the I-1631 fee based on their CO_2 emissions from the combustion of supplied fossil fuels; (2) The Initiative only applies the I-1631 fee on fossil fuel GHG emissions, thereby exempting all non-fossil GHG emissions.

[22] This likely overstates the quantity of emissions that should be exempt as this would exempt heating oil as well as motor vehicle fuels.

We note that the exemption for "Coal Closure Facilities" could lead to some unintended consequences. As indicated in the Washington State Department of Commerce's CTAM model, the different treatments of coal-fired generation—*i.e.*, with some generation subject to the I-1631 fee and some exempt—could lead to a shift away from generation subject to the fee and towards generation that is exempt. In our analysis of I-1631, this shift occurs in the form of (a) increased imports from Colstrip units 1 and 2 prior to the retirement of these units and (b) increased dispatch of Centralia units 1 and 2, prior to their respective retirements; both increases displace imports of generation from Colstrip 3 and 4, which is subject to the I-1631 fee.

As shown in Table 5, due to exemptions, 59% of Washington state GHG emissions are covered in 2020 by the I-1631 fee provisions of the Initiative (based on projected 2020 baseline GHG emissions). (This percentage would be lower if "biogenic" GHG emissions are included in the total Washington state GHG emissions.)

Table 5: Coverage and Exemptions (Million Metric Tons)

	2020	**%**
Total Baseline GHG Emissions	92.5	100%
Total Fossil CO_2 Emissions	77.8	84%
Total Covered Fossil CO_2 Emissions	54.4	59%
Total Exempt Fossil CO_2 Emissions	23.4	25%
Total Non-Fossil CO_2e (all Exempt)	14.7	16%
Total Covered GHG Emissions	54.4	59%
Total Exempt GHG Emissions	38.1	41%

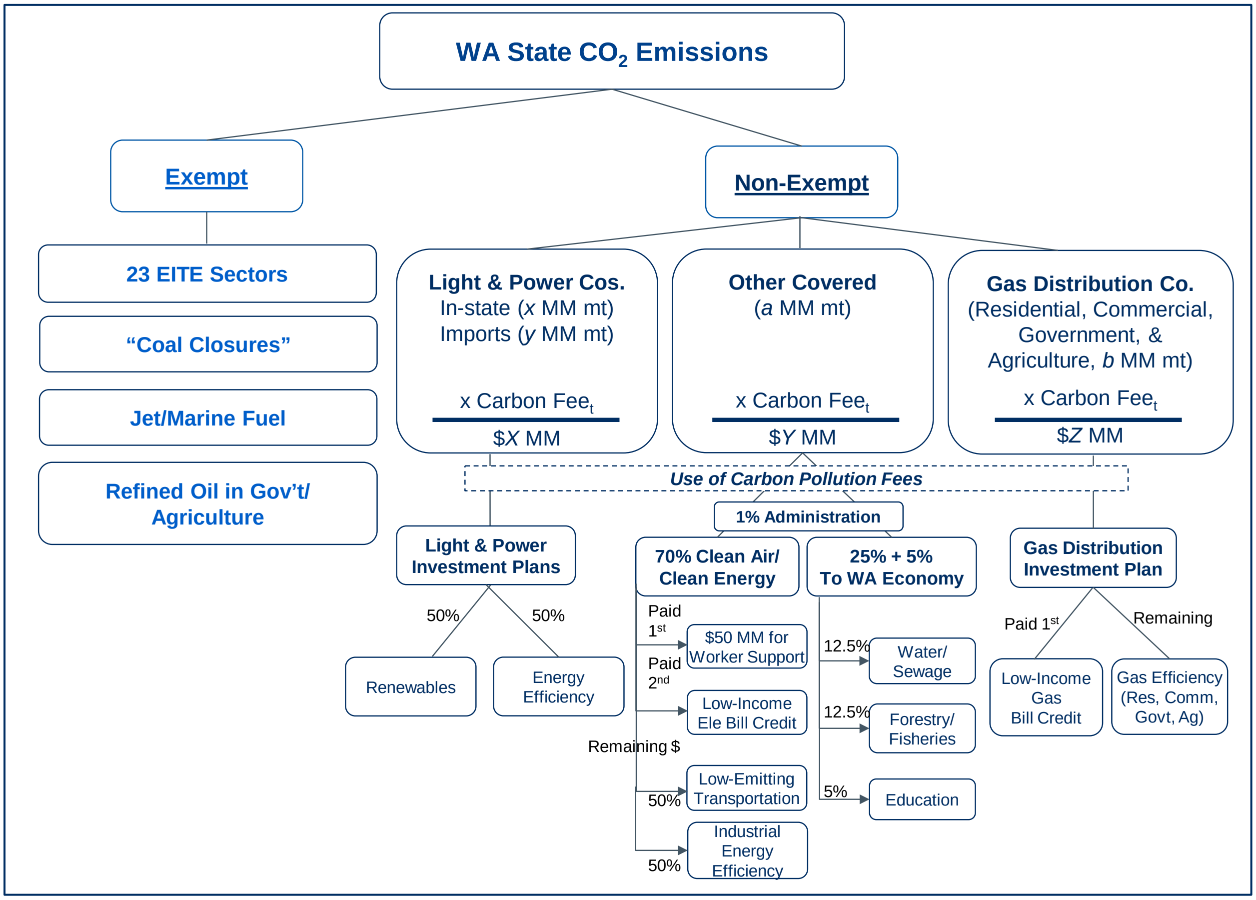
Note: Numbers may not add up due to rounding.
Sources: I-1631 and NERA calculations as described in report. Total Non-Fossil CO_2e based on 2010-2013 average for non-fossil CO_2e in "Report to the Legislature on Washington Greenhouse Gas Emissions Inventory: 2010 – 2013," Washington Department of Ecology, Oct. 2016.

4. Expenditures from I-1631 Fees

The I-1631 fees would be collected and then would be used to fund various activities. This study developed assumptions regarding the uses of the I-1631 fee revenues that are consistent with the allowable uses of such funds as described in the Initiative. This section summarizes these assumptions; more details are provided in Appendix II.

Figure 2 summarizes the allocation of the collected I-1631 fees to various types of expenditures. Although different allocations would be consistent with the Initiative, we believe that the allocations included in Figure 2 are reasonable considering the Initiative's descriptions of how the determination regarding expenditures would be made under the Initiative. We note that although 41% of the state's non-biogenic GHG emissions are exempted from payment of the I-1631 fee, our analysis has assumed that even the exempt sources will benefit from some of the spending of the collected fees. For example, EITE industrial sectors are assumed to receive a share of the Clean Air/Clean Energy spending on industrial energy efficiency, and shares of the spending on efficiency projects paid by gas and electric utilities to garner credits.

Figure 2: Graphical Representation of Use of I-1631 Fees



a. Light and Power Companies

I-1631 fees would be collected on non-exempt in-state electric generators, power imports (if any) from Colstrip units 3 and 4 (at their actual emission levels), and from power flows from other states (assumed to have a generic emission rate of 0.428 metric tons per MWh). These I-1631 fees would be collected by the light and power companies. We assume that these funds would remain in the control of the power sector, which would spend them on approved builds of solar photovoltaic (PV) installations (50%) and incremental demand-side energy efficiency (DSEE) projects related to electricity end-uses (50%).

b. Natural Gas Distribution Companies

I-1631 fees would be collected by natural gas distribution companies on their sales of natural gas. We assume that Washington state natural gas distribution companies supply all the natural gas used by the residential, commercial, government, and agriculture sectors in Washington, and collect the associated carbon revenues associated with combustion of this natural gas.[23] These funds are presumed to be used first to provide a credit to low-income households' bills to help offset the higher cost of natural gas. Remaining funds are assumed to be used to improve the natural gas energy efficiency for natural gas customers (including residential, commercial, government, and agriculture sectors).

c. Clean Up Pollution Fund

I-1631 fees collected from all sources besides light and power companies and natural gas distribution companies would be put into the Clean Up Pollution Fund. These fees would then be used for a range of investments or to assist workers and/or communities in Washington. The following are assumptions regarding these expenditures.

i. Clean Air and Clean Energy Investments

The Clean Air and Clean Energy Investments account would be allocated 70% of the fees in the Clean Up Pollution Fund (after netting out administrative costs). These funds are assumed to be used first to support workers "affected by the transition to a clean energy economy"[24] and to assist low-income residents with higher electricity bills. The remaining funds would be used (in equal amounts) (a) to reduce personal transportation CO_2 emissions in Washington state and (b) to improve the efficiency of industrial processes.[25] With respect to the latter, we assigned the funds to exempt and non-exempt sectors alike, in proportion to their respective share of natural gas demand/combustion.

ii. Clean Water and Healthy Forests Investments

The Clean Water and Healthy Forests Investments account would be allocated 25% of the fees in the Clean Up Pollution Fund (after netting out administrative costs). These funds are assumed to be used to fund additional government spending within Washington state on activities specifically allowable under the Initiative. These activities include projects in the water/sewage and forestry/fisheries sectors.

iii. Healthy Communities Investments

The Healthy Communities Investments account would be allocated 5% of the fees in the Clean Up Pollution Fund (after netting out administrative costs). These funds were assumed to be used to fund additional government spending within Washington state on activities specifically allowable under the

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[23] According to the EIA, in 2016 approximately 94% of natural gas deliveries to the industrial sector in Washington state were "delivered for the account of others," meaning that the gas was not owned by the company that delivered the gas. Approximately 15% of deliveries to the commercial sector also met this criterion. See https://www.eia.gov/dnav/ng/ng_cons_acct_dcu_SWA_a.htm. Natural gas delivered to power generators is exempt from the I-1631 fee and is typically also not owned by the natural gas distribution company.

[24] This appears to be the only spending category that is mandated and not just an option under the Initiative. This spending can be thought of as a transitional cost, like re-training workers. Workers would be re-trained and then employed in other sectors.

[25] These funds could be used for nearly the same suite of investment options as light and power companies. Similar to our decisions for the light and power and natural gas distribution companies, our assumptions on the use of these funds is one possible representation of the use of these funds whereby all the funds are recycled back to the economy.

Initiative. These activities include government spending on education projects (*e.g.*, community preparedness related to wildfires).

IV. ESTIMATED ENERGY, ECONOMIC, AND GHG EMISSIONS IMPACTS OF I-1631

This chapter provides estimates of the energy price, economic, and GHG emission impacts of I-1631 in Washington state based upon the macroeconomic modeling of the Initiative. We begin with estimates of the total I-1631 fees and how those fees would be spent in Washington state. We then summarize estimates of how I-1631 would affect energy prices in Washington state. We then present estimates of the net economic impacts on households, workers, and the Washington state economy. Finally, we present estimates of the estimated GHG emission reductions in Washington state due to I-1631. All dollar values in this section are in current dollars. (Values in year 2020 constant dollars are provided in Appendix III.)[26]

A. I-1631 Fees and Spending Due to I-1631

Table 6 shows the estimated total I-1631 fees that would be collected in each year. Total fees collected, including fees retained by light and power companies and gas distribution companies, amount to almost $790 million in 2020, increasing to about $3.1 billion in 2035, and totaling about $30 billion from 2020 through 2035. The bulk of total fees collected would go to the Carbon Pollution Fund. We note that our estimates of total I-1631 fees are generally consistent with those estimated in the State's Fiscal Impact Statement (FIS) for 2020 and 2023 (the only two years for which direct comparisons are possible), after adjusting for the difference between fiscal years and calendar years.[27] Compared to our estimates, the FIS estimates that more I-1631 fees are collected by the utilities (light/power plus gas) and less in the Carbon Pollution Fund. The likely source of this difference is that our analysis assumes that fees on natural gas consumed by industrial consumers are paid into the Carbon Pollution Fund rather than to the natural gas utility (because most industrial consumers procure their own natural gas). Note that the difference does not affect the modeling results because funds in both instances are assumed to be used for natural gas efficiency.

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[26] Current dollars differ from year 2020 constant dollars by including the effects of future inflation. The inflation estimates are based on the U.S. Energy Information Administration's *Annual Energy Outlook 2018's* projection of the consumer price index for all urban wage earners and clerical workers for the U.S. The average annual rate of inflation based on this index from 2020 through 2035 is 2.6%. Results stated in constant (year 2020) dollars are provided in Appendix III.

[27] Office of Financial Management, State of Washington. 2018. "Fiscal Impact Statement - I-1631 Reducing Pollution," Revised August 24. Available at: https://www.ofm.wa.gov/budget/fiscal-impact-ballot-measures-and-proposed-legislation/2018-general-election-ballot-fiscal-information.

Table 6: I-1631 Fee Collections (Millions of Current Dollars)

	2020	2023	2026	2029	2032	2035
Total I-1631 Fees	**$786**	**$1,169**	**$1,601**	**$2,058**	**$2,571**	**$3,147**
Electric Sector	$16	$39	$87	$113	$138	$163
Natural Gas LDC Distribution	$117	$176	$241	$315	$397	$490
Total Carbon Pollution Fund	$653	$954	$1,272	$1,630	$2,036	$2,494

Note: Numbers may not add up due to rounding.
Source: I-1631 and NERA calculations as described in report.

Total fees collected for the Carbon Pollution Fund specifically are projected to amount to about $650 million in 2020, increasing to $2.5 billion in 2035. Table 7 shows how our analysis has assumed those collections would be spent across the major spending categories. The table shows the disbursements to the allowable investment activities, including administrative costs, clean air and clean energy investments (70% of the funds, after accounting for administrative costs), clean water and health forests investments (25% of the funds, after accounting for administrative costs), and healthy community investments (5% of the funds, after accounting for administrative costs).

Table 7: Carbon Pollution Fund Spending (Millions of Current Dollars)

	2020	2023	2026	2029	2032	2035
Total Carbon Pollution Fund	**$653**	**$954**	**$1,272**	**$1,630**	**$2,036**	**$2,494**
Administration	$7	$10	$13	$16	$20	$25
Clean Air/Clean Energy	$452	$661	$882	$1,130	$1,411	$1,729
Worker Support	$0	$50	$54	$58	$63	$68
Low-Income Electricity Bill Credit	$15	$12	$6	$8	$10	$12
Low-Emitting Transportation	$219	$300	$411	$532	$669	$825
Industrial Energy Efficiency	$219	$300	$411	$532	$669	$825
Total Clean Water/Healthy Forests	$162	$236	$315	$403	$504	$617
Water/Sewage	$81	$118	$157	$202	$252	$309
Forestry/Fisheries	$81	$118	$157	$202	$252	$309
Healthy Communities	$32	$47	$63	$81	$101	$123
Education	$32	$47	$63	$81	$101	$123

Notes: Excludes spending within the light and power and natural gas distribution sectors that are assumed to retain their carbon fees for use on allowable investments.
Numbers may not add up due to rounding.
Source: I-1631 and NERA calculations as described in report.

B. Energy Price Impacts of I-1631

Energy prices will increase due to the Initiative to reflect the I-1631 fee and the macroeconomic impacts of the I-1631 fee. Table 8 summarizes the estimated changes in energy prices relative to projected baseline energy prices, expressed in dollars and in percentages, for 2020 through 2035. Prices of gasoline and diesel (cents per gallon), natural gas (dollars per Mcf), and electricity (¢/kWh) are projected to increase in each model year. Gasoline prices are projected to increase by 13¢ per gallon in 2020 and by 59¢ per gallon in 2035. Diesel prices are projected to increase by 15¢ per gallon in 2020 and by 66¢ per gallon in 2035, slightly more than gasoline because of their slightly higher carbon content. Natural gas prices are projected to increase by $0.76 per Mcf in 2020 and by $3.54 per Mcf in 2035. Electricity rates are projected to increase by 0.03¢ per kilowatt-hour in 2020 and by 1.7¢ per kilowatt-hour in 2035.

Table 8: Net Energy Price Impacts of I-1631, Relative to Baseline (Current Dollars)

	2020	2023	2026	2029	2032	2035
Change in Gasoline Price at Pump (¢/gallon and % change)	13¢	19¢	27¢	36¢	47¢	59¢
	5.9%	7.5%	9.4%	11.2%	13.1%	14.1%
Change in Diesel Price at Pump (¢/gallon and % change)	15¢	23¢	32¢	43¢	55¢	66¢
	4.4%	5.7%	7.2%	8.7%	10.3%	11.3%
Change in Delivered Price of Natural Gas to Households ($/Mcf and % change)	$0.76	$1.16	$1.64	$2.18	$2.82	$3.54
	6.0%	8.3%	10.4%	12.6%	15.2%	17.9%
Change in Delivered Price of Electricity to Households (¢/kWh and % change)	0.03¢	0.3¢	1.0¢	1.2¢	1.1¢	1.7¢
	0.3%	2.6%	7.7%	7.8%	6.6%	9.2%

Source: I-1631 and NERA calculations as described in report.

C. Net Economic Impacts of I-1631

Table 9 shows the Initiative's net impact on total costs for the average Washington state household for the period from 2020 through 2035, where costs reflect the reduction in spending power due to the Initiative. The Initiative is projected to increase total net costs per household by $440 in 2020 and by $990 in 2035. These estimates reflect the net effects of combining the negative effects of the I-1631 fees and the positive effects of the spending of the fees. We emphasize that these net costs per household estimates reflect the macroeconomic impacts of the Initiative, not just the simple estimates of added spending due to the I-1631 fee. The estimates include effects on Washington state household income due to changes in economic productivity and increased economic distortions due to the I-1631 fees (*e.g.*, interaction effects with existing taxes on labor and capital earnings).

Table 9: Average Total Cost per Washington State Household with I-1631 (Current Dollars)

	2020	2023	2026	2029	2032	2035
Average Total Cost per Washington State Household ($/Household)	$440	$550	$660	$760	$830	$990

Source: I-1631 and NERA calculations as described in report.

Table 10 shows the estimated net changes in Washington's Gross State Product (GSP) relative to projected baseline GSP, expressed in billions of dollars and in percentage change, for the period from 2020 through 2035. The Initiative is projected to reduce GSP by $2.2 billion (0.4%) in 2020 and by $5.3 billion (0.5%) in 2035. As with the other estimated impacts, these impacts reflect the combination of negative effects of the I-1631 fees and positive effects of the spending of the fees, including the full macroeconomic impacts of these effects.

Table 10: Net Change in Gross State Product with I-1631, Relative to Baseline (Current Dollars)

	2020	2023	2026	2029	2032	2035
Change in Gross State Product (Billions of $)	-$2.2	-$2.7	-$3.6	-$3.8	-$5.4	-$5.3
Percentage Change in Gross State Product (%)	-0.4%	-0.4%	-0.5%	-0.4%	-0.5%	-0.5%

Source: I-1631 and NERA calculations as described in report.

Table 11 shows the net changes in wage rate, labor income, and net worker income, relative to projected baseline levels for 2020 through 2035. I-1631 is projected to reduce Washington state workers' annual income (after accounting for the offsetting effects of worker financial assistance provided for in I-1631) by $800 million in 2020, rising to $3.2 billion in 2035. These reductions are equivalent to the income from approximately 9,000 jobs in 2020, and 21,300 jobs in 2035 (based upon average income levels in each year).[28] As with the other economic impact measures, these estimates of worker income reductions reflect the full net macroeconomic effects of the I-1631 fees and the spending of the fees.

[28] This measure does not represent a projection of the numbers of job positions that would be lost, since losses in household income reflect the possibilities of less income per worker as well as fewer workers in the Washington state economy. They also do not reflect an estimate of potential layoffs that might occur during transition to a new economic equilibrium; our analysis considers only the net changes that last after any transitional disruptions.

Table 11: Net Change in Net Employment Impacts with I-1631, Relative to Baseline

		2020	2023	2026	2029	2032	2035
% Change in Wage Rate	%	-0.3%	-0.4%	-0.4%	-0.5%	-0.5%	-0.6%
% Change in Labor Income	%	-0.3%	-0.4%	-0.4%	-0.5%	-0.5%	-0.6%
Change in Worker Income	Billions	-$0.8	-$1.3	-$1.6	-$2.0	-$2.2	-$3.2
	Job-Equivalents	-9,000	-12,300	-14,000	-16,000	-15,900	-21,300

Notes: A change in "job-equivalents" is defined as the change in total labor income divided by the average annual income per job in a given year and sector.
Source: I-1631 and NERA calculations as described in report.

D. Greenhouse Gas Emission Impacts of I-1631

Table 12 shows the projected total GHG emissions in Washington state for the baseline and with the Initiative (including both fossil CO_2 and non-fossil CO_2e, and excluding biogenic CO_2e emissions) for 2020 through 2035. Total non-fossil CO_2e emissions are assumed to remain constant at 14.7 million metric tons in each of the model years.[29] In the baseline, total GHG emissions are projected to be 92.5 million metric tons in 2020, declining to 80.5 million metric tons in 2035, a reduction of 12.0 million metric tons. These reductions over time in the baseline are from the effects of existing rules, regulations, and GHG emission reduction programs (mainly reductions from coal-fired electricity consumption) and are projected to occur with or without the Initiative. With the Initiative in place, total GHG emissions are projected to be 90.1 million metric tons in 2020, declining to 73.4 million metric tons in 2035.[30] This total comes from total fossil CO_2 emissions of 75.4 million metric tons in 2020 and 58.7 million metric tons in 2035, with the remaining GHG emissions from non-fossil CO_2e. Relative to the baseline, by 2035 Washington is projected to reduce its in-state GHG emissions (plus imported electricity GHG emissions) by 7.2 million metric tons (Table 13). As with the economic impacts, these reductions in GHG emissions reflect the total combined macroeconomic effects of the I-1631 fees and the spending of these fees.

[29] Total Non-Fossil CO_2e emissions are not included in our modeling and instead are assumed to remain at average levels from 2010 through 2013 as reported by the Washington Department of Ecology.

[30] The projected total GHG emissions in 2035 with the Initiative of 73. 4 million metric tons is more than 7 million metric tons above the State's 2035 goal of 66.3 million tons (see footnote 3).

Table 12: Total Washington State GHG Emissions for Baseline and the I-1631 Scenario (Million Metric Tons of CO_2e)

	2020	2023	2026	2029	2032	2035
Total GHG Emissions (Baseline)	**92.5**	**87.2**	**84.7**	**84.6**	**80.3**	**80.5**
Total GHG Emissions (I-1631)	**90.1**	**82.4**	**75.9**	**74.8**	**74.0**	**73.4**
Total Fossil CO_2 Emissions	75.4	67.7	61.2	60.1	59.3	58.7
Total Non-Fossil CO_2e Emissions	14.7	14.7	14.7	14.7	14.7	14.7

Notes: Total GHG Emissions excludes biogenic CO_2 emissions.
Numbers may not add up due to rounding.
Source: Total GHG and Total Fossil CO_2e based on I-1631 and NERA calculations as explained in text. Total Non-Fossil CO_2e based on 2010-2013 average for non-fossil CO_2e in "Report to the Legislature on Washington Greenhouse Gas Emissions Inventory: 2010 – 2013," Washington Department of Ecology, Oct. 2016.

Table 13: Changes in Total Washington State GHG Emissions with I-1631, Relative to Baseline (Million Metric Tons of CO_2e)

	2020	2023	2026	2029	2032	2035
Total GHG Emissions	-2.4	-4.8	-8.8	-9.8	-6.3	-7.2
Total Fossil CO_2 Emissions	-2.4	-4.8	-8.8	-9.8	-6.3	-7.2
Total Non-Fossil CO_2e	0	0	0	0	0	0

Notes: Changes in Total Washington State GHG Emissions are the difference between Total GHG Emissions (I-1631) and Total GHG Emissions (Baseline) in Table 12.
Total GHG Emissions excludes biogenic CO_2 emissions.
Numbers may not add up due to rounding.

It is possible to separate out the effect of the I-1631 fee and the effect of the expenditures on GHG emission reductions. Our analysis finds that approximately 4.6 million metric tons of the 7.2 million metric ton GHG reduction in 2035 results from the incentives created by the I-1631 fee itself, while the remaining 2.6 million metric tons are the incremental reductions from how the revenues (and credits) are projected to be spent, which we assume are targeted to GHG reduction projects. Note that this second element (the 2.6 million metric tons) would be a smaller reduction if the spending was not as clearly targeted toward GHG reduction projects as our analysis has assumed (as depicted in Figure 2).

The fluctuations in GHG emission reductions over time are mainly due to the timing of retirements of coal closure facilities and the assumed stoppage of imported power from Colstrip units 3 and 4. This can be seen more easily in Table 16 and Table 17 on the following pages.

Table 14 shows the Initiative's impact on Washington's covered GHG emissions (by sector) for 2020 through 2035. Table 15 shows changes in covered GHG emissions relative to projected baseline covered GHG emissions for 2020 through 2035. Across the modeling horizon, reductions in GHG emissions are projected for total covered GHG emissions as well as individual sectors. By 2035, the covered sectors in aggregate are projected to reduce their covered GHG emissions by 6.9 million metric tons.

Table 14: Washington State Covered GHG Emissions with I-1631 (Million Metric Tons of CO_2e)

	2020	2023	2026	2029	2032	2035
Covered Emissions	**52.4**	**51.2**	**50.4**	**49.1**	**48.2**	**47.3**
Manufacturing	7.0	6.9	6.6	6.5	6.4	6.3
Refining	2.5	2.4	2.5	2.5	2.6	2.7
Households	27.2	25.5	23.6	22.1	21.1	20.1
Commercial Trucking/Rail	10.6	10.8	11.1	11.3	11.6	11.8
Services	2.8	2.7	2.7	2.7	2.8	2.8
Government (excluding transportation fuel)	0.8	0.8	0.8	0.7	0.7	0.7
Agriculture (excluding diesel fuel)	0.2	0.3	0.2	0.2	0.3	0.2
Commercial Air/Marine (excl. jet/marine fuel)	0.1	0.2	0.2	0.2	0.2	0.3
Covered Electric Sector	1.1	1.7	2.7	2.7	2.6	2.5

Note: Numbers may not add up due to rounding.
Source: I-1631 and NERA calculations as described in report.

Table 15: Changes in Covered GHG Emissions with I-1631, Relative to Baseline (Million Metric Tons of CO_2e)

	2020	2023	2026	2029	2032	2035
Covered Emissions (Electric & Non-Electric)	-7.2	-7.6	-8.7	-9.6	-6.1	-6.9
Manufacturing	-0.1	-0.3	-0.5	-0.7	-0.9	-1.0
Refining	-0.1	-0.1	-0.1	-0.2	-0.2	-0.2
Households	-0.9	-1.2	-1.5	-1.9	-2.3	-2.7
Commercial Trucking/Rail	-0.1	-0.1	-0.2	-0.2	-0.2	-0.3
Services	0.0	-0.1	-0.1	-0.1	-0.2	-0.2
Government (excluding transportation fuel)	0.0	-0.1	-0.1	-0.1	-0.2	-0.2
Agriculture (excluding diesel fuel)	0.0	0.0	0.0	0.0	0.0	0.0
Commercial Air/Marine (excl. jet/marine fuel)	0.0	0.0	0.0	0.0	0.0	-0.1
Covered Electric Sector	-5.9	-5.7	-6.2	-6.3	-2.0	-2.1

Note: Changes in Covered GHG Emissions are the difference between Covered GHG Emissions (I-1631) and Covered GHG Emissions (Baseline).
Numbers may not add up due to rounding.
Source: I-1631 and NERA calculations as described in report.

Table 16 shows the Initiative's impact on electric sector GHG emissions (based on consumption), including both covered and exempt emissions for 2020 through 2035. The relatively high values for total exempt electric emissions are associated with emissions from Centralia units 1 and 2 (scheduled to retire by the ends of 2020 and 2025, respectively) and from Colstrip units 1 and 2 (scheduled to retire no later than 2022), collectively the "coal closure facilities." Table 17 shows the changes in electric sector GHG emissions relative to projected baseline electric sector GHG emissions, for 2020 through 2035. The greatest changes in electric sector emissions are projected reductions of 6.2 and 6.3 million metric tons in 2026 and 2029, respectively, which are primarily from changes in emissions related to imports from Colstrip units 3 and 4 (this power is directly imported in the baseline and projected not to be imported under implementation of I-1631).

Table 16: Electric Sector GHG Emissions (Consumption-Based) with I-1631 (Million Metric Tons of CO_2e)

	2020	2023	2026	2029	2032	2035
Electric Sector Emissions	**13.6**	**7.5**	**2.7**	**2.7**	**2.6**	**2.5**
Total Covered Electric	1.1	1.7	2.7	2.7	2.6	2.5
Covered In-State	0.7	1.2	1.6	1.5	1.5	1.4
Covered Other Imports	0.3	0.5	1.2	1.2	1.1	1.0
Total Exempt Electric	12.5	5.8	0.0	0.0	0.0	0.0
Exempt In-State	7.7	5.8	0.0	0.0	0.0	0.0
Exempt Imports	4.8	0.0	0.0	0.0	0.0	0.0

Notes: Covered Other Imports are assigned an emission rate of 0.428 metric tons per megawatt-hour.
Numbers may not add up due to rounding.
Source: I-1631 and NERA calculations as described in report.

Table 17: Changes in Electric Sector GHG Emissions (Consumption-Based) with I-1631, Relative to Baseline (Million Metric Tons of CO_2e)

	2020	2023	2026	2029	2032	2035
Electric Sector Emissions	**-1.1**	**-2.8**	**-6.2**	**-6.3**	**-2.0**	**-2.1**
Total Covered Electric	-5.9	-5.7	-6.2	-6.3	-2.0	-2.1
Covered In-State	-0.6	-0.7	-1.3	-1.5	-1.5	-1.4
Covered Other Imports	-5.3	-5.0	-4.9	-4.8	-0.5	-0.7
Total Exempt Electric	4.8	2.9	0.0	0.0	0.0	0.0
Exempt In-State	1.9	2.9	0.0	0.0	0.0	0.0
Exempt Imports	2.9	0.0	0.0	0.0	0.0	0.0

Notes: Changes in Electric Sector GHG Emissions are the difference between Electric Sector GHG Emissions (I-1631) and Electric Sector GHG Emissions (Baseline).
Covered Other Imports are assigned an emission rate of 0.428 metric tons per megawatt-hour.
Numbers may not add up due to rounding.
Source: I-1631 and NERA calculations as described in report.

Table 18 shows the Initiative's impact on exempt GHG emissions, for 2020 through 2035. Across the modeling horizon, GHG reductions are projected for total exempt emissions, largely driven by reductions in exempt electric sector emissions. Exempt emissions are projected to remain relatively flat in the 23 Energy-Intensive Trade-Exposed sectors, motor fuel in Government, and diesel in Agriculture. Slight GHG emission increases are projected for jet fuel and marine fuel consumption. Table 19 shows the changes in exempt GHG emissions relative to projected baseline exempt GHG emissions, for 2020 through 2035. The largest changes in total exempt GHG emissions are projected reductions of 2.1 million metric tons in 2023 and 5.1 million metric tons in both 2026 and 2029 (again, largely driven by reductions in exempt electric sector emissions).

Table 18: Washington State Exempt GHG Emissions with I-1631 (Million Metric Tons of CO_2e)

	2020	2023	2026	2029	2032	2035
Exempt Emissions	23.1	16.5	10.8	11.0	11.2	11.3
Energy-Intensive Trade-Exposed	1.2	1.2	1.2	1.2	1.2	1.2
Motor Fuel in Government	0.3	0.3	0.3	0.3	0.3	0.3
Diesel in Agriculture	0.5	0.4	0.4	0.4	0.4	0.4
Jet Fuel and Marine Fuel	8.5	8.7	8.9	9.0	9.2	9.4
Exempt Electric Sector	12.5	5.8	0.0	0.0	0.0	0.0

Note: Numbers may not add up due to rounding.
Source: I-1631 and NERA calculations as described in report.

Table 19: Changes in Washington State Exempt GHG Emissions with I-1631, Relative to Baseline (Million Metric Tons of CO_2e)

	2020	2023	2026	2029	2032	2035
Exempt Emissions	4.8	2.8	-0.13	-0.17	-0.22	-0.27
Energy-Intensive Trade-Exposed	-0.02	-0.07	-0.11	-0.15	-0.20	-0.24
Motor Fuel in Government	0.01	0.01	0.02	0.03	0.03	0.04
Diesel in Agriculture	0.00	0.00	0.00	0.00	0.00	0.00
Jet Fuel and Marine Fuel	-0.03	-0.03	-0.04	-0.05	-0.06	-0.06
Exempt Electric Sector	4.8	2.9	0.00	0.00	0.00	0.00

Note: Changes in Exempt GHG Emissions are the difference between Exempt GHG Emissions (I-1631) and Exempt GHG Emissions (Baseline).
Numbers may not add up due to rounding.
Source: I-1631 and NERA calculations as described in report.

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Appendix I. N$_{ew}$ERA MODELING FRAMEWORK

A. Introduction

NERA developed the N$_{ew}$ERA model to forecast the impact of policy, regulatory, and economic factors on the energy sectors and the economy. When evaluating policies that have significant impacts on the entire economy, this model specification captures the effects as they ripple through all sectors of the economy and the associated feedback effects. The N$_{ew}$ERA model combines a macroeconomic model with all sectors of the economy with a detailed electric sector model that represents electricity production. This combination allows for a complete understanding of the economic impacts of different policies on all sectors of the economy.

The macroeconomic model incorporates all production sectors except electricity and final demand of the economy. Policy consequences are transmitted throughout the economy as sectors respond until the economy reaches equilibrium. The production and consumption functions employed in the model enable gradual substitution of inputs in response to relative price changes, thus avoiding all-or-nothing solutions.

The main benefit of the integrated framework is that the electric sector can be modeled in great detail yet through integration the model captures the interactions and feedbacks between all sectors of the economy. Electric technologies can be well represented according to engineering specifications. The integrated modeling approach also provides consistent price responses since all sectors of the economy are modeled. In addition, under this framework electricity demand response is modeled.

The electric sector model is a detailed model of the electric and coal sectors. Each of the more than 18,000 electric generating units in the United States is represented in the model. The model minimizes costs while meeting all specified constraints, such as demand, peak demand, emissions limits, and transmission limits. The model determines investments to undertake and units to dispatch. The N$_{ew}$ERA model also represents the domestic and international crude oil and refined petroleum markets.

The N$_{ew}$ERA model outputs include demand and supply of all goods and services, prices of all commodities, and terms of trade effects (including changes in imports and exports). The model outputs also include gross regional/state product, consumption, investment, and changes in "job equivalents" based on labor wage income.

B. Overview

NERA's N$_{ew}$ERA modeling system is an integrated energy and economic model that includes a bottom-up representation of the electricity sector, including all of the unit-level details that are required to accurately evaluate changes in the electric sector. N$_{ew}$ERA integrates the electricity sector model with a macroeconomic model that includes all other sectors of the economy (except for the electricity production) using a top-down representation. The model produces integrated forecasts for future years. The model produces a standard set of reports that includes the following information:

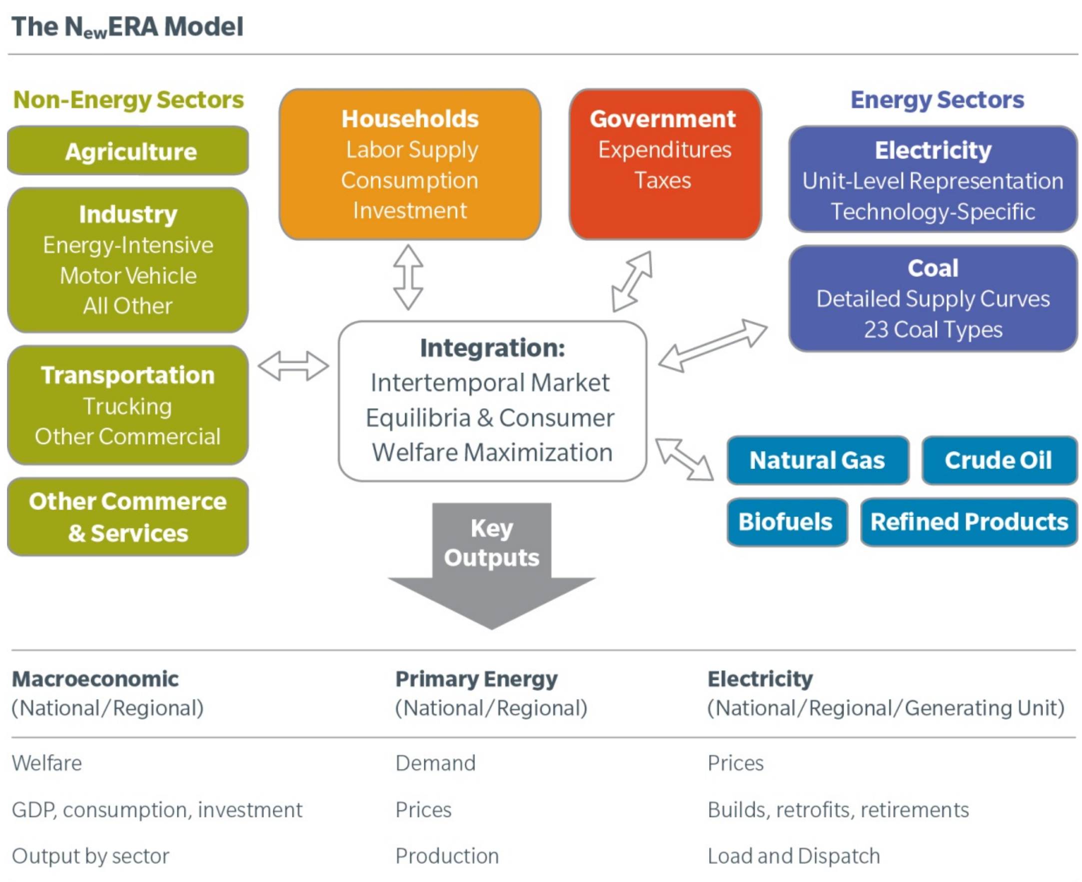
- *Unit-level dispatch decisions in the electric sector* – changes in unit dispatch in response to different operating constraints (*e.g.*, emission rate limits).

- *CO_2 emissions* – power sector CO_2 emissions based on unit dispatch and a representation of the U.S. transmissions system (including interconnections with Canada). For Washington state, CO_2 emissions include in-state emissions, emissions associated with contracted power flows from outside of the state, and non-contracted power flows from outside the state.

- *Macroeconomic results* – gross domestic product (and gross regional/state product for each macroeconomic region), changes in household consumption, changes in labor income and wage rates (used to estimate labor market changes in terms of an equivalent number of jobs), economy-wide energy usages, fuel prices, economy-wide CO_2 emissions by sector.

Figure 3 provides a simplified representation of the key elements of the N$_{ew}$ERA modeling system.

Figure 3: N$_{ew}$ERA Modeling System Representation



C. Electric Sector Model

The electric sector model that is part of the N$_{ew}$ERA modeling system is a bottom-up model of the electric and coal sectors. Consistent with the macroeconomic model, the electric sector model is fully dynamic and includes perfect foresight (under the assumption that future conditions are known). Thus, all decisions within the model are based on minimizing the present value of costs over the entire time horizon of the model while meeting all specified constraints, including demand, peak demand, emissions limits, transmission limits, RPS regulations, fuel availability and costs, and new build limits. The model set-up is intended to mimic (as much as is possible within a model) the approach that electric sector investors use to make decisions. In determining the least-cost method of satisfying all these constraints, the model endogenously decides:

- What investments to undertake (*e.g.*, addition of retrofits, build new capacity, repower unit, add fuel switching capacity, or retire units);

- How to operate each modeled unit (*e.g.*, when and how much to operate units, which fuels to burn) and what is the optimal generation mix; and

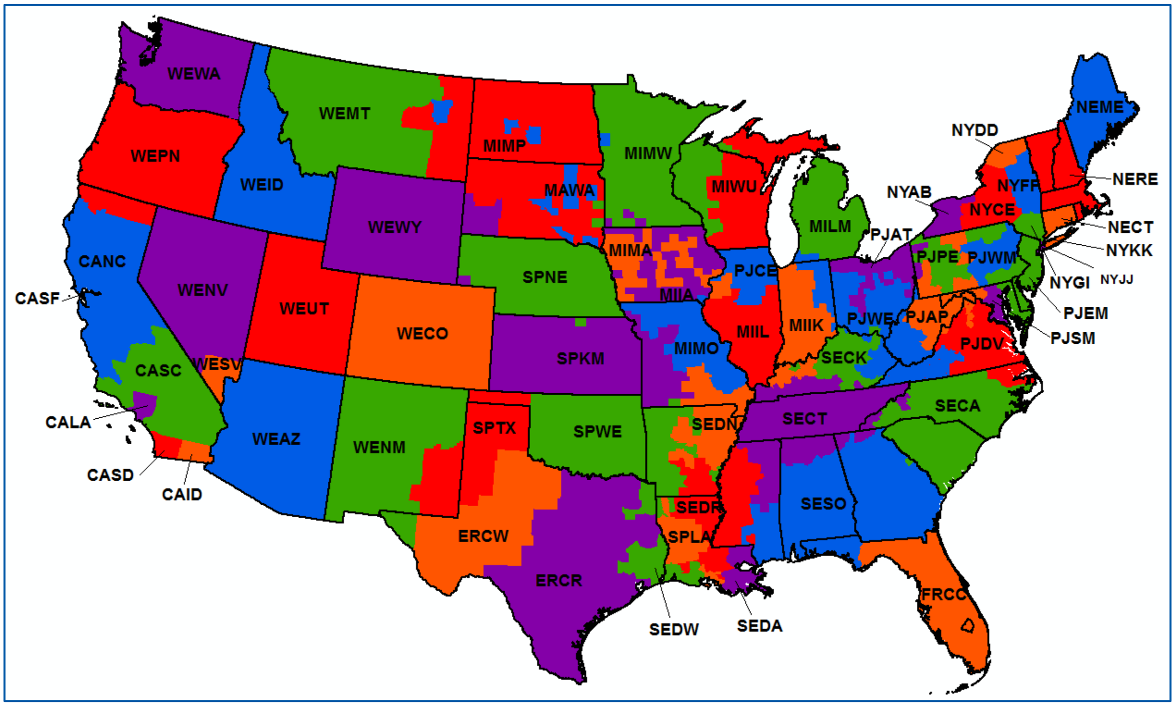
- How demand will respond. The model thus assesses the trade-offs between the amount of demand-side management (DSM) to undertake and the level of electricity usage.

Each unit in the model has certain actions that it can undertake. For example, all units can retire, and many can undergo retrofits. Any publicly-announced actions, such as planned retirements, planned retrofits (for existing units), or new units under construction can be specified.

To meet increasing electricity demand and reserve margin requirements over time, the electric sector must build new generating capacity. Future environmental regulations and forecasted energy prices influence which technologies to build and where. For example, if a national RPS policy is to take effect, some share of new generating capacity will need to come from renewable power. On the other hand, if there is a policy to address emissions, it might elicit a response to retrofit existing fossil-fired units with pollution control technology or enhance existing coal-fired units to burn different types of coals, biomass, or natural gas. Policies calling for improved heat rates may lead to capital expenditure spent on repowering existing units. All these policies will also likely affect retirement decisions. The N_{ew}ERA electric sector model endogenously captures all of these different types of decisions.

The model contains 64 U.S. electricity regions (and 11 Canadian electricity regions), including a breakout for Washington state. Figure 4 shows the U.S. electricity regions.

Figure 4: N$_{ew}$ERA Electric Sector Model – U.S. Regions



D. Macroeconomic Model

1. Overview

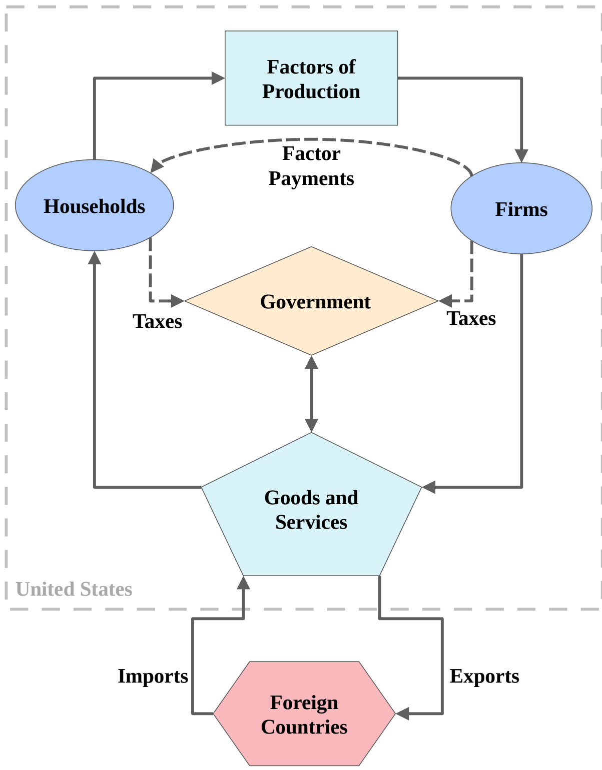
The N$_{ew}$ERA macroeconomic model is a forward-looking, dynamic, computable general equilibrium (CGE) model of the United States. The model simulates all economic interactions in the U.S. economy, including those among industry, households, and the government. Additional background information on CGE models can be found in Burfisher.[31]

The N$_{ew}$ERA CGE framework uses the standard theoretical macroeconomic structure to capture the flow of goods and factors of production within the economy. A simplified version of these interdependent macroeconomic flows is shown in Figure 5. The model implicitly assumes "general equilibrium," which implies that all sectors in the economy are in balance and all economic flows are endogenously accounted for within the model. In this model, households supply factors of production, including labor and capital, to firms. Firms provide households with payments for the factors of production in return. Firm output is produced from a combination of productive factors and intermediate inputs of goods and services supplied by other firms. Individual firm final output can be consumed within the United States or exported. The model also accounts for imports into the United States. In addition to consuming goods and services, households can accumulate savings, which they provide to firms for investments in new capital. Government receives taxes from both households and firms, contributes to the production of

[31] Burfisher ME. 2011. *Introduction to Computable General Equilibrium Models*. New York: Cambridge University Press.

goods and services, and purchases goods and services. Although the model assumes equilibrium, a region in the model can run deficits or surpluses in current accounts and capital accounts. In aggregate, all markets clear, meaning that the sum of regional commodities and factors of production must equal their demands, and the income of each household must equal its factor endowments plus any net transfers received.

Figure 5: Interdependent Economic Flows in N$_{ew}$ERA's Macroeconomic Model



The model uses the standard CGE framework developed by Arrow and Debreu (1954).[32] Behavior of households is represented by a nested Constant Elasticity of Substitution (CES) utility function. The model assumes that households seek to maximize their overall welfare, or utility, across time periods. Households have utility functions that reflect trade-offs between leisure (which reduces the amount of time available for earning income) and an aggregate consumption of goods and services. Households maximize their utility over all time periods subject to an intertemporal budget constraint based on their income from supplying labor, capital, and natural resource to firms. In each time period, household income is used to consume goods and services or to fund investment. Within consumption, households substitute between energy (including electricity, coal, natural gas, and petroleum), personal transportation, and goods and services based on the relative price of these inputs. Figure 6 illustrates the utility function of the households. Figure 7 provides additional detail on personal transportation services within households.

[32] Arrow KJ and Debreu G. 1954. "Existence of an Equilibrium for a Competitive Economy." *Econometric*a 22:265-290.

Figure 6: Household Consumption Structure in N_{ew}ERA's Macroeconomic Model

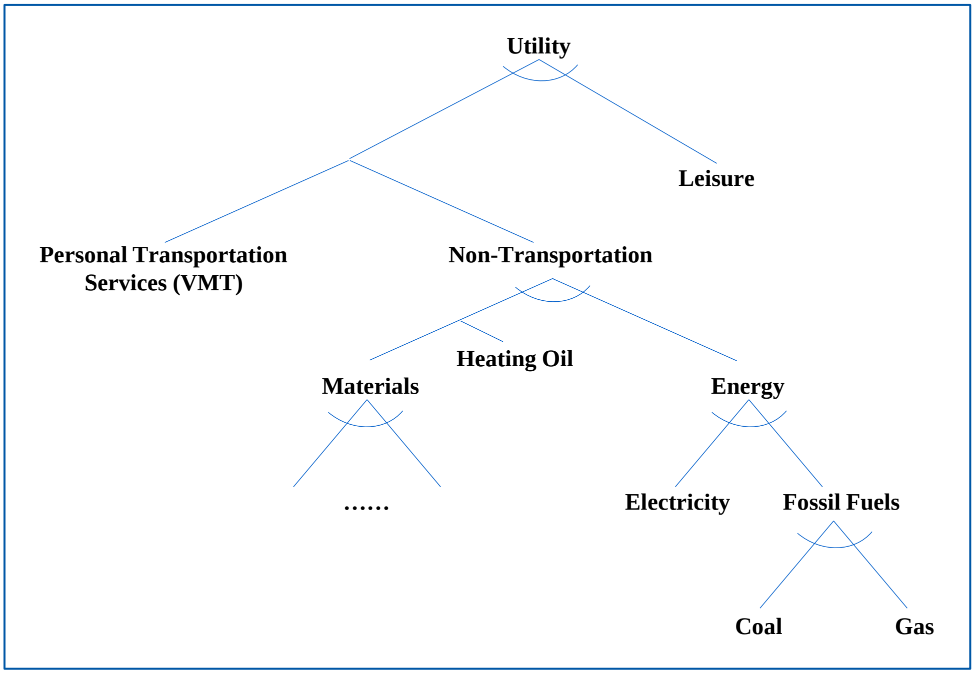
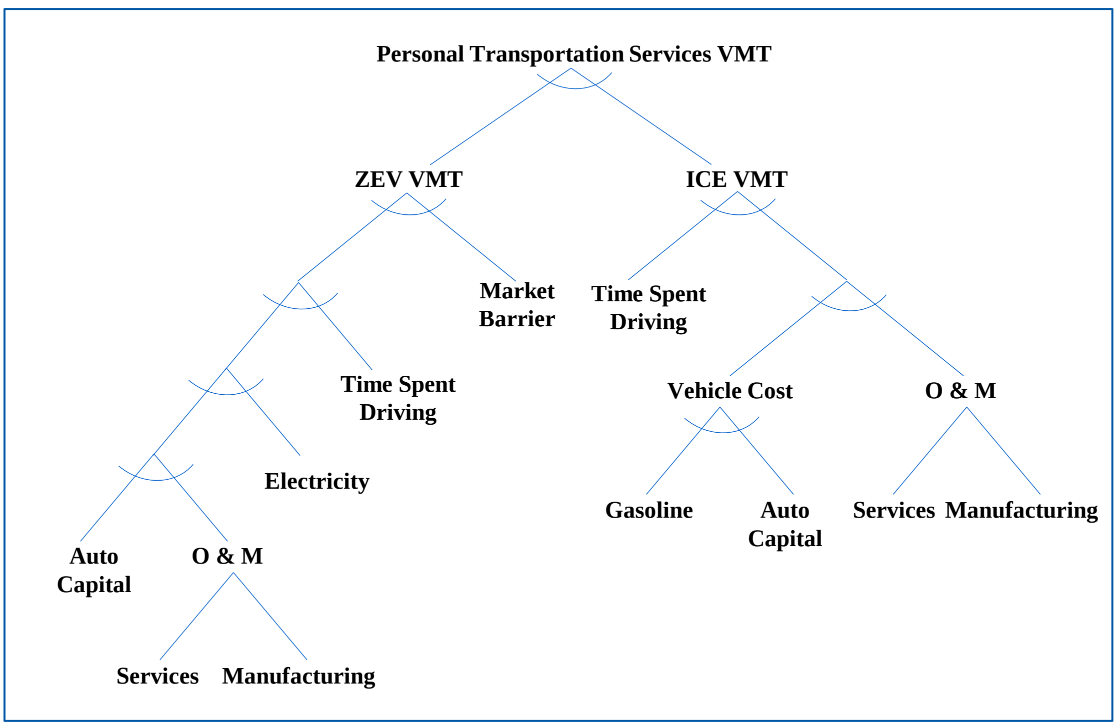


Figure 7: Household Personal Transportation Services in N_{ew}ERA's Macroeconomic Model



On the production side, Figure 8 shows the production structure for the manufacturing and energy-intensive structures and Figure 9 shows the production structure for the refining sector. The model assumes all industries maximize profits subject to technological constraints. The inputs to production are energy (including the same four types noted above for household consumption), capital, and labor. Production also uses inputs from intermediate products (*i.e.*, materials) provided by other firms. The N$_{ew}$ERA model allows producers to gradually change the technology and the energy source they use to manufacture goods over time. If, for example, refined petroleum prices rise, an industry can shift to a cheaper energy source. It can also choose to use more capital or labor in place of refined petroleum, increasing energy efficiency and maximizing profits with respect to industry constraints.

Figure 8: Production Structure for Manufacturing and Energy-Intensive Sectors in N$_{ew}$ERA's Macroeconomic Model

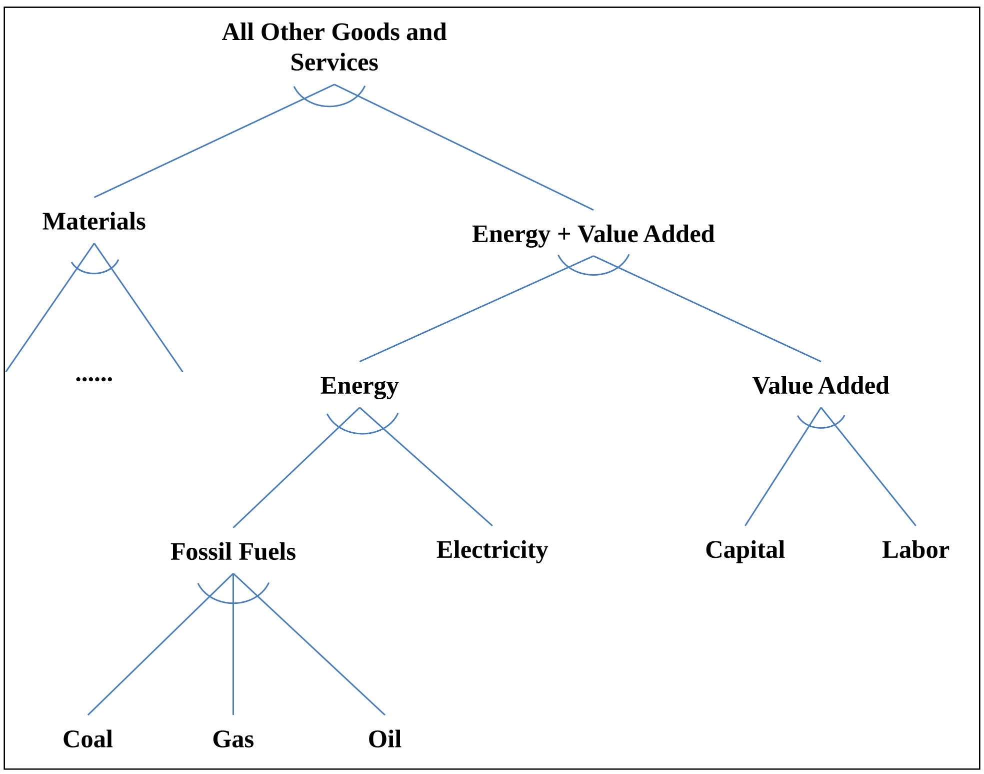
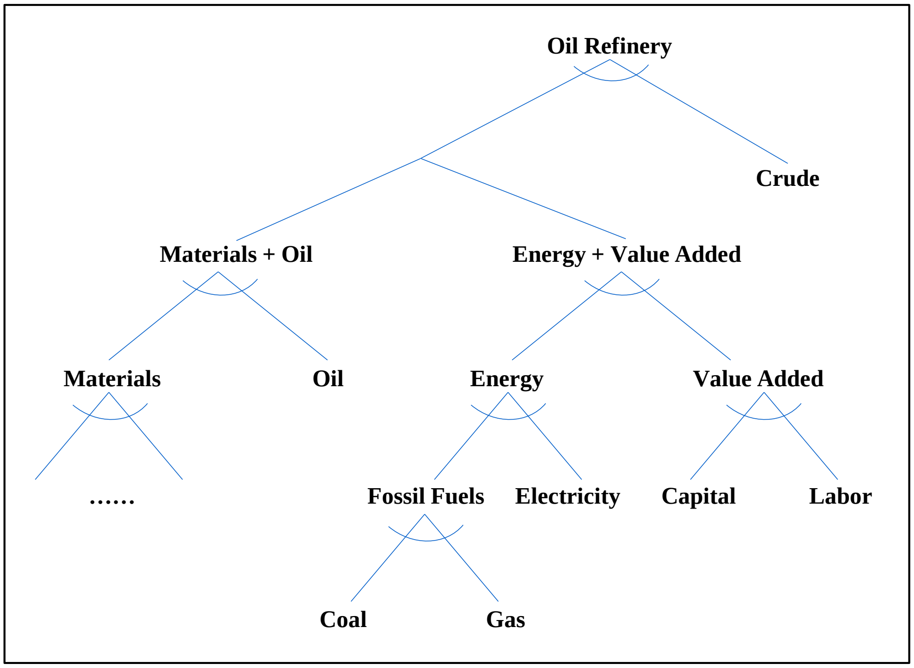


Figure 9: Production Structure for Refining Sector in N$_{ew}$ERA's Macroeconomic Model



All goods and services, except crude oil, are treated as Armington goods, which assume the domestic and foreign goods are differentiated and thus are imperfect substitutes.[33] The level of imports depends upon the elasticity of substitution between the imported and domestic goods. The Armington elasticity among imported goods is assumed to be twice as large as the elasticity between the domestic and imported goods, characterizing the greater substitutability among imported goods.

Business investment decisions are informed by future policies and outlook. The forward-looking characteristic of the model enables businesses and consumers to determine the optimal savings and investment levels while anticipating future policies with perfect foresight.

The benchmark year economic interactions are based on the IMPLAN 2008 database, which includes regional detail on economic interactions among 440 different economic sectors. The macroeconomic and energy forecasts that are used to project the benchmark year going forward are calibrated to EIA's *AEO 2018* Reference case.

1. Interactions between Compliance Costs, Capital Investment, and Household Expenditures

Regulations cause producers in the affected industries to make capital expenditures that they would not make otherwise. In addition, regulations change consumption patterns for households. To model the

[33] Armington P. 1969. "A Theory of Demand for Products Distinguished by Place of Production." *International Monetary Fund Staff Papers*, XVI: 159-78.

macroeconomic impacts of regulations, N_{ew}ERA accounts for interactions between compliance costs, capital investments, and household expenditures based on the following three effects.

1. *Compliance costs for producers in the regulated industries*. Producers in the regulated industries have to make capital expenditures to comply with the regulation. These expenditures increase the costs of producing goods and services in the regulated industries. The higher costs lead to higher prices for the goods and services, which in turn lead to lower demand in the regulated industries. Thus, this effect reduces economic activity.

2. *Scarcity effect due to non-optimal capital allocation*. In N_{ew}ERA's modeling framework, the capital expenditures for regulatory compliance are assumed to be unproductive. The capital expenditures in the regulated industries make less capital available to produce goods and services throughout the economy. In other words, the unproductive capital expenditures in the regulated industries "crowd out" productive capital investment in the broader economy. This scarcity effect increases the opportunity cost of capital in the economy, which implies higher costs of capital. This in turn lowers investment in productive capital and slows economic growth.

3. *Household purchases of unproductive durable goods*. Regulations also cause households to change their consumption patterns, particularly in terms of durable goods. For example, households may need to purchase new automobiles, lawn mowers, or equipment for compliance with the regulation. These additional expenditures on unproductive durable goods are non-optimal from the standpoint of households, but they represent increased demand for the manufacturing sector. Thus, these additional household purchases increase economic activity.

The net macroeconomic impacts of regulations calculated by N_{ew}ERA reflect the combination of these three effects.

2. Regional Aggregation

The N_{ew}ERA macroeconomic model for this engagement includes 4 macroeconomic regions built up from economic data for the 50 U.S. states and the District of Columbia. The regions are Washington state, California, rest of West (OR, ID, MT, WY, UT, CO, NV, AZ, NM, AK, and HI), and rest of U.S.

3. Sectoral Aggregation

The N_{ew}ERA model for this engagement includes 14 economic sectors: five energy (coal, natural gas, crude oil, electricity, and refined petroleum products) and nine non-energy sectors (agriculture, commercial transportation (air and sea), commercial transportation (trucking and trains), motor vehicle manufacturing, food manufacturing, airplane manufacturing, energy-intensive sectors, other manufacturing, and services). These sectors are aggregated up from the 440 IMPLAN sectors. There is also a government sector.

4. Natural Gas and Crude Oil Markets

As with most commodity markets, there are uncertainties about how the U.S. natural gas market will evolve, and the N_{ew}ERA modeling system is designed explicitly to address the key factors affecting future natural gas supply and prices. The N_{ew}ERA model represents the domestic and international crude oil and refined petroleum markets. The international markets are represented by flat supply curves with exogenously specified prices. Because crude oil is treated as a homogeneous good, the international price for crude oil sets the U.S. price for crude oil.

5. Macroeconomic Outputs

As with other CGE models, the N_{ew}ERA macroeconomic model outputs include demand and supply of all goods and services, prices of all commodities, and terms of trade effects (including changes in imports and exports). The model outputs also include gross regional product, consumption, investment, cost of living or burden on consumers, and changes in "job equivalents" based on changes in labor wage income. All model outputs are calculated by time, sector, and region.

Impacts on workers are often considered an important output of policy evaluations. Impacts on workers are complicated to estimate and to explain because they can include several different impacts, including involuntary unemployment, reductions in wage rates for those who continue to work, and voluntary reductions in hours worked due to lower wage rates. No model addresses all of these potential impacts. The N_{ew}ERA model is a long-run equilibrium model based upon full employment, and thus its results relate to the longer-term effects on labor income and voluntary reductions in hours worked rather than involuntary unemployment impacts. It addresses long-run employment impacts, all of which are based on estimates of changes in labor income, also called the "wage bill" or "payments to labor." Labor income impacts consist of two effects: (1) changes in wage per hour worked; and (2) changes in labor market participation (hours worked) in response to changed wage rates. The labor income change can also be expressed on a per-household basis, which represents one of the key components of disposal income per household. (The other key components of disposable income are returns on investments or "payments to capital," and income from ownership of natural resources). The labor income change can also be stated in terms of job-equivalents, by dividing the labor income change by the annual income from the average job. A loss of one job-equivalent does not necessarily mean one less employed person—it may be manifested as a combination of fewer people working and less income per person who is working. However, this measure allows us to express employment-related impacts in terms of an equivalent number of employees earning the average prevailing wage.

E. Integrated N_{ew}ERA Model

The N_{ew}ERA modeling framework fully integrates the macroeconomic model and the electric sector model so that the final solution is a consistent equilibrium for both models and thus for the entire U.S. economy.

To analyze any policy scenario, the system first solves for a consistent baseline solution; it then iterates between the two models to find the equilibrium solution for the scenario of interest. For the baseline, the electric sector model is solved first under initial economic assumptions and forecasts for electricity demand and energy prices. The equilibrium solution provides the baseline electricity prices, demand, and supply by region as well as the consumption of inputs—capital, labor, energy, and materials—by the electric sector. These solution values are passed to the macroeconomic model.

Using these outputs from the electric sector model, the macroeconomic model solves the baseline while constraining the electric sector to replicate the solution from the electric sector model and imposing the same energy price forecasts as those used to solve the electric sector baseline. In addition to the energy price forecasts, the macroeconomic model's non-electric energy sectors are calibrated to the desired exogenous forecast (EIA's *AEO 2018* Reference case forecast) for energy consumption, energy production, and macroeconomic growth. The macroeconomic model solves for equilibrium prices and quantities in all markets subject to meeting these exogenous forecasts.

After solving the baseline, the integrated N_{ew}ERA modeling system solves for the scenario. First the electric sector model reads in the scenario definition. The electric sector model then solves for the equilibrium level of electricity demand, electricity supply, and inputs used by the electric sector (*i.e.*, capital, labor, energy, emission permits). The electric sector model passes these equilibrium solution quantities to the macroeconomic model, which solves for the equilibrium prices and quantities in all markets. The macroeconomic model then passes to the electric sector model the following (solved for equilibrium prices):

- Electricity prices by region;
- Prices of non-coal fuels used by the electric sector (*e.g.*, natural gas and oil); and
- Prices of any permits that are tradable between the non-electric and electric sectors (*e.g.*, carbon permits under a nationwide greenhouse gas cap-and-trade program).

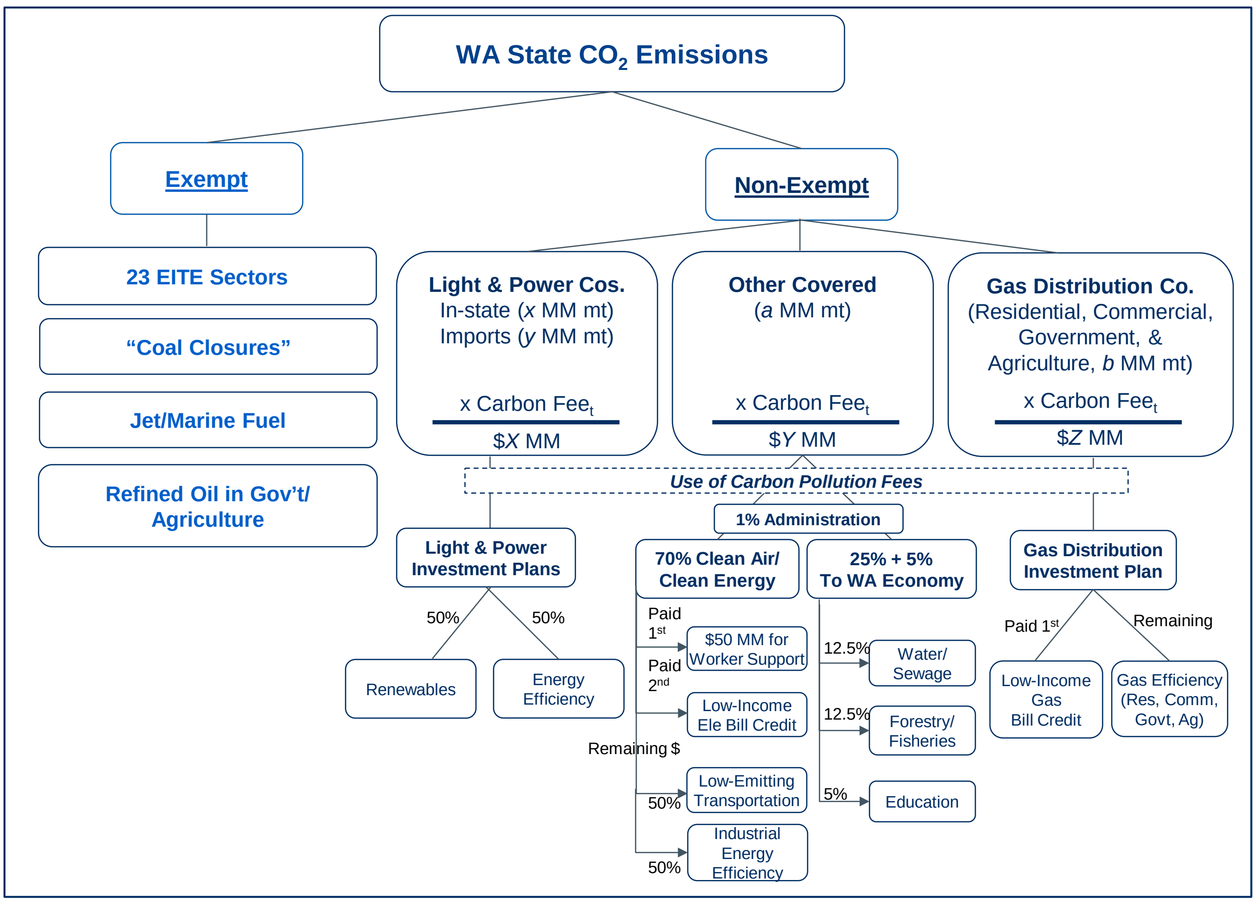
The electric sector model then solves for the new electric sector equilibrium, taking the prices from the macroeconomic model as exogenous inputs. The models iterate—prices being sent from the macroeconomic model to the electric sector model and quantities being sent from the electric sector model to the macroeconomic model—until the prices and quantities in the two models differ by less than a fraction of a percent.

This decomposition algorithm allows the N_{ew}ERA model to retain the information in the detailed electricity model, while at the same time accounting for interactions with the rest of the economy. The detailed information on the electricity sector enables the model to represent regulatory policies that are imposed on the electricity sector in terms of their impacts at a unit level.

Appendix II. ASSUMPTIONS ON SPENDING OF I-1631 FEE FUNDS

Section II.C provided a high-level overview of the use of the collected I-1631 fees, summarized in Figure 10. This appendix is a technical discussion of the representation in the model as to how the funds have been assumed to be spent to create incremental CO_2 emissions reductions, offset some of the economic harm to selected groups (*i.e.*, lower income households and displaced workers), increase resiliency of the state's waters and forests, and increase awareness and preparedness of communities on climate change.

Figure 10: Graphical Representation of Use of I-1631 Fees



a. Light and Power Companies

The I-1631 fees collected by the light and power companies are assumed to all remain in the power sector and are used to fund builds of solar photovoltaic (PV) installations (50%) and incremental demand-side energy efficiency (DSEE) in electricity (50%).

i. New Solar Photovoltaic Plants

Funds collected by light and power companies are used in the model to build new solar PV plants in Washington. Funds are used to pay for all capital costs for as many megawatts as there are available funds in each year. The capital costs for new solar PV plants are based on assumptions from EIA's *Assumptions to Annual Energy Outlook 2018* (capital costs are net of any available Federal tax credits), which reflect declining costs over time. To ensure that the new solar PV plants are incremental builds, we do not allow the generation from these plants built with the I-1631 fee funds to count towards the state's renewable energy standard. I-1631 fee funds that would have been collected in non-model years (*e.g.*, 2021 and 2022) are added to funds collected in the next model year (*e.g.*, 2023) to determine the total quantity of new solar PV builds in that model year. By 2035, the funds have been used in the model to build an additional 734 MW of solar PV plants in Washington. The capital costs of these plants are not included in customer electricity rates.

ii. Demand-Side Energy Efficiency

Funds collected by light and power companies are also used in the model to procure incremental DSEE in Washington. DSEE is available in our modeling of the baseline (without the Initiative) and in the policy case with the Initiative. With higher electricity prices, more DSEE is undertaken in the policy case. Then up to 50% of I-1631 fee funds collected by the light and power companies are used to purchase incremental DSEE above and beyond this level. The costs and availability of DSEE are based on the U.S. EPA's most recent levelized cost assumptions ($57.3/MWh, in 2016$). These assumptions are included in the Regulatory Impact Analysis (RIA) for EPA's recently-released Affordable Clean Energy (ACE) rule (a replacement for the Clean Power Plan).[34] From this information, NERA developed an upward-sloping supply curve of DSEE in Washington, while maintaining the same average cost of DSEE and the same maximum quantities of DSEE as in EPA's assumptions.[35] We converted the average cost of DSEE to an upward sloping supply curve with a y-intercept at 0, while maintaining the same average levelized cost over the entire supply curve. We then converted this curve to a step function with seven different steps, each accounting for 0.6% of electricity demand that could be replaced with DSEE. The levelized for each successive step represents the average cost of the available DSEE within that percentage of available DSEE. The levelized costs at the different steps are as low as $8/MWh and as high as $106/MWh.

In several years, all of the available DSEE is already undertaken in the model before any funds could be used to pay for incremental DSEE. In these cases, the funds originally allocated for DSEE are instead used to build additional new solar PV plants in Washington state.

[34] U.S. Environmental Protection Agency. 2018. "Regulatory Impact Analysis for the Proposed Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units; Revisions to Emission Guideline Implementing Regulations; Revisions to New Source Review Program," August. Available at: https://www.epa.gov/sites/production/files/2018-08/documents/utilities_ria_proposed_ace_2018-08.pdf.

[35] In EPA's analysis, a maximum quantity of DSEE as a percentage of electricity demand was set at 2.6% in 2025, 4.0% in 2030 and 4.2% in 2035. We assumed that one-half of the 2025 percentage would be available in 2020, or 1.3%.

b. Natural Gas Distribution Companies

The I-1631 fee funds collected by natural gas distribution companies are first used in the model to provide a bill credit to low-income households to help offset the higher cost of natural gas. Remaining funds are used to improve the natural gas energy efficiency for customers for which the natural gas distribution procures natural gas (residential, commercial, government, and agriculture sectors).

i. Low-Income Natural Gas Bill Credit

The credit given to low-income households to offset higher natural gas bills is based on the increase in natural gas rates for low-income households in aggregate.[36] The estimated bill impacts for low-income households are based on an assumption that 20% of residential natural gas demand is from low-income households in Washington state, and the increase in natural gas rates from the carbon content of natural gas and the I-1631 fee in a given year, while assuming no change in natural gas demand for these households.[37]

ii. Natural Gas Efficiency for Residential, Commercial, Government, and Agriculture Sectors

The remaining I-1631 fees collected by the natural gas distribution companies are used in the model to increase the efficiency of natural gas use by their direct customers (residential, commercial, government, and agriculture customers). These funds are distributed among the customer types based on their respective shares of natural gas consumption. The natural gas efficiency funded by the I-1631 fees is incremental to any efficiency gains undertaken by customers (and paid for by the customers) in response to the higher cost of delivered natural gas due to the carbon content of natural gas and the I-1631 fee.

Residential, commercial, agriculture, and government sectors receive natural gas efficiency (natural gas use per output) in the model by installing “energy efficiency capital” that is fully funded by the I-1631 fees. Any reduction in natural gas efficiency or reduction in natural gas consumption by the sectors requires corresponding spending on this “energy efficiency capital.” The reduction in natural gas in the sector depends upon the availability of funds to support the spending and the reduction it can achieve for the spending, which is based on the implied sectoral marginal cost of reducing natural gas intensity in a given year. We reviewed these sectoral marginal cost curves to some of the economics literature on the levelized costs of natural gas efficiency and found our curves to be consistent with the literature.[38] The

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[36] The funds will be given as a bill credit, not a reduction in the natural gas rate to be charged. If the rate were to be reduced this could incentivize higher natural gas consumption and lead to increases in CO_2 emissions.

[37] The 20% estimate of low-income households’ share of residential natural gas consumptions is based on a NERA review of the U.S. Department of Labor, Bureau of Labor Statistics’ Consumer Expenditure Survey (https://www.bls.gov/cex/) for the most recent four quarters, and the distribution of Washington households by income class according to the U.S. Census Bureau (https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_1YR_S1901&prodType=table). The bill impacts are calculated as follows: 20% of residential natural gas consumption (MMBtu) x I-1631 fee ($/metric ton) x 117 lbs of CO_2 per MMBtu of natural gas.

[38] See for example, National Academy of Sciences, National Academy of Engineering, and National Research Council. 2010. *Real Prospects for Energy Efficiency in the United States*. Washington, DC: The National Academies Press. https://doi.org/10.17226/12621.

primary difference between our marginal cost curves and those in the literature is that our marginal cost curves remain relatively flat (*i.e.*, lower cost) at higher percentage reductions in natural gas use, whereas the economics literature suggests a "hockey stick"-like uptick in the marginal cost after a certain percentage reduction (*i.e.*, after a 10% to 15% reduction, the marginal cost becomes quite high). The spending in the "energy efficiency capital" is estimated by levelizing the I-1631 fee available in each year over the life of the "energy efficiency capital." We assume a life of the ten years.[39] The dollars spent on energy efficiency are assumed to provide efficiency benefits over this ten-year life. The levelized stream of spending would be a cost to the customers by increasing its overall expenditures, if no further changes were made in the model. To address this, sectors are made whole from the I-1631 fees (*i.e.*, compensation is equal to the energy efficiency expenditures in each year). The costs to pay for this energy efficiency are from these I-1631 fees paid on natural gas purchased and delivered by the natural gas distribution company, and therefore do not further increase the cost structure for the industries and households. The spending on "energy efficiency capital" is undertaken concomitantly with the carbon fee so the resulting reduction in natural gas consumption is a combined effect. Table 20 shows the natural gas use efficiency (natural gas intensity) and natural gas percentage reduction resulting from implementation of the spending on natural gas efficiency in the residential, commercial, agriculture, and the government sectors.

Table 20: Levelized Spending on Energy Efficiency for Residential, Commercial, Agriculture, and Government and Percentage Change in Natural Gas Intensity

		Residential	Commercial	Agriculture	Government
Levelized Spending (2020$ millions)	2020	$7.0	$3.4	$1.2	$0.4
	2023	$34	$16	$5.9	$1.9
	2026	$69	$33	$12	$3.8
	2029	$113	$54	$19	$6.3
	2032	$140	$69	$24	$7.9
	2035	$167	$83	$28	$10
Percentage Change in Natural Gas Intensity (%)	2020	-1.3%	-1.4%	-3.1%	-5.2%
	2023	-2.7%	-2.7%	-5.7%	-9.1%
	2026	-4.4%	-3.9%	-8.2%	-12%
	2029	-6.5%	-5.3%	-11%	-15%
	2032	-8.4%	-6.8%	-13%	-18%
	2035	-11%	-8.2%	-16%	-22%

Sources: NERA calculations as explained in text.

While the energy efficiency reduces the natural gas intensity for the sectors, there is also a positive economic stimulus from these energy efficiency investments on the rest of the economy. The "energy efficiency capital" installed to achieve reductions in natural gas is treated in the model as manufacturing

[39] The ten-year life of energy efficiency is consistent with EPA assumptions for electrical energy efficiency of 10.2 years. See df-cpp-demand-side-ee-at3.xlsx, available at https://www.epa.gov/sites/production/files/2015-11/df-cpp-demand-side-ee-at3.xlsx, Expiration Table worksheet.

goods supported by services to install and operate the capital equipment. We assume that the services spending accounts for 80% of the spending and the manufacturing goods are the remaining 20% in each year. This spending boosts demand for services and manufacturing goods.

c. All Other Funds – Clean Up Pollution Fund

I-1631 fees collected from all sources besides light and power companies and natural gas distribution companies all go into the Clean Up Pollution Fund. These fees are then used in the model for a range of investments or to assist workers and/or communities in Washington.

i. Administration

In the "Fiscal Impact Statement" released by the State's Office of Financial Management,[40] it was estimated that between 0.6% and 2.0% of the state revenues from the I-1631 fee for fiscal 2020 through fiscal 2023 would be used for Administration of the Clean Up Pollution Fund. We assume 1.0% in all years in the model, but also note that this percentage is low compared to the actual experience of states participating in the Regional Greenhouse Gas Initiative.

ii. Clean Air and Clean Energy Investments

The Clean Air and Clean Energy Investments account are allocated 70% of the fees in the Clean Up Pollution Fund (after netting out administrative costs). These funds are first used in the model to support workers "affected by the transition to a clean energy economy"[41] and assist low-income residents with higher electricity bills. After using the funds in this manner, the remaining funds are used equally in the model to reduce personal transportation CO_2 emissions in Washington state and to improve the efficiency of industrial processes.[42]

Worker Support

Starting in 2023, $50 million per year is used for "worker support," which could take on the form of wage replacement, health benefits, pension contributions, worker retraining, and employment placement

[40] Office of Financial Management, State of Washington. 2018. "Fiscal Impact Statement - I-1631 Reducing Pollution," Revised August 24. Available at: https://www.ofm.wa.gov/budget/fiscal-impact-ballot-measures-and-proposed-legislation/2018-general-election-ballot-fiscal-information.

[41] This appears to be the only spending category that is mandated and not just an option under the Initiative. This spending can be thought of as a transitional cost, like re-training workers. Workers would be re-trained and then employed in other sectors.

[42] These funds could be used for nearly the same suite of investment options as light and power companies. Similar to our decisions for the light and power and natural gas distribution companies, our assumptions on the use of these funds is one possible representation of the use of these funds whereby all the funds are recycled back to the economy.

services.[43] We include the $50 million worker support as labor income when evaluating changes in labor income.

Electricity Bill Credits – Electricity

The credit given to low-income households to offset higher electricity bills is based on the increase in electricity rates for low-income households in aggregate.[44] The estimated bill impacts for low-income households are based on an assumption that 20% of residential electricity demand is from low-income households in Washington state, and the increase in electricity rates from the baseline carbon intensity of Washington state electricity in a given year, while assuming no change in electricity demand for these households.[45]

Low-Emitting Personal Transportation

After using available funds for worker support and low-income electricity bill credits, 50% of the remaining funds are used in the model to reduce personal transportation CO_2 emissions through funding of less emissions-intensive ways that households can meet their demands for transportation services (*i.e.*, vehicle miles traveled). This can be thought of as tax credits for purchasing more efficient vehicles, incentives for telecommuting, and spending to incentivize the use of public transit.

The model represents consumer demand for personal transportation services by vehicle miles traveled (VMT). To model the improvement in personal transportation CO_2 emissions, we use the available carbon pollution funds to subsidize zero-carbon transportation options (collectively ZEVs) to replace internal combustion engine (ICE) transportation. The "subsidy" to zero-carbon transportation lowers the cost of this option and leads to greater switching away from higher-emitting ICE transportation, and reducing the average CO_2 per VMT.

Table 21 shows the percentage of VMT using ICE vehicles and ZEVs with I-1631 (all ZEV VMT is in response to the I-1631 fee spending). Support for ZEVs induces penetration of these transportation options and by 2035 the share of VMT in ZEV is 7%.

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[43] The $50 million spending increases with inflation after 2023.

[44] Just like the bill credits for natural gas, these funds will be given as a bill credit, not a reduction in the electricity rate to be charged. If the rate were to be reduced this could incentivize higher electricity consumption and lead to increases in CO_2 emissions.

[45] The 20% estimate of low-income households' share of residential electricity consumptions is based on a NERA review of the U.S. Department of Labor, Bureau of Labor Statistics' Consumer Expenditure Survey (https://www.bls.gov/cex/) for the most recent four quarters, and the distribution of Washington households by income class according to the U.S. Census Bureau (https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_1YR_S1901&prodType=table). The bill impacts will be calculated as follows: 20% of residential electricity consumption (MWh) x I-1631 fee ($/metric ton) x baseline carbon intensity of Washington state electricity (in lbs/MWh).

Table 21: Share of ICE and ZEV Vehicle Miles Traveled (%)

	2020	2023	2026	2029	2032	2035
ICE VMT %	99%	98%	98%	96%	95%	93%
ZEV VMT %	1%	2%	2%	4%	5%	7%

Sources: NERA calculations as explained in text.

Industrial Energy Efficiency

The remaining available funds are used in the model to increase the efficiency of natural gas use by the manufacturing and energy-intensive sectors. As with the spending on "energy efficiency capital" for customers of natural gas distribution companies, industrial energy efficiency spending is undertaken in the food manufacturing, airplane manufacturing, and other energy-intensive sectors (collectively, the energy-intensive sectors), and other manufacturing sectors. These funds are distributed among the sectors based on their respective shares of natural gas consumption.[46] The natural gas efficiency funded by the I-1631 fees is incremental to any efficiency gains undertaken by these sectors (and paid for by these sectors) in response to the higher cost of delivered natural gas due to the carbon content of natural gas and the I-1631 fee.

The spending on "energy efficiency capital" is undertaken concomitantly with the I-1631 fee so the resulting reduction in natural gas intensity is a combined effect. Table 22 shows the natural gas use efficiency (natural gas intensity) resulting from implementation of the spending on natural gas efficiency in these sectors.

[46] Note, that the chemicals sector, which is part of the EITE sector, consumes natural gas as a feedstock in addition for combustion. The feedstock portion of natural gas consumption for this sector is not included for purposes of allocating funds between the sectors. We estimated that 25% of the natural gas consumption in the energy-intensive sector accounts for natural gas feedback used in the bulk chemicals sector (EIA's AEO 2018).

Table 22: Levelized Spending on Energy Efficiency for Energy-Intensive and Other Manufacturing Sectors by Sectors and Percentage Change in Natural Gas Intensity

		Food Manufacturing	Airplane Manufacturing	Energy-Intensive Sectors	Other Manufacturing
Levelized Spending (2020$ millions)	2020	$5.1	$0.2	$3.7	$20
	2023	$23	$1.0	$17	$92
	2026	$46	$2.0	$36	$183
	2029	$75	$3.2	$59	$294
	2032	$94	$4.0	$77	$356
	2035	$115	$4.9	$95	$420
Percentage Change in Natural Gas Intensity (%)	2020	-4.1%	-2.6%	-1.3%	-3.9%
	2023	-12%	-10%	-5.8%	-10%
	2026	-18%	-16%	-10%	-17%
	2029	-24%	-21%	-15%	-24%
	2032	-29%	-26%	-19%	-29%
	2035	-34%	-30%	-23%	-34%

Sources: NERA calculations as explained in text.

Within the model, the energy efficiency functionality is identical to that for the residential, commercial, agriculture, and government sectors. However, each sector faces a slightly different marginal cost curve (the manufacturing sectors have lower marginal cost curves than the residential and commercial sectors).

iii. Clean Water and Healthy Forests Investments

The Clean Water and Healthy Forests Investments account is allocated 25% of the fees in the Clean Up Pollution Fund (after netting out administrative costs). These funds are used in the model to fund additional government spending within Washington state on activities specifically allowable under the Initiative. These activities include projects in the water/sewage and forestry/fisheries sectors.

iv. Healthy Communities Investments

The Healthy Communities Investments account is allocated 5% of the fees in the Clean Up Pollution Fund (after netting out administrative costs). These funds are used in the model to fund additional government spending within Washington state on activities specifically allowable under the Initiative. These activities include government spending on education projects (*e.g.*, community preparedness related to wildfires).

Appendix III. STUDY RESULTS IN YEAR 2020 CONSTANT DOLLARS

The following tables present dollar values of the results in year 2020 constant dollars. The dollar values in the Executive Summary and main report are in current dollars (*i.e.*, including the effect of inflation).

Table 23: Carbon Fees and Energy Price Impacts of I-1631 in Washington State (Year 2020 Constant Dollars)

	2020	2023	2026	2029	2032	2035
I-1631 Fee ($/metric ton)	$15	$21	$27	$33	$39	$45
Total I-1631 Fee Collections (in millions $)	$786	$1,087	$1,388	$1,672	$1,959	$2,243
Increase in Price of Gasoline (¢/gallon)	13¢	18¢	23¢	29¢	34¢	40¢
Increase in Price of Diesel (¢/gallon)	15¢	21¢	27¢	34¢	40¢	45¢
Increase in Delivered Price of Natural Gas to Households ($/Mcf)	$0.76	$1.07	$1.39	$1.72	$2.06	$2.40
Increase in Delivered Price of Electricity to Households (¢/kWh)	0.03¢	0.3¢	0.9¢	0.9¢	0.8¢	1.1¢

Sources: I-1631 and NERA calculations as explained in text.

Table 24: Average Total Cost per Household with I-1631 (Year 2020 Constant Dollars)

	2020	2023	2026	2029	2032	2035
Average Total Cost per Washington State Household ($/Household)	$440	$510	$560	$600	$610	$670

Source: I-1631 and NERA calculations as explained in text.

Table 25: Net Change in Gross State Product with I-1631, Relative to Baseline (Year 2020 Constant Dollars)

	2020	2023	2026	2029	2032	2035
Change in Gross State Product (Billions of $)	-$2.2	-$2.5	-$3.1	-$3.0	-$3.9	-$3.6

Source: I-1631 and NERA calculations as explained in text.

Table 26: Net Energy Price Impacts of I-1631, Relative to Baseline (Year 2020 Constant Dollars)

	2020	2023	2026	2029	2032	2035
Increases in Price of Gasoline (¢/gallon and % change)	13¢	18¢	23¢	29¢	34¢	40¢
	5.9%	7.5%	9.4%	11.2%	13.1%	14.1%
Increases in Price of Diesel (¢/gallon and % change)	15¢	21¢	27¢	34¢	40¢	45¢
	4.4%	5.7%	7.2%	8.7%	10.3%	11.3%
Increases in Delivered Price of Natural Gas to Households ($/Mcf and % change)	$0.76	$1.07	$1.39	$1.72	$2.06	$2.40
	6.0%	8.3%	10.4%	12.6%	15.2%	17.9%
Increases in Delivered Price of Electricity to Households (¢/kWh and % change)	0.03¢	0.3¢	0.9¢	0.9¢	0.8¢	1.1¢
	0.3%	2.6%	7.7%	7.8%	6.6%	9.2%

Notes: Price at the Pump is dollars per gallon, Delivered Price of Natural Gas is dollars per Mcf, Delivered Price of Electricity to Households is cents per kilowatt-hour.
Source: I-1631 and NERA calculations as explained in text.

Table 27: I-1631 Fee Collections (Millions of Year 2020 Constant Dollars)

	2020	2023	2026	2029	2032	2035
Total I-1631 Fees	**$786**	**$1,076**	**$1,360**	**$1,621**	**$1,878**	**$2,130**
Electric Sector	$16	$36	$74	$89	$101	$110
Natural Gas LDC Distribution	$117	$162	$205	$248	$290	$332
Total Carbon Pollution Fund	$653	$878	$1,081	$1,284	$1,487	$1,688

Note: Numbers may not add up due to rounding.
Source: I-1631 and NERA calculations as explained in text.

Table 28: Carbon Pollution Fund Spending (Millions of Year 2020 Constant Dollars)

	2020	2023	2026	2029	2032	2035
Total Carbon Pollution Fund	**$653**	**$878**	**$1,081**	**$1,284**	**$1,487**	**$1,688**
Administration	$7	$9	$11	$13	$15	$17
Clean Air/Clean Energy	$452	$609	$749	$890	$1,031	$1,170
Worker Support	$0	$46	$46	$46	$46	$46
Low-Income Electricity Bill Credit	$15	$11	$5	$6	$8	$8
Low-Emitting Transportation	$219	$276	$349	$419	$489	$558
Industrial Energy Efficiency	$219	$276	$349	$419	$489	$558
Total Clean Water/Healthy Forests	$162	$217	$267	$318	$368	$418
Water/Sewage	$81	$109	$134	$159	$184	$209
Forestry/Fisheries	$81	$109	$134	$159	$184	$209
Healthy Communities	$32	$43	$53	$64	$74	$84
Education	$32	$43	$53	$64	$74	$84

Note: Numbers may not add up due to rounding.
Source: I-1631 and NERA calculations as explained in text.

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