Washington State

Economic Modeling of Greenhouse Gas Emission Reductions

Forecasting and Research Division
Office of Financial Management

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Executive Summary

The Washington State Office of Financial Management modeled the economic impacts of a carbon charge on Washington's economy and found negligible impacts on income, employment and output, with most measures showing slight improvement over time. This is mostly due to reinvestment of the charge and the relatively small size of the program compared to the overall state economy. The table below summarizes these findings. The study also used household consumption data by income quintiles to estimate the effect of increased prices on household expenditures. This analysis shows that low-income families who are eligible for the Working Families tax rebate will receive rebates that are larger, on average, than the increased cost for energy sources subject to the carbon charge.

(1)Policy Scenario (2)Difference from Baseline (3)(Percent Difference)	2016 Policy vs Baseline Difference	2020 Policy vs Baseline Difference	2035 Policy vs Baseline Difference
Gas Price (Nominal)	$3.39 (1) $0.12 (2) (3.54%) (3)	$3.43 $0.13 (3.94%)	$4.51 $0.41 (9.96%)
Disposable Personal Income (Billions, Nominal)	$342.46 $0.46 (0.13%)	$419.04 $0.50 (0.12%)	$793.97 $2.55 (0.32%)
Real Disposable Personal Income (Billions, Fixed)	$289.12 $-0.10 (-0.03%)	$326.15 $-0.21 (-0.06%)	$455.40 $-0.13 (-0.03%)
Employment (Thousands of Jobs)	3,452.87 4.05 (0.12%)	3,636.07 2.52 (0.07%)	4,138.96 10.63 (0.26%)
Real Gross State Product (Billions, Fixed)	$398.12 $0.59 (0.15%)	$419.04 $0.40 (0.09%)	$625.27 $1.36 (0.22%)

Fuel and energy prices could increase due to a carbon charge, assuming the carbon charge is largely passed on to retail consumers. The estimated gas price changes are smaller than historic price volatility, and the potential increases in fuel costs do not affect the overall net positive effect of the program on the statewide economy.

The Office of Financial Management modeled the impact of a carbon price on inflation-adjusted personal income, job growth, gross state product and energy prices. The modeling also considered the impact of reinvesting proceeds generated through the auctions back in the economy, as specified in the proposed legislation.

The economic analysis did not quantify future benefits of the proposed policy and investments related to transportation, education and working families. This is not a comprehensive cost-benefit analysis.

The indirect benefits of the proposed policy and the Governor's proposed investments, including specific jobs resulting from transportation investments, improved education outcomes and support for working families, are not summarized here because the detail required is not possible in the REMI (Regional Economic Models, Inc.) model. In addition, the economic models did not allow for consideration of the costs related to impacts of climate change (e.g., water supply, forest fires, shoreline and flooding damage and public health) that could be avoided over the long term.

OVERVIEW

In April 2014, through Executive Order 14-04, Governor Jay Inslee created the Carbon Emissions Reduction Task Force to provide recommendations on the design and implementation of a market-based carbon pollution reduction program. As part of its work, the Governor directed the Office of Financial Management (OFM) to model a carbon charge market mechanism related to a cap on carbon pollution emissions in Washington state. Preliminary work on that model was completed by OFM in October 2014 to better reflect the final policy design in Senate Bill 5285 and House Bill 1314. As described below, additional refinements to the model were concluded by OFM at the end of 2014 to adjust prices with new data and update assumptions about expenditure categories for the carbon charge revenue.

This study models the policy impacts of a carbon emissions reduction market, with some simplifying assumptions described below, on the Washington state economy. The modeling starts by setting a "baseline" scenario for 2015 to 2035. The model then incorporates the policy assumptions described below and generates a "policy" scenario that runs from 2016 through 2035. The study was designed to investigate the implications of the policy for significant macroeconomic outcomes: private non-farm employment, gross state product, personal income, tax revenues and energy consumption.

Throughout this analysis, OFM uses the term "baseline" to represent the business-as-usual economy in which no carbon charge market exists and "policy" to represent the time period wherein the policy is implemented: 2016 through 2035. OFM also uses the term "policy analysis period" to indicate the time frame of the policy modeling: 2016 through 2035.

MODELING METHODOLOGY

OFM used an integrated approach to model the economic impact of carbon emission reduction in Washington, based on other relevant studies. OFM combined software called the Carbon Tax Analysis Model (CTAM)[1] and software called REMI Tax-PI (REMI) [2] to take advantage of the

[1] CTAM is frequently used for studies like this. The method of connecting REMI and CTAM is also well tested, including by REMI staff. See: Nystrom, S. and Zaidi, A. (2013), "Modeling the Economic, Demographic, and

capabilities of each. CTAM translates emission levels into consumption and prices for categories of energy. As described below, CTAM is used to allocate energy consumption across industries, determine carbon emissions per industry, distribute the costs of emissions by industry and integrate the revenue recycling policy described below. REMI is used to model the macroeconomic effects (output, income, employment) resulting from the changes CTAM estimates for the carbon charge.

Carbon Tax Analysis Model

The CTAM model calculates annual emissions for the *business as usual* case and the *adjusted emissions* case after applying the carbon charge across industries. CTAM is a Microsoft Excel-based energy demand model with four sectors (industrial, commercial, transportation and residential consumers) that account for about 75 percent of all greenhouse gas emissions. CTAM energy consumption is calculated based on short-term and long-term demand elasticities, meaning that consumption in the model responds to energy prices. CTAM incorporates the Energy Information Administration's 2014 Annual Energy Outlook (AEO) Pacific region energy consumption and price forecasts.[3] These forecasts were adjusted to reflect Washington's fuel and energy consumption patterns. Specifically, the AEO electricity and on-road fuel price forecasts in CTAM were adjusted using a ratio of historical Washington-to-California prices for electricity, gasoline and diesel. This is necessary to reflect price differences within the regional estimates and ensure that the model reflects market conditions unique to Washington.

CTAM allows researchers to include state-specific aspects of the market for energy. For the Washington analysis, OFM made the following assumptions to reflect the proposed carbon charge:

- Jet fuel emissions are included
- Marine fuel emissions are included
- Emissions forecasts from Washington's only coal-fired power plant, in Centralia, reflect the current timeline for ending plant operations (2025)
- Imported electricity emissions are included
- Modest innovation change is included (fuel emissions fall 5 percent 2015 to 2025)

Although CTAM includes price elasticities (meaning that demand responds to prices), it does not include more significant consumer responses such as changes in sources of energy or new technologies that increase efficiency and lower input costs.

Climate Impact of a Carbon Tax in Massachusetts," Regional Economic Models, Inc.; Nystrom, S. and Luckow, P. (2014), "The Economic, Climate, Fiscal, Power, and Demographic Impact of a National Fee-and-Dividend Carbon Tax," Regional Economic Models, Inc.; Nystrom, S. Zaidi, A. (2013), "The Economic, Demographic, and Climate Impact of Environmental Tax Reform in Washington and King County," Regional Economic Models, Inc. See also: http://www.remi.com/download/presentations/2013_energy_and_environment_series/MA%20Carbon%20Tax%20Paper.pdf

[2] Special thanks for technical assistance from Chris Brown and Scott Nystrom at Regional Economic Models, Inc.

[3] Energy Information Administration, Annual Energy Outlook 2014 with Projections to 2014, http://www.eia.gov/forecasts/aeo/

REMI Tax PI

REMI is a dynamic regional impact modeling software that allows researchers to investigate the impact of policy changes after accounting for complex economic relationships. To do this, it incorporates a large number of equations to capture the economic interactions in a state and input-output model to capture the supply and demand relationships among industries. It is an internationally recognized tool for analysis like this study.

For this project, OFM uses industry impacts from CTAM to influence the economic outcomes predicted by REMI. REMI plays two key roles in the modeling exercise. First, REMI is needed to convert the changes in industry revenue from CTAM into economic impacts. REMI's major contribution is the ability to allocate the economic impact of the carbon charge across industries, households and government. Second, REMI incorporates an input-output model linked to a supply and price response mechanism to compute the employment, income and output effects of policy changes. Input-Output tables identify the connections among industries (which industries they sell to and buy from) and the implications of those purchases and sales for employment and income. REMI provides economic output data on 160 industry sectors.

Revenue Recycling Model

The "revenue recycling model" refers to the fact that revenue from the carbon charge is not just collected; it is "recycled" into the economy when the revenue from the charge is invested by state government in tax breaks or direct expenditures. To capture the full effects of the proposed policy, OFM modeled the impact of the carbon charge upon industries and consumers as well as the impact of the investment choices that are made using the revenue.

Revenue generated by the carbon charge under the proposed policy could be invested by the state government in several ways: toward targeted industries through B&O tax breaks, on households through tax rebates, on transportation through construction spending, and on government for administration and services. Governor Inslee's policy staff, along with OFM economists, worked with state agencies[4] and the Carbon Emissions Reduction Task Force (CERT)[5] to design the Revenue Recycling Model used for this study. One of the difficulties of an exercise like this is to convert detailed policy into variables that can be used within the confines of the available software.

OFM was directed to allocate revenue from the carbon charge in the following proportions:

- 40 percent transportation
- 40 percent education
- 10 percent Working Families tax rebate
- 3 percent affordable housing
- 3 percent manufacturing B&O tax cut
- 3 percent forestry and rural B&O tax cut
- 1 percent administration

[4] Department of Ecology, Department of Commerce, Department of Revenue
[5] An independent group of organization and business representatives, which included a few local and state government officials

The transportation and housing investments were modeled as construction spending. Education and administration expenditures were modeled by increasing spending in the "government" sector of the model. The Working Families tax rebate is modeled by increasing disposable household income in the model. The B&O tax breaks were allocated to affected industries in the 160 industry sectors.

General Results

By almost all measures, the proposed carbon charge and revenue recycling induces modest economic changes above and below the business as usual baseline. This is due to at least two factors. First, the macroeconomic changes are generally small because the carbon charge revenue is relatively small compared to the state economy. For example, the total revenue collections forecast during 2016 ($932 million) are less than three-tenths of 1 percent (0.29 percent) of 2013 gross state product[6] ($381 billion). Second, the fact that all the revenue from the carbon charge is recycled into the economy reduces the impact of the change in carbon prices. The revenue recycling assumptions include significant positive impacts from construction spending and other investments. Some of the impact will also be due to higher in-state spending as state investments include more Washington-specific content. The structure of the REMI/CTAM model makes specific results available for macroeconomic measures (output, employment, income) and prices.

Macroeconomic results

Output: real gross state product

The increase in real gross state product (GSP)[7] throughout the carbon charge policy modeling time frame is similar to historical GSP growth. Table 1 shows the Bureau of Economic Analysis (BEA) data for Washington state over the period 2010–13. The BEA average GSP growth is 2.2 percent annually and the average GSP is $366.9 billion.

Table 1. Bureau of Economic Analysis Washington Real Gross State Product 2010 to 2013

Year	GSP ($B)	Percentage Change
2010	$356.4	1.8
2011	358.9	0.7
2012	371.2	3.4
2013	381.0	2.7
Average	$366.9	2.2

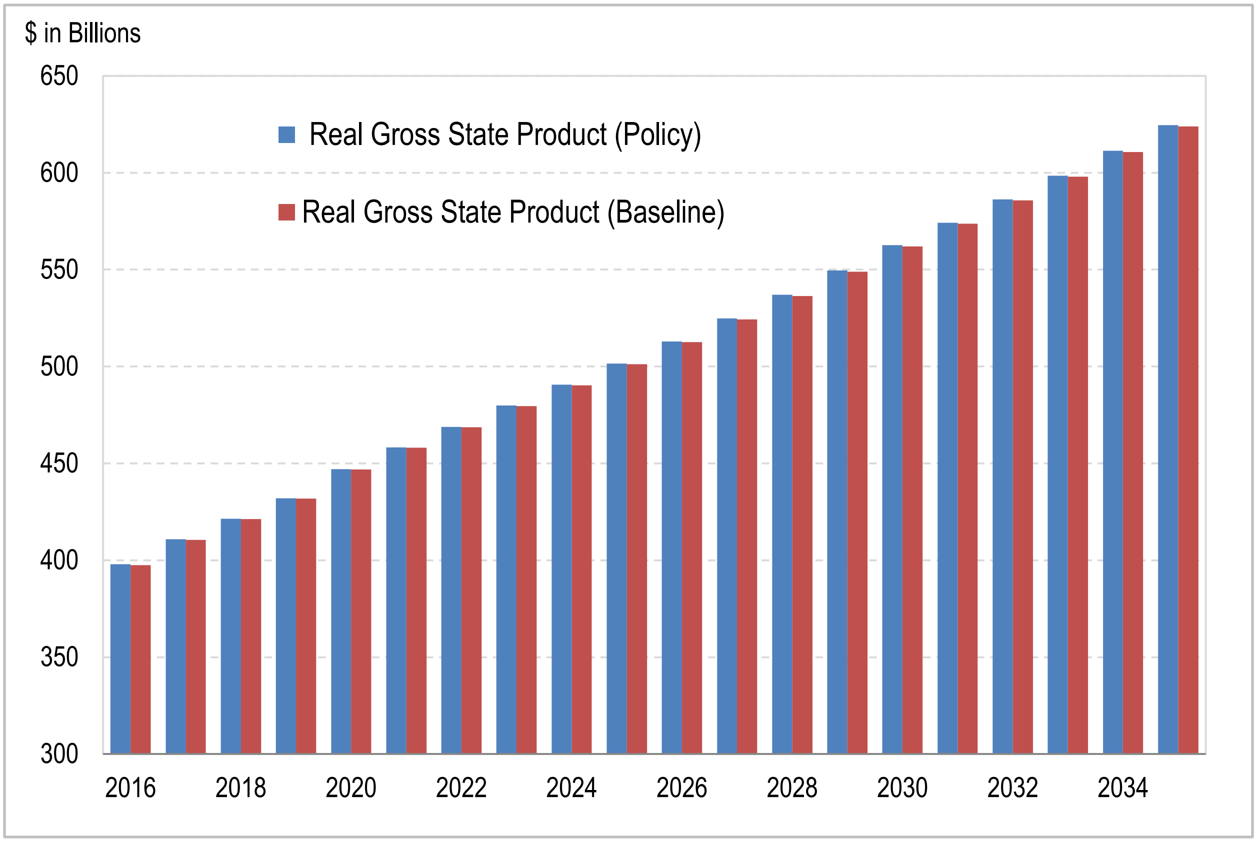
OFM's modeling of the carbon market proposal is consistent with this history. Over the policy analysis period, OFM forecast annual real GSP increasing from the 2015 baseline of $382.72 billion to $623.91 billion in 2035. Similarly, the scenario for the carbon charge policy shows real GSP increasing to $624.57 billion by year 2035. OFM estimates modest average annual real GSP growth of 0.08 percent above the baseline throughout the policy analysis period 2016–35. Both the baseline and policy average annual growth are just above the BEA average of 2.2 percent

[6] Advance statistics from: http://bea.gov/newsreleases/regional/gdp_state/gsp_newsrelease.htm

[7] See Appendix A-1 for a discussion on the components that compose GSP.

(Table 1) at 2.40 and 2.48 percent average annual growth, respectively. Figure 1 depicts the baseline and policy trajectories for real GSP throughout the course of the policy analysis period. The similarities are apparent. The extremely small improvement in GSP is a function of the change in spending patterns that results from the "revenue recycling" policies.

Figure 1. Real Gross State Product, Baseline and Policy, 2016 through 2035, Billions of 2009 Dollars

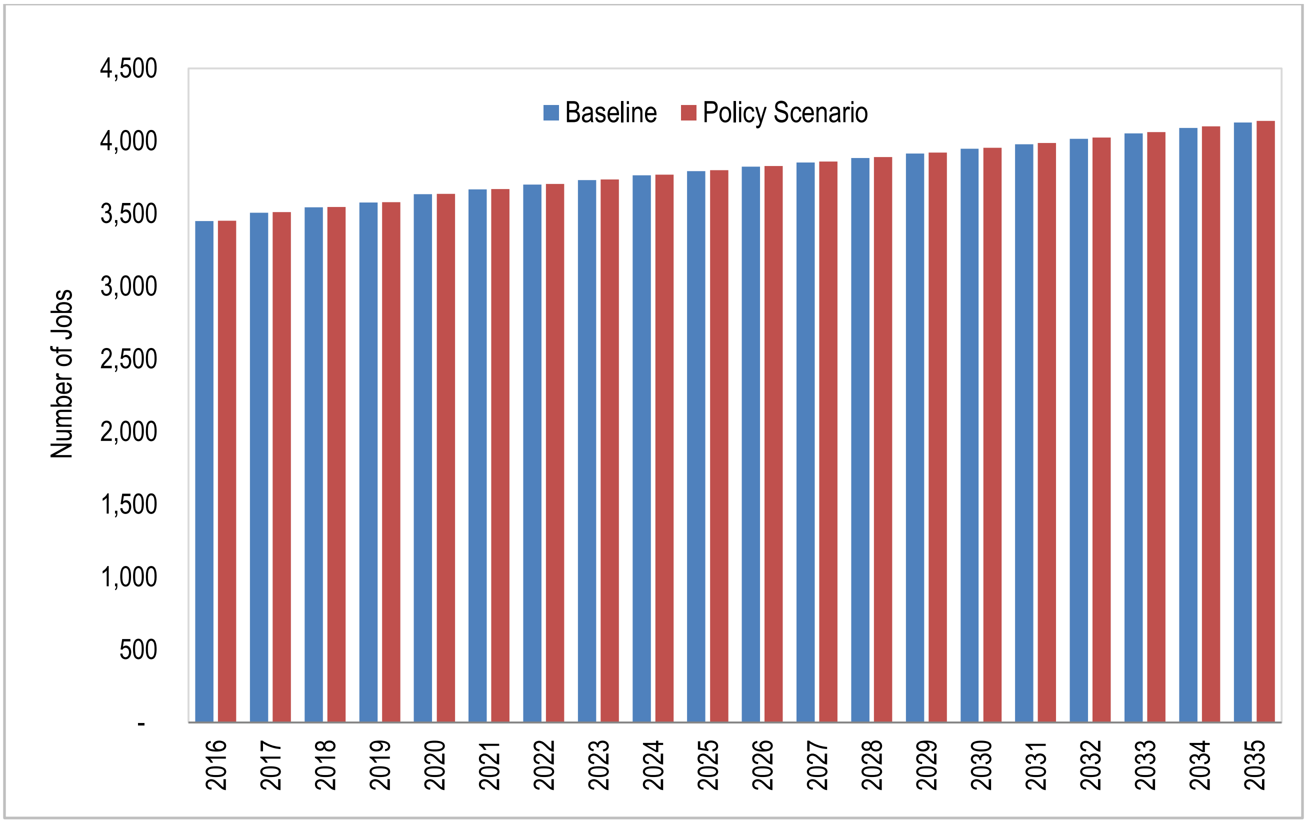


Private non-farm employment

To produce more output, the economy must use more labor or automation. The close relationship between output and labor utilization is well documented in economic research (Okun 1962, Kuznets 1973, Wilson, 1960) and well supported in more recent carbon emission reduction studies. Our estimates include comparisons between years (for example, jobs in the baseline for 2020 compared to jobs under the policy for 2020) and comparisons across the study period (for example, average annual job change under the baseline until 2035 and under the policy until 2035). REMI allows variations in these measures for total jobs, jobs by industry and jobs by occupation.

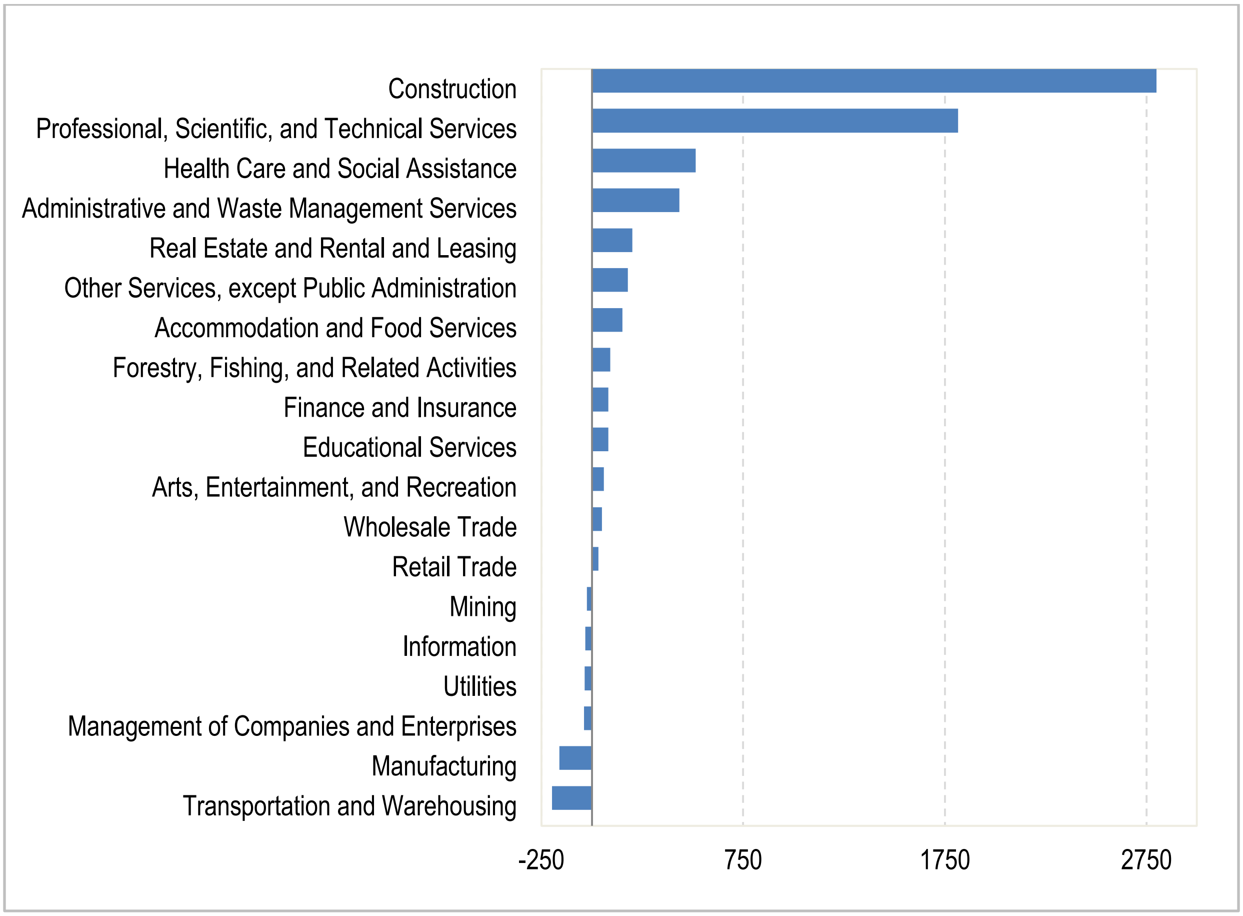
Figure 2 shows a very small (much less than 1 percent) net increase in jobs due to the policy throughout the program period. The increased costs of carbon pricing and attendant higher energy costs, combined with recycling of the revenue from these changes, results in fewer existing jobs lost than are gained. Figure 2 indicates that there is a net addition of 2,500 jobs in 2020, and in 2035, there is a net addition of 10,600 jobs compared to the baseline case. These are equal to an increase of 0.07 percent in 2020 and 0.26 percent in 2035. The net change is a result of shifting resources from industries that pay the carbon charge to higher labor-content industries that benefit from the recycling policy. Because the REMI model compares the policy scenario change to the baseline case, the simulation results imply that implementing a carbon price policy with revenue recycling will increase employment slightly above the natural job creation that would otherwise be expected.

Figure 2. Total Private Non-farm Employment, Thousands of Jobs Each Year



Industries Gaining and Losing Jobs

Figure 3. Average Annual Jobs Gained/Lost Above Baseline (2016 to 2035)



REMI allows researchers to disaggregate total employment by industry or by occupation. Figure 3 compares the baseline and policy scenario, showing the industry-level average annual jobs gained or lost above or below the baseline. The figures are annual average differences, meaning the difference each year is calculated, and then the average of those calculations between 2016 and 2035 is presented in the table. **The largest job-gaining industries are in labor-intensive industries such as construction and service industries, a finding that is consistent with the spending patterns included in the revenue recycling policy.** Figure 3 shows the data by relatively broad industry categories (the two-digit NAICS industry codes in REMI). For a table of more detailed industry data, see Appendix A-4.

Figure 4. Employment Percentage Change by Occupation, 2016–2035

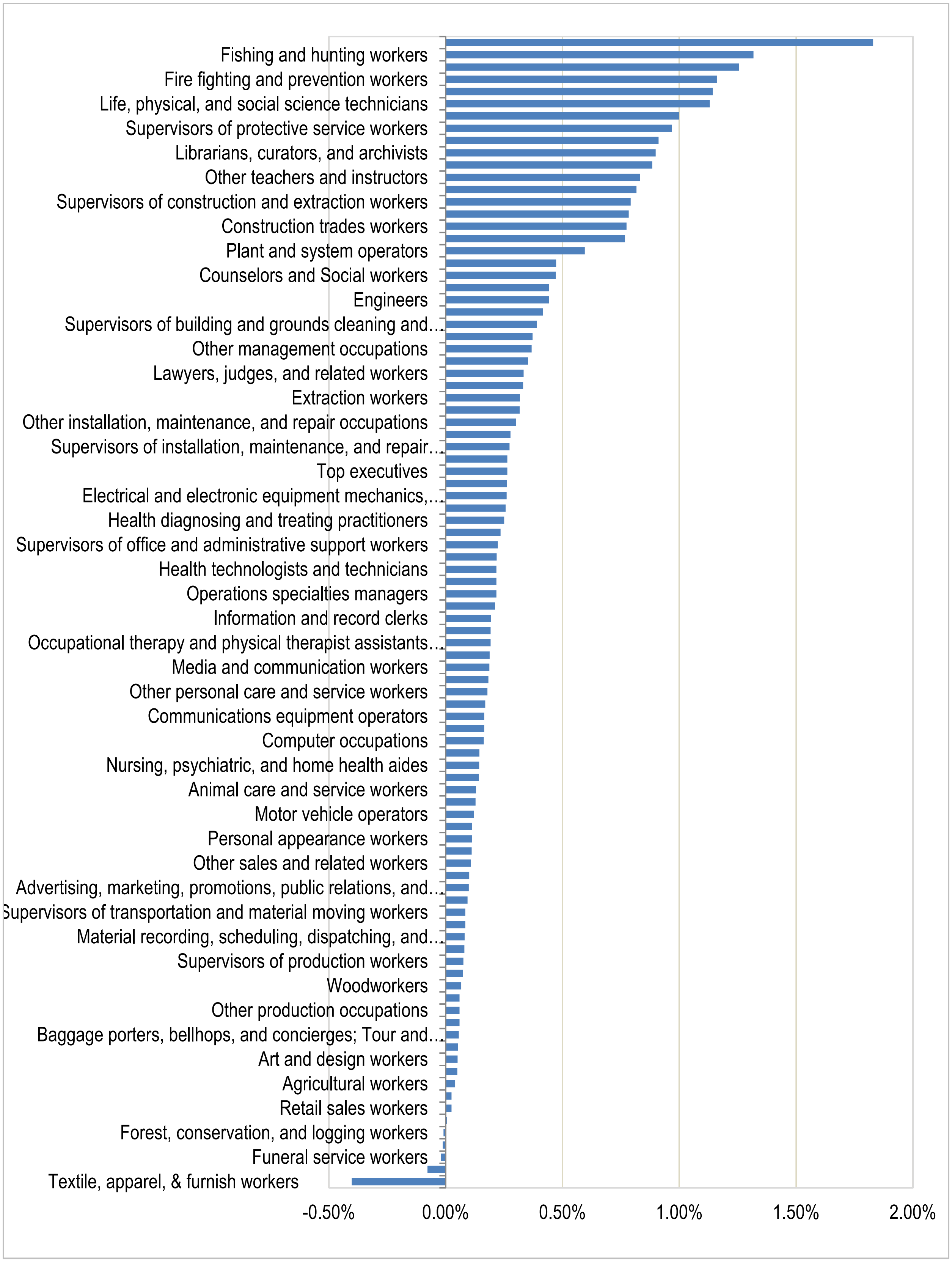


Figure 4 shows information for occupations. The data summarize the findings for the average percentage change in jobs by occupation above or below the baseline from 2016 to 2035. As with the industry employment change figures, these numbers are derived by calculating the change in each year and averaging across the years of the scenario. **Of the 94 occupations on the list, 95 percent realize job gains (however small) above baseline and only about 5 percent lose jobs relative to baseline during the 20-year scenario period.** This repeats the same trend observed in the non-farm private employment in Figure 2 and illustrates that the carbon price policy creates more jobs above baseline than it would lose over the life of the program. Top occupation gainers include life scientists, professionals, firefighters, law enforcement workers, school teachers, librarians and construction workers. The largest percentage gain (fishing and hunting workers) is potentially misleading because it is an increase of a very small base.

OCCUPATIONAL INCOME

Figure 5. Average Sector Total Wages and Salaries Above Baseline, Average 2016-2035 (Millions of Current Dollars)

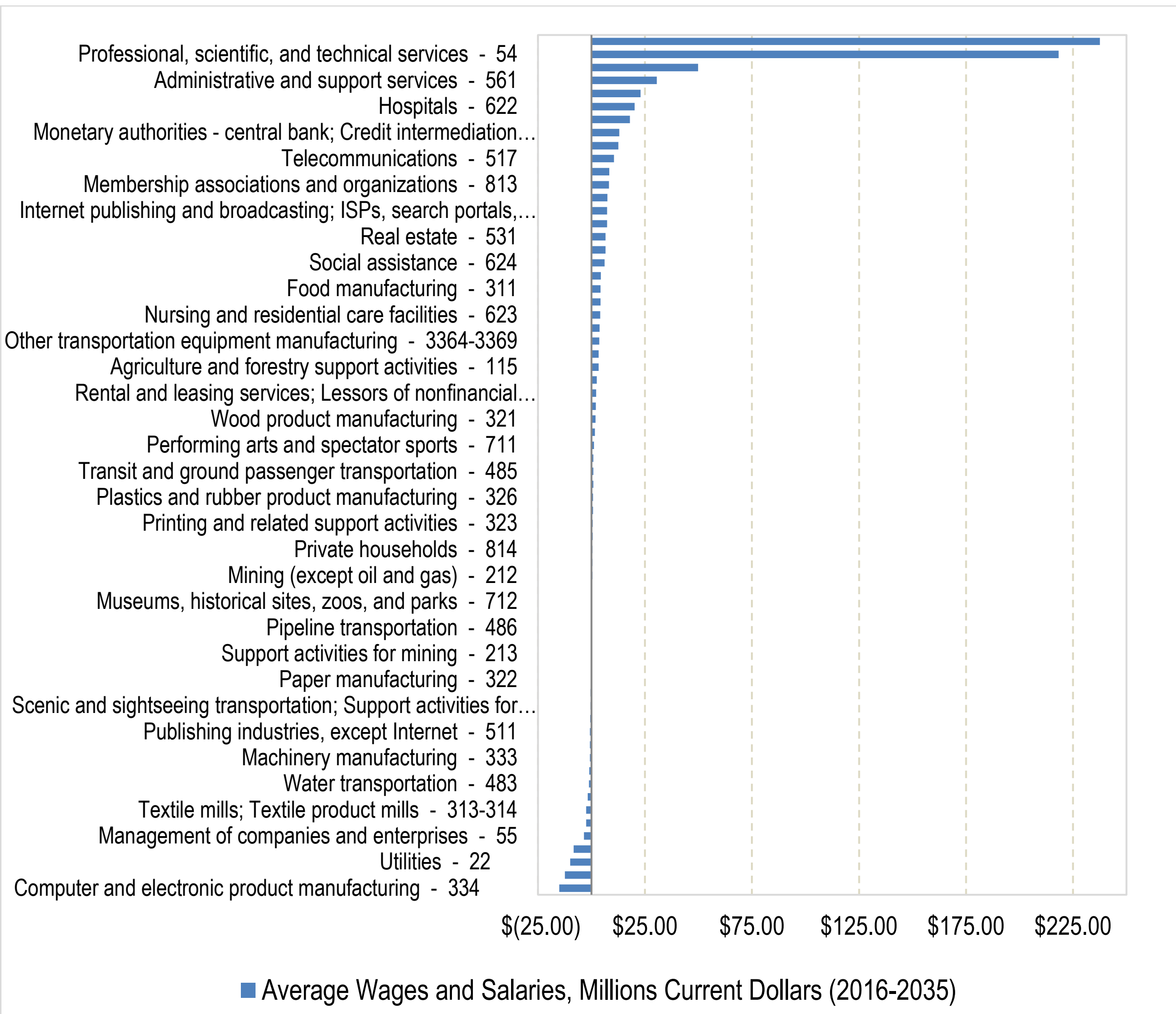


Figure 5 shows simulation results of total payments of sector wages and salaries above or below baseline for the period 2016–2035. **Results show a majority of the sectors increasing wages and salaries due to the stimulative effect of the carbon charge as funds move across sectors.** Economy-wide gainers include sectors such as construction, professional scientific and technical services such as engineering, health care services, educational services, retail trade, wholesale trade, administrative support services, food services and drinking places. The majority of these sectors are labor-intensive. Sectors losing wages include truck transportation, computer and electronic product manufacturing, apparel manufacturing, and leather and allied product manufacturing.

Personal income concepts

The four sections below detail inflation-adjusted and current personal income concepts.

Personal income

Gross personal income (GPI) is income received from all sources, including government transfer payments. It is the sum of all Washington employees' compensation, supplements to wages and salaries, proprietors' income, rental income, personal income receipts on assets and personal current transfer receipts less contributions for government social assistance. In the baseline, GPI starts at $361.9 billion in the 2015 baseline year and increases throughout the policy period to $890.73 billion by 2035. It increases to $891.61 billion over the same period under the policy scenario. Average annual personal income over the policy period is $615.06 billion for the policy and $614.34 billion for the baseline.

Disposable personal income

Disposable personal income (DPI) in billions of current dollars is total state GPI minus taxes. DPI increases from $322.98 billion in 2015 to $791.42 billion in 2035 in the baseline and to $792.24 billion under the policy scenario, an increase of 0.07 percent. The average annual DPI over the study period is $546.97 billion for the policy scenario and $546.60 billion for the baseline. DPI grows throughout the research period at fluctuating positive rates, generally between 4 and 5 percent annual growth per year. The average annual DPI growth rate for the research period is 4.59 percent under the policy scenario and 4.58 percent for the baseline, a 0.12 percent increase due to the policy scenario. Again, this is an extremely small increase over the baseline as the revenue recycling aspect of the policy shifts funds toward labor-intensive industries.

Personal consumption expenditures price index

The personal consumption expenditure price index (PCEPI) used in REMI to deflate personal income to real personal income is based on a national reference year and set equal to 100 (prices in 2009=100). The PCEPI is then adjusted to the regional level, and may or may not equal 100 in the reference year, depending on regional price levels relative to the nation. The PCEPI is used as a composite index to reflect the prices that consumers, businesses and the government face in the regional market place.

The PCEPI for Washington starts at 116.20 in the 2015 baseline year and steadily increases throughout the analysis period to 174.34 for the policy and to 173.74 for the baseline. The policy scenario result is 0.34 percent above the baseline by 2035.

Real disposable personal income

Figure 6. Total Real Disposable Personal Income, Policy and Baseline, 2016–2035

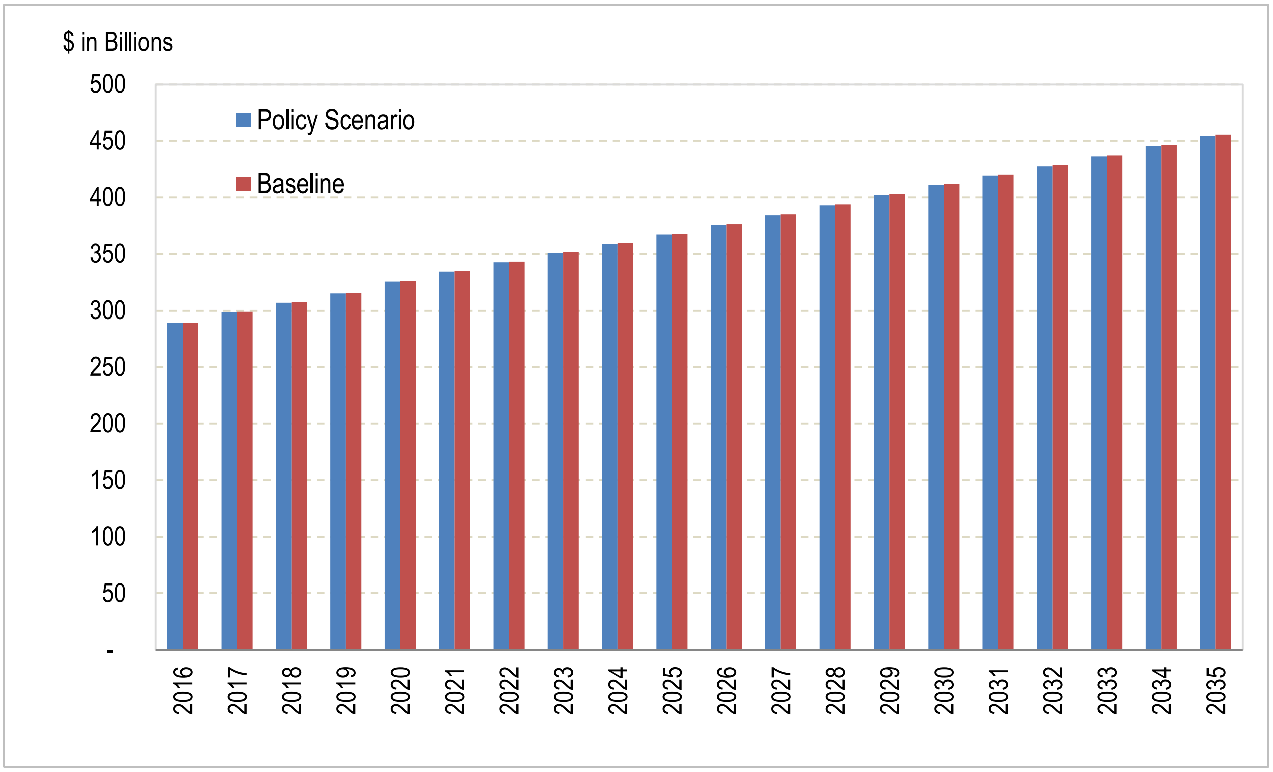


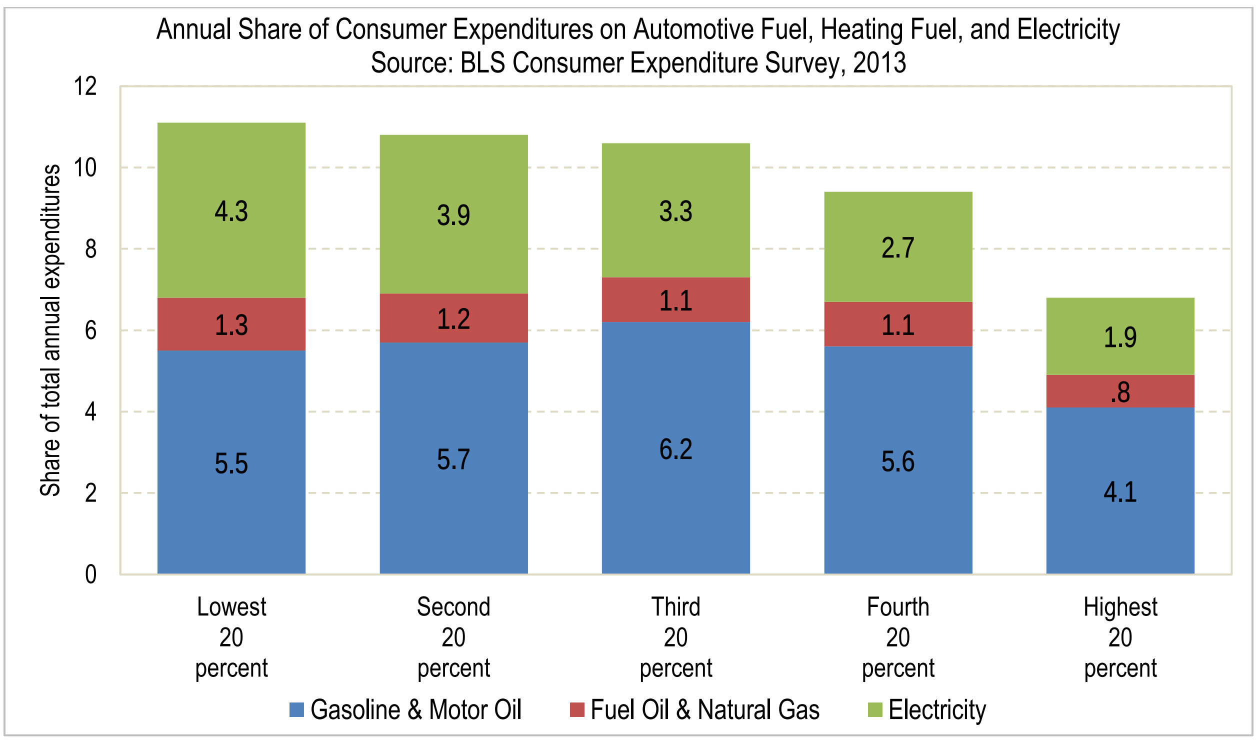
Figure 6 displays total real disposable personal income. **Total real disposable income is slightly lower under the policy scenario than in the baseline.** The main factors driving real disposable personal income are personal income, the quantity and quality of jobs, personal taxes and inflation as measured by the PCEPI. Relative costs of production for businesses are also factored into the PCEPI. Introduction of a carbon fee feeds into the PCEPI in the form of higher energy costs for both businesses and consumers (see PCEPI discussion above), resulting in a higher PCEPI compared to the "current situation" baseline scenario. The Working Families tax rebate, B&O tax rebates and other revenue recycling mitigate some of the higher carbon costs and change the distribution of employment across industries so the resulting simulation reveals a gradual upward trend in total real disposable income, despite higher prices. Real disposable personal income continues an upward trend during the policy scenario, though the rate of increase levels off in later years.

Household income results

One of the areas of interest in evaluating a carbon pricing policy has been the distribution of effects across income groups. A full accounting of the differential effects of the policy by income is beyond the scope of the tools available for the OFM analysis. To shed at least some light on the topic with available data, OFM turned to household expenditure data, which is available by income quintile and for spending categories that are associated with the carbon charge.

The federal government compiles information on the spending patterns of households across income groups for significant consumption categories, including gasoline and motor oil, natural gas and electricity. Figure 7 below shows national data from the Consumer Expenditure Survey by quintile, meaning each bar represents one-fifth of all households stratified by income. There are no equivalent data for Washington. These data suggest that gasoline and oil expenditures compose about 5.5 percent of all the spending by the lowest-income household category, compared to 6.2 percent for middle-income households. Studies have also shown that low-income household spending is relatively "inelastic" relative to gasoline prices, meaning these households continue to spend their income on fuel despite increases in gas prices. Looking at electricity, the consumption patterns suggest that the lowest-income households spend about 4.3 percent of their total expenditures on electricity compared to just 3.3 percent for middle-income households.

Figure 7. Bureau of Labor Statistics Consumer Expenditure Survey Detail, Annual Share of Expenditures on Energy (%)



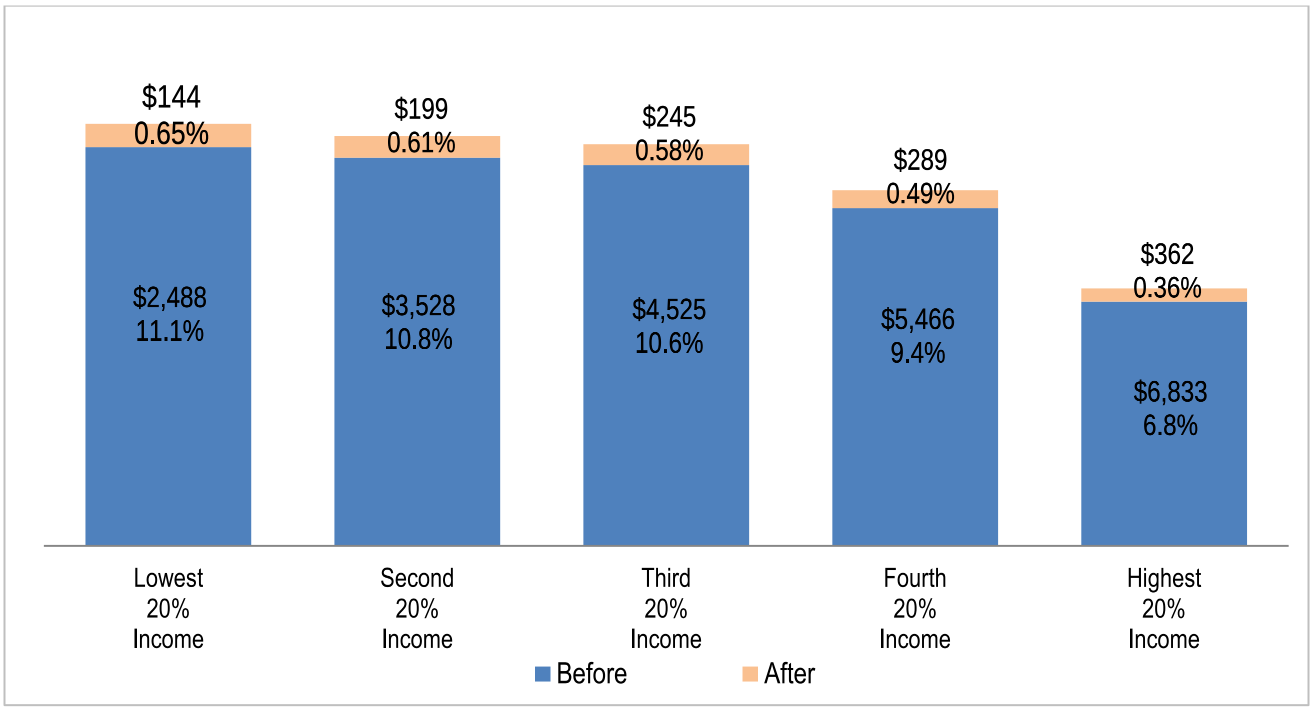
Note: Low-income consumers spend about the same portion of household income on gas, natural gas and electricity as middle-income consumers. Based on the 2013 BLS CES survey.

Returning to the national data on household expenditures provides a partial view of the effects of the policy. Figure 8 allocates the 2016 price increases from REMI output across the household data in the most recently available BLS Household Expenditure Survey. OFM used a conservative estimate for the impact of price increases by assuming that all the additional cost will show up as increases in the percentage of household spending on those categories of goods. In other words, they make no substitutes among products. The lowest-income category is the place to start to understand the findings. With 11.1 percent of their household expenditures being on carbon-based fuels, lowest-income households spent about $2,488 on these products in a year.

By changing the price of carbon-based energy sources, the policy adds approximately $144 per year to household expenditures in the lowest-income household and about $245 per year to expenditures by middle-income households. From state Department of Revenue estimates for the proposed Working Families tax rebate (WFTR), the average rebate under this program is $223. OFM cannot directly compare the household expenditure data and the WFTR data because the rebate program data include a mix of households and individuals, depending on tax filing status. Support through the WFTR is also subject to eligibility rules. Nevertheless, personal income and household income are strongly correlated, and most eligible recipients of the WFTR are in the lowest income category. The combination of expenditure data and WFTR data suggests that the majority of low- and middle-income households qualifying for the rebate will be better off under the proposed policy that combines a carbon charge and funding for the WFTR.

Figure 8. Percentage and Dollars of Household Expenditures Spent on Carbon-Based Energy and Fuels Before and After Carbon Charge 2016

Bureau of Labor Statistics Consumer Expenditure Survey



Note: The difference between expenditures and income for the lowest-income households is closed by non-wage transfers. The average household expenditure for the lowest quintile is $22,393. The average Working Families tax rebate is $223.

Energy prices

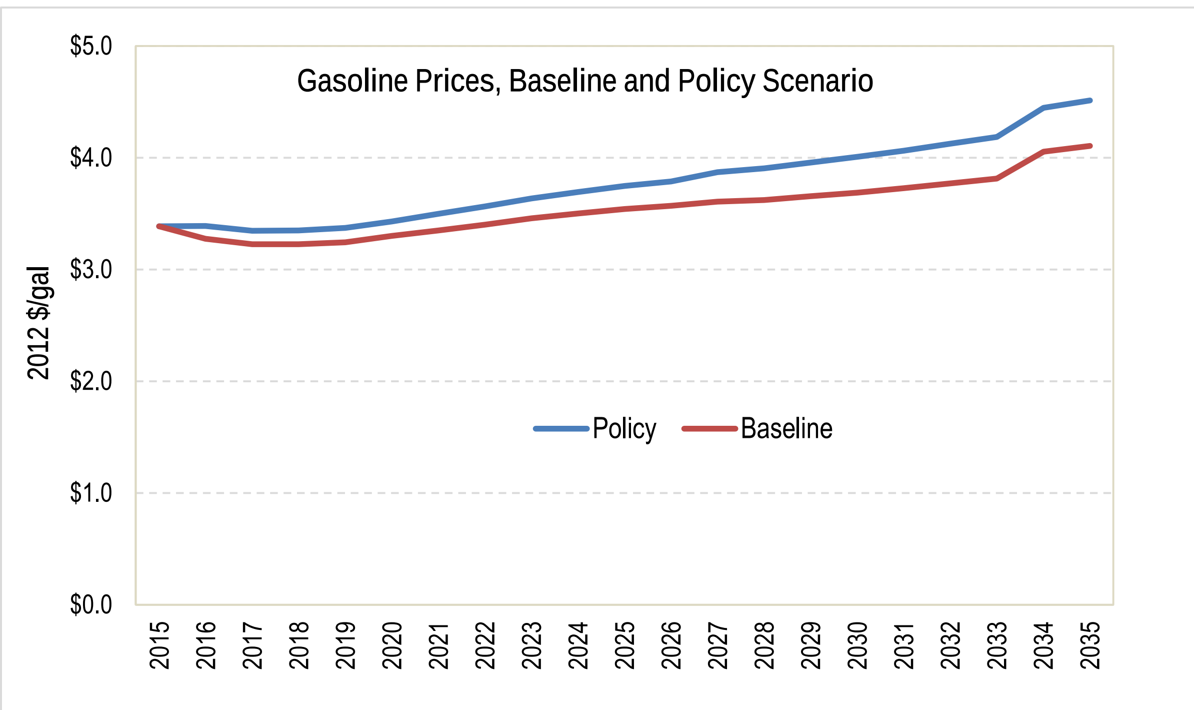
Baseline energy consumption data as well as baseline energy and road fuel price projections used in the REMI model come from the CTAM model, which was created by the Washington State Energy Office in the Department of Commerce (Mori, 2012). As noted in the overview, the CTAM model was updated to reflect the AEO reference case. CTAM contains AEO's forecasted prices, which were adjusted for Washington. All energy and road fuel prices are in 2012 dollars.

Changes in energy prices due to carbon pricing depend on a number of factors (Lasky, 2003). These price change factors include:

- Substitution among fuels from high-carbon emission energy to low-carbon emissions energy
- Long-run sensitivity of overall energy demand
- Expectations and speed of adjustment, which may be gradual because capital stock turnover is gradual
- Price sensitivity in neighboring jurisdictions

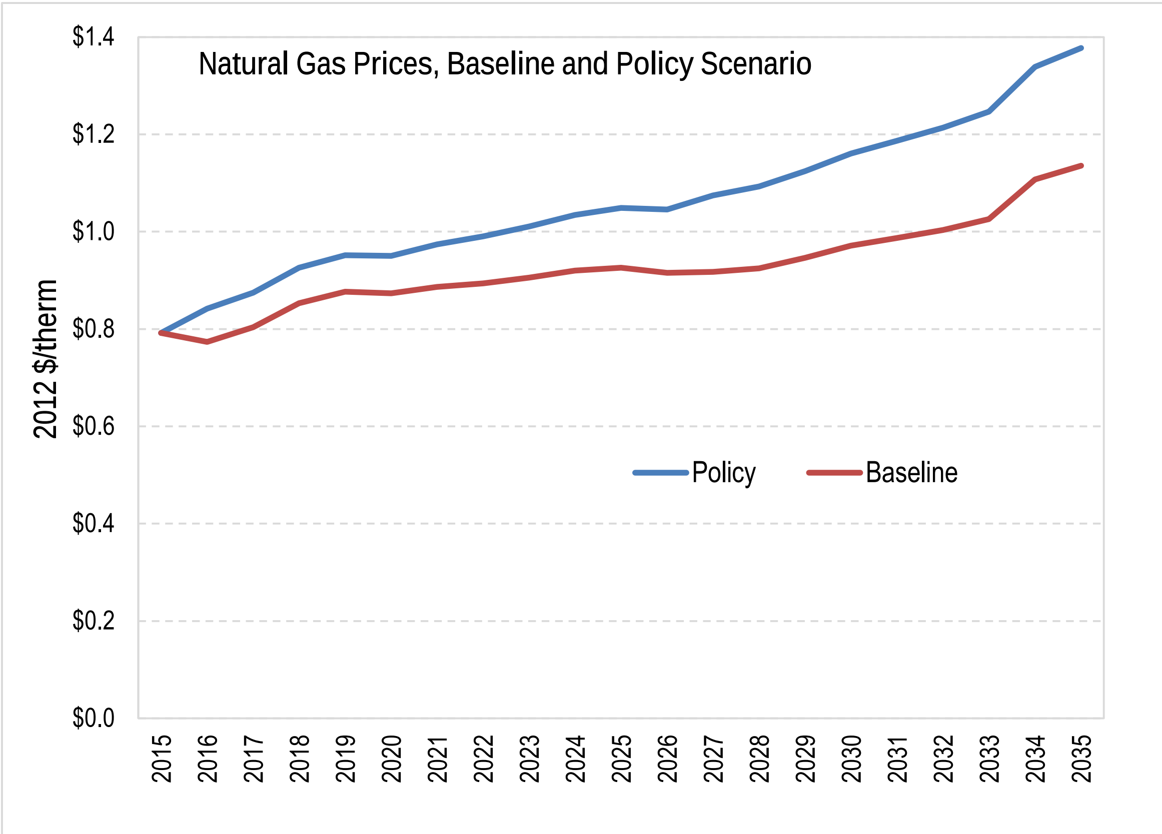
Figure 9 indicates that in 2020, the gasoline price change from baseline is $0.13 per gallon and in 2035, the change from baseline is $0.41 per gallon, all in 2012 dollars. On a percentage change-from-baseline basis, gasoline prices are 9.96 percent higher in 2035 under the policy than they would be under the baseline scenario.

Figure 9. Gasoline Energy Prices, Baseline Compared to Policy Scenario



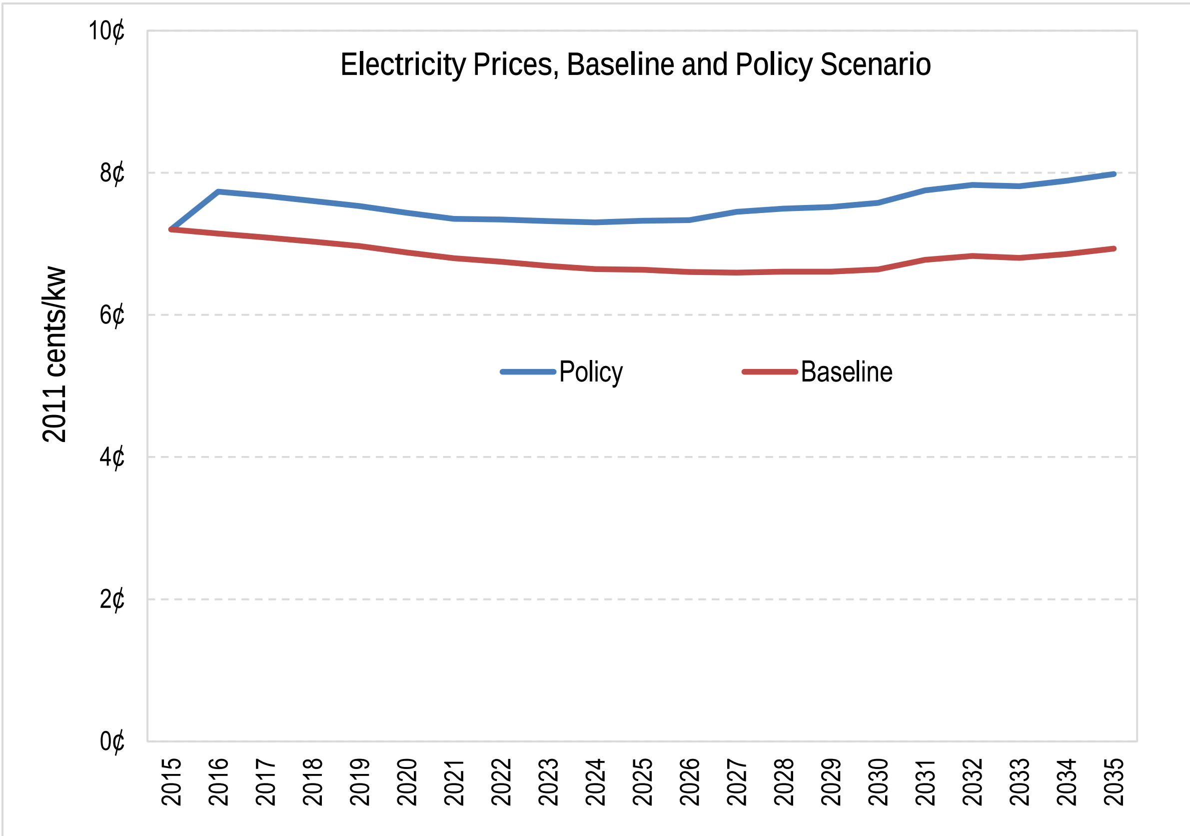
For natural gas, the price change from baseline in 2020 is $0.08 per therm and in 2035 is $0.24 per therm (Figure 10). On a percentage change-from-baseline basis, natural gas prices are 21.31 percent higher in 2035 under the policy than they would be under the baseline scenario. It should be reiterated that the change from baseline is "a vector "one-time" adjustment upwards, and not a change in the rate" (Nystrom, 2014). The Department of Commerce estimates that a household with natural gas space and water heating uses about 600 to 800 therms of energy a year. The change in prices is thus equal to about $48 to $64 a year.

Figure 10. Natural Gas energy Prices, Baseline Compared to Policy Scenario



Similarly, for electricity the price change from baseline in 2020 is 0.56 cents per kWh (Figure 11). In 2035, the change from baseline is 1.05 cents per kWh. On a percentage change-from-baseline basis, electricity prices are 15.1 percent higher in 2035 under the policy than they would be under the baseline scenario. See Appendix tables A-2 and A-3 for the full series of annual prices and changes. The Department of Commerce estimates that a typical household uses 11,000 to 13,000 kWh per year of electricity. At that rate, the price change represents about $61.60 to $72.80 per household per year.

Figure 11. Electricity Energy Prices, Baseline Compared to Policy Scenario



Natural gas changed the most percentage-wise, in part because it has a lower starting baseline price of $0.77 per therm (which is about $7.36 per million BTU equivalent) in 2016 compared to gasoline at $3.27 per gallon (which is about $28.89 per million BTU) and electricity at $7.14 kWh (which is about $35.35 per million BTU). The BTUs in parenthesis provide a common unit that shows the starting price differentials for each of the three energy commodities under discussion.

Electricity price averages are calculated by simple average and weighted average by use intensity. This model uses the higher of the two — the simple average — because the weighting of the average may mistakenly assume constant ratios among the categories. Nevertheless, OFM provides both the weighted and simple averages for comparison. Comparing the aggregate price components of electricity (residential, commercial, industrial), simple average calculation to the average weighted by use intensity calculation shows that the simple average is consistently above the weighted average by anywhere from 1 cent to 29 cents. See Appendix A-2 for more detailed data.

Table 2. Electricity Prices: Simple and Weighted Average Price Comparison					
Electricity Components Adjusted			Comparison of Baseline to Adjusted		
Average	Weighted Average	Difference between Simple and weighted	Simple Difference from Baseline	Adjusted Difference from Baseline	Difference of Differences
7.20	7.49	0.29	0.00	0.00	0.00
7.73	7.99	0.26	0.59	0.58	0.00
7.67	7.90	0.23	0.58	0.58	-0.01
7.60	7.82	0.21	0.57	0.56	0.00
7.53	7.74	0.21	0.56	0.56	-0.01
7.44	7.63	0.20	0.56	0.56	-0.01
7.35	7.44	0.09	0.56	0.45	-0.10
7.34	7.42	0.08	0.60	0.49	-0.11
7.32	7.38	0.06	0.63	0.52	-0.11
7.30	7.35	0.05	0.66	0.55	-0.11
7.33	7.37	0.04	0.69	0.58	-0.12
7.33	7.24	-0.09	0.73	0.48	-0.25
7.45	7.32	-0.13	0.85	0.57	-0.28
7.50	7.36	-0.14	0.89	0.60	-0.29
7.52	7.38	-0.14	0.91	0.62	-0.29
7.57	7.43	-0.15	0.93	0.64	-0.29
7.75	7.60	-0.16	0.98	0.68	-0.30
7.83	7.67	-0.16	1.00	0.70	-0.30
7.81	7.65	-0.16	1.01	0.71	-0.30
7.88	7.73	-0.15	1.03	0.73	-0.30
7.98	7.83	-0.15	1.05	0.75	-0.29

Conclusion

The economic impacts of a carbon charge on Washington's income, employment and output are relatively small, with most measures showing slight improvement over time. None of the policy scenario impacts is particularly large relative to underlying trends and the scale of the inputs. This is mostly due to reinvestment of the charge and the relatively small size of the program compared to the overall state economy.

Key findings and observations

1. Whether positive or negative, the net statewide economic effects are extremely small in relation to the state economy. Employment, output, income and inflation-adjusted income are essentially unchanged under the carbon charge policy. Most of these measures show slight

improvement over 20 years. A very small decline in inflation-adjusted income is extremely sensitive to inflation assumptions over the study period.

- Economy-wide job gains are small, though some sectors could gain jobs and other sectors could lose jobs. All gains and losses, including at the detailed sector level, are small relative to the overall changes in job growth predicted under a "business-as-usual" baseline scenario.
- Sectors that could gain jobs as of 2035 include industries such as construction (4,774 jobs/1.21 percent), health practitioners (370 jobs/0.23 percent), engineering services (231 jobs/0.29 percent), forestry/fishing (121 jobs/2.79 percent) and cement/concrete production (79 jobs/0.88 percent).
- Sectors that could lose jobs as of 2035 include truck transportation (227 jobs/0.58 percent), aerospace manufacturing (57 jobs/0.08 percent), electric power generation (38 jobs/1.51 percent), natural gas distribution (8 jobs/2.27 percent) and petroleum/coal manufacturing (8 jobs/0.37 percent).
- GSP rises steadily through the study period even as the carbon price is increased. Disposable personal income also rises through the study period, though the baseline and the policy cases are nearly identical if income is adjusted for inflation.

2. Inflation-adjusted fuel and energy prices could increase due to a carbon charge, compared to a "business-as-usual" baseline, as follows:

Table 3. Fuel Price Change Forecast Summary

	Gasoline	Natural Gas	Electricity
2016	3.5% (12 cents/gallon)	8.9% (7 cents/therm)	8.2% (0.59 cents/kWh)
2020	3.9% (13 cents/gallon)	8.8% (8 cents/therm)	8.2% (0.56 cents/ kWh)
2025	5.9% (21 cents/gallon)	13.2% (12 cents/therm)	10.4% (0.69 cents/ kWh)
2035	10% (41 cents/gallon)	21.3% (24 cents/therm)	15.1% (1.05 cents/ kWh)

- The CTAM and REMI tools include elasticities for prices. These use historic relationships to estimate how much of the carbon charge is paid by consumers through price changes and how much is absorbed by sellers.
- The estimated gas price changes are smaller than historic price volatility.
- Gas prices reflect only the future innovations and efficiencies that are built into the Annual Energy Outlook. They do not include dramatic changes in fuel efficiency, new vehicle technology or improved alternatives for transportation.
- The potential increases in fuel costs do not affect the overall net positive effect of the program on the statewide economy, mostly because fuel costs are a relatively small portion of average household and business expenditures. These positive changes to the economy result primarily from reinvestment of the program funds.

3. Based on household expenditure quintiles, the proposed Working Families tax rebate provides eligible low-income households with sufficient benefits to cover the increased cost of fuels subject to the carbon charge.

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APPENDIX

A-1. Composition of REMI GSP Components

This section discusses the components of GSP used in REMI. GSP is calculated by summing consumption, investment, government spending and net exports and subtracting intermediate goods. DPI represents consumption by consumers and businesses. Residential and nonresidential structures, and nonresidential equipment and intellectual property represent investment by businesses. Federal national defense, federal nondefense and state and local represent the government spending portion. Imports and exports comprise three components: exports and imports to the rest of the world; exports and imports to the rest of the nation, and government and farm exports and imports.

A-2. Energy prices detail

Figure A-2.1. Gasoline, Natural Gas and Electricity Prices - Baseline Compared to Policy Scenario

	Gasoline: 2012 $/gal				Natural gas: 2012 $/therm				Electricity: 2012 cents/Kwh			
	Baseline	Scenario	In Yr % Ch	Difference	Baseline	Scenario	In Yr % Ch	Difference	Baseline	Scenario	In Yr % Ch	Difference
2015	3.3855490	3.3855490	0.000	0.00	0.7918990	0.7918990	0.000	0.00	7.2028858	7.2024911	-0.005	0.00
2016	3.2739272	3.3899179	3.543	0.12	0.7733015	0.8419569	8.878	0.07	7.1435561	7.7327062	8.247	0.59
2017	3.2259441	3.3458788	3.718	0.12	0.8033975	0.8743873	8.836	0.07	7.0916789	7.6747044	8.221	0.58
2018	3.2252134	3.3481958	3.813	0.12	0.8528768	0.9256705	8.535	0.07	7.0325422	7.6052222	8.143	0.57
2019	3.2443066	3.3710538	3.907	0.13	0.8764738	0.9514959	8.560	0.08	6.9667280	7.5296534	8.080	0.56
2020	3.3003474	3.4303215	3.938	0.13	0.8733799	0.9503120	8.809	0.08	6.8770684	7.4376802	8.152	0.56
2021	3.3508910	3.4994201	4.433	0.15	0.8862464	0.9741613	9.920	0.09	6.7969493	7.3525920	8.175	0.56
2022	3.4024277	3.5655676	4.795	0.16	0.8937434	0.9903065	10.804	0.10	6.7479893	7.3442651	8.836	0.60
2023	3.4571867	3.6351616	5.148	0.18	0.9052212	1.0105652	11.637	0.11	6.6909229	7.3215917	9.426	0.63
2024	3.5011055	3.6938258	5.505	0.19	0.9202703	1.0343421	12.395	0.11	6.6450543	7.3036221	9.911	0.66
2025	3.5414300	3.7484922	5.847	0.21	0.9260719	1.0486328	13.234	0.12	6.6345982	7.3256486	10.416	0.69
2026	3.5692558	3.7884190	6.140	0.22	0.9154675	1.0451911	14.170	0.13	6.6041168	7.3328681	11.035	0.73
2027	3.6064057	3.8717322	7.357	0.27	0.9172160	1.0742638	17.122	0.16	6.5974320	7.4487904	12.904	0.85
2028	3.6211333	3.9043872	7.822	0.28	0.9248370	1.0924960	18.128	0.17	6.6106950	7.4963317	13.397	0.89
2029	3.6562099	3.9573912	8.238	0.30	0.9462850	1.1245554	18.839	0.18	6.6093106	7.5177242	13.744	0.91
2030	3.6881868	4.0072956	8.652	0.32	0.9714825	1.1603642	19.443	0.19	6.6403511	7.5751414	14.077	0.93
2031	3.7271553	4.0641916	9.043	0.34	0.9869825	1.1864755	20.212	0.20	6.7774255	7.7530987	14.396	0.98
2032	3.7712115	4.1261752	9.412	0.35	1.0037571	1.2138615	20.932	0.21	6.8288373	7.8291955	14.649	1.00
2033	3.8125604	4.1854516	9.781	0.37	1.0258442	1.2465600	21.516	0.22	6.8005103	7.8130404	14.889	1.01
2034	4.0557655	4.4465842	9.636	0.39	1.1070313	1.3383584	20.896	0.23	6.8564184	7.8864004	15.022	1.03
2035	4.1045741	4.5133202	9.958	0.41	1.1353684	1.3773068	21.309	0.24	6.9326507	7.9797960	15.105	1.05

Percent Change Scenario 2016 to baseline 2016	3.54		8.88		8.25	
Percent Change Scenario 2020 to baseline 2020	3.94		8.81		8.15	
Percent Change Scenario 2025 to baseline 2025	5.85		13.23		10.42	
Percent Change Scenario 2035 to baseline 2035	9.96		21.31		15.10	

Figure A-2.2. Electricity Component Prices - Policy Scenario, Simple and Weighted Averages

Electricity Components	Residential			Commercial			Industrial			Electricity Components Baseline			Electricity Components Adjusted			Comparison of Baseline to Adjusted		
Estimates are in Cents per Kilowatt Hour	Base-line	Adjusted	Change from Baseline	Base-line	Adjusted	Change from Baseline	Base-line	Adjusted	Change from Baseline	Average	Weighted Average	Difference between simple and weighted	Average	Weighted Average	Difference between simple and weighted	Simple Difference from baseline	Adjusted Difference from baseline	Difference of Differences
2015	8.91	8.91	0.00	8.00	8.00	0.00	4.70	4.70	0	7.20	7.49	0.29	7.20	7.49	0.29	0.00	0.00	0.00
2016	8.84	9.57	0.73	7.94	8.59	0.65	4.65	5.03	0.38	7.14	7.41	0.26	7.73	7.989832	0.26	0.59	0.58	0.00
2017	8.78	9.50	0.72	7.88	8.53	0.65	4.61	4.99	0.38	7.09	7.33	0.24	7.67	7.903166	0.23	0.58	0.58	-0.01
2018	8.70	9.40	0.70	7.81	8.44	0.63	4.60	4.97	0.37	7.04	7.25	0.22	7.60	7.817812	0.21	0.57	0.56	0.00
2019	8.60	9.29	0.69	7.74	8.36	0.62	4.56	4.93	0.37	6.97	7.18	0.22	7.53	7.739065	0.21	0.56	0.56	-0.01
2020	8.49	9.18	0.69	7.64	8.26	0.62	4.50	4.87	0.37	6.88	7.08	0.20	7.44	7.634811	0.20	0.56	0.56	-0.01
2021	8.38	9.07	0.69	7.54	8.16	0.62	4.47	4.83	0.36	6.80	6.99	0.19	7.35	7.442847	0.09	0.56	0.45	-0.10
2022	8.31	9.05	0.74	7.48	8.14	0.66	4.45	4.84	0.39	6.75	6.93	0.18	7.34	7.420457	0.08	0.60	0.49	-0.11
2023	8.24	9.01	0.77	7.40	8.10	0.70	4.43	4.85	0.42	6.69	6.86	0.17	7.32	7.382614	0.06	0.63	0.52	-0.11
2024	8.17	8.98	0.81	7.34	8.06	0.72	4.42	4.86	0.44	6.64	6.81	0.17	7.30	7.354531	0.05	0.66	0.55	-0.11
2025	8.16	9.01	0.85	7.31	8.07	0.76	4.43	4.90	0.47	6.63	6.79	0.16	7.33	7.368657	0.04	0.69	0.58	-0.12
2026	8.11	9.01	0.90	7.27	8.07	0.80	4.43	4.92	0.49	6.60	6.76	0.15	7.33	7.238337	-0.09	0.73	0.48	-0.25
2027	8.10	9.15	1.05	7.25	8.18	0.93	4.44	5.01	0.57	6.60	6.75	0.15	7.45	7.320621	-0.13	0.85	0.57	-0.28
2028	8.13	9.22	1.09	7.25	8.22	0.97	4.45	5.05	0.6	6.61	6.76	0.15	7.50	7.35951	-0.14	0.89	0.60	-0.29
2029	8.14	9.26	1.12	7.24	8.23	0.99	4.45	5.06	0.61	6.61	6.76	0.15	7.52	7.376455	-0.14	0.91	0.62	-0.29
2030	8.19	9.34	1.15	7.26	8.28	1.02	4.47	5.10	0.63	6.64	6.78	0.14	7.57	7.426292	-0.15	0.93	0.64	-0.29
2031	8.38	9.59	1.21	7.38	8.44	1.06	4.57	5.23	0.66	6.78	6.92	0.14	7.75	7.596458	-0.16	0.98	0.68	-0.30
2032	8.47	9.71	1.24	7.42	8.51	1.09	4.60	5.27	0.67	6.83	6.97	0.14	7.83	7.667482	-0.16	1.00	0.70	-0.30
2033	8.42	9.67	1.25	7.38	8.48	1.10	4.60	5.29	0.69	6.80	6.94	0.14	7.81	7.650842	-0.16	1.01	0.71	-0.30
2034	8.47	9.74	1.27	7.43	8.55	1.12	4.66	5.36	0.7	6.85	7.00	0.14	7.88	7.73094	-0.15	1.03	0.73	-0.30
2035	8.56	9.85	1.29	7.52	8.65	1.13	4.72	5.44	0.72	6.93	7.08	0.14	7.98	7.829133	-0.15	1.05	0.75	-0.29

A-3. Detailed description of the CTAM revenue estimation process

The following discussion is derived from Mori's papers on CTAM. (Keibun Mori, 2012). There are two steps to determining revenues from each fuel source:

Step 1: Calculate the change in price impact that results from the carbon fee. This is done by calculating the delta, or the change in price, which in essence becomes the *effective* carbon price. The magnitude of the price impact is different for each emission source in each sector. The difference is due to the different carbon intensity associated with each emission-producing source. For illustration purposes, OFM will use the gasoline price in 2016 and its emission factor. Remember that this *effective* carbon price changes every year because the carbon fee is changing every year, emissions are changing every year and fuel prices are also changing year to year over the time horizon 2015 to 2035.

Change in Price

$\Delta P = rC$ is the *effective* carbon fee (equation 1)

Where:

r is the carbon fee – as an example, let's assume a carbon fee of \$12.60/ton of CO2e in 2016

C is the carbon intensity in tons of CO2e — in this illustrative example gasoline's carbon emission factor is {70.877kgs of CO2e/MMBtu}/1000=0.070877 tons of CO2

P Baseline price without the carbon fee

The change is:

$\Delta P = \$12.60 * 0.070877 = \$0.8930$

Step 2: Calculate the impact on consumption

$$D'_{f,} = \{D_{f,s} * \frac{\Delta P_f}{P_f} * \varepsilon_{f,s}\} + D_{f,s} \qquad \text{(equation 2)}$$

Where:

$D_{f,}$: consumption without carbon fee =0.292 Quad btu

$D'_{f,}$: consumption with carbon fee =0.291 Quad btu

P_f: price =\$27.11/mmbtu

P'_f: adjusted price = \$28.04/mmbtu

$\varepsilon_{f,}$: price elasticity of demand (consumption) = -0.12 (elasticity is negative and will reduce consumption due to the carbon fee which translates to a higher price).

The subscript f represents individual fuels and s represents each sector since the emissions and revenues are calculated individually for each fuel in each sector. The behavioral change in consumption due to introducing the carbon fee, experienced as a higher price, is contained in the bracketed expression in equation (2) above.

Adjusted consumption (after the carbon fee) is: =0.292*0.0345*(-0.12) + 0.292=0.291

In this example, gasoline has now responded to the higher price (due to the carbon fee) by reducing consumption from a total of 0.292 mmbtus of gasoline to a lower total of 0.291 mmbtus of gasoline.

Steps 1and 2 lead to the final step of calculating revenues:
Gasoline revenue in 2016 is calculated as:
(.291*1000)*$0.89=$259.94 million. The reason for multiplying by 1000 is to convert the emissions back to kilograms of CO2e. Recall in step 1 Kgs of CO2e are divided by 1000 to convert to tons.

Sources for calculation of revenues:
Recognize that the "price" has two components:

- Base price — in 2016, it is $12.60/ton of CO2e
- The intensity of carbon content or emissions sets the *actual* price applied to each fuel source in each sector.
- Applied elasticities have a 10-year and 20-year horizon with an elasticity ramp-up factor for each year (Mori, 2012).

Definition of effective fee or rate:
The carbon fee in 2016 is $12.60 and is a "base rate" that is applied to the emission content of the fuel which yields the *individual tax rates* for each fuel. So, for example, the *individual or effective* carbon tax rate or fee for gasoline is $0.89 per million Btu = ($12.60*[70.88kgs/1000]) (Keibun Mori, CTAM, page 22).

Table A-3.1. Emission Factors	
Emission Factors	
Motor gasoline	70.88
Natural gas	53.06
Coal	94.70
Distillate fuel	73.15
Jet fuel (+ other petroleum in transportation = aviation gasoline)	70.88
Liquid petroleum gas	62.28
Kerosene	72.31
Ethanol (E85)	14.79
Residual fuel	78.80
Electricity imports	0.00
Renewable energy, etc.	0.00

Table A-3.2. Fuel Tax and Effective Fee Rates	
Fuel Tax Rates ($/mmBtu)	2016 Effective Fee Rates
Motor gasoline	$0.89
Natural gas	$0.67
Coal	$1.19
On-road distillate fuel	$0.92
Distillate fuel	$0.92
Jet fuel	-
Liquid petroleum gas	$0.78
Ethanol	$0.19
Residual fuel	-

A-4. Jobs Gained and Lost

Table A-4. Detailed List of Jobs Gained and Lost in 2035	
Category	Average 2016–35
Construction - 23	4,774
Scientific research and development services - 5,417	2,336
Services to buildings and dwellings - 5,617	558
Food services and drinking places - 722	394
Real estate - 531	372
Offices of health practitioners - 6,211–6,213	370
Architectural, engineering, related services - 5,413	231

Retail trade - 44-45	186
Individual and family services; community and vocational rehabilitation services - 6,241–6,243	178
Hospitals - 622	169
Educational services - 61	168
Management, scientific, technical consulting services - 5,416	130
Forestry; fishing, hunting, trapping - 1,131, 1,132, 114	121
Outpatient, laboratory, other ambulatory care services - 6,214, 6,215, 6,219	120
Wholesale trade - 42	94
Personal care services - 8,121	92
Other professional, scientific, technical services - 5,419	82
Cement and concrete product manufacturing - 3,273	79
Amusement, gambling, recreation industries - 713	78
Legal services - 5,411	76
Religious organizations; grant making and giving services, social advocacy organizations - 8,131–8,133	70
Monetary authorities, credit intermediation, related activities - 521, 522	69
Business support services; investigation and security services; other support services - 5,614, 5,616, 5,619	67
Support activities for agriculture and forestry - 115	66
Accounting, tax preparation, bookkeeping, payroll services - 5,412	57
Child day care services - 6,244	51
Automotive repair and maintenance - 8,111	51
Computer systems design and related services - 5,415	40
Waste management and remediation services - 562	38
Employment services - 5,613	37
Seafood product preparation and packaging - 3,117	34
Telecommunications - 517	33
Nursing and residential care facilities - 623	31
Office administrative services; facilities support services - 5,611, 5,612	30
Transit and ground passenger transportation - 485	27
Home health care services - 6,216	27
Data processing, hosting, related services, other information services - 518, 519	26
Insurance carriers - 5241	26
Civic, social, professional, similar organizations - 8,134, 8,139	24
Architectural and structural metals manufacturing - 3,323	23
Other personal services - 8,129	22
Dry cleaning and laundry services - 8,123	21
Consumer goods rental and general rental centers - 5,322, 5,323	19
Commercial and industrial machinery and equipment rental and leasing - 5,324	16
Bakeries and tortilla manufacturing - 3,118	15
Veneer, plywood, engineered wood product manufacturing - 3,212	14
Other wood product manufacturing - 3,219	14
Lime, gypsum, other nonmetallic mineral product manufacturing - 3,274, 3,279	14

Performing arts companies; promoters of events; agents and managers - 7,111, 7,113, 7,114	14
Beverage manufacturing - 3,121	13
Agencies, brokerages, other insurance related activities - 5,242	12
Personal and household goods repair and maintenance - 8,114	12
Glass and glass product manufacturing - 3,272	11
Electronic and precision equipment repair and maintenance - 8,112	11
Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance - 8,113	11
Travel arrangement and reservation services - 615	10
Basic chemical manufacturing - 3,251	9
Foundries - 3,315	8
Printing and related support activities - 323	7
Independent artists, writers, performers - 7,115	7
Nonmetallic mineral mining and quarrying - 2,123	6
Clay product and refractory manufacturing - 3,271	6
Plastics product manufacturing - 3,261	6
Automotive equipment rental and leasing - 5,321	5
Specialized design services - 5,414	5
Iron and steel mills and ferroalloy manufacturing - 3,311	4
Advertising and related services - 5,418	4
Spectator sports - 7,112	4
Alumina and aluminum production and processing - 3,313	3
Broadcasting (except Internet) - 515	3
Funds, trusts, other financial vehicles - 525	3
Water, sewage, other systems - 2,213	2
Steel product manufacturing from purchased steel - 3,312	2
Nonferrous metal (except aluminum) production and processing - 3,314	2
Dairy product manufacturing - 3,115	2
Museums, historical sites, similar institutions - 712	2
Sawmills and wood preservation - 3,211	1
Coating, engraving, heat treating, allied activities - 3,328	1
Ventilation, heating, air conditioning and commercial refrigeration equipment manufacturing - 3,334	1
Motor vehicle manufacturing - 3,361	1
Sugar and confectionery product manufacturing - 3,113	1
Animal slaughtering and processing - 3,116	1
Pulp, paper, paperboard mills - 3,221	1
Paint, coating, adhesive manufacturing - 3,255	1
Coal mining - 2,121	0
Metal ore mining - 2,122	0
Support activities for mining - 213	0
Forging and stamping - 3,321	0

Hardware manufacturing - 3,325	0
Spring and wire product manufacturing - 3,326	0
Commercial and service industry machinery manufacturing - 3,333	0
Electric lighting equipment manufacturing - 3,351	0
Motor vehicle body and trailer manufacturing - 3,362	0
Motor vehicle parts manufacturing - 3,363	0
Railroad rolling stock manufacturing - 3,365	0
Other transportation equipment manufacturing - 3,369	0
Office furniture (including fixtures) manufacturing; other furniture related product manufacturing - 3,372, 3,379	0
Animal food manufacturing - 3,111	0
Tobacco manufacturing - 3,122	0
Resin, synthetic rubber, and artificial synthetic fibers and filaments manufacturing - 3,252	0
Soap, cleaning compound and toilet preparation manufacturing - 3,256	0
Other chemical product and preparation manufacturing - 3,259	0
Rubber product manufacturing - 3,262	0
Lessors of nonfinancial intangible assets (except copyrighted works) - 533	0
Death care services - 8,122	0
Cutlery and hand tool manufacturing - 3,322	-1
Boiler, tank, shipping container manufacturing - 3,324	-1
Engine, turbine, power transmission equipment manufacturing - 3,336	-1
Household appliance manufacturing - 3,352	-1
Ship and boat building - 3,366	-1
Grain and oilseed milling - 3,112	-1
Pesticide, fertilizer, other agricultural chemical manufacturing - 3,253	-1
Pipeline transportation - 486	-1
Manufacturing and reproducing magnetic and optical media - 3,346	-2
Electrical equipment manufacturing - 3,353	-2
Fruit and vegetable preserving and specialty food manufacturing - 3,114	-2
Pharmaceutical and medicine manufacturing - 3,254	-2
Newspaper, periodical, book, directory publishers - 5,111	-2
Other fabricated metal product manufacturing - 3,329	-3
Industrial machinery manufacturing - 3,332	-3
Other electrical equipment and component manufacturing - 3,359	-3
Medical equipment and supplies manufacturing - 3,391	-3
Other food manufacturing - 3,119	-3
Agriculture, construction, and mining machinery manufacturing - 3,331	-4
Metalworking machinery manufacturing - 3,335	-4
Air transportation - 481	-4
Other general purpose machinery manufacturing - 3,339	-5
Communications equipment manufacturing - 3,342	-5

Household and institutional furniture and kitchen cabinet manufacturing - 3,371	-5
Converted paper product manufacturing - 3,222	-5
Oil and gas extraction - 211	-6
Computer and peripheral equipment manufacturing - 3,341	-7
Natural gas distribution - 2,212	-8
Machine shops; turned product; and screw, nut, bolt manufacturing - 3,327	-8
Petroleum and coal products manufacturing - 324	-8
Rail transportation - 482	-8
Warehousing and storage - 493	-10
Private household - 814	-11
Logging - 1,133	-12
Audio and video equipment manufacturing - 3,343	-13
Motion picture, video, sound recording industries - 512	-13
Securities, commodity contracts, other financial investments and related activities - 523	-16
Water transportation - 483	-19
Other miscellaneous manufacturing - 3,399	-21
Accommodation - 721	-27
Scenic and sightseeing transportation and support activities - 487, 488	-30
Navigational, measuring, electromedical, control instruments manufacturing - 3,345	-31
Electric power generation, transmission, distribution - 2,211	-38
Semiconductor and other electronic component manufacturing - 3,344	-44
Couriers and messengers - 492	-48
Aerospace product and parts manufacturing - 3,364	-57
Management of companies and enterprises - 55	-69
Textile mills and textile product mills - 313, 314	-70
Software publishers - 5,112	-114
Apparel manufacturing; leather and allied product manufacturing - 315, 316	-154

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