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Appendix 3:

Memorandum on Macroeconomic Modeling

E3 supplemental research to support Oregon Department of Environmental Quality's study of a market-based approach to reducing greenhouse gas emissions

February 6, 2017

Contents

1 Introduction

The Oregon Department of Environmental Quality (DEQ) engaged Energy and Environmental Economics, Inc. (E3) to evaluate the potential economic impacts of a hypothetical cap and trade program in Oregon. E3 undertook this analysis in three parts: 1) through an evaluation of the existing literature on the economic impacts of cap and trade programs, as detailed Appendix 2; 2) by modeling the gap between forecasted GHG emissions, after taking into account current policies, and the state's GHG goals, as detailed in Section 2 of this appendix; and 3) by modeling the potential macroeconomic impacts of a cap and trade program in Oregon, as described in Section 3 of this appendix.

Oregon's climate goals are set to reduce greenhouse gas (GHG) emissions by 10% below 1990 levels by 2020 and 75% below 1990 levels by 2050, as shown in Figure 1. The impacts to the Oregon economy of reducing greenhouse gas emissions will depend on the interplay between direct regulation, or complementary policies, and carbon markets. Complementary policies will determine the overall size of a potential carbon market, and thus its overall economy-wide impact. This assessment is limited to the impacts of a cap and trade program; E3 did not examine the impacts of complementary policies.

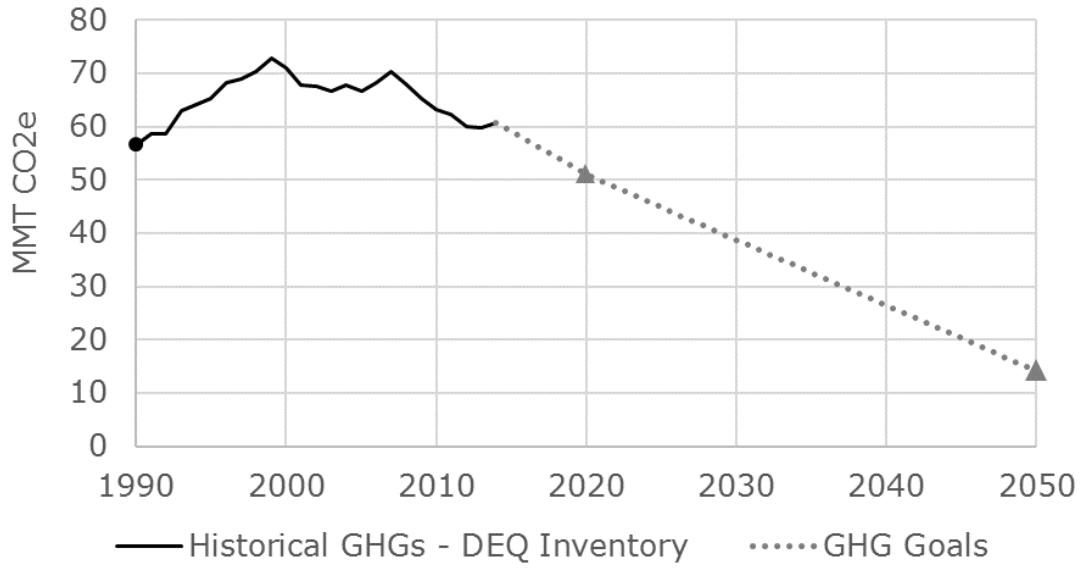

Figure 1: Historical GHG Emissions in Oregon and Interpolated Trajectories to 2020 and 2050 Policy Goals

2 Complementary Policy Analysis

2.1 Approach

Before evaluating the macroeconomic impacts of a cap and trade program, it is first necessary to understand how big the gap between current policies and the state's GHG goals is likely to be. Oregon already has complementary policies being implemented, including a renewable portfolio standard (RPS) and clean fuels program (CFP), both of which target GHG emissions reductions among other goals. To answer this question, E3 built a model projecting energy demand in Oregon which captures the impact of complimentary policies. This model estimates the remaining emissions reductions necessary to meet state goals, to be covered through a cap and trade program.

2.2 LEAP

E3 built a bottom-up model of the Oregon economy using the LEAP tool (Long-range Energy Alternatives Planning system)[1], developed by the Stockholm Environment Institute. This model quantifies the emissions reductions associated with the projected trends in energy use and complementary policies targeting future mitigated emissions. We modeled the period of 2015-2050, with a focus on 2035, as this year is the mid-point between Oregon's 2020 and 2050 goals. This model does not include a calculation of cost impacts of the modeled policies, as that was outside the scope of this analysis.

LEAP is an integrated, scenario-based modeling tool that can be used to track energy consumption, production and resource extraction in all sectors of an economy. It can be used to account for both energy sector and non-energy sector greenhouse gas (GHG) emission sources and sinks. LEAP is not a model of a specific energy system, but rather a modeling framework that can be adapted for different jurisdictions. E3 built a model of Oregon's energy and non-energy emission sources, projecting them through 2050 using different scenarios to understand current trajectories and different pathways that can be reached through existing complementary policies within the state. This provides an understanding of the emissions remaining to be governed by a potential carbon market.

2.3 Cap and Trade Program Coverage

Through discussion with the DEQ, we made assumptions about the extent to which Oregon's emissions would be covered by a cap and trade program. These assumptions are shown in Table 1 and reflected in

[1] More information on the LEAP software can be found at www.energycommunity.org

the LEAP model. Emissions accounting by fuel and sector mirrors DEQ GHG inventory accounting.[2] All CO2 equivalencies are based on 100-year global warming potential multipliers.

Table 1: Assumed Sectoral Coverage by an Oregon Cap and Trade Program

Sector	**2015 Total Emissions by Sector [MMTCO2e]**	**Percent Assumed Emissions Coverage**	**Notes**
Electricity consumption	18.8	100%	In-state generation and imported electricity are covered
Natural gas consumption	7.1	100%	All in-state natural gas combustion is covered
Petroleum consumption	23.1	99%	All importers over 25,000tCO2e/yr
Landfills	1.8	59%	Includes methane production from municipal solid waste and industrial landfill sites with air quality permits over 25,000tCO2e/yr
HGWP gases[3]	2.4	25%	Semiconductor facilities with air permits emitting over 25,000tCO2e/yr
Industrial process emissions	1.1	90%	Cement manufacture, ammonia production, glass production, and pulp and paper facilities with air permits emitting over 25,000tCO2/yr
Agriculture emissions	5.2	0%	Agricultural CO2, methane, and N20 not covered
Natural gas distribution	0.9	0%	No facilities above 25,000tCO2/yr emissions threshold
Waste water and waste incineration	0.6	0%	Methane and N2O emissions from waste processing not covered
Other	0.1	0%	N2O emissions from fertilization of landscaped areas and nitric acid production
Total	**61.1**	**84%**	

Note that the coverage estimated in Table 1 is not indicative of a final decision, only the assumptions for this analysis.

2.4 Scenarios

E3 modeled three scenarios to evaluate a range of emissions reductions from complementary policies.

[2] Available online: https://www.oregon.gov/DEQ/AQ/Pages/Greenhouse-Gas-Inventory-Report.aspx
[3] HGWP = High Global Warming Potential gases

1. **Baseline Scenario**: represents Oregon GHGs in the absence of the recent extension of the Renewable Portfolio Standard (RPS) and suspension of importation of electricity generated from coal by 2035.
2. **Reference Policy Scenario**: represents Oregon GHGs with updated electricity policies signed into law in 2016 including a 50% RPS by 2040 and suspension of coal-fired electric imports.
3. **Aggressive Policy Scenario**: represents Oregon GHGs if the state pursued additional policies to reduce GHGs outside of a carbon market, focusing on incremental energy efficiency and increased zero emission vehicles.

Specific assumptions for each scenario are shown in Table 2.

Table 2: LEAP Scenario Assumptions by Category

	Baseline	**Reference Policy**	**Aggressive Policy**
RPS	25% by 2025	50% by 2040	
Coal-fired electricity	Boardman facility retires in 2020	Suspension of coal electricity imports by 2035; Boardman facility retires in 2020	
Biofuels	Clean Fuels Program targets of 10.5% renewable diesel and biodiesel by 2025; 75% biogas for transportation natural gas		
Zero Emission Vehicles[4]	90,000 EVs, 120,000 PHEVs by 2025, consistent with Clean Fuels Program targets		300,000 EVs, 600,000 PHEVs by 2035
Energy Efficiency	Utility-projected load growth		Reductions of 22,000 GWh by 2030
Industrial Process Emissions	Emissions grow at same rate as industrial energy demand		
Non-Energy Emissions (i.e. Landfills and HGWP gases)	No change from 2014		

2.5 Inputs

To populate the LEAP model, we focused on in-state data sources where possible, supplementing with national data sets to fill remaining data gaps. Specific inputs are listed below.

- 2014 DEQ GHG Inventory[5]: Historical emissions, historical energy consumption, emission factors
- 2014 ICF Analysis of Updated Compliance Scenarios with a proposed Clean Fuels Program in Oregon [6]: clean fuels program targets
- 2015 Oregon Global Warming Commission (OGWC) Biennial Report to the Legislature[7]
    - Energy efficiency projections

[4] Zero Emission Vehicles include light-duty EVs = Electric Vehicles and PHEVs = Plug In Hybrid Vehicles
[5] Available online: https://www.oregon.gov/DEQ/AQ/Pages/Greenhouse-Gas-Inventory-Report.aspx
[6] ICF 2014. Updated Compliance Scenarios. Available online: http://www.deq.state.or.us/aq/cleanFuel/docs/ComplianceScenarios_ICF.pdf
[7] Specific assumptions provided by DEQ. Report available online: http://www.keeporegoncool.org/sites/default/files/ogwc-standard-documents/OGWC_Rpt_Leg_2015_final.pdf

    - Zero-emission vehicle targets
- Utility electric load and generation forecasts consistent with scenario definitions[8]
- US EIA AEO 2016 (Reference Case; Pacific Region)[9]: non-electricity fuel consumption growth rates from 2015-2040

2.6 Results

The GHG results for the Baseline scenario were scaled down to reflect coverage under a potential cap and trade program, as described in Table 1, allowing E3 to evaluate the three scenarios outlined in Table 2. Figure 2 shows the results of these scenarios, first with the total emissions for Oregon from the Baseline Scenario, and then the results for all three scenarios for covered sectors only. The cap noted in the figure is set at the share of Oregon's 2020 and 2050 GHG goals for the covered sectors outlined in Table 1 (i.e. 10% below 1990 levels in 2020 for covered emissions). This figure highlights the fact that no scenario, including the Aggressive Policy Scenario, reaches the covered sector share of the 2020 or 2050 GHG goal.

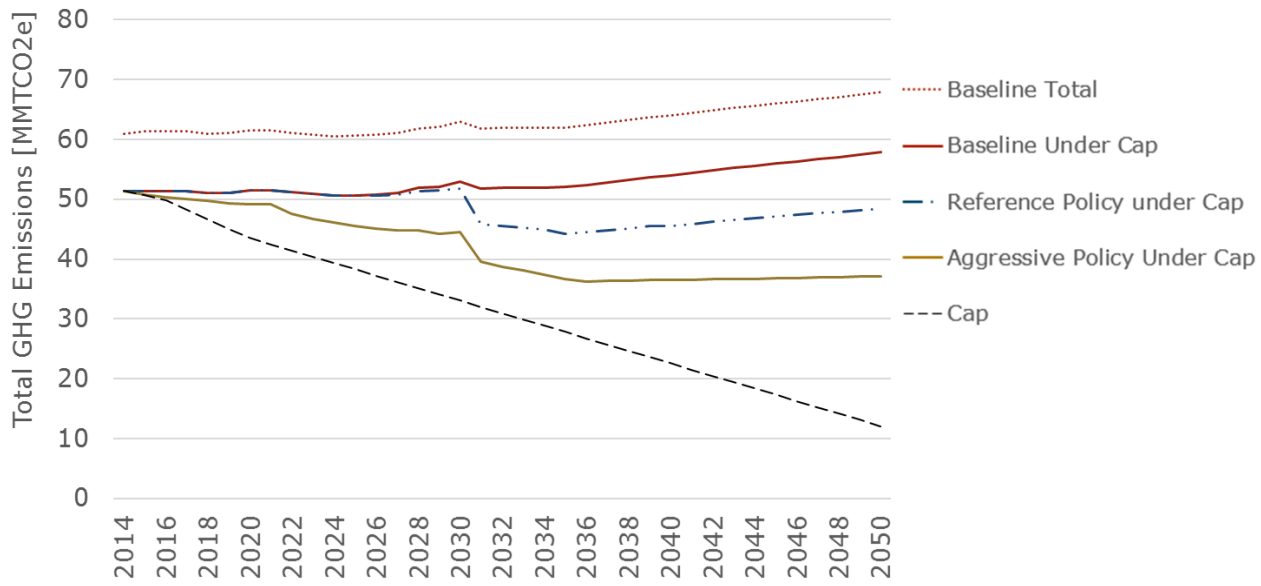

Figure 2: Oregon GHG Emissions Results for Baseline Scenario, and for GHGs Covered under a Cap and Trade Program by Scenario

The gap in emissions between each policy scenario and the covered sources' share of Oregon's GHG goals is the quantity of emissions that could be covered by a cap and trade program. Figure 3 highlights this in more detail for each of our policy scenarios. The difference between the Baseline Scenario emissions and the Policy Scenario emissions represents the emissions reductions to be achieved through

[8] PacifiCorp and PGE provided electric load forecasts consistent with 50% RPS and suspension of coal imports; load forecasts for other electricity providers were provided by DEQ
[9] Available online: http://www.eia.gov/outlooks/aeo/

complementary policy. The remaining emissions between the Policy Scenario and the GHG emission reduction goals, or program cap, is the size of the cap and trade program.

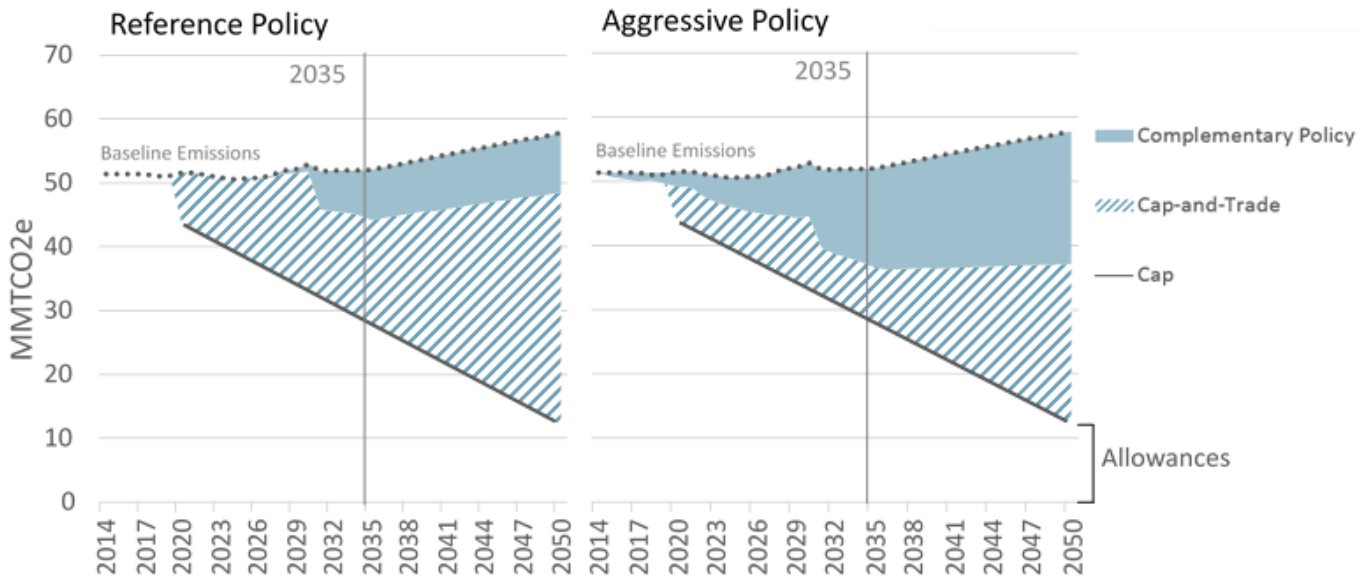

Figure 3: GHG Implications for Complementary Policies and Cap and Trade Emissions Reductions by Scenario

Table 3 shows the results in 2035 of emissions reduced through complementary policy and through cap and trade for each scenario evaluated. More aggressive complementary policy acts to reduce the remaining emissions to be covered through a cap and trade program, as neither the total emissions coverage or emissions cap changes between scenarios.

Table 3: 2035 Reference and Aggressive Policy Scenario Results (million metric tons of CO2-equivalent)

	Reference Policy	**Aggressive Policy**
Total emissions covered under cap and trade	52.0	52.0
GHG reductions due to Complementary Policies	7.8	15.4
GHG reductions due to Cap and Trade	16.4	8.8
Emissions Cap	27.8	27.8

Based on this analysis, complementary policies in Oregon may achieve reductions of 8 to 15 million tCO2e, leaving a gap of 9 to 16 million tCO2e to be reduced by cap and trade in 2035. The resulting size of a cap and trade program in Oregon serves as an input to the carbon market analysis, detailed in Section 3.

3 Cap and Trade Impact Analysis

3.1 Approach

This section describes the methods and approach E3 used to estimate the potential macroeconomic impacts to Oregon's economy in 2035 due to the implementation of a hypothetical cap and trade program.

The macroeconomic impact analysis uses the Oregon state package for IMPLAN Pro 2015. IMPLAN is an industry standard input-output model that is based on U.S. national income accounts.[10] Input-output models calculate changes in macroeconomic variables — such as value added and employment — that result from changes in spending by households, government agencies, investors, and export markets. At the core of IMPLAN is a matrix of multipliers that describes how changes in spending (final demand) "multiply" throughout the economy, increasing or reducing output from different sectors based on their supply chain linkages. More information on different types of macroeconomic models can be found in section 3.1.3 of Appendix 2.

Analyzing the impact of cap and trade in IMPLAN requires translating carbon market impacts into changes in spending. For this analysis, the effect of a cap and trade program in Oregon was modeled as the net of two effects:

(1) GHG abatement and GHG permits increase the costs of goods included under the cap; increases in cost result in a decrease in economy-wide spending.
(2) GHG abatement and revenue recycling result in an increase in economy-wide investment and consumption spending.

This section describes the steps and assumptions used to create inputs to capture these different effects. It then describes the results for 16 scenarios.

3.2 IMPLAN

IMPLAN includes a database of over 500 sectors of Oregon's economy. E3 aggregated those sectors into 19 sectors for the purposes of this analysis, described in Table 4. In addition to the top-line statistics on industry size and employment in Table 4, IMPLAN includes an input-output table for each of the 500 sectors that define the interaction between each of the sectors in the economy. This table was also aggregated to 19 sectors. Since the input-output table defines the composition of intermediate and

[10] IMPLAN Pro 2015 is equipped with 2014 data. More information about IMPLAN is available here: http://implan.com/product/state-totals/

value added expenditures in a particular industry, it drives the results of the analysis, as described further below.

Table 4: IMPLAN Aggregated Sectors for Analysis

Aggregated Sectors - Summary				
	Total Industry Size (Millions)	**Industry Size as % of Oregon Economy**	**Total Estimated Employment**	**Employment as % of Oregon Total**
Advanced Manufacturing	**$2,947**	**1.14%**	**7,686**	**0.37%**
Agriculture	$3,346	1.29%	69,872	3.37%
Clean Tech	**$344**	**0.13%**	**10,087**	**0.49%**
Construction	$16,429	6.34%	118,490	5.71%
Energy	$3,239	1.25%	6,644	0.32%
Entertainment	$12,622	4.87%	260,863	12.57%
Finance	$8,835	3.41%	98,345	4.74%
Forestry and Wood Products	**$8,434**	**3.25%**	**55,218**	**2.66%**
General Manufacturing	$39,770	15.34%	134,150	6.46%
Government	$3,195	1.23%	24,196	1.17%
High Tech	**$55,842**	**21.53%**	**84,857**	**4.09%**
Media	$1,758	0.68%	14,856	0.72%
Mining	$350	0.13%	3,726	0.18%
Outdoor Gear and Activewear	**$388**	**0.15%**	**1,766**	**0.09%**
Real Estate	$23,759	9.16%	88,481	4.26%
Retail	$22,800	8.79%	320,615	15.45%
Service	$48,986	18.89%	709,245	34.17%
Transportation	$5,318	2.05%	64,547	3.11%
Utilities	$970	0.37%	1,931	0.09%
Total	**$259,332**	**100.00%**	**2,075,572**	**100.00%**

*Sectors in bold are those described as "Key Industries" in the Northwest Economic Research Center study on the impacts of a carbon tax policy in Oregon, prepared for the Oregon Legislature in 2014[11]

IMPLAN calculates impacts in one year; this analysis uses 2035 as our year of analysis, as it is at the midway point between Oregon's 2020 and 2050 climate goals. However, the assumptions about the relative size and sectoral distribution of Oregon's economy are based on IMPLAN's representation of Oregon's economy in 2014, the most recent year for which data was available. By basing the analysis on the 2014 Oregon economy, this analysis likely overstates the impact of cap and trade as a percentage of the Oregon economy, since total state economic output is likely to grow by 2035. Furthermore, though the sectoral makeup of the Oregon economy is likely to change over time, E3 has not attempted to adjust the default IMPLAN input-output matrix to reflect potential future changes or include their effects in this analysis.

[11]Northwest Economic Research Council, "Economics and Emissions Impact of a Clean Air Tax or Fee in Oregon (SB306)", available at https://www.oregonlegislature.gov/lro/Documents/RR%204-14%20SB%20306%20Clean%20Air.pdf

3.3 Scenarios

To capture a range of potential program design outcomes and uncertainty, this analysis tests four key variables, each tested with two potential outcomes, which in combination produce sixteen distinct scenarios:

1. Policy Scenario: Reference and Aggressive Policy Scenario
2. Carbon Allowance Prices: Low and High
3. Loss Factors: Low and High
4. Allowance Allocation: Free Allocation to Emitters and Auction with Revenue Recycling to Consumers

These scenarios were chosen to represent plausible bookends for each of these variables in order to test the range of potential outcomes. They are not intended to advocate for a specific cap and trade program design. For example, no cap and trade program in operation has 100% free allocation to emitters, and the WCI and EU-ETS have a combination of auctioning and freely allocating permits. Realistic program designs and market outcomes should fall within the range of impacts shown within these scenarios.

3.3.1 POLICY SCENARIO

As described in Section 2.4, the "Reference Policy" scenario assumes complementary policies include a 50% RPS by 2040 and the suspension of coal imports, leaving 16.4 MMT CO2e to be reduced by cap and trade program in 2035. The "Aggressive Policy" scenario assumes the addition of further complementary policies, leaving 8.8 MMT CO2e to be reduced by cap and trade in 2035.

For each scenario, the LEAP results indicate both the amount of emission reduction necessary to meet Oregon's GHG reduction goals, as well as the quantity of emissions allowances available to Oregon industries under the proposed cap and trade program. Assumptions about the costs of mitigation and the value of allowances, coupled with the results of the LEAP analysis shown above, drive the direct costs associated with a cap and trade system in 2035.

3.3.2 CARBON ALLOWANCE PRICES

The analysis examines two scenarios for CO2 allowance prices in 2035:

- Low price scenario - $32/tCO2 (2015$), based on a forecast of the California Air Resources Board (CARB) auction price floor for 2035
- High price scenario - $89/tCO2 (2015$), based on a forecast of the CARB reserve trigger price for 2035[12]

These two prices provide potential bookends for expected CO2 prices for an Oregon program linked to the Western Climate Initiative jurisdictions in 2035.

[12] These prices are extrapolated from values in https://www.arb.ca.gov/cc/scopingplan/meetings/110716/economicspresentation.pdf.

3.3.3 LOSS FACTOR

The scenario analysis also tested the impact of economic inefficiency or loss within the cap and trade system. This loss factor is an approximation of the inefficiencies, or friction, that might arise from the implementation of a cap and trade program, but that are not directly calculated by an input-output model like IMPLAN. A program with economy-wide impacts like the cap and trade system described here will not be totally frictionless: implementation of the policy will have effects on nearly every part of the economy. For instance, prices will change, which could lead to economic inefficiencies as producers and consumers adjust; companies may choose to invest the net incomes that they receive under a free allocation program or through rising energy prices out-of-state; there will be administrative costs associated with managing the program.

In the absence of these kinds of losses, a cap and trade program implemented in the IMPLAN model would simply reallocate spending among different sectors. While a precise accounting of these influences was beyond the scope of this project, E3 tested the effect of two loss factor levels, in an attempt to understand a range of potential impacts of a cap and trade policy:

- 30% Loss Factor (higher loss and inefficiency)
- 15% Loss Factor (lower loss and inefficiency)

These relative impact of these loss factors can be understood within the competing spending effects of the cap and trade program. A loss factor of zero will mean that the increase in spending (final demand) that results from the cap and trade program is exactly equal to the decrease in spending that results from the program. A loss factor greater than zero will mean that the decrease in spending is larger than the increase in spending. Higher loss factors will increase the gap between decreases and increases in spending associated with the cap and trade program.

3.3.4 ALLOWANCE ALLOCATION

There are many ways a cap and trade program might be structured with respect to GHG allowance allocation. For the purposes of this analysis, two simplified bookend scenarios were examined to understand the range of impacts resulting from different approaches to allocation:

- Free allocation of 100% of allowances to covered emitters, and
- 100% auction of allowances, and proceeds of this auction are returned to consumers in Oregon.

An allocation scheme with a combination of free allocation and auction of allowances should fall with the two bookends outlined above. These two program designs are captured in sector-specific changes in expenditures and income, which are made up of four distinct sector-specific changes:

- Decreases in expenditure by sector as a result of abatement costs, i.e. the cost of reducing emissions to the level mandated by the cap and trade program
- Decreases in expenditure by sector as a result of allowance costs, i.e. the cost of obtaining the necessary permits to cover sectoral emissions
- Increases in expenditure by sector as a result of abatement investment, i.e. money spent in a sector associated with reducing emissions

- Increases in expenditure by sector as a result of revenue recycling, i.e. the effects of revenue recycling if permits are auctioned and the money returned to consumers, or the reinvestment of industry net incomes arising from free allocation of permits

For each case, decreases in sector expenditures are calculated based on two factors: (1) remaining GHG emissions in the Oregon economy (from the LEAP analysis) by source type; and (2) relative shares of the consumption of GHG-emitting goods by sector. The costs of abatement and obtaining allowances are assigned to sectors based on the shares of GHG-emitting goods they consume.

Increases in expenditures assigned to different sectors are determined by whether the permits are assumed to be freely allocated to emitters or auctioned off with the revenues from the auctions recycled back to consumers. If the permits are assumed to be freely allocated to emitters, we assume that industries reinvest these net incomes. For this analysis, this reinvestment is distributed among capped sectors according to their share of investment in IMPLAN (after accounting for the loss factor as described above).

To approximate the effect of returning the revenues of an auction to consumers rather than freely allocating the permits, we assumed that money collected from the permit auction was returned to households, who then used that money to increase household expenditures. Within the model, this was accomplished by increasing sector expenditures proportional to each sector's share of overall household expenditures in Oregon.

3.4 Model Implementation

The following section described the specific methods through which E3 implemented the above assumptions in IMPLAN.

3.4.1 POLICY SCENARIO

Different policy scenarios were reflected in the baseline emissions, accounting for complementary policies, that required either mitigation (for emissions in excess of the cap) or allowances (for covered emissions. Table 3, above, describes the breakdown of emissions by scenario and category which were incorporated in the IMPLAN analysis.

3.4.2 CARBON ALLOWANCE PRICES

The carbon allowance prices modeled for the IMPLAN analysis ($32 and $89/tCO2e) was used to represent both the cost of mitigation (for emissions exceeding the cap) and the price of allowances. This value, multiplied by the total quantity of emissions mitigated or permitted, determined the total size of the carbon market created by the cap-and-trade program.

The costs of mitigation and purchasing allowances were assigned to sectors based on their contribution to non-energy greenhouse gas emissions and their reliance on three fuels: natural gas, petroleum, and electricity. IMPLAN provided information on the extent to which each sector spent money on these energy commodities, while LEAP provided the total emissions associated with each of these fuels in

2035. The costs of mitigation and allowances were assigned to sectors based on their share of expenditures on these energy commodities (a proxy for a sector's share of emissions) and the carbon price for that scenario.

3.4.3 LOSS FACTOR

As described in Section 3.3.3 above, the loss factor describes the extent to which the money captured in the carbon market is made available to increase spending in other sectors through either investment (for mitigation expenses and the value of freely allocated permits) or through increased household expenditures (for auctioned permits). The loss factor was applied to the total size of the carbon market (described above) before any revenues or net income was recycled back through the Oregon economy.

3.4.4 MITIGATION EXPENDITURES

In all cases and scenarios, complementary policies were insufficient to reduce emissions to Oregon's cap, requiring the mitigation of up to 16.4 MMTCO2e to comply. The costs of these mitigation efforts were assigned to sectors as described in Section 3.4.2. This money was then assumed to be returned to the Oregon economy in the form of capital investment, distributed according to each sector's share of the statewide capital as described in the IMPLAN data.

3.4.5 ALLOWANCE ALLOCATION

The method of allowance allocation did not affect the way in which money was collected from industries under a cap-and-trade plan, but instead determined which groups received the economic value associated with these permits.

Under *free allocation*, energy intensive industries are awarded rights to an asset, the right to pollute, and control the value associated with that asset. For the purposes of this analysis, E3 assumed that this value (net of the loss factor) was reinvested in the Oregon economy, according to each sector's share of Oregon's total capital. Functionally, this is the same method used to distribute mitigation expenditures among sectors.

Under *auctioning of permits*, the revenue raised from the sale of permits in the carbon market is returned to consumers (net of the loss factor). To model the effects of such a program on the Oregon economy, E3 assumed that such an increase in household income would be spent immediately, and would mirror existing patterns of household expenditures by sector.

3.5 Results

Based on the variable assumptions described above, E3 ran 16 scenarios exploring the impact of a cap and trade program on the Oregon economy. Together, these cases provide results for each of several sets of bookends to inform the overall results and likely contain the range of impacts expected. The bookend approach is used to evaluate efficiency in the economy of deploying cap and trade ('loss factor'), the market price of carbon allowances, the quantity of emissions reductions required in the cap and trade design, and the degree to which permits are freely allocated versus auctioned.

Table 5 (GDP) and Table 6 (employment) show the results for each scenario examined, both as in absolute terms and as a change from 2014 levels. According to IMPLAN data, the size of the Oregon economy in 2014 was $259 billion. As mentioned previously, by using the 2014 Oregon gross state product to calculate the percentage change in output, this will tend to overstate the impact of cap and trade, given that the Oregon economy will grow between 2014 and 2035. Furthermore, the results in Table 5 assume that the sectoral distribution and relationships in the 2035 Oregon economy are similar to 2014. Estimating the potential for structural changes that could change the makeup of the Oregon economy by 2035 was beyond the scope of this project.

Table 5: Net Benefits to the Total Oregon economy of the Modeled Cap and Trade Program in 16 Analyzed Scenarios in 2035

		$32/tCO2e		$89/tCO2e	
		15% Loss Factor	30% Loss Factor	15% Loss Factor	30% Loss Factor
Reference Policies	Free Allocation	+$173	($14)	+$481	($40)
		+0.07%	-0.01%	+0.19%	-0.02%
	Auctioned Permits	+$102	($73)	+$282	($203)
		+0.04%	-0.03%	+0.11%	-0.08%
Aggressive Policies	Free Allocation	+$160	+$5	+$445	+$13
		+0.06%	+0.00%	+0.17%	+0.00%
	Auctioned Permits	+$89	($54)	+$246	($151)
		+0.03%	-0.02%	+0.10%	-0.06%
* - All costs in millions, percentages relative to 2014 Oregon economy ($259 Billion)					

Table 6: Direct Changes in Employment by Scenario (Change in 2035 Number of Jobs) in 16 Analyzed Scenarios

		$32/tCO2e		$89/tCO2e	
		15% Loss Factor	30% Loss Factor	15% Loss Factor	30% Loss Factor
Reference Policies	Free Allocation	+492	(555)	+1,368	(1,543)
		+0.02%	-0.03%	+0.07%	-0.07%
	Auctioned Permits	+2,277	+915	+6,332	+2,545
		+0.11%	+0.04%	+0.31%	+0.12%
Aggressive Policies	Free Allocation	+580	(289)	+1,614	(803)
		+0.03%	-0.01%	+0.08%	-0.04%
	Auctioned Permits	+2,365	+1,181	+6,578	+3,285
		+0.11%	+0.06%	+0.32%	+0.16%

The impacts from the scenarios ranges from a reduction in state GDP of 0.08% to an increase in GDP of 0.19%. Historical GDP growth in Oregon ranged from -1.5% to 10.9% annually from 2005 through 2015, averaging 4% per year.[13] Based on the impacts shown above, new annual growth rates in 2035 would range between 3.92% and 4.19%. In terms of overall impact on economic growth, it would take between 8 days more and 18 days less per year to achieve the same GDP growth as it would without the simulated cap- and -trade program.

The results in the two tables illustrate the intuitive result that "Aggressive Policies" reduce the costs associated with a cap and trade program, by reducing the amount of abatement that industries need to do to comply with the cap. The difference in impacts under the "Reference Policies" and "Aggressive

[13] Per the Bureau of Economic Analysis, https://www.bea.gov/newsreleases/regional/gdp_state/qgsp_newsrelease.htm

Policies" scenario becomes larger with higher GHG prices. Balancing complementary policies and the "lift" required by the cap and trade program requires a careful analysis of the potential economic risks of higher GHG prices, and the effectiveness, efficiency, and fairness of these two approaches in different sectors.

Positive results in the two tables indicate that the potential positive multiple effects of increased spending in IMPLAN outweigh the negative multiplier effects of decreased spending. In IMPLAN, this balance is generally determined by the extent to which industries that experience changes in spending produce goods and services in the state. The positive results in Table 5 and Table 6 show that the assumed changes in spending are shifting more of Oregon's economic activity to in-state industries.

Differences between the "Free Allocation" and "Auction Permits" scenarios in Table 5 and Table 6 highlight a tradeoff between investment and consumption spending in the Oregon economy. Investment spending (free allocation) generates more value added, thus reducing the GDP impacts of a cap and trade program. Consumption spending is more employment intensive, thus reducing the employment impacts of a cap and trade program. This result is in line with economic intuition. Within each of these scenarios, increasing GHG prices and shifting more spending into investment or consumption tends to accentuate this effect. In either case, the overall effects tend to be relatively small relative to the size of Oregon's economy and labor force.

IMPLAN also provides information on the differing impacts to specific sectors within Oregon's economy. Though the overall modeled impact on Oregon's economy is less than 0.2%, the impact to individual sectors will vary, depending on each sector's GHG intensity and the changes in spending determined by different allowance allocation methods.

Table 7 shows the range of impacts to the 19 aggregated IMPLAN sectors across the modeled cases, as a percentage change in total sector value added and employment. Those industries that increase in size in all scenarios are highlighted with green font, while those that shrink in all scenarios are highlighted in red. As expected, industries that are more energy intensive (e.g., mining, transportation) are impacted more negatively. In IMPLAN, "government" is also relatively energy intensive and is more negatively impacted. Sectors that have positive impacts (media, retail, services) tend to be service-related sectors.

Table 7: Range of Impacts Across all Tested Scenarios for 19 Aggregated IMPLAN Economic Sectors

Impacts on Aggregated Sectors (Range)		
	Value Added Impact as % of Total Sector Output	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	(0.00%) - 0.03%	(0.02%) - (0.00%)
Agriculture	(0.06%) - 0.12%	(0.01%) - 0.06%
Clean Tech	(0.06%) - 0.29%	(0.09%) - (0.02%)
Construction	(0.33%) - 3.30%	(0.40%) - 6.49%
Energy	(0.54%) - 0.29%	(0.20%) - 0.08%
Entertainment	(0.39%) - 0.69%	(0.58%) - 0.87%
Finance	(0.29%) - 0.59%	(0.04%) - 0.32%
Forestry and Wood Products	(0.50%) - (0.11%)	(0.64%) - (0.17%)
General Manufacturing	(0.13%) - (0.02%)	(0.22%) - (0.06%)
Government	(3.82%) - (1.13%)	(5.35%) - (1.64%)
High Tech	(0.11%) - 0.24%	0.10% - 1.92%
Media	0.12% - 0.89%	0.08% - 0.63%
Mining	(4.83%) - (0.99%)	(4.99%) - (1.43%)
Outdoor Gear and Activewear	(0.01%) - 0.00%	(0.02%) - (0.00%)
Real Estate	(0.19%) - 0.36%	(0.39%) - 0.11%
Retail	0.10% - 0.65%	(0.08%) - 0.81%
Service	0.04% - 0.73%	(0.22%) - 0.70%
Transportation	(5.49%) - (1.50%)	(4.54%) - (1.22%)
Utilities	(0.33%) - (0.01%)	(0.51%) - (0.03%)
Statewide Impact	**(0.08%) - 0.19%**	**(0.07%) - 0.32%**

3.6 Conclusions

We draw four conclusions from this analysis:

1. Impacts of a cap and trade program on the Oregon economy are likely to be modest. Modeled impacts are less than 1% of Oregon GDP in all cases considered.
2. Complementary policies affect the overall impact of a cap and trade program. It is important to weigh the tradeoffs between the two approaches in evaluating the desired level of risk and effort for a cap and trade system.
3. Individual sectors within the Oregon economy will be impacted differently by a cap and trade program. Based on the assumptions in this analysis, more energy-intensive sectors tend to be more negatively impacted, while service sectors tend to see value added and employment gains.
4. The distribution of impacts to individual sectors depends on the method for allocating GHG permits. The IMPLAN results highlight a tradeoff between allocating permit auction revenues to consumers, which tends to be more employment intensive, and giving permits to industry, which tends to generate higher value added. These effects are likely to be small relative to the size of the overall Oregon economy.

4 Sectoral Details

This section contains sectoral details of the results from each of the 16 scenarios evaluated in this analysis for 2035, each defined in Table 8.

Table 8: List of modeled IMPLAN cases

		$32/tCO2e		$89/tCO2e	
		15% Loss Factor	**30% Loss Factor**	**15% Loss Factor**	**30% Loss Factor**
Reference Policies	**Auctioned Permits**	Case 1	Case 2	Case 5	Case 6
	Free Allocation	Case 3	Case 4	Case 7	Case 8
Aggressive Policies	**Auctioned Permits**	Case 9	Case 10	Case 13	Case 14
	Free Allocation	Case 11	Case 12	Case 15	Case 16

The results represented in this section are a part of the preliminary economic analysis for 16 illustrative bookend scenarios for Oregon. These results are not intended to advocate for any specific implementation approach to a cap and trade program in Oregon, nor are they to be interpreted as a forecast of economic impacts. These results are meant to test the potential magnitude of total and distributional impacts to state GDP and employment within the state.

Table 9: Sectoral Impacts from Case 1 – Reference Policy, Auctioned Permits, $32/tCO2e, 15% Loss

Impacts on Aggregated Sectors - Reference Case, $32/tCO2e Allowance Price, 15% Loss Factor: Auctioned Permits

Aggregated Sector	Value Added Impact as % of Total Sector Output	Employment Impact as % of Sector Employment
Advanced Manufacturing	0.00%	(0.01%)
Agriculture	0.04%	0.02%
Clean Tech	0.06%	(0.03%)
Construction	0.15%	0.34%
Energy	0.07%	0.02%
Entertainment	0.22%	0.26%
Finance	0.21%	0.11%
Forestry and Wood Products	(0.17%)	(0.23%)
General Manufacturing	(0.04%)	(0.07%)
Government	(1.20%)	(1.72%)
High Tech	(0.02%)	0.25%
Media	0.23%	0.14%
Mining	(1.68%)	(1.79%)
Outdoor Gear and Activewear	(0.00%)	(0.00%)
Real Estate	0.10%	(0.02%)
Retail	0.23%	0.27%
Service	0.26%	0.24%
Transportation	(1.86%)	(1.53%)
Utilities	(0.03%)	(0.08%)
Total Statewide Impact	0.04%	0.11%

Table 10: Sectoral Impacts from Case 2 – Reference Policy, Auctioned Permits, $32/tCO2e, 30% Loss

Impacts on Aggregated Sectors - Reference Case, $32/tCO2e Allowance Price, 30% Loss Factor: Auctioned Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.00%	(0.01%)
Agriculture	0.02%	0.02%
Clean Tech	(0.02%)	(0.03%)
Construction	0.03%	0.13%
Energy	(0.02%)	0.00%
Entertainment	0.13%	0.18%
Finance	0.10%	0.09%
Forestry and Wood Products	(0.18%)	(0.23%)
General Manufacturing	(0.05%)	(0.08%)
Government	(1.25%)	(1.76%)
High Tech	(0.03%)	0.19%
Media	0.15%	0.11%
Mining	(1.74%)	(1.79%)
Outdoor Gear and Activewear	(0.00%)	(0.00%)
Real Estate	(0.00%)	(0.08%)
Retail	0.11%	0.19%
Service	0.15%	0.17%
Transportation	(1.94%)	(1.56%)
Utilities	(0.07%)	(0.09%)
Total Statewide Impact	(0.03%)	0.04%

Table 11: Sectoral Impacts from Case 3 – Reference Policy, Freely Allocated Permits, $32/tCO2e, 15% Loss

Impacts on Aggregated Sectors - Reference Case, $32/tCO2e Allowance Price, 15% Loss Factor: Freely Allocated Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.01%	(0.00%)
Agriculture	(0.01%)	(0.00%)
Clean Tech	0.10%	(0.03%)
Construction	1.19%	2.33%
Energy	(0.15%)	(0.07%)
Entertainment	(0.11%)	(0.21%)
Finance	(0.04%)	(0.01%)
Forestry and Wood Products	(0.14%)	(0.22%)
General Manufacturing	(0.03%)	(0.07%)
Government	(1.34%)	(1.92%)
High Tech	0.09%	0.69%
Media	0.32%	0.23%
Mining	(1.25%)	(1.79%)
Outdoor Gear and Activewear	(0.00%)	(0.01%)
Real Estate	0.02%	(0.10%)
Retail	0.22%	0.01%
Service	0.13%	(0.07%)
Transportation	(1.90%)	(1.62%)
Utilities	(0.10%)	(0.18%)
Total Statewide Impact	0.07%	0.02%

Table 12: Sectoral Impacts from Case 4 – Reference Policy, Freely Allocated Permits, $32/tCO2e, 30% Loss

Impacts on Aggregated Sectors - Reference Case, $32/tCO2e Allowance Price, 30% Loss Factor: Freely Allocated Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.01%	(0.00%)
Agriculture	(0.02%)	(0.00%)
Clean Tech	0.02%	(0.03%)
Construction	0.88%	1.77%
Energy	(0.19%)	(0.07%)
Entertainment	(0.14%)	(0.21%)
Finance	(0.10%)	(0.01%)
Forestry and Wood Products	(0.15%)	(0.22%)
General Manufacturing	(0.04%)	(0.08%)
Government	(1.38%)	(1.92%)
High Tech	0.05%	0.56%
Media	0.22%	0.18%
Mining	(1.39%)	(1.79%)
Outdoor Gear and Activewear	(0.00%)	(0.01%)
Real Estate	(0.07%)	(0.14%)
Retail	0.10%	(0.03%)
Service	0.04%	(0.08%)
Transportation	(1.97%)	(1.63%)
Utilities	(0.12%)	(0.18%)
Total Statewide Impact	(0.01%)	(0.03%)

Table 13: Sectoral Impacts from Case 5 – Reference Policy, Auctioned Permits, $89/tCO2e, 15% Loss

Impacts on Aggregated Sectors - Reference Case, $89/tCO2e Allowance Price, 15% Loss Factor: Auctioned Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.01%	(0.02%)
Agriculture	0.11%	0.06%
Clean Tech	0.17%	(0.08%)
Construction	0.41%	0.95%
Energy	0.19%	0.05%
Entertainment	0.61%	0.73%
Finance	0.57%	0.31%
Forestry and Wood Products	(0.48%)	(0.64%)
General Manufacturing	(0.11%)	(0.21%)
Government	(3.33%)	(4.79%)
High Tech	(0.04%)	0.69%
Media	0.64%	0.39%
Mining	(4.66%)	(4.99%)
Outdoor Gear and Activewear	(0.00%)	(0.01%)
Real Estate	0.28%	(0.07%)
Retail	0.65%	0.76%
Service	0.73%	0.66%
Transportation	(5.18%)	(4.27%)
Utilities	(0.09%)	(0.21%)
Total Statewide Impact	0.11%	0.31%

Table 14: Sectoral Impacts from Case 6 – Reference Policy, Auctioned Permits, $89/tCO2e, 30% Loss

Impacts on Aggregated Sectors - Reference Case, $89/tCO2e Allowance Price, 30% Loss Factor: Auctioned Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.00%	(0.02%)
Agriculture	0.05%	0.05%
Clean Tech	(0.06%)	(0.09%)
Construction	0.07%	0.37%
Energy	(0.05%)	0.00%
Entertainment	0.36%	0.49%
Finance	0.28%	0.25%
Forestry and Wood Products	(0.50%)	(0.64%)
General Manufacturing	(0.13%)	(0.22%)
Government	(3.49%)	(4.89%)
High Tech	(0.09%)	0.54%
Media	0.41%	0.30%
Mining	(4.83%)	(4.99%)
Outdoor Gear and Activewear	(0.00%)	(0.01%)
Real Estate	(0.01%)	(0.23%)
Retail	0.30%	0.53%
Service	0.42%	0.48%
Transportation	(5.41%)	(4.35%)
Utilities	(0.18%)	(0.26%)
Total Statewide Impact	(0.08%)	0.12%

Table 15: Sectoral Impacts from Case 7 – Reference Policy, Freely Allocated Permits, $89/tCO2e, 15% Loss

Impacts on Aggregated Sectors - Reference Case, $89/tCO2e Allowance Price, 15% Loss Factor: Freely Allocated Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.03%	(0.00%)
Agriculture	(0.02%)	(0.01%)
Clean Tech	0.29%	(0.09%)
Construction	3.30%	6.49%
Energy	(0.41%)	(0.20%)
Entertainment	(0.30%)	(0.58%)
Finance	(0.12%)	(0.04%)
Forestry and Wood Products	(0.39%)	(0.61%)
General Manufacturing	(0.08%)	(0.21%)
Government	(3.74%)	(5.34%)
High Tech	0.24%	1.92%
Media	0.89%	0.63%
Mining	(3.49%)	(4.98%)
Outdoor Gear and Activewear	(0.00%)	(0.02%)
Real Estate	0.05%	(0.27%)
Retail	0.60%	0.02%
Service	0.36%	(0.18%)
Transportation	(5.28%)	(4.50%)
Utilities	(0.26%)	(0.51%)
Total Statewide Impact	0.19%	0.07%

Table 16: Sectoral Impacts from Case 8 – Reference Policy, Freely Allocated Permits, $89/tCO2e, 30% Loss

Impacts on Aggregated Sectors - Reference Case, $89/tCO2e Allowance Price, 30% Loss Factor: Freely Allocated Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.02%	(0.01%)
Agriculture	(0.06%)	(0.01%)
Clean Tech	0.04%	(0.09%)
Construction	2.45%	4.93%
Energy	(0.54%)	(0.20%)
Entertainment	(0.39%)	(0.58%)
Finance	(0.29%)	(0.04%)
Forestry and Wood Products	(0.43%)	(0.62%)
General Manufacturing	(0.10%)	(0.22%)
Government	(3.82%)	(5.35%)
High Tech	0.14%	1.55%
Media	0.62%	0.50%
Mining	(3.87%)	(4.98%)
Outdoor Gear and Activewear	(0.01%)	(0.02%)
Real Estate	(0.19%)	(0.39%)
Retail	0.27%	(0.08%)
Service	0.11%	(0.22%)
Transportation	(5.49%)	(4.54%)
Utilities	(0.33%)	(0.51%)
Total Statewide Impact	(0.02%)	(0.07%)

Table 17: Sectoral Impacts from Case 9 – Aggressive Policy, Auctioned Permits, $32/tCO2e, 15% Loss

Impacts on Aggregated Sectors - Aggressive Case, $32/tCO2e Allowance Price, 15% Loss Factor: Auctioned Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.00%	(0.01%)
Agriculture	0.04%	0.02%
Clean Tech	0.04%	(0.02%)
Construction	(0.05%)	(0.03%)
Energy	0.10%	0.03%
Entertainment	0.25%	0.31%
Finance	0.21%	0.11%
Forestry and Wood Products	(0.14%)	(0.18%)
General Manufacturing	(0.03%)	(0.06%)
Government	(1.13%)	(1.64%)
High Tech	(0.03%)	0.14%
Media	0.18%	0.10%
Mining	(1.41%)	(1.43%)
Outdoor Gear and Activewear	0.00%	(0.00%)
Real Estate	0.13%	0.04%
Retail	0.21%	0.29%
Service	0.24%	0.25%
Transportation	(1.50%)	(1.22%)
Utilities	(0.01%)	(0.03%)
Total Statewide Impact	0.03%	0.11%

Table 18: Sectoral Impacts from Case 10 – Aggressive Policy, Auctioned Permits, $32/tCO2e, 30% Loss

Impacts on Aggregated Sectors - Aggressive Case, $32/tCO2e Allowance Price, 30% Loss Factor: Auctioned Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	(0.00%)	(0.01%)
Agriculture	0.02%	0.02%
Clean Tech	(0.02%)	(0.02%)
Construction	(0.12%)	(0.15%)
Energy	0.03%	0.01%
Entertainment	0.16%	0.23%
Finance	0.12%	0.09%
Forestry and Wood Products	(0.14%)	(0.18%)
General Manufacturing	(0.04%)	(0.06%)
Government	(1.18%)	(1.68%)
High Tech	(0.04%)	0.10%
Media	0.12%	0.08%
Mining	(1.45%)	(1.43%)
Outdoor Gear and Activewear	(0.00%)	(0.00%)
Real Estate	0.04%	(0.01%)
Retail	0.11%	0.21%
Service	0.15%	0.19%
Transportation	(1.57%)	(1.25%)
Utilities	(0.04%)	(0.05%)
Total Statewide Impact	(0.02%)	0.06%

Table 19: Sectoral Impacts from Case 11 – Aggressive Policy, Freely Allocated Permits, $32/tCO2e, 15% Loss

Impacts on Aggregated Sectors - Aggressive Case, $32/tCO2e Allowance Price, 15% Loss Factor: Freely Allocated Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.01%	(0.00%)
Agriculture	(0.00%)	(0.00%)
Clean Tech	0.09%	(0.02%)
Construction	0.99%	1.96%
Energy	(0.11%)	(0.06%)
Entertainment	(0.08%)	(0.16%)
Finance	(0.04%)	(0.01%)
Forestry and Wood Products	(0.11%)	(0.17%)
General Manufacturing	(0.02%)	(0.06%)
Government	(1.28%)	(1.84%)
High Tech	0.08%	0.58%
Media	0.27%	0.19%
Mining	(0.99%)	(1.43%)
Outdoor Gear and Activewear	(0.00%)	(0.00%)
Real Estate	0.05%	(0.03%)
Retail	0.20%	0.02%
Service	0.11%	(0.05%)
Transportation	(1.53%)	(1.31%)
Utilities	(0.07%)	(0.14%)
Total Statewide Impact	0.06%	0.03%

Table 20: Sectoral Impacts from Case 12 – Aggressive Policy, Freely Allocated Permits, $32/tCO2e, 30% Loss

Impacts on Aggregated Sectors - Aggressive Case, $32/tCO2e Allowance Price, 30% Loss Factor: Freely Allocated Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.01%	(0.00%)
Agriculture	(0.01%)	(0.00%)
Clean Tech	0.02%	(0.02%)
Construction	0.74%	1.49%
Energy	(0.15%)	(0.06%)
Entertainment	(0.11%)	(0.16%)
Finance	(0.09%)	(0.01%)
Forestry and Wood Products	(0.12%)	(0.17%)
General Manufacturing	(0.03%)	(0.06%)
Government	(1.30%)	(1.84%)
High Tech	0.04%	0.47%
Media	0.19%	0.15%
Mining	(1.10%)	(1.43%)
Outdoor Gear and Activewear	(0.00%)	(0.00%)
Real Estate	(0.03%)	(0.07%)
Retail	0.10%	(0.01%)
Service	0.04%	(0.06%)
Transportation	(1.59%)	(1.32%)
Utilities	(0.09%)	(0.14%)
Total Statewide Impact	0.00%	(0.01%)

Table 21: Sectoral Impacts from Case 13 – Aggressive Policy, Auctioned Permits, $89/tCO2e, 15% Loss

Impacts on Aggregated Sectors - Aggressive Case, $89/tCO2e Allowance Price, 15% Loss Factor: Auctioned Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.01%	(0.01%)
Agriculture	0.12%	0.06%
Clean Tech	0.12%	(0.07%)
Construction	(0.14%)	(0.09%)
Energy	0.29%	0.08%
Entertainment	0.69%	0.87%
Finance	0.59%	0.32%
Forestry and Wood Products	(0.39%)	(0.50%)
General Manufacturing	(0.09%)	(0.16%)
Government	(3.14%)	(4.55%)
High Tech	(0.07%)	0.38%
Media	0.51%	0.29%
Mining	(3.92%)	(3.99%)
Outdoor Gear and Activewear	0.00%	(0.00%)
Real Estate	0.36%	0.11%
Retail	0.59%	0.81%
Service	0.68%	0.70%
Transportation	(4.16%)	(3.40%)
Utilities	(0.02%)	(0.09%)
Total Statewide Impact	0.10%	0.32%

Table 22: Sectoral Impacts from Case 14 – Aggressive Policy, Auctioned Permits, $89/tCO2e, 30% Loss

Impacts on Aggregated Sectors - Aggressive Case, $89/tCO2e Allowance Price, 30% Loss Factor: Auctioned Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	(0.00%)	(0.02%)
Agriculture	0.07%	0.05%
Clean Tech	(0.06%)	(0.07%)
Construction	(0.33%)	(0.40%)
Energy	0.07%	0.03%
Entertainment	0.45%	0.63%
Finance	0.33%	0.25%
Forestry and Wood Products	(0.40%)	(0.51%)
General Manufacturing	(0.11%)	(0.17%)
Government	(3.28%)	(4.66%)
High Tech	(0.11%)	0.28%
Media	0.33%	0.23%
Mining	(4.03%)	(3.99%)
Outdoor Gear and Activewear	(0.00%)	(0.01%)
Real Estate	0.11%	(0.03%)
Retail	0.31%	0.59%
Service	0.41%	0.52%
Transportation	(4.35%)	(3.48%)
Utilities	(0.10%)	(0.15%)
Total Statewide Impact	(0.06%)	0.16%

Table 23: Sectoral Impacts from Case 15 – Aggressive Policy, Freely Allocated Permits, $89/tCO2e, 15% Loss

Impacts on Aggregated Sectors - Aggressive Case, $89/tCO2e Allowance Price, 15% Loss Factor: Freely Allocated Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.03%	(0.00%)
Agriculture	(0.01%)	(0.01%)
Clean Tech	0.25%	(0.07%)
Construction	2.75%	5.44%
Energy	(0.31%)	(0.17%)
Entertainment	(0.22%)	(0.44%)
Finance	(0.10%)	(0.03%)
Forestry and Wood Products	(0.30%)	(0.47%)
General Manufacturing	(0.06%)	(0.15%)
Government	(3.55%)	(5.11%)
High Tech	0.21%	1.60%
Media	0.76%	0.53%
Mining	(2.75%)	(3.98%)
Outdoor Gear and Activewear	(0.00%)	(0.01%)
Real Estate	0.13%	(0.09%)
Retail	0.55%	0.06%
Service	0.31%	(0.14%)
Transportation	(4.26%)	(3.63%)
Utilities	(0.20%)	(0.39%)
Total Statewide Impact	0.17%	0.08%

Table 24: Sectoral Impacts from Case 16 – Aggressive Policy, Freely Allocated Permits, $89/tCO2e, 30% Loss

Impacts on Aggregated Sectors - Aggressive Case, $89/tCO2e Allowance Price, 30% Loss Factor: Freely Allocated Permits		
Aggregated Sector	**Value Added Impact as % of Total Sector Output**	**Employment Impact as % of Sector Employment**
Advanced Manufacturing	0.01%	(0.01%)
Agriculture	(0.04%)	(0.01%)
Clean Tech	0.04%	(0.07%)
Construction	2.05%	4.15%
Energy	(0.42%)	(0.17%)
Entertainment	(0.30%)	(0.44%)
Finance	(0.24%)	(0.03%)
Forestry and Wood Products	(0.33%)	(0.48%)
General Manufacturing	(0.08%)	(0.17%)
Government	(3.62%)	(5.12%)
High Tech	0.12%	1.29%
Media	0.54%	0.42%
Mining	(3.07%)	(3.98%)
Outdoor Gear and Activewear	(0.00%)	(0.01%)
Real Estate	(0.08%)	(0.20%)
Retail	0.27%	(0.02%)
Service	0.10%	(0.17%)
Transportation	(4.44%)	(3.67%)
Utilities	(0.25%)	(0.39%)
Total Statewide Impact	0.00%	(0.04%)