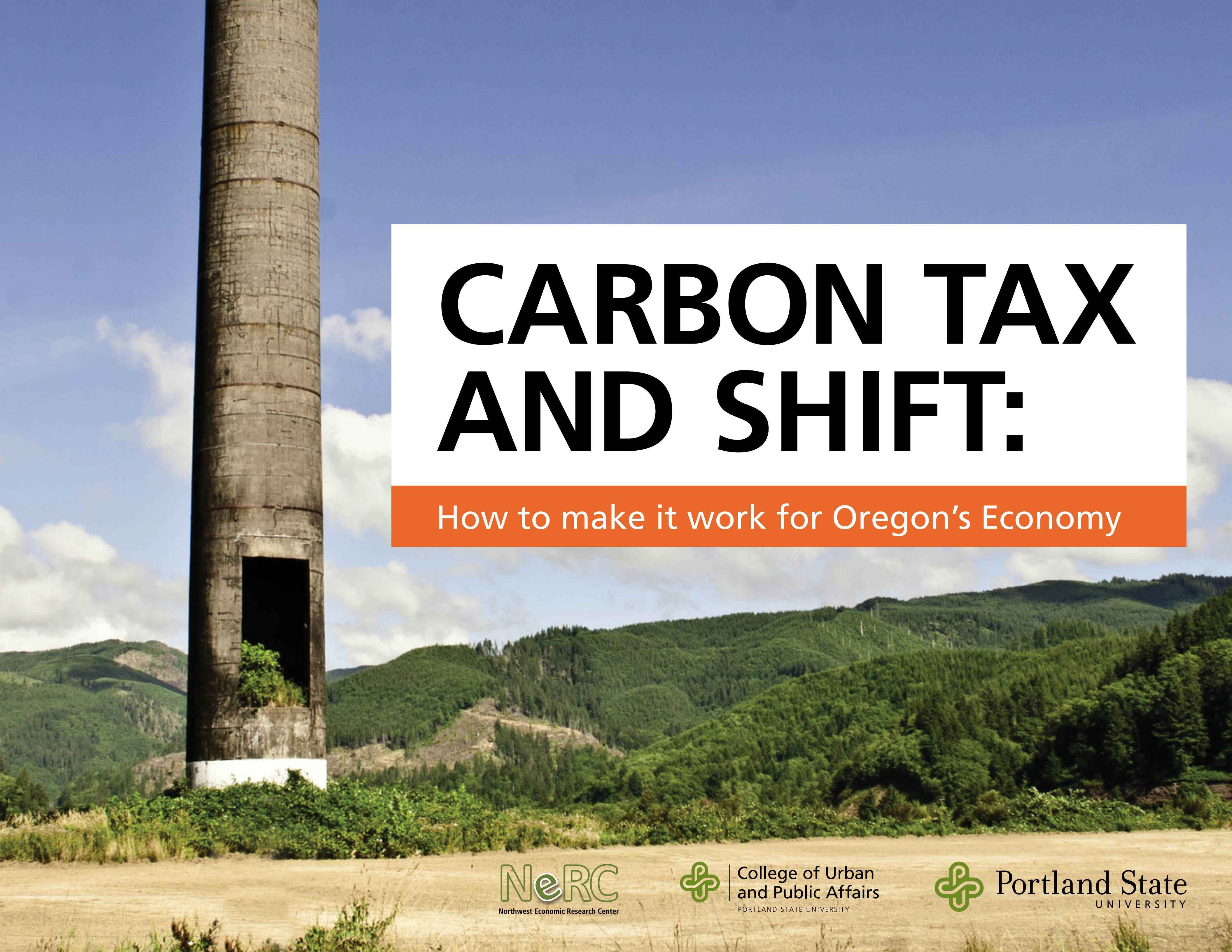


CARBON TAX AND SHIFT:

How to make it work for Oregon's Economy

NeRC
Northwest Economic Research Center

College of Urban and Public Affairs
PORTLAND STATE UNIVERSITY

Portland State
UNIVERSITY

Acknowledgements

Carbon Tax and Shift: How to Make it Work for Oregon's Economy

March 1, 2013

Liu, Jenny H. and Renfro, Jeff. (2013) *Carbon Tax and Shift: How to make it work for Oregon's Economy.* Northwest Economic Research Center Report. http://www.pdx.edu/nerc/carbontax2013.pdf

The following report was researched and written by the Northwest Economic Research Center (NERC) with funding support from the Energy Foundation and Portland State University's Institute for Sustainable Solutions (ISS).

The mission of The Energy Foundation is to promote the transition to a sustainable energy future by advancing energy efficiency and renewable energy. ISS advances sustainability research, education, and outreach at Portland State, leading the University to be a powerful catalyst and model for a more equitable, ecologically balanced, and economically vibrant future. The Northwest Economic Research Center also provided in-kind contributions to the project's budget.

Keibun Mori is the creator of the Carbon Tax Analysis Model (C-TAM) and served as Technical Advisor. Mr. Mori not only allowed us to adapt his work for Oregon, but also reviewed early versions of the model and provided feedback on modeling assumptions and design. Yoram Bauman provided assistance early in the modeling process, and offered helpful suggestions and feedback. Staff from the Oregon Environmental Council (OEC) provided data, feedback on project design, and support throughout.

NERC is based at Portland State University in the College of Urban and Public Affairs. The Center focuses on economic research that supports public-policy decisions-making, and relates to issues important to Oregon and the Portland Metropolitan Area. NERC serves the public, nonprofit, and private sector community with high quality, unbiased, and credible economic analysis. The Director of NERC is Dr. Tom Potiowsky, who also serves as the Chair of the Department of Economics at Portland State University. The report was researched and written by Dr. Jenny H. Liu, Assistant Director, and Jeff Renfro, Senior Economist. Research support was provided by Janai Kessi and Hudson Munoz, NERC Research Assistants. Mauryn Quintero, Administrative Assistant, worked on report formatting and presentation. The report was designed by Brooke Barnhardt.

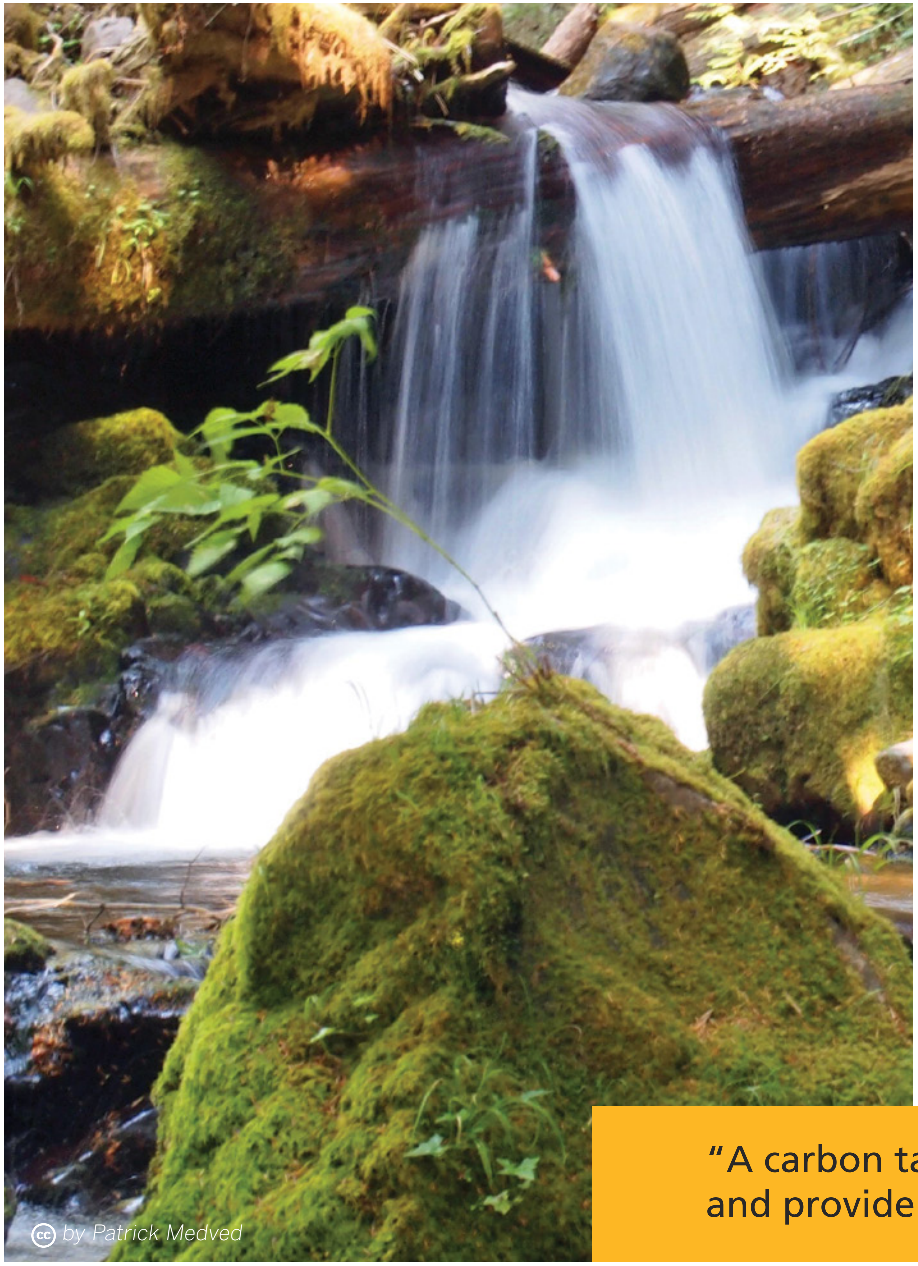
College of Urban and Public Affairs
PORTLAND STATE UNIVERSITY

NeRC
Northwest Economic Research Center

Portland State University
College of Urban and Public Affairs
PO BOX 751
Portland, OR 97207-0751
(503) 725-8167
www.pdx.edu/nerc

Table of Contents

Executive Summary



This study analyzes a carbon tax and tax shift in Oregon as a means of reducing market inefficiencies by placing a meaningful price on carbon emissions. This study shows that a carbon tax can reduce distortionary income taxes, and provide new revenue opportunities for Oregon. By taxing carbon emissions and reducing Corporate and Personal Income tax rates, Oregon can reduce the negative incentives created by income taxes while generating revenue and reducing carbon emissions. The report shows that putting a price on carbon in Oregon can result in reductions in harmful emissions and have positive impacts on the economy.

Carbon emissions impose negative externalities on society, such as damage to property and critical infrastructure, increased health costs, losses of natural resources including drinking water supplies and other potential effects of climate change, leading to serious global market failures. Thus, the social costs of climate change need to be incorporated into the decision-making processes of energy suppliers, consumers and policy makers to reduce potential economic inefficiencies and major economic losses.

> "A carbon tax and shift can reduce distortionary income taxes, and provide new revenue opportunities for Oregon."

NERC utilized the carbon tax implemented in British Columbia (BC) as the basis for our analysis since it is the first carbon tax to be implemented across all economic sectors in North America. The BC carbon tax is designed as a revenue-neutral tax levied on all fossil fuels combusted within its jurisdiction, starting at $10 per ton of CO_2e in 2008 and increasing by $5 per ton each year up to its current cap price of $30 in 2012. The revenues are repatriated back to the economy primarily through corporate income tax and personal income tax reductions, including support for low-income households. Preliminary research shows growth in the BC economy at similar rates with the rest of Canada since the carbon tax went into effect.

Oregon would benefit from diversified revenue sources and new economic development opportunities, and has a goal to cut greenhouse gas emissions to 10 percent below 1990 levels by 2020 and at least 75 percent by 2050. Within this context, we analyzed a variety of carbon tax scenarios.

This study details revenue and emissions change estimates for several carbon prices, but the reported scenarios use a maximum price of $60/ton CO_2e, starting at $10/ton and increasing by $10 per year. At this price, revenues from the tax would total $1,173M annually in 2015 and rise to $2,157M annually in 2025. It is important to note that these scenarios assume the continuation of existing climate and clean energy related policies, such as the Renewable Energy Portfolio Standard and Clean Fuels Program. Even with these existing policies and an additional price on carbon, Oregon would still fall short of its emission goals. A price of approximately $100/ton CO_2e would be necessary to reduce emissions to 1990 levels by 2030.

Figure A
Oregon's GHG Emissions at $60/ton Price, $10 Annual Increase

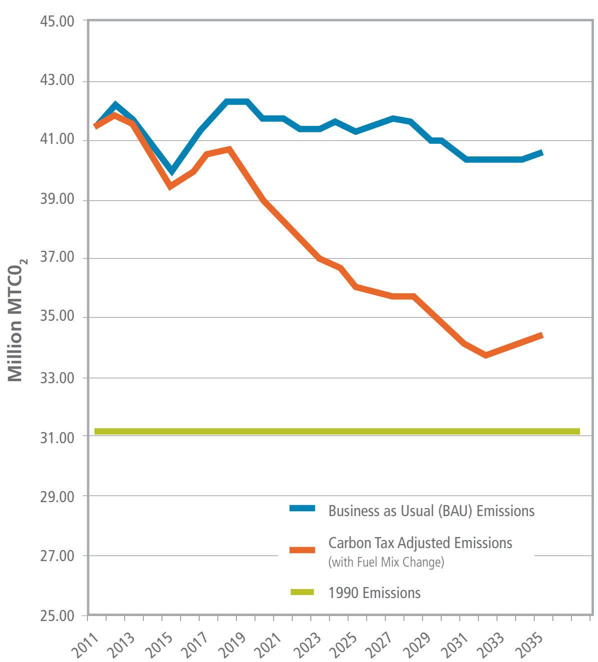


Table A
Estimated Carbon Emissions Reductions & Tax Revenues: $60/ton Maximum Price, $10 Annual Increase

Price/Ton CO_2e	2015 $30	2025 $60	2035 $60
GHG Change from Baseline Forecast			
Residential	-4.7%	-20.3%	-25.6%
Commercial	-6.1%	-26.0%	-32.2%
Industrial	-4.0%	-20.3%	-25.5%
Transportation	-3.0%	-5.2%	-6.0%
Total	-2.0%	-12.5%	-15.1%
GHG Change from 1990 Levels	**25.7%**	**16.1%**	**10.6%**
Carbon Tax Revenues (million)			
Residential	$150	$259	$237
Commercial	$132	$237	$240
Industrial	$295	$548	$494
Transportation	$597	$1,113	$1,052
(Individual)	$535	$913	$796
(Business)	$638	$1,244	$1,227
Total	**$1,173**	**$2,157**	**$2,023**

After estimating dozens of repatriation schemes, we arrived at two promising scenarios that:

- Produce additional jobs and overall growth in the Oregon economy
- Include relief for low-income households
- Set aside revenue for targeted reinvestment that offset costs for selected industries and contribute to reaching Oregon's climate goals

10% Reinvestment Scenario

The 10% reinvestment scenario uses 70% of revenue for Corporate Income tax cuts, 20% for Personal Income tax cuts, and 10% for reinvestment in industrial energy efficiency programs. This scheme is structured so that households making less than $35,000 annually incur no extra cost from the program.

25% Reinvestment Scenario

The 25% reinvestment scenario uses 50% of revenue for Corporate Income tax cuts, 25% for Personal Income tax cuts, and 25% for reinvestment in industrial energy efficiency programs, residential energy efficiency programs, and transportation infrastructure. This version also leaves low-income households with no extra cost from the program.

We began the process by estimating boundary scenarios (devoting all revenue to either Corporate or Personal Income Tax cuts) to gain a better understanding of the tax dynamics. The outcomes of these boundary scenarios, or splitting the revenue between them, helped in constructing two promising implementation options. From the boundary scenarios, we learned that Corporate Tax cuts are important to stimulate enough additional economic activity to offset the burden caused by higher energy prices, yet yield inequitable outcomes unless corrected. Personal Income taxes alone do not generate the economic activity necessary to offset losses. Shifting revenues to offset the regressivity of the income tax cuts and increases in energy prices are important for the equity of the program, and increase the positive economic impact of the tax shift to households.

When revenues were split evenly between Corporate and Personal Income Tax cuts, our model showed low growth with concentrated negative outcomes in a few industry sectors. The outcomes that best balance the study's goals include a combination of Corporate and Personal Income tax cuts (with support for low-income households), and targeted reinvestment that uses revenues for energy efficiency and transportation infrastructure programs that create jobs and helps industry stay competitive.

This report shows that a BC-style carbon tax and shift could generate a significant amount of revenue and reduce tax distortions while creating new jobs and reducing carbon emissions. The specifics of the tax shift program are key to ensure equitable distribution of costs and benefits, as well as preserve the strength of the price signal.

Recommended Scenario:

10% Reinvestment of Carbon Tax Revenue
(Scenario 1.1)

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	3,464	153
Indirect Effect	763	34
Induced Effect	-1,439	-66
Total Effect	**2,787**	**121**

Recommended Scenario:

25% Reinvestment of Carbon Tax Revenue
(Scenario 1.2)

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	2,191	93
Indirect Effect	538	25
Induced Effect	-1,498	-71
Total Effect	**1,231**	**47**

Background & Motivation

The objective of this study is to analyze a carbon tax and tax shift for Oregon not only as a viable market mechanism to internalize the external cost of carbon emissions and reduce overall emissions, but also as an opportunity to generate new revenue and increase economic efficiency by replacing distortionary tax revenues with carbon tax revenues (Aldy et al. 2009; Metcalf 2009; Nordhaus 2010). This is commonly known as the double-dividend effect in environmental economics (Pearce 1991).

Reports such as the Stern Review (2006) and the Intergovernmental Panel on Climate Change's (IPCC) Fourth Assessment Report (2007) have shown that the accumulated concentration levels of carbon dioxide (CO_2) in the atmosphere generate negative externalities on society through "health impacts, economic dislocation, agricultural changes, and other effects that climate change can impose on humanity" (Bell and Callan 2011). These negative externalities impose costs on society but are not internalized as actual costs when the CO_2-emitting activities are conducted (Tietenberg and Lewis 2004; Nordhaus 1994).

By taxing the emissions, the social costs of carbon emissions are incorporated into the decision-making processes of market actors such as energy suppliers, consumers and policy makers, reducing economic inefficiencies. By structuring a carbon tax shift where carbon tax revenues are structured to reduce Corporate and Personal Income tax rates, Oregon could reduce the negative incentives created by the distortionary income taxes while continuing to generate the same level of revenue.

"By structuring a revenue-neutral tax shift, Oregon could reduce the negative incentives created by the distortionary income taxes while continuing to generate the same level of revenue."

British Columbia (BC) Carbon Tax

In 2008, British Columbia implemented a provincial revenue-neutral carbon tax that reduced corporate and personal income taxes using carbon tax revenues. BC's Ministry of Finance included the carbon tax in its 2008 Budget and Fiscal Plan, which was passed by the parliament as the Carbon Tax Act (Bill 37) in May 2008 and became effective on July 1, 2008. The tax was designed to ascribe a price to each metric ton of CO_2-equivalent (CO_2e) emissions from fossil fuels[1] purchased and combusted within the provincial borders, starting at $10 per ton of CO_2e in 2008 and increasing by $5 per ton each year until the cap price of $30 per ton was reached in 2012[2]. Although a number of northern European countries such as Norway, Ireland **(see sidebar)** and Sweden have instituted carbon taxes, the BC carbon tax is unique as the first carbon tax to be implemented across all economic sectors in North America (Sustainable Prosperity 2012).

The BC carbon tax has few exemptions. We believe that this minimal-exemption strategy preserves a strong incentive to reduce fossil fuel use and creates equity amongst sectors. With exemptions, it is possible that an energy-intensive industry will become more competitive based on the cut in their taxes, thereby increasing the incentive to pollute.

Table 1: BC Carbon Tax Revenue and Revenue Repatriation

	Carbon Tax Revenue *($ Millions)*	Revenue Repatriation *($ Millions)*	Net Revenue from Carbon Tax *($ Millions)*
2008/09 Fiscal Year	$306	$313	($7)
2009/10 Fiscal Year	$542	$767	($225)
2010/11 Fiscal Year	$741	$865	($124)
2011/12 Fiscal Year *(forecasted)*	$960	$1,152	($192)
2012/13 Fiscal Year *(forecasted)*	$1,172	$1,275	($103)

(Source: BC Ministry of Finance Budget and Fiscal Plans)

Exemptions can also be conceptualized as an environmental subsidy paid by the rest of the society. While this should not automatically disqualify the idea of exemptions, it is imperative that the full costs of an exemption are considered and the policy is carefully targeted. During conversations with administrators of the BC tax, it was cited that the broad base of the tax is a major strength of BC's program.

In British Columbia, all of the forecasted carbon tax revenue is repatriated back into the economy as required by law. **Table 1** shows the actual and forecasted BC carbon tax revenue and revenue repatriation amounts[3].

The main repatriation mechanisms ranked by magnitude are:

- general and small business corporate income tax reductions;
- personal income tax cuts in the first two brackets (i.e. income below $70,000);
- Low Income Climate Action Tax;
- benefits of up to $200 to rural and northern homeowners;
- Industrial Property Tax Credit of 60% of school property taxes payable by light and major industrial (BC Ministry of Finance 2012).

Sustainable Prosperity (SP), a policy and research network based at University of Ottawa, published its report on the first four years of the BC carbon tax in 2012. SP finds only a small difference of 0.1% in total economic growth during 2008-2011 between British Columbia and the rest of Canada, as measured by the growth of GDP (gross domestic product) per capita, and concludes that the evidence does not show that the carbon tax is harming the provincial economy. These preliminary results appear to be consistent with previous studies looking at the effect of environmental taxes in European nations on their economic growth (Andersen et al. 2007). Because GHG emissions data was unavailable for 2011 and 2012, SP examined the per capita consumption of refined petroleum products and motor gasoline as proxies for the environmental impacts of the tax. The report finds that the consumption of refined petroleum products between 2008-2011 decreased by 15.1% in

BC and increased by 1.3% in the rest of Canada, and the consumption of motor gasoline in the same period decreased by 4.0% in BC and increased by 3.3% in the rest of Canada. Although the economic and environmental impacts shown by Sustainable Prosperity cannot be interpreted as direct impacts of the carbon tax, the study demonstrates carbon tax as a potential approach where increased jobs and overall economic activity can occur in conjunction with reductions in carbon emissions and environmental damages.

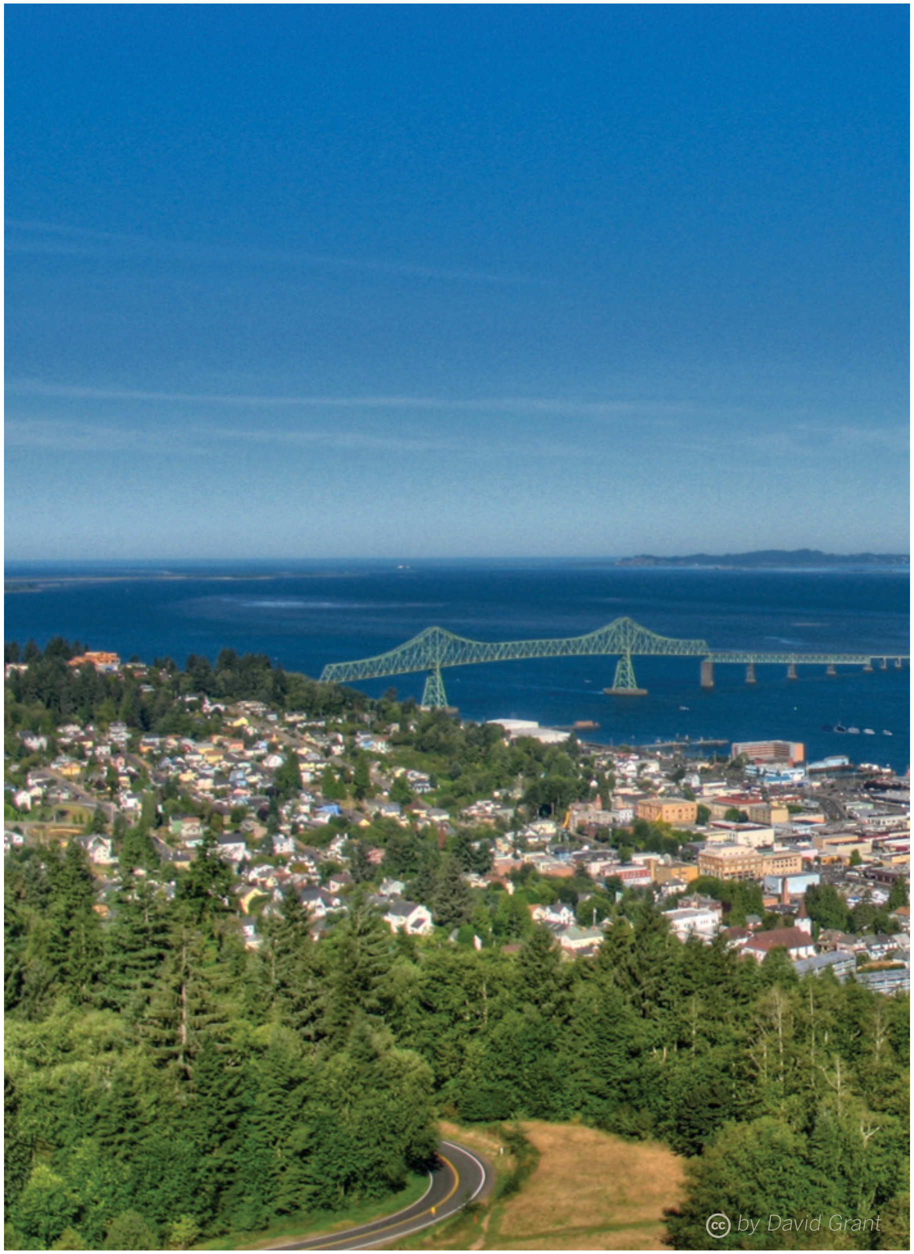
“The consumption of refined petroleum products between 2008-2011 decreased by 15.1% in BC and increased by 1.3% in the rest of Canada, and the consumption of motor gasoline in the same period decreased by 4.0% in BC and increased by 3.3% in the rest of Canada.”

Carbon Tax in Ireland

In 2010, Ireland began to levy a carbon tax on fossil fuels, including kerosene, diesel fuel, liquid petroleum, fuel oil, and natural gas, and the tax was expanded to include solid fuels such as peat and coal in 2012. The tax started at €5 per ton of CO_2e, and increased to €20 per ton in 2012. The carbon tax on solid fuels is phased in starting at €5 per ton in 2012, and will increase to €10 and €20 per ton in May 2013 and May 2014, respectively. The tax is estimated to generate €500 million in revenue in 2013, and can potentially offset approximately 3.5% of the Irish income tax (Convery 2012).

The Irish carbon tax only applies to sectors that are not a part of the European Union Emission Trading Scheme (EU ETS), and it is computed based on emissions rather than consumption. In 2011, Ireland’s Environmental Protection Agency estimates that overall GHG dropped by 6.7%, and energy GHG emissions (primarily electricity generation) dropped by 10.5%, with slight growth in the economy. This decline results from a combination of environmental policies such as the carbon tax and the Vehicle Registration Tax, which has been based on CO_2 emissions since 2008 (Convery 2012).

Recommendations & Implementation



NERC ran dozens of scenarios in order to find the combinations of tax cuts and targeted reinvestment that resulted in the best combination of economic growth, fairness, and reduction of emissions. The following scenarios feature two levels of targeted reinvestment that use carbon tax revenues for projects that help reduce carbon and plug persistent funding gaps. Both scenarios include low-income relief, which yields a slightly larger positive economic impact and offsets the regressiveness of the increase in energy prices and cut in personal income taxes. Revenue estimates are based on a maximum carbon price of $60/ton CO_2e.

For more on the process of arriving at these recommendations, see Scenario and Estimation Results (pg. 17)

Scenario 1: Recommended Scenarios Summary

1.1 - 10% Reinvestment of Carbon Tax Revenue:

- Positive Jobs Impact
- More Equitable Distribution of Costs
- Provides Revenue for Targeted Reinvestment

1.2 - 25% Reinvestment of Carbon Tax Revenue:

- Positive Jobs Impact
- More Equitable Distribution of Costs
- Provides Largest Amount of Revenue (of Recommended Scenarios) for Targeted Reinvestment

Sectors

Residential:

- Home Energy Use
- Residential Construction
- Some Building & Apartment Management

Industrial:

- Manufacturers
- Agricultural Activity
- Natural Resources

Commercial:

- Catch-All Category
- Includes Retail, Services, Government Services, Etc.

Transportation:

- Motor Vehicle Transportation
- Shipping and Transport by all Means

Recommended Scenario: 10% Reinvestment of Carbon Tax Revenue

(Scenario 1.1)

This scenario uses:

- 70% of revenue for uniform Corporate Income Tax cuts
- 20% of revenues for Personal Income Tax cuts (with low-income relief)
- 10% of funds set aside for investment in industrial energy efficiency.

The revenue devoted to Corporate Tax cuts would replace 82% of the tax revenue forecast for 2025, while the Personal Income Tax revenues would replace 1.6% of forecast revenue for 2025. Because of the modeling limitations caused by the aggregation of the industry sectors, the 10% targeted reinvestment is modeled as benefiting the Industrial sector as a whole. This investment represents large-scale public support for industrial providers of energy efficiency inputs or could be used for industrial energy efficiency upgrades.

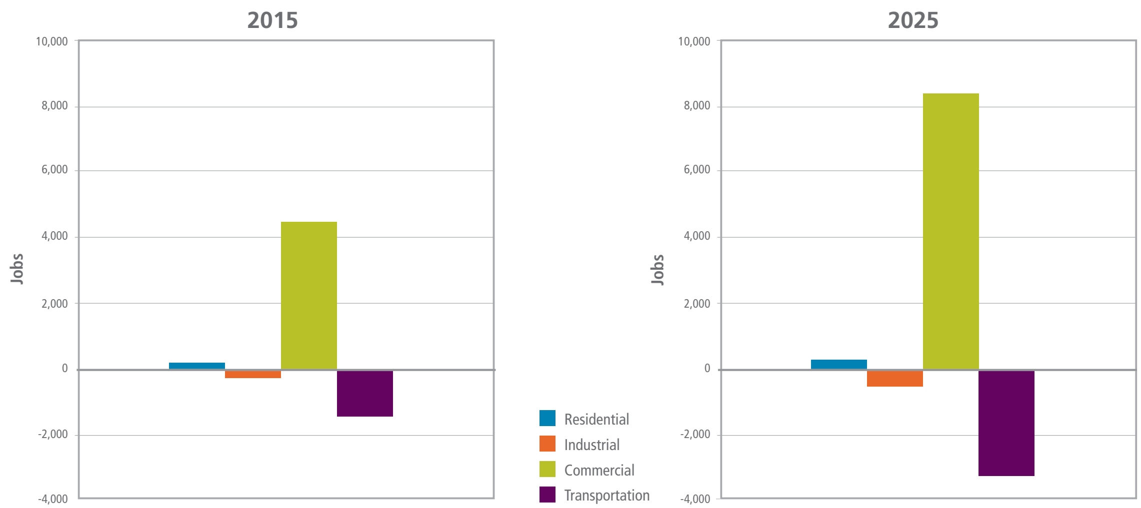
Table 2: 2015: 10% Reinvestment

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	3,464	153
Indirect Effect	763	34
Induced Effect	-1,439	-66
Total Effect	**2,787**	**121**

Table 3: 2025: 10% Reinvestment

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	5,852	255
Indirect Effect	1,154	51
Induced Effect	-2,161	-99
Total Effect	**4,845**	**207**

Figure 1: Sector Jobs Impacts: 10% Reinvestment



The reinvestment money offsets the potential negative impact on the industrial sector. The Commercial sector still enjoys the largest positive impact and the Transportation sector is losing approximately 3% of its workforce. The impacts on the Industrial and Residential sectors are so small, that they are effectively zero.

Although the total number of jobs created in Scenario 1.1 is less than the total created in the 100% Corporate Tax cut scenario, the total job creation is still relatively high. Targeting revenue toward the industrial sector (combined with corporate tax cuts) would contribute to the twin goals of making Oregon manufacturing more competitive, while also moving the state toward its climate change goals. This scenario resulted in one of the best combinations of economic growth, fairness, and reduction of carbon emissions.

Table 4: Relative Jobs Impacts by Sector

Sector	2015	
	Change in Total Jobs *(% of jobs in sector)*	Change in Total Jobs
Residential	0.09%	118.2
Industrial	-0.08%	-290.3
Commercial	0.2%	4,431.7
Transportation	-3%	-1.471.6
Total	**0.17%**	**2788.0**

Interpreting Economic Impact Analysis Results

Direct Impacts: These are defined by the modeler, and placed in the appropriate industry. They are not subject to multipliers. In this case, purchasing, employment, and wage data were collected from the sources described above and placed into the appropriate industry.

Indirect Impacts: These impacts are estimated based on national purchasing and sales data that model the interactions between industries. This category reflects the economic activity necessary to support the new economic activity in the direct impacts by other firms in the supply chain.

Induced Impacts: These impacts are created by the change in wages and employee compensation. Employees change purchasing decisions based on changes in income and wealth.

Figure 2: Sector Jobs Impacts: 25% Reinvestment

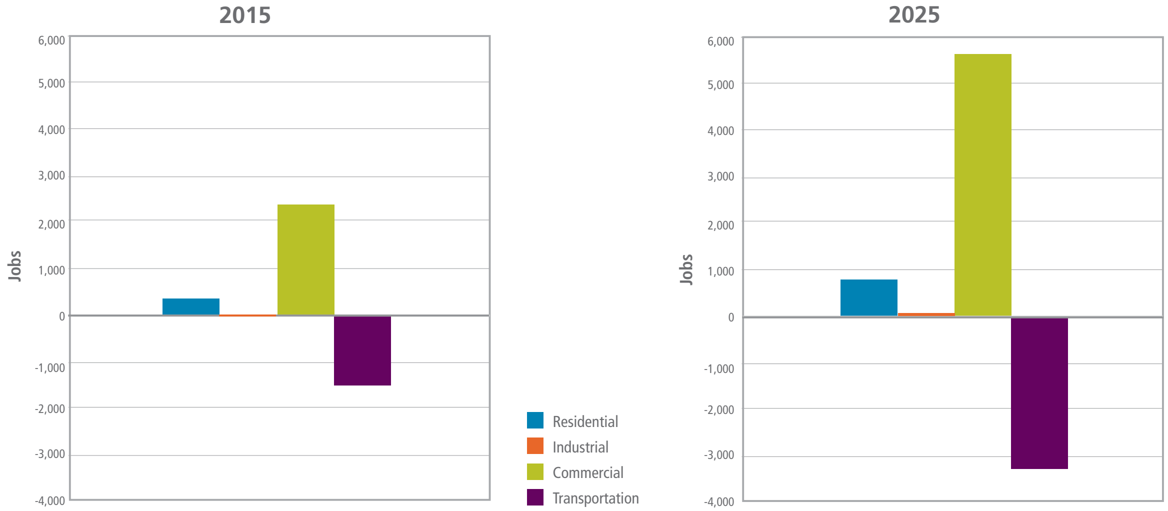


Table 5: 2015: 25% Reinvestment

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	2,191	93
Indirect Effect	538	25
Induced Effect	-1,498	-71
Total Effect	**1,231**	**47**

Table 6: 2025: 25% Reinvestment

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	3,503	176
Indirect Effect	736	42
Induced Effect	-970	-57
Total Effect	**3,270**	**161**

Recommended Scenario: 25% Reinvestment of Carbon Tax Revenue *(Scenario 1.2)*

This scenario uses:

- 50% of revenues for Corporate Income Tax cuts
- 25% of revenues for Personal Income Tax cuts
- 25% of revenues for targeted reinvestment

The corporate tax cuts would replace 59% of revenue forecast for 2025, and the personal income cuts would replace 1.8% of projected 2025 revenue. The 25% reinvestment is split into three categories: home energy efficiency (25%), industrial energy efficiency (25%), and transportation infrastructure (50%). The industrial energy efficiency projects are the same types of projects used in the previous scenario. Home energy efficiency projects benefit the Residential sector, in particular the renovation/remodeling industry. An example of this type of investment would be an expansion of Clean Energy Works home efficiency-type programs. The Clean Energy Works programs have provided jobs to the housing sector during the recent housing slump, while also contributing to the success of Oregon's long-term climate goals. Although more research needs to be done on the economic impact of these programs, it is likely that expanding home energy efficiency projects would have significant economic and environmental returns.

Table 7: Relative Jobs Impacts by Sector

Sector	2015	
	Change in Total Jobs *(% of jobs in sector)*	Change in Total Jobs
Residential	0.2%	362.3
Industrial	0.02%	13.6
Commercial	0.1%	2,368.9
Transportation	-3%	-1,513.3
Total	**0.08%**	**1,231.5**

> "It is likely that expanding home energy efficiency projects would have significant economic and environmental returns."

> "Measures to correct for regressivity in the carbon tax structure should be considered in any policy package."

The investment in transportation infrastructure as modeled here does not explicitly relate to climate change goals. This portion of the reinvestment is modeled as benefiting the Industrial sector (the economic sector responsible for infrastructure projects). An example of how these funds could be used would be to cover the persistent shortfall in road construction funding. This investment could be conceptualized as any other large-scale public works project with funds targeted to construction and manufacturing firms.

This scenario produces a smaller net increase in jobs than Scenario 2.1, but the Industrial sector is effectively held harmless, and the Residential sector has its strongest positive increase in jobs. These increases come at the expense of the Commercial sector, which still has a large, but smaller, increase in jobs. The smaller employment impact in this scenario is partially offset by the large investment in climate change mitigation projects. The tradeoff in these two scenarios is between greater overall employment impact in Oregon or additional assistance for the Industrial and Residential sectors. Targeted assistance to industries can be effective, but it comes at the price of economic efficiency. This scenario also resulted in one of the best combinations of economic growth, fairness, and reduction of emissions.

Implementation

In general, a carbon tax can be characterized by the coverage of the tax (e.g., which fuels are taxed), the tax rate, the timing and magnitude of incremental increases in the rate, and how revenues from the tax are utilized.

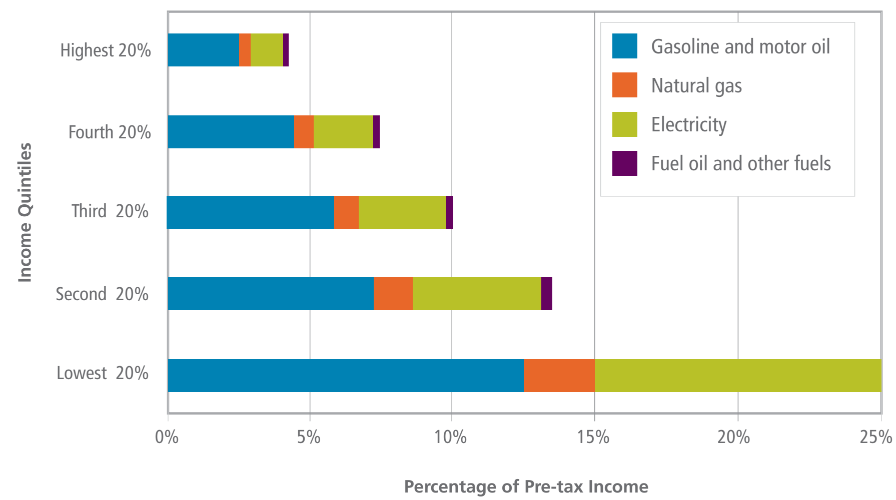
The carbon tax analyzed in this study is primarily based on the carbon tax implemented in British Columbia which levies a carbon tax on all fossil fuels combusted within its jurisdiction. Although BC's carbon tax is currently capped at $30 per ton of CO_2e, it has been shown that the social cost of carbon ranges from $21 (US IAWG 2010) to $310 per ton of CO_2e (Stern 2006), depending on the discount rate, climate change model, valuation methodology of impacts, and treatment of catastrophic events (Nordhaus 2011; Johnson and Hope 2012; Parry et al. 2007). IPCC's (2007) meta-analysis shows a mean of $43 per ton of CO_2e with a standard deviation of $83 amongst peer-reviewed studies. Therefore, NERC's analysis will start with a carbon tax of $10 per ton of CO_2e in 2013, and increase in fixed annual increments up until a pre-determined price cap. The annual increments and cap are pre-determined to reduce uncertainty to consumers, businesses and industries.

In the context of carbon taxation, state authorities may structure taxes as either revenue-positive or revenue-neutral. Revenue-positive is when some of the carbon tax revenue is retained and reutilized by the state. Revenue neutrality means that all revenue from the tax must be returned or repatriated to taxpayers through tax cuts, or credits, essentially creating a tax shift, and/or designated reinvestments. However, the goal of revenue neutrality does not explicitly specify any repatriation structure or scheme. In the case of British Columbia, most of the carbon tax revenues were used towards reductions in corporate income tax and personal income taxes, and credits for low-income households. This study models the impacts of a version of the revenue-neutral tax, which includes reinvestment expenditures in addition to tax rate cuts.

Issues for Implementation: Distribution of Impacts

Numerous studies have shown that carbon tax and other types of energy taxes are regressive with respect to income levels, placing a disproportional burden on lower-income households (Callan et al. 2009; Schaffrin 2013). This is illustrated in the below figure where the bottom 20% of households spend a quarter of their income on energy as opposed to less than 5% for those households in the top 20%. Even with low-income tax credits, Lee and Sanger's 2008 report for the Canadian Centre for Policy Alternatives (CCPA) still concludes that the BC carbon tax results in negative distributional impacts. However, the degree of regressivity of a carbon tax is highly dependent on the types of fuel to which the tax applies, and the particular structure of revenue repatriation (Speck 1999). As illustrated in our recommended scenarios, we believe that measures to correct for regressivity in the carbon tax structure should be considered in any policy package. Further research will be needed to accurately characterize the extent of carbon usage and demand elasticities across income groups in Oregon.

Figure 3: Household Energy Expenditure by Income Quintiles



(Source: Consumer Expenditure Survey 2011

Issues for Implementation: Competitiveness

One concern of applying a carbon tax at the state level is that it could reduce the competitiveness of Oregon-based industries. Competitiveness within a region is linked to the issue of emissions leakage, "the movement of economic activity from high carbon price to low or no carbon price" regions and resulting in higher emissions in less regulated regions (Metcalf 2009; Reinaud 2009), and potential capital flight, where businesses shift investments to jurisdictions where the cost of doing business is lower (Parry and Williams 2011). A carbon tax in Oregon would have disparate impacts on industry sectors operating within the state with varying carbon-intensities. For example, the service sector would shoulder less of a carbon tax burden than fossil fuel intensive industries such as concrete manufacturing (Kuik and Hofkes 2009). However, a carbon tax is a straightforward price mechanism that provides businesses with the most certainty about the cost of compliance, as opposed to a quantity mechanism like the cap-and-trade system where the carbon outcomes are more certain, but the price varies (Aldy and Stavins 2012). Both carbon tax and cap-and-trade systems place a price on carbon, which can increase the cost of doing business for regulated industries and create competition from other less regulated markets.

One way to mitigate this negative economic consequence and maintain competitiveness is through a border carbon adjustment tax, which would increase the price of fossil-fuel intensive products imported into Oregon or decrease the price of fossil-fuel intensive products as they are exported outside of the region (Cosbey 2008; Fischer and Fox 2009). It will be important for such a border tax to differentiate between similar goods made with different levels of fossil fuel input. Under current reporting protocols, gathering accurate information on the CO_2e emitted during the production of an imported project may be difficult, or impossible. Using estimates or standard rates for similar goods could weaken the price signal of the tax by punishing low-carbon goods or rewarding high-carbon goods. Zabin et al. (2009) estimated cost increases and job losses to be small for carbon intensive industries[5] in Oregon at a carbon price of $15 per ton of CO_2e. They additionally suggest sectoral agreements, free allowances to industries prone to leakage, output-based rebates, and incentives for energy efficiency investments as mechanisms to mitigate these effects. Furthermore, Fullerton et al. (2011) found that capital mobility is one of the main determinants of emissions leakage. Further research will need to be conducted in order to appropriately characterize the magnitude of emissions leakage and capital flight due to a carbon tax in Oregon.

Parameters for Scenarios

When designing scenarios for this study we did not have one set target; instead, we found tax program structures that significantly reduced emissions, created a net increase in jobs, and distributed costs and benefits fairly between industry sectors and households.

In order to understand the effects of changes in each variable, NERC ran scenarios that estimated outcomes of different combinations of carbon prices and repatriation schemes. The two recommended scenarios above are examples that we feel balance all of the study's goals, and could form the basis of workable carbon tax programs that reduce emissions while providing economic benefits and addressing equity concerns. The four boundary scenarios in this section represent the boundaries and demonstrate the effects of different repatriation options.

For all scenarios, we chose to use a carbon price of $60/ton of CO_2e. This price goes beyond the $30/ton cap currently in place in BC. This is partially motivated by our conversations with people in BC responsible for implementing the carbon tax. Because of the positive initial results of the BC tax, an effort is being made to increase the cap. Based on our conversations and review of news reports, we expect this the cap to be raised eventually. At $60/ton, the price would place Oregon ahead of regional efforts to price carbon, but well below the world's highest prices.

With a tax starting in 2013 with a $60 maximum and $10 annual increase, in 2015 emissions would be 2% below the baseline forecast and $1,173M in revenues would be generated[6]. In 2025, the emissions would be 12.5% below the baseline forecast and the revenues would be $2,157M[7].

Scenarios & Estimated Results

Revenue Repatriation Scenarios

Scenario 1 - Targeted Reinvestment

- 1.1 - 10% Reinvestment Set Aside *(pg. 11)*
- 1.2 - 25% Reinvestment Set Aside *(pg. 13)*

Scenario 2 - Boundaries

- 2.1 - 100% Corporate Income Tax Cuts
- 2.2 - 100% Personal Income Tax Cuts
- 2.3 - 100% Personal Income Cuts
- 2.4 - 50/50 Split

Scenario 2: Boundary Scenarios Summary

2.1 - 100% Corporate Income Tax Cuts:

- Largest Positive Job Impact
- Inequitable Distribution of Costs for Industries and Households

2.2 - 100% Personal Income Tax Cuts:

- Large Negative Effect on Jobs
- Spreads Distribution of Negative Industry Impacts

2.3 - 100% Personal Income Tax Cuts with Low-Income Relief:

- More Favorable Effect on Employment
- Caused by Higher Marginal Propensity to Consume for Low-Income
- Still Net Loss of Jobs

2.4 - 50/50 Split:

- Small Positive Increase in Jobs
- Inequitable Distribution of Costs
- Bad Combination of Worst Results of Previous Scenarios

"With a tax starting in 2013 with a $60 maximum and $10 annual increase, in 2015 emissions would be 2% below the baseline forecast and $1,173M in revenues would be generated. In 2025, the emissions would be 12.5% below the baseline forecast and the revenues would be $2,157M. "

Scenario 2.1
100% Corporate Income Tax Cuts

In this scenario, we model a revenue-neutral option that uses 100% of revenues generated by the tax to reduce Corporate Income Tax rates. In order to model a uniform reduction in tax rates, we calculated the distribution of tax revenue contributions by sector and returned the revenue to each industry according to this distribution. The BC carbon tax has few exemptions, and industry support or assistance is provided using funds raised from the tax. We believe that this minimal-exemption strategy preserves a strong incentive to reduce fossil fuel use.

Returning 100% of the revenue through Corporate Income Tax cuts would offset enough of the revenue projected for 2025 to eliminate the Corporate Income tax, and leave an additional 17% of projected revenues left to be redistributed.

This scenario results in the highest positive employment impact in the study, but the impact on households is extremely regressive and the positive impacts are concentrated in the Commercial sector. It should be noted that all positive job impacts in the study are small relative to Oregon's current 1.6M total nonfarm jobs (2012). In this scenario, the impact on the Commercial sector is only a 0.4% increase in employment, 0.4% decrease in Industrial employment, 0.2% increase of Residential employment, and a 7% decrease in Transportation employment.

Table 8: 2015: 100% Corporate Income Tax Cuts

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	5,955	266
Indirect Effect	1,413	64
Induced Effect	-2,504	-115
Total Effect	**4,864**	**215**

Table 9: 2025: 100% Corporate Income Tax Cuts

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	10,176	448
Indirect Effect	2,172	97
Induced Effect	-4,309	-197
Total Effect	**8,039**	**347**

Scenario 2.2
100% Personal Income Tax Cuts

In this scenario, we model a repatriation scheme that returns all revenues in the form of Personal Income Tax Cuts. To model this, we calculated the distribution of Personal Income Tax Revenues and returned the revenue according to this distribution. Low-income households devote a larger proportion of their income to energy expenditures, and would be disproportionately negatively impacted by the increase in energy costs. Because high-income households pay a disproportionate portion of personal income tax, when rates are cut, high-income receives most of the benefit.

Returning revenues to households does not generate the same level of economic activity as the 100% corporate scenario. In this scenario, a larger portion of the repatriated revenue would go toward consumption. This type of spending is associated with a smaller economic multiplier because the impact is fleeting, as opposed to longer-term investments which continue to provide economic benefits into the future. In 2025, the revenue generated by the tax would replace 8.6% of projected Personal Income tax revenue.

Table 10: 2015: 100% Personal Income Tax Cuts

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	- 4,139	- 213
Indirect Effect	- 2,093	-101
Induced Effect	2,965	135
Total Effect	**- 3,267**	**-179**

Table 11: 2025: 100% Personal Income Tax Cuts

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	- 8,131	- 418
Indirect Effect	- 4,101	- 198
Induced Effect	5,945	271
Total Effect	**- 6,287**	**- 344**

Scenario 2.3
100% Personal Income Tax Cuts with Low-Income Relief

In order to offset the regressive impact of the increase in energy prices and the decrease in personal income tax rates, we modeled a modified version of the 100% personal income tax scenario. In this scenario, the impact of the increase in energy prices is estimated for each household income level. When the carbon tax revenue is repatriated, households earning less than $35,000 a year are held harmless. A portion of repatriated funds are transferred from households earning $100,000 or more annually to the lower-income households. The repatriated funds transferred to low-income households are more than the personal income tax revenue paid by these households. In order to transfer a sufficient amount of revenue, the state would need to undertake policies like an expansion of the Earned Income Tax Credit, or directly subsidize energy purchases for low-income. A program that transfers funds through the tax code would be preferred because it decouples the additional burden of the carbon tax with the benefits of the tax shift. This would preserve the strength of the price signal.

While the overall impact of this scenario is still negative, the impact is smaller. This is because low-income households have a high marginal propensity to consume. More of the repatriated funds are being put back into the economy. This scenario variation shows that low-income relief has positive economic impacts, as well as being more equitable.

Table 12: 2015: 100% Personal Income Tax Cuts with Low-Income Relief

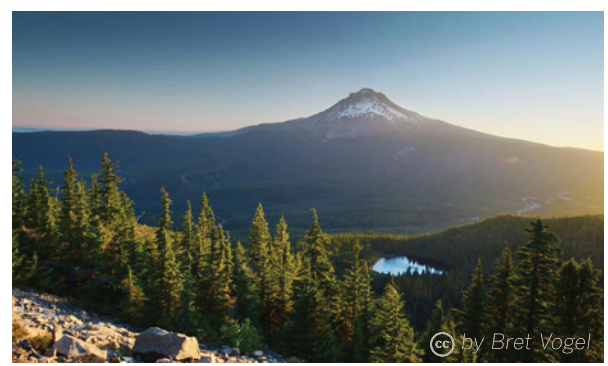
Impact Type	Employment	Labor Income *(Million)*
Direct Effect	- 4,139	- 222
Indirect Effect	- 2,094	-105
Induced Effect	3,063	145
Total Effect	**- 3,169**	**-181**

Table 13: 2025: 100% Personal Income Tax Cuts with Low-Income Relief

Impact Type	Employment	Labor Income *(Million)*
Direct Effect	- 8,131	- 532
Indirect Effect	- 4,101	- 252
Induced Effect	6,145	357
Total Effect	**- 6,088**	**- 426**

Scenario 2.4
50/50 Split between Corporate and Personal Income Tax Cuts

A natural reaction to these extreme scenarios is to split the repatriated funds evenly between corporate and personal income tax cuts. This scenario resulted in the worst of both outcomes. The overall economic impact was a small increase in jobs, and the positive impacts are concentrated in the Commercial sector.



Conclusion

The results of this report (along with initial results out of BC) show that there does not need to be a tradeoff between correcting market failures associated with emissions and economic growth. In fact, if revenues are used to eliminate the distortionary effects of existing income taxes, a carbon tax might stimulate growth. This would leave Oregon with a tax system that disincentivizes emissions while promoting less-energy-intensive output. Additionally, a carbon tax offers a significant revenue generation option at a time when the state is evaluating new options to diversify Oregon's revenue mechanisms.

Our scenarios show that reinvestment in public works and energy efficiency programs can be part of a successful plan. These reinvestments can also be used to offset competitiveness issues, contribute to Oregon's climate goals, and provide revenue for traditionally underfunded state activities.

According to our results, some level Corporate Income Tax cuts would be necessary to have net economic growth. Returning money to households through Personal Income Tax cuts should be included for equity reasons, but it does not generate enough economic activity to offset the tax burden. Careful program design can also offset the potential extra burden on low-income households.

"If Oregon adopts carbon pricing…Oregon companies would have a head start on the adaptation and industry reconfiguration necessary under a new tax regime."

"A carbon tax offers a significant revenue generation option at a time when the state is evaluating new options to diversify Oregon's revenue mechanisms."

It is impossible to institute a Carbon Tax without negatively affecting some industries. Good program design can more than make up for these negative outcomes by increasing the competitiveness of some industries. Targeted revenue shifting can result in a successful Oregon-only program, but many of the potential negative outcomes of the tax could be eliminated if a national or regional carbon price was instituted. BC and California already have put a price on carbon, and there are carbon pricing discussions happening in Washington State. If Oregon adopts carbon pricing as a significant source of revenue, and other states follow, Oregon companies would have a head start on the adaptation and industry reconfiguration necessary under a new tax regime.

Further Research

This report gives evidence that a carbon tax, if properly implemented, could have a small positive effect on the Oregon economy. This analysis is a good first step toward estimating the effects the tax, but before a tax is implemented, a more in-depth analysis must be performed. The following research methods should be incorporated into future analysis.

Dynamic Feedback

The baseline forecast in the C-TAM model is derived using a dynamic model, but the estimated effect of the new carbon tax in Oregon is not dynamic. We made an effort to pass on costs to households where appropriate, but there is additional inter-industry burden shifting that is not captured by the model. It is possible that more of the tax burden will be shifted out of the Transportation sector, reducing the negative impact on Transportation jobs.

- This analysis would also benefit from dynamic industry interaction coefficients. A limitation of our study is that the coefficients used to estimate inter-industry impacts are static. More work could be done to forecast shifting supply chains.

Environmental Feedback Effects

The IMPLAN section estimates the economic impact of the targeted reinvestment options, but the additional environmental benefits of investing in cleaner technologies is not captured. We anticipate additional, longer-term decreases in emissions based on these investments.

More Industry Sectors

A limiting factor of the analysis was the industry aggregation used by EIA. With access to more sophisticated models, an expanded industry classification system could be used that would break out industry effects with more granularity. There is important variation within our industry sectors that needs to be taken into account. This would also allow for a focus on traded sector industries.

Competitiveness

Related to the additional industry sectors would be a more detailed look at which industries were put at a competitive disadvantage, and a study of best practices in mitigating these effects.

Design of Import Duties

Although a carbon tax may be preferred over other climate mitigation programs, a potential weakness is the difficulty of establishing import duties. Because this process is so complex, different options should be modeled beforehand.

Further Look at Transportation-Specific Effects

Several models used to estimate the effects of policy and economic change on transportation are used in Oregon. These models could be used in conjunction with future carbon models to provide a richer picture of the possible effects of the tax.

Appendix A
Modeling

The gold-standard for energy forecasting is the National Energy Modeling System (NEMS) run by the Energy Information Administration (EIA). NEMS includes sophisticated economic modeling modules as well as dynamic feedbacks. Running simulations on this model requires extensive training and is expensive. In order to run estimates of the net impacts of an Oregon Carbon Tax, we combined two different modeling techniques that draw from more complicated analysis.

The process began with the Carbon Tax Analysis Model (C-TAM) (Mori 2012), originally created by Keibun Mori for the Washington State Department of Commerce. C-TAM incorporates NEMS energy forecasts and local economic projections, and features an interface appropriate for non-technical users. We took the Washington State model and adapted it for use in Oregon.

C-TAM is a production-based model, meaning not all sources of GHG emissions are captured in the model. The emissions from fuel use in the production of cement are captured, but the GHG given off by the materials are not captured. Emissions from tractors and trucks used on agricultural land are captured, but GHG given off by fertilized fields are not captured. We chose to use a production-based model because the BC Carbon Tax (our model) applies to fuels combusted in BC, and is not applied to non-production emissions sources. As emissions monitoring technology improves, it is possible that these non-production sources could be subject to the tax, but for now, the costs and viability of this expansion is unknown. The model also ignores the emissions created during the manufacture of products imported into Oregon or the generation of imported electricity. This issue and the challenges of assigning an appropriate price to these emissions were discussed in the Implementation section in this report.

C-TAM begins with the energy-usage forecast for the Pacific Region created using NEMS. This baseline forecast can be customized to include the effects of different carbon mitigation policies. We chose to use the Extended Policy forecast as the baseline. Extended Policy incorporates all laws and regulations currently on the books and assumes that energy efficiency and carbon mitigation regulations that are normally renewed will continue to be renewed, and that energy efficiency standards that are normally altered upon renewal will continue to be altered accordingly. This forecast also assumes full implementation of the new CAFE standards[8], the Renewable Energy Portfolio Standard, and the Clean Fuels Program. It is important to note that the following results assume continued carbon mitigation efforts from policy-makers, and the ensuing changes in behavior by consumers and businesses.

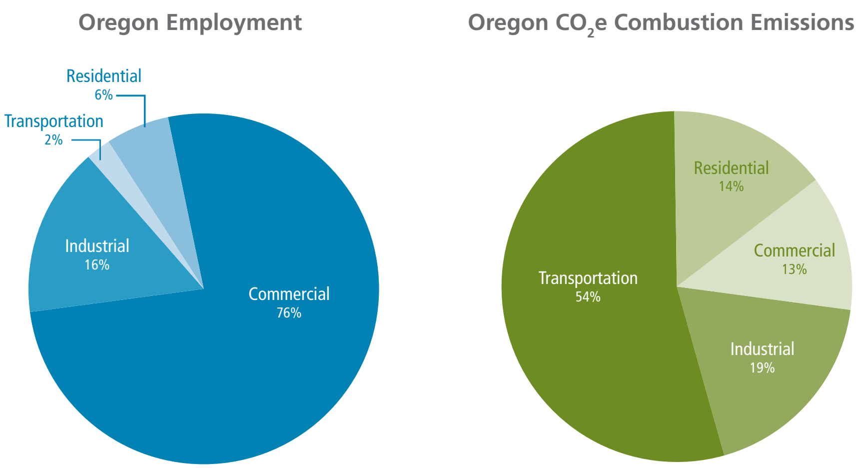
This forecast is then pro-rated using historical Oregon energy-consumption data to create an Oregon energy-usage forecast. Tax revenue and population forecasts from the Oregon Office of Economic Analysis are also used as inputs. In order to estimate the effect of the Carbon Tax, we shock this system by increasing the price of fuels according to the price of carbon and the carbon content of each fuel. Change in usage is predicted based on elasticities drawn from multiple published papers. These elasticities are fuel-specific when possible; when an elasticity estimate has not been computed (or has not been computed recently), the fuel is assumed to have the same elasticity as a comparable fuel. This change in consumption is used to calculate the change in emissions, and the revenue generated by the tax. Figure A diagrams the C-TAM process.

C-TAM Results

To simulate the emission reduction and revenue potential of a Carbon Tax with C-TAM, we assumed that the tax would be put in effect in 2013, at a starting price of $10. In each subsequent year, the price of carbon would increase by a set amount, until the maximum carbon price is reached, at which point the price remains fixed indefinitely. This report shows results for 2015, 2025, and 2035. The revenues generated are annual measures. The change in emissions is compared to the business as usual (BAU) scenario established by the baseline forecast. The revenues generated by each sector are not necessarily paid by that sector. For instance, fossil fuel use in the transportation sector generates the largest revenues of any sector, but the sector's structure allows it to pass these costs on to households. The net effect of these pass-ons are addressed later in the report in the IMPLAN section.

Because of disparities in energy expenditures as a proportion of total income among income classes, it is important for the model to target the extra burden on households. NERC used data from the 2011 BLS Consumer Expenditure Survey to estimate the impact of energy expenditures on each household income class (Bureau of Labor Statistics 2013).

Figure A: The C-TAM Process



The tax burden associated with residential energy use was split between income classes according to each income class's proportion of total residential energy consumption. A similar allocation was performed using data on gasoline expenditures. Once the tax burden has been established and split out to the appropriate industry sector or household, the net economic effect of the tax and repatriation scenarios need to be estimated.

The initial fall and recovery we see in the graph between 2011 and 2017 is due to the Great Recession and recovery. It reflects changes in economic activity, rather than the carbon intensity of the activity. At a maximum carbon price of $30/ton, the tax would generate a significant amount of revenue, but the change in emissions would still leave Oregon far short of the 1990 emissions threshold. For context, the $788M in revenues generated in 2015 would represent 5% of Oregon' annual General Fund and Lottery revenues . At this price, there is a drop in emissions, but in 2025 emission levels are still 25% greater than in 1990.

At a maximum price of $60, emissions get closer to the 1990 threshold, but still fall short. The increase in revenue generated would be able to displace a greater portion of other revenue sources. The revenue generated by the tax would equal 15% of Oregon's current annual General Fund and Lottery revenues in 2015, and 29% in 2025.

In order to reach Oregon's 1990 emissions levels, a price comparable to the world's current highest carbon pricing schemes would be needed. Even with this high price, in 2020 Oregon's emissions reduction would still fall short of the state's emissions goals. It would also be difficult for Oregon to institute such a high price on its own. We assume that a price this high would negatively affect Oregon's competitiveness, but estimating the net effect of such a high price is beyond the modeling capacity of this project. It is assumed that large-scale reorganization and adaptation would take place, rather than the marginal changes we are able to anticipate in the modeling.

Interpreting Economic Impact Analysis Results

The impact summary results are given in terms of employment, labor income, total value added, and output:

Employment represents the number of annual, 1.0 FTE jobs. These job estimates are derived from industry wage averages.

Labor Income is made up of total employee compensation (wages and benefits) as well as proprietor income. Proprietor income is profits earned by self-employed individuals.

Total Value Added is made up of labor income, property type income, and indirect business taxes collected on behalf of local government. This measure is comparable to familiar net measurements of output like gross domestic product.

Output is a gross measure of production. It includes the value of both intermediate and final goods. Because of this, some double counting may occur. Output is presented as a gross measure because IMPLAN is capable of analyzing custom economic zones. Producers may be creating goods that would be considered intermediate from the perspective of the greater national economy. However, these intermediate goods may leave the custom economic zone, making them a local final good.

Table 14-$30/ton Maximum Price; $5 Annual Increase

Price/Ton CO_2e	2015 $20	2025 $30	2035 $30
GHG Change from Baseline Forecast			
Residential	-3.8%	-10.8%	-13.3%
Commercial	-4.9%	-14.0%	-16.8%
Industrial	-3.0%	-10.5%	-13.0%
Transportation	-2.6%	-1.9%	-3.0%
Total	-1.3%	-6.1%	-7.3%
GHG Change from 1990 Levels	**26.7%**	**24.7%**	**20.8%**
Carbon Tax Revenues (million)			
Residential	$101	$145	$138
Commercial	$89	$138	$147
Industrial	$198	$293	$269
Transportation	$400	$579	$546
(Individual)	$360	$486	$429
(Business)	$428	$669	$671
Total	**$788**	**$1,155**	**$1,101**

Figure 5: Oregon's GHG Emissions at $30/ton

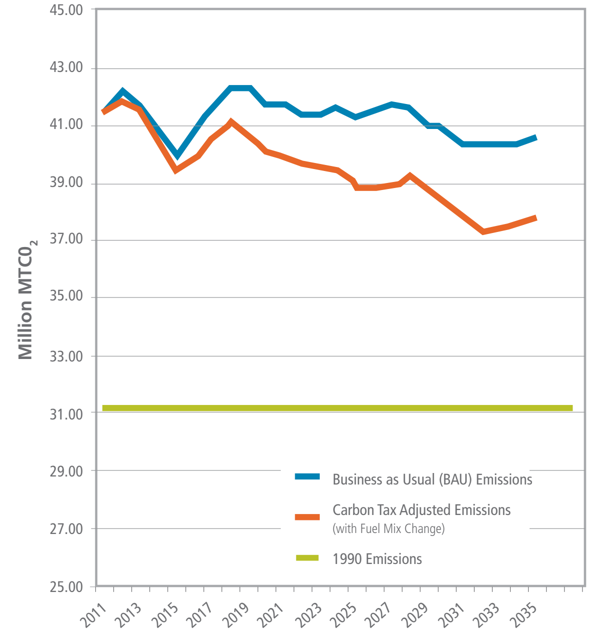


Table 15-$60/ton Maximum Price; $10 Annual Increase

Price/Ton CO_2e	2015 $30	2025 $60	2035 $60
GHG Change from Baseline Forecast			
Residential	-4.7%	-20.3%	-25.6%
Commercial	-6.1%	-26.0%	-32.2%
Industrial	-4.0%	-20.3%	-25.5%
Transportation	-3.0%	-5.2%	-6.0%
Total	-2.0%	-12.5%	-15.1%
GHG Change from 1990 Levels	**25.7%**	**16.1%**	**10.6%**
Carbon Tax Revenues (million)			
Residential	$150	$259	$237
Commercial	$132	$237	$240
Industrial	$295	$548	$494
Transportation	$597	$1,113	$1,052
(Individual)	$535	$913	$796
(Business)	$638	$1,244	$1,227
Total	**$1,173**	**$2,157**	**$2,023**

Figure 6: Oregon's GHG Emissions at $60/ton

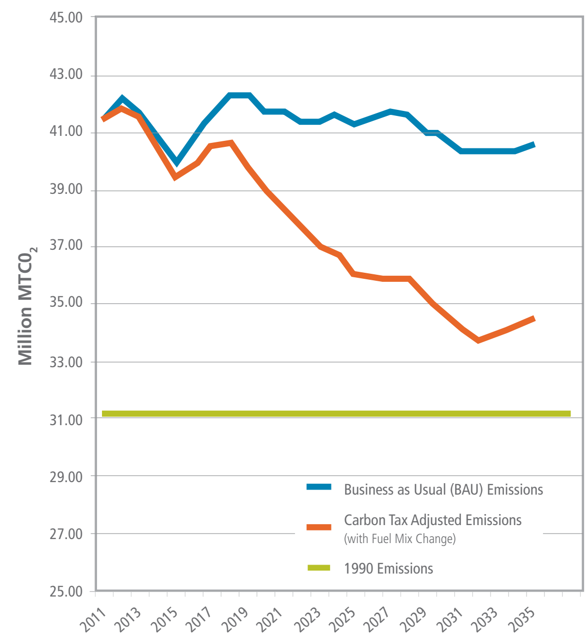
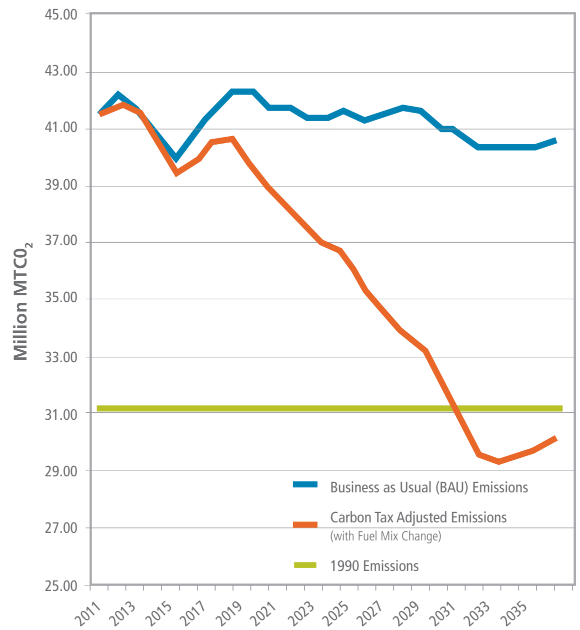


Table 16-$100/ton Maximum Price; $10 Annual Increase

Price/Ton CO_2e	2015 $30	2025 $60	2035 $60
GHG Change from Baseline Forecast			
Residential	-4.7%	-32.9%	-42.1%
Commercial	-6.1%	-41.9%	-52.7%
Industrial	-4.0%	-33.3%	-42.1%
Transportation	-3.0%	-9.6%	-10.1%
Total	-2.0%	-21.2%	-25.6%
GHG Change from 1990 Levels	**25.7%**	**4.7%**	**-3.1%**
Carbon Tax Revenues (million)			
Residential	$150	$364	$307
Commercial	$132	$311	$280
Industrial	$295	$825	$724
Transportation	$597	$1,755	$1,665
(Individual)	$535	$1,388	$1,189
(Business)	$638	$1,867	$1,788
Total	**$1,173**	**$3,255**	**$2,976**

Figure 7: Oregon's GHG Emissions at $100/ton

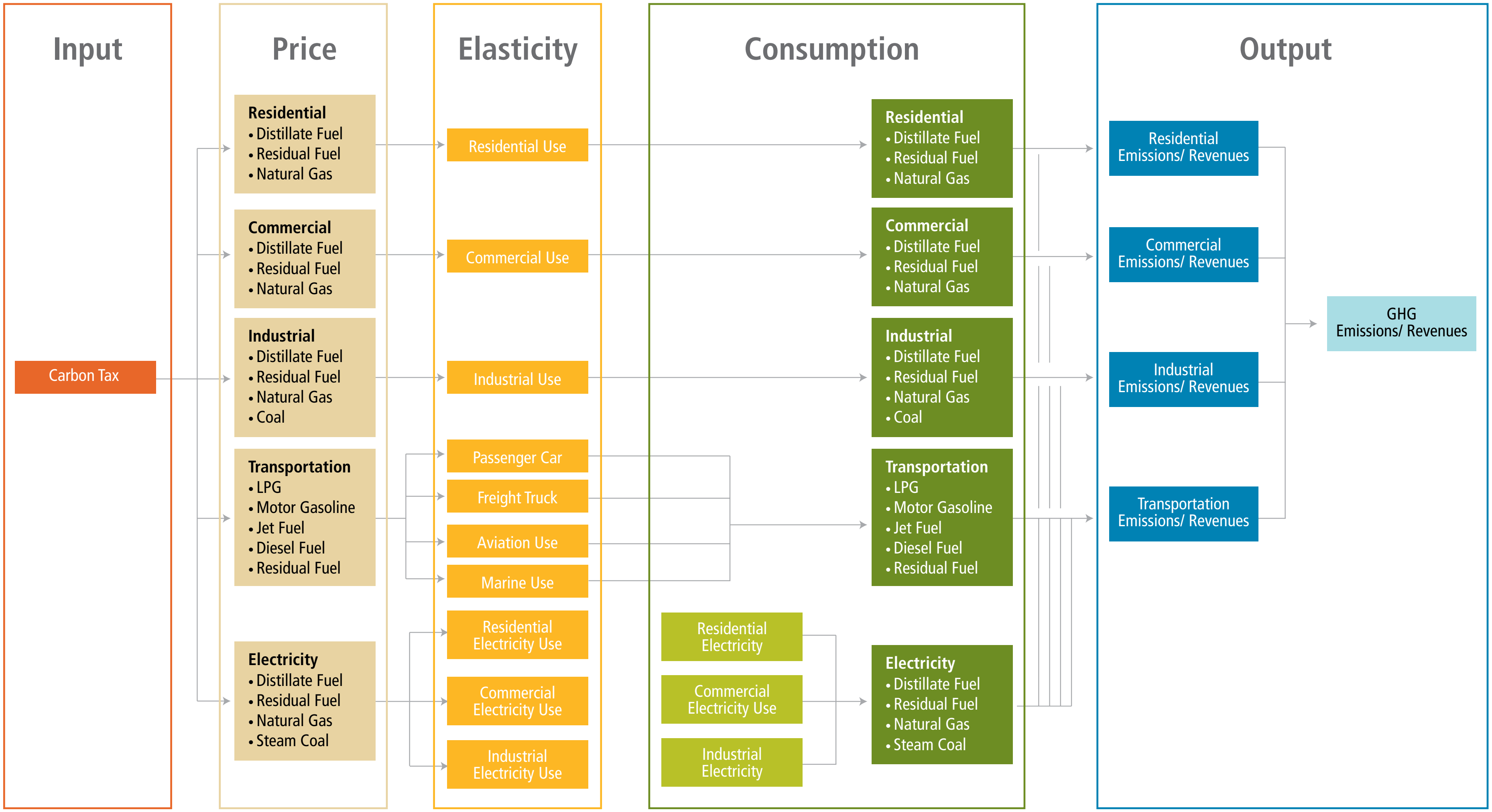


Even with this high price, the continuation of existing programs is necessary to approach emissions goals. A carbon tax on its own will not be enough to reduce emissions to desirable levels, unless the price of carbon is set at a level that is currently beyond even the most aggressive carbon pricing schemes.

C-TAM takes a dynamically generated forecast and adds a non-dynamic price change. Emissions decrease based on the projected change in demand, but the effects of additional restructuring in the economy or additional reinvestment in less carbon-intensive technology are not captured.

The outputs of C-TAM are carbon tax revenues based on energy usage and the change in carbon emissions in each sector. Depending on the elasticity of the goods produced by each sector, the additional cost of the tax can be passed on to consumers or other sectors. It is beyond the scope of this report to estimate all of the burden-shifting of this tax, but we performed an initial tax shift based on expectations of which fuel costs are paid directly by consumers. For the purposes of estimating the net economic effect of the tax, it is assumed that the tax burden related to residential energy usage and motor gasoline for passenger cars fall on households. The rest of the costs are split between the industry sectors according to their share of CO_2e emissions.

Figure 8



Input
Carbon Tax
Price
Residential
• Distillate Fuel
• Residual Fuel
• Natural Gas
Commercial
• Distillate Fuel
• Residual Fuel
• Natural Gas
Industrial
• Distillate Fuel
• Residual Fuel
• Natural Gas
• Coal
Transportation
• LPG
• Motor Gasoline
• Jet Fuel
• Diesel Fuel
• Residual Fuel
Electricity
• Distillate Fuel
• Residual Fuel
• Natural Gas
• Steam Coal
Elasticity
Residential Use
Commercial Use
Industrial Use
Passenger Car
Freight Truck
Aviation Use
Marine Use
Residential Electricity Use
Commercial Electricity Use
Industrial Electricity Use
Consumption
Residential
• Distillate Fuel
• Residual Fuel
• Natural Gas
Commercial
• Distillate Fuel
• Residual Fuel
• Natural Gas
Industrial
• Distillate Fuel
• Residual Fuel
• Natural Gas
• Coal
Transportation
• LPG
• Motor Gasoline
• Jet Fuel
• Diesel Fuel
• Residual Fuel
Residential Electricity
Commercial Electricity Use
Industrial Electricity
Electricity
• Distillate Fuel
• Residual Fuel
• Natural Gas
• Steam Coal
Output
Residential Emissions/ Revenues
Commercial Emissions/ Revenues
Industrial Emissions/ Revenues
Transportation Emissions/ Revenues
GHG Emissions/ Revenues

IMPLAN

In order to capture the full economic impact of the Carbon Tax, we used IMPLAN, an input-output software that simulates changes to the economy. NERC customized an IMPLAN model that covers the entire state of Oregon for this analysis. IMPLAN models are constructed using Social Accounting Matrices (SAM) based on spending and purchasing data from the Bureau of Economic Analysis (BEA) supplemented by data from other publicly available sources. SAMs are constructed that reflect the actual industry interactions in a region, and include government activities that are not traditionally reflected in this type of economic analysis.

SAMs create a map showing how money and resources flow through the economy. In a simulation, new economic activity is assumed to occur in an industry or group of industries. Based on past spending and purchasing activity, IMPLAN simulates the purchasing and spending necessary for this new economic activity to occur. IMPLAN tracks this new economic activity as it works its way through the economy. Also included in SAMs are household and government behavior. In addition to following purchasing and spending through the private sector, IMPLAN also estimates the impact of changes in disposable income and tax revenue.

Each industry is modeled using a production function, which reflects the supply chain of the industry and its connections to other industries. The original economic change is multiplied through this process as new economic activity motivates additional economic activity in other parts of the supply chain, and through changes in spending habits.

IMPLAN breaks out analysis results into three types: direct, indirect, and induced.

- **Direct Impacts:** These are defined by the modeler, and placed in the appropriate industry. They are not subject to multipliers. In this case, purchasing, employment, and wage data were collected from the sources described above and placed into the appropriate industry.
- **Indirect Impacts**: These impacts are estimated based on national purchasing and sales data that model the interactions between industries. This category reflects the economic activity necessary to support the new economic activity in the direct impacts by other firms in the supply chain.
- **Induced Impacts:** These impacts are created by the change in wages and employee compensation. Employees change purchasing decisions based on changes in income and wealth.

In order to make the two models compatible, definitions of the industry sectors used by EIA were converted to NAICS codes, and these codes were converted to the IMPLAN sector scheme. The IMPLAN sectors were aggregated to match the sectoring scheme used by EIA. The C-TAM outputs were split into business and household impacts, the impact on business was split into the appropriate sectors, and the impacts on households were split into the appropriate household income levels.

Appendix B
Detailed Scenario Results

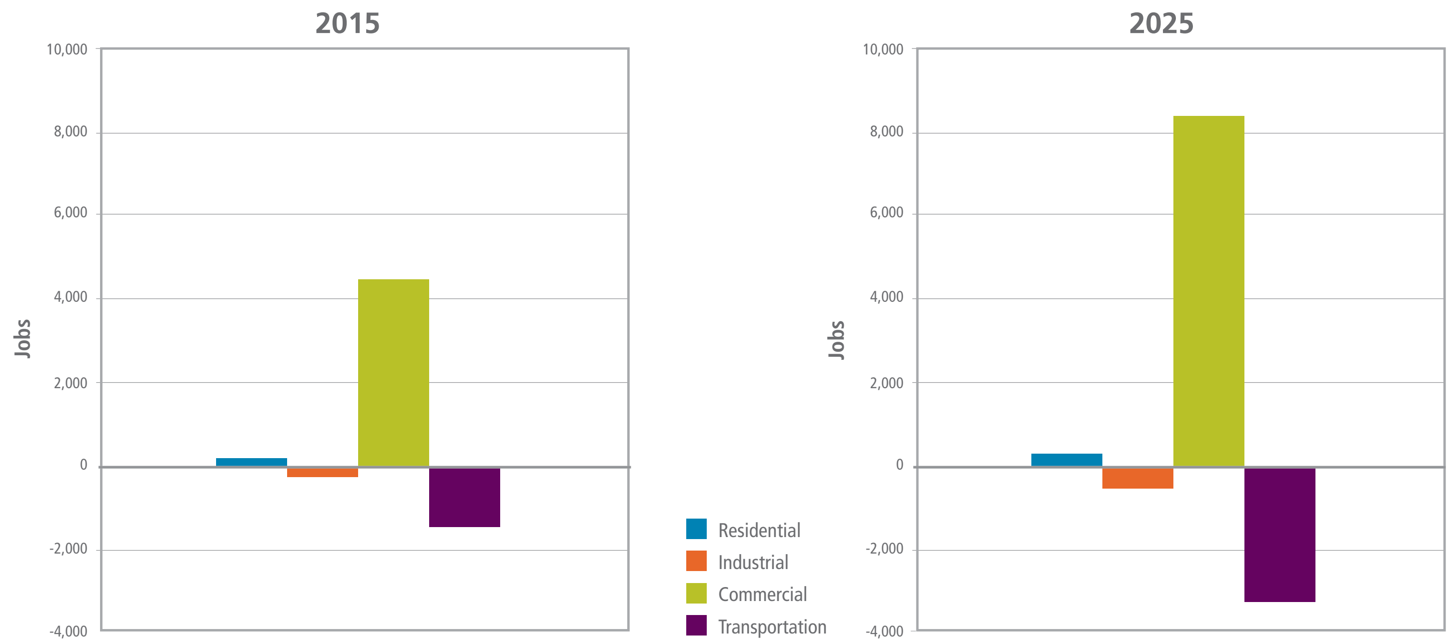
1.1 10% Reinvestment
Table 17: 2015

Impact Type	Employment	Labor Income *(Million)*	Total Value Added *(Million)*	Output *(Million)*
Direct Effect	3,464	153	217	287
Indirect Effect	763	34	55	81
Induced Effect	- 1,439	- 66	- 108	- 171
Total Effect	**2,787**	**121**	**164**	**197**

1.1 10% Reinvestment
Table 18: 2025

Impact Type	Employment	Labor Income *(Million)*	Total Value Added *(Million)*	Output *(Million)*
Direct Effect	5,852	255	360	454
Indirect Effect	1,154	51	84	120
Induced Effect	- 2,161	- 99	- 163	- 254
Total Effect	**4,845**	**207**	**282**	**318**

Figure 9: Sector Job Impacts: 10% Reinvestment



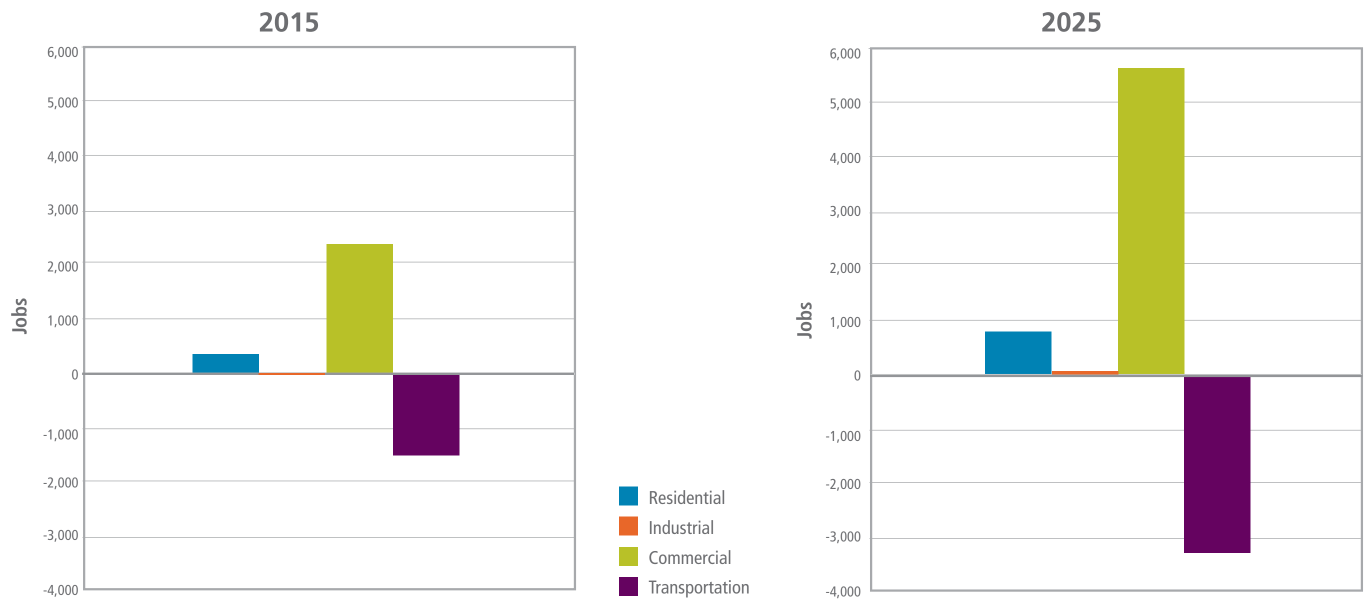
1.2 25% Reinvestment
Table 19: 2015

Impact Type	Employment	Labor Income *(Million)*	Total Value Added *(Million)*	Output *(Million)*
Direct Effect	2,191	93	183	240
Indirect Effect	538	25	42	65
Induced Effect	- 1,498	- 71	- 117	- 184
Total Effect	**1,231**	**47**	**108**	**121**

1.2 25% Reinvestment
Table 20: 2025

Impact Type	Employment	Labor Income *(Million)*	Total Value Added *(Million)*	Output *(Million)*
Direct Effect	3,503	176	361	443
Indirect Effect	736	42	72	108
Induced Effect	- 970	- 57	- 93	- 146
Total Effect	**3,270**	**161**	**341**	**405**

Figure 10: Sector Job Impacts: 25% Reinvestment



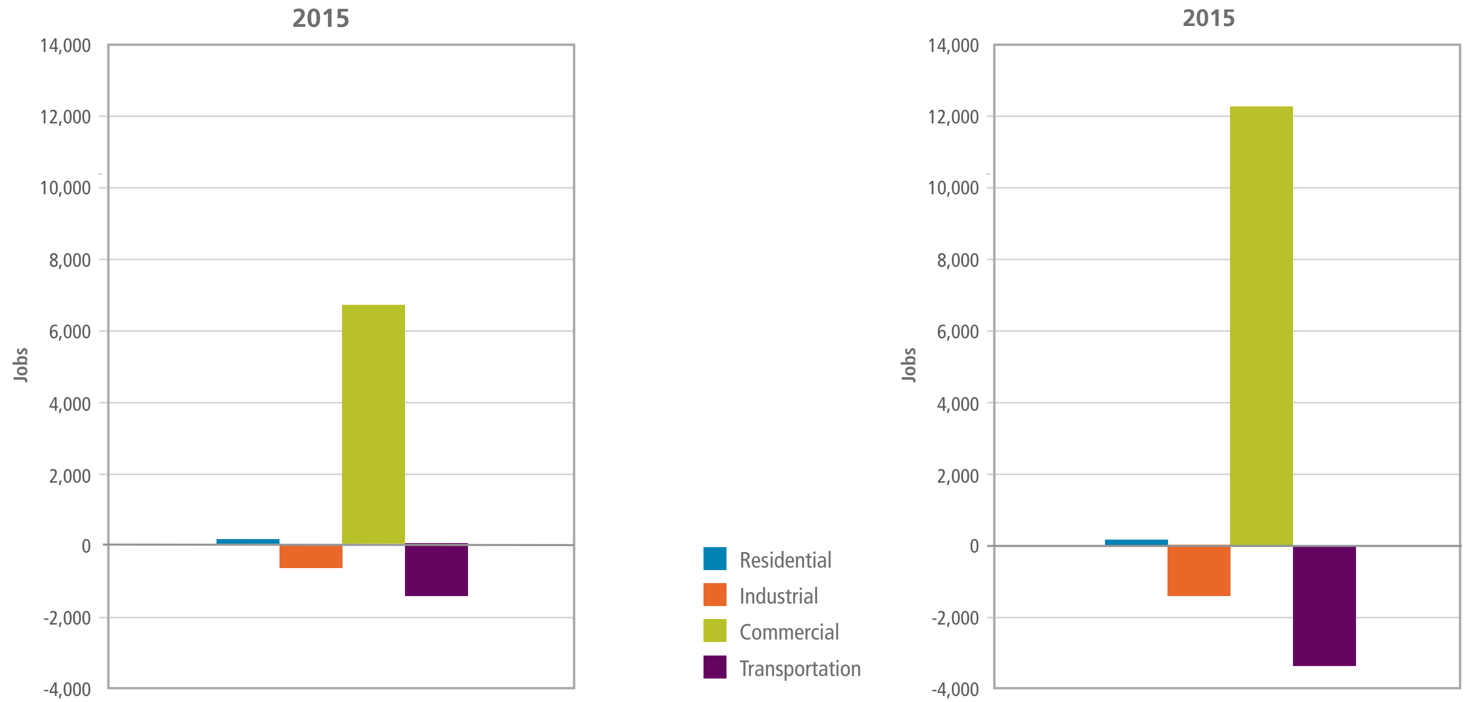
2.1 100% Corporate Income Tax
Table 21: 2015

Impact Type	Employment	Labor Income *(Million)*	Total Value Added *(Million)*	Output *(Million)*
Direct Effect	5,955	266	376	503
Indirect Effect	1,413	64	101	150
Induced Effect	- 2,504	- 115	- 189	- 297
Total Effect	**4,864**	**215**	**288**	**362**

2.1 100% Corporate Income Tax
Table 22: 2025

Impact Type	Employment	Labor Income *(Million)*	Total Value Added *(Million)*	Output *(Million)*
Direct Effect	10,176	448	630	810
Indirect Effect	2,172	97	156	222
Induced Effect	- 4,309	- 197	- 325	- 511
Total Effect	**8,039**	**347**	**460**	**521**

Figure 11: Sector Jobs Impact: 100% Corporate Income Tax



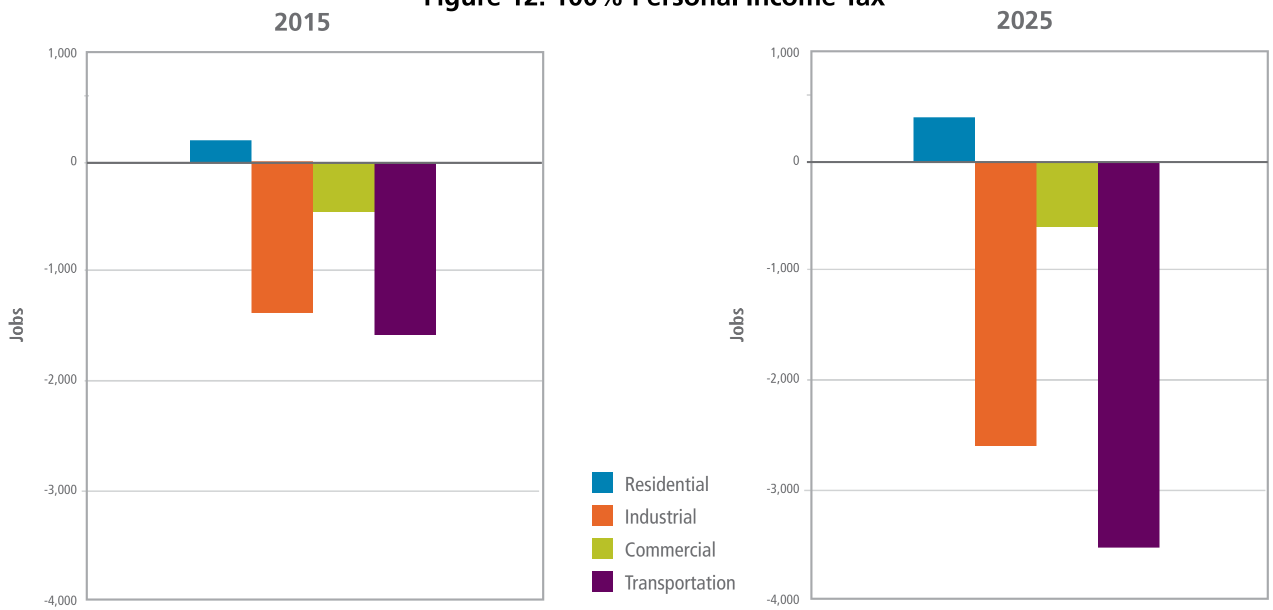
2.2 100% Personal Income Tax
Table 23: 2015

Impact Type	Employment	Labor Income *(Million)*	Total Value Added *(Million)*	Output *(Million)*
Direct Effect	- 4,139	- 213	- 321	- 638
Indirect Effect	- 2,093	- 101	- 153	- 265
Induced Effect	2,965	135	225	350
Total Effect	**- 3,267**	**- 179**	**- 249**	**- 553**

2.2 100% Personal Income Tax
Table 24: 2025

Impact Type	Employment	Labor Income *(Million)*	Total Value Added *(Million)*	Output *(Million)*
Direct Effect	- 8,131	- 418	- 630	- 1,247
Indirect Effect	- 4,101	- 198	- 299	- 518
Induced Effect	5,945	271	450	702
Total Effect	**- 6,287**	**- 344**	**- 478**	**- 1,063**

Figure 12: 100% Personal Income Tax



2.3 100% Personal Income Tax with Low-Income Relief
Table 25: 2015

Impact Type	Employment	Labor Income *(Million)*	Total Value Added *(Million)*	Output *(Million)*
Direct Effect	- 4,139	- 222	- 334	- 651
Indirect Effect	- 2,094	- 105	- 159	- 273
Induced Effect	3,063	145	241	376
Total Effect	**- 3,169**	**- 181**	**- 251**	**- 549**

2.3 100% Personal Income Tax with Low-Income Relief
Table 26: 2025

Impact Type	Employment	Labor Income *(Million)*	Total Value Added *(Million)*	Output *(Million)*
Direct Effect	- 8,131	- 532	- 801	- 1,530
Indirect Effect	- 4,101	- 252	- 380	- 646
Induced Effect	6,145	357	592	923
Total Effect	**- 6,088**	**- 426**	**- 589**	**- 1,254**

Endnotes

1. The fossil fuels taxed in BC include gasoline, diesel, natural gas, fuel oil, propane and coal. Emission factors are calculated by Environment Canada for each fuel type based on carbon content. In other words, the tax on each ton of CO_2e is translated into carbon tax rates for each fuel type.

2. Due to the closed-door budgeting process of the Ministry of Finance in BC, NERC was unable to obtain documentation to explain the rationale behind the specific price points and the cap price.

3. The amount of carbon tax revenue repatriated back into the economy is determined by revenue forecasts. Therefore, the net revenues from the BC carbon tax have been negative due to inaccurate revenue forecasts. BC's Ministry of Finance is exploring options to further refine their revenue forecasts.

4. The Low Income Climate Action Tax Credit is $115.50 per adult plus $34.50 per child as of July 1, 2011.

5. Iron and steel mills were the only manufacturers with a substantial employment base (more than 1000 workers) that experienced a cost increase of more than 2% with the $15 per ton of CO_2e price. (Zabin et al. 2009)

6. This corresponds to 15% of Annual General Fund and Lottery Revenues from the 2011-2013 budget.

7. Which is 29% of Annual General Fund and Lottery Revenues from the 2011-2013 budget.

8. For full description of new CAFE Standards, see National Highway Traffic Safety Administration: http://www.nhtsa.gov/fuel-economy (Retrieved February 22, 2013)

References

Aldy, J. E., Krupnick, A. J., Newell, R. G., Parry, I. W., &Pizer, W. A. (2009). ***Designing climate mitigation policy (No. w15022)***. National Bureau of Economic Research.

Ahearn, A. (2013) ***Talk of a Carbon Tax in the Northwest.*** Oregon Public Broadcast. Retrieved January 20, 2013, from http://earthfix.opb.org/energy/article/taxing-carbon-to-pay-for-transportation-infrastruc/.

Aldy, J. E., &Stavins, R. N. (2012). ***The Promise and Problems of Pricing Carbon Theory and Experience.*** The Journal of Environment & Development, 21(2), 152-180.

Andersen, M. S., Barker, T., Christie, E., Ekins, P., Fitz Gerald, J., Jilkova, J., et al. (2007). ***Competiveness Effects of Environmental Tax Reforms.*** Denmark: National Environmental Research Institute.

Bell, R. G., &Callan, D. (2011). ***More than Meets the Eye: The Social Cost of Carbon in US Climate Policy.*** Environmental Law.

British Columbia Ministry of Finance. (2008). ***Budget and Fiscal Plan.*** Vancouver, BC: National Library of Canada Cataloguing in Publication Data.

British Columbia Ministry of Finance. (2009). ***Budget and Fiscal Plan.*** Vancouver, BC: National Library of Canada Cataloguing in Publication Data.

British Columbia Ministry of Finance. (2010). ***Budget and Fiscal Plan.*** Vancouver, BC: National Library of Canada Cataloguing in Publication Data.

British Columbia Ministry of Finance. (2011). ***Budget and Fiscal Plan.*** Vancouver , BC: National Library of Canada Cataloguing in Publication Data.

British Columbia Ministry of Finance. (2012). ***Budget and Fiscal Plan.*** Vancouver, BC: National Library of Canada Cataloguing in Publication Data.

Bureau of Labor Statistics. (2013). ***Consumer Expenditure Survey.*** United States Department of Labor. Washington, D.C. Retrieved February 22, 2013 from http://www.bls.gov/cex/.

Callan, T., Lyons, S., Scott, S., Tol, R. S., & Verde, S. (2009). ***The distributional implications of a carbon tax in Ireland.*** Energy Policy, 37(2), 407-412.

Cosbey, A. (2008). ***Border carbon adjustment.*** In IISD, Background Paper for the Trade and Climate Change Seminar, June, 18-20.

Convery, Frank. (2012). ***Budget 2013- Three Cheers for the Carbon Tax. Public Policy Ireland.*** Dublin. Retrieved December 21, 2012, from http://www.irishfiscalpolicyresearchcentre.com/budget-2013-three-cheers-for-the-carbon-tax/.

Fischer, C., & Fox, A. (2011). ***Comparing Policies to Combat Emissions Leakage: Border Carbon Adjustments versus Rebates.*** Resources for the Future.

Fullerton, D., Karney, D., &Baylis, K. (2011). ***Negative Leakage. Energy and Climate Economics.*** Retrieved December 20, 2012, from http://www.econstor.eu/dspace/simple-search?query=negative+leakage.

Grainger, Corbett A., and Charles D. Kolstad. (2012). ***Who Pays the Price on Carbon?.*** Environmental Resource Economics, 359-376.

Green, D., Harrison, K., Richards, J., &Olewiler, N. (2008, June 24). ***We Shouldn't 'Axe' B.C.'S Carbon Tax; The Issue Should be Helping People Adjust to Higher Fuel Prices and Reduce their Dependence on Fossil Fuels.*** The Vancouver Sun, pp. A11.

Harrison, K. (2012). ***A Tale of Two Taxes: The Fate of Environmental Tax.*** Review of Policy Research, 392-393.

Hassett, Kevan A., MathurAparna, and Gilbert E. Metcalf. (2007). ***The Incidence of a U.S. Carbon Tax: A Lifetime and Regional Analysis.*** The Energy Journal.

James, C. (2008, June 20). ***NDP Leader Carole James Says Carbon Tax Hurts Average Families.*** The Vancouver Province, pp. A20.

Johnson, L. T., & Hope, C. (2012). ***The social cost of carbon in US regulatory impact analyses: an introduction and critique.*** Journal of Environmental Studies and Sciences, 1-17.

Kolstad, C. D. (1996). ***Learning and stock effects in environmental regulation: the case of greenhouse gas emissions.*** Journal of Environmental Economics and Management, 31(1), 1-18.

Kuik, O., &Hofkes, M. (2010). ***Border adjustment for European emissions trading: Competitiveness and carbon leakage.*** Energy Policy, 38(4), 1741-1748.

Lee, M., & Sanger, T. (2008). ***Is BC's Carbon Tax Fair? An Impact Analysis for Different Income Levels.*** Vancouver, BC: Canadian Centre for Policy Alternatives.

Lee, M. (2010). ***By Our Own Emissions: The Distribution of GHGs in BC.*** Vancouver, BC: Canadian Centre for Policy Alternatives.

McMullen, B. Starr, Lei Zhang, and Kyle Hakahara. (2010). ***Distributional Impacts of Changing from a Gasoline Tax to a Vehicle-Mile Tax for Light Vehicles: A case Study of Oregon.*** Transport Policy, 359-366.

Metcalf, G. E. (2009). ***Designing a carbon tax to reduce US greenhouse gas emissions.*** Review of Environmental Economics and Policy, 3(1), 63-83.

Mori, Keibun. (2012). ***Modeling the Impact of a Carbon Tax: A Trial Analysis for Washington State.*** Energy Policy, 48, 627-639.

Nordhaus, W. D. (1994). ***Managing the global commons: the economics of climate change.*** Cambridge: The MIT Press.

Nordhaus, W. D. (2010). ***Economic aspects of global warming in a post-Copenhagen environment.*** Proceedings of the National Academy of Sciences, 107(26), 11721-11726.

Nordhaus, W. D. (2011). ***Estimates of the social cost of carbon: background and results from the RICE- 2011 model (No. w17540).*** National Bureau of Economic Research.

Oregon Governor's Office (2012). ***Draft 10-Year Energy Plan.*** State of Oregon. Salem, Oregon. Retrieved February 22, 2013 from http://www.oregon.gov/energy/Pages/Ten_Year_Energy_Plan_Draft.aspx

Parry, M. L., Canziani, O. F., Palutikof, J. P., van der Linden, P. J., & Hanson, C. E. (2007). ***Climate change 2007: impacts, adaptation and vulnerability.*** Intergovernmental Panel on Climate Change.

Parry, I., & Williams, R. (2011). ***Moving US Climate Policy Forward: Are Carbon Taxes the Only Good Alternative?.*** Resources for the Future Discussion Paper, 11-02.

Pearce, D. (1991). ***The role of carbon taxes in adjusting to global warming.*** The Economic Journal, 101(407), 938-948.

Rausch, Sebastian, Gilbert E. Metcalf, and John M. Reilly. (2011). D***istributional Impacts of Carbon Pricing: A General Equilibrium Approach with Micro-Data for Households.*** Energy Economics.

Read, R. (2012). ***Evraz Portland Will Fire Up Oregon Steel Mill Closed in 2009, Hiring 200.*** The Oregonian. Retrieved December 21, 2012, from http://www.oregonlive.com/business/index.ssf/2012/10/evraz_oregon_steel_will_fire_u.html.

Reinaud, J. (2009). ***Trade, competitiveness and carbon leakage: challenges and opportunities.*** Energy, Environment and Development Programme Paper, 9(01).

Rivers, N. (2010). I***mpacts of climate policy on the competitiveness of Canadian industry: How big and how to mitigate?.*** Energy Economics, 32(5), 1092-1104.

Schaffrin, A. (2013). ***Who Pays for Climate Mitigation? An Empirical Investigation on the Distributional Effects of Climate Policy in the Housing Sector.*** Energy and Buildings. Forthcoming.

Speck, S. (1999). ***Energy and carbon taxes and their distributional implications.***Energy Policy, 27(11), 659-667.

Stern, N.H. (2006). ***Stern Review:The economics of climate change.*** Vol. 30. London: HM treasury.

Sustainable Prosperity. (2012). ***British Columbia's Carbon Tax Shift: The First Four Years.*** Ottawa, Canada: University of Ottawa.

Tietenberg, T. H., & Lewis, L. (2004). ***Environmental economics and policy.*** Boston: Pearson Addison Wesley.

Tol, R. S. (2011). ***The social cost of carbon.*** Annual Review of Resource Economics, 3(1), 419-443.

US IAWG (2010). ***Technical support document: Social cost of carbon for regulatory impact analysis under executive order 12866.***

Willcocks, P. (2008). ***Carbon Tax Opposition A Challenge For Liberals; The Opposition To The New Tax Is Stronger Than Expected And Coming From All Sides Which Is Not A Good Thing For Campbell With 11 Months Until An Election.*** Nelson Daily News, 6.

Wooster, R. B., & Lehner, J. W. (2009). ***Reexamining the Border Tax Effect: A case Study of Washington State.*** Contemporary Economic Policy, 511-523.

Zabin, C., Buffa, A., & Scholl, L. (2009).***The Impact of Climate Change Policies on Carbon-Intensive Manufacturing Industries in Oregon.*** Berkeley, CA: UC Berkeley Labor Center.

Printed on 100% post-consumer recycled paper