Carbon Policy Office

CONSULTANT REPORT

Oregon's Cap-and-Trade Program (HB2020): An Economic Assessment

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ABBREVIATIONS:
BLS – U.S. Bureau of Labor Statistics
CGE – Computable General Equilibrium
C&T – Cap-and-Trade
CPO – Carbon Policy Office
CI - Carbon Intensity
DEQ – Department of Environmental Quality
EITE – Emissions Intensive, Trade Exposed
GHG – Greenhouse gases
MMTC02e – Million metric tonnes of CO2 equivalents
NERC – Northwest Economic Research Center
ODOT – Oregon Department of Transportation
PGE – Portland General Electric
RPS – Renewable Portfolio Standard
ZEV - Zero Emissions Vehicle

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Oregon's HB2020 Cap-and-Trade Policy:

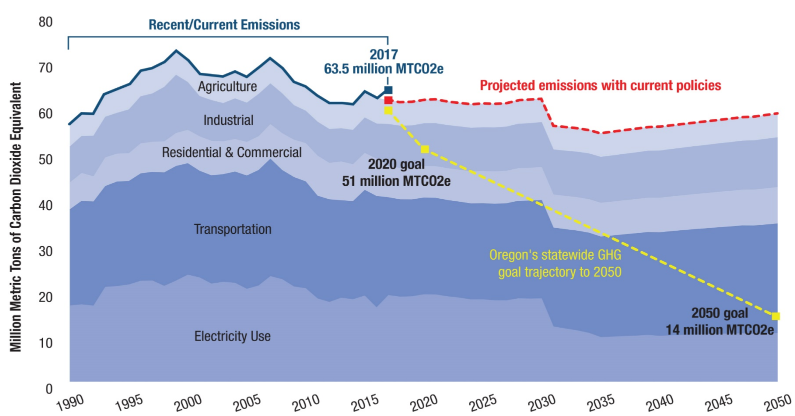
An Economic Assessment

Prepared for the Oregon Carbon Policy Office
by
Berkeley Economic Advising and Research, LLC

1 INTRODUCTION

Oregon's proposed cap-and-trade Policy (HB2020) has established ambitious public commitments to energy efficiency, pollution mitigation, and long-term environmental security. Under the right conditions, these policies have the potential to both limit resource waste and climate risk and promote development of the next generation of clean and energy efficient technologies. However, substantive mitigation policy must recognize some direct and indirect costs. Moreover, the distributional impacts of cap-and-trade policies are largely dependent on the design and conditions related to implementation (Rausch et al 2011).

Figure 1.1: Oregon's GHG Emissions Targets



The established milestone for GHG reductions in Oregon's proposed policy, 80% below 1990 levels by 2050, is ambitious and would require Oregon to reduce emissions even faster than it has since 2000 (Figure 1.1). In this report, we examine alternative cap-and-trade policy scenarios that could achieve the 2050 goal, assessing their economic impacts and implications for economic growth. Generally, we find that while there are adjustment costs, the overall benefits to the economy outweigh the costs.

Our approach, which integrates the latest available technology information with a long term economic forecasting model, reveals that innovations in the transportation, electric power, and other sectors can facilitate GHG reductions in ways that confer economic savings on households and enterprises across the state. These savings, made possible by rapid innovation and a pervasive restructuring of the light vehicle fleet and electric power system and other sector innovations can offer a pathway to Oregon's emission goals that promotes higher economic growth and employment than continuing the status quo. While we cannot predict the details of individual behavior and enterprise decision making, our results clearly reveal the potential of technology adoption and diffusion to reconcile the state's ambitious climate goals with economic growth objectives. More importantly to individual Oregonians, adoption of already available and forthcoming technologies can offset most of the adjustment costs of decarbonizing the state economy. Indeed, economic savings from energy efficiency and renewable energy can be a potent catalyst for inclusive economic growth.

In terms of the pathway to 2050, we also show that more aggressive technology adoption would permit the state to fulfill the ambitious intermediate (2035) emissions targets in HB 2020. While the 2050 goals would be met under all the scenarios we consider, a more aggressive approach to medium term GHG reduction would reduce total state emissions significantly. On the one hand, steeper targets would increase the cost of compliance. At the same time, more aggressive intermediate GHG targets would improve Oregon's air quality faster and offer more opportunities for innovation, energy savings, and technology leadership. Balancing these tradeoffs will determine the most appropriate path forward.

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2 BACKGROUND

As part of their own policy research and implementation activities, Oregon's Carbon Policy Office commissioned Berkeley Energy and Resources (BEAR) to undertake the present study. This study uses a long-term dynamic Computable General Equilibrium (CGE) model, combined with the latest economic and technology data, to evaluate alternative cap-and-trade policy mixes from now to 2050. Updating contributions made by other public and private research, we explicitly model existing Oregon climate policies, as well as some alternatives being discussed for intermediate GHG targets and pathways. We examine the interaction between combined policies while accounting for diverse institutions and behaviors, and explore whether these policies would be complementary and improve policy effectiveness. We also demonstrate the importance of recognizing uncertainty and creating mechanisms to accommodate this during a significant structural adjustment process because, as most experts already acknowledge, a truly low carbon economy would be very different from today's Oregon.

The distinguishing feature of a general equilibrium model, applied or theoretical, is its closed form specification of all specified activities in the economic system under study. This can be contrasted with more traditional partial equilibrium analysis, where linkages to other domestic markets and agents are deliberately excluded from consideration. A large and growing body of evidence suggests that indirect effects (e.g., upstream and downstream production linkages) arising from policy changes are not only substantial, but may in some cases even outweigh direct effects. Only a model that consistently specifies economy-wide interactions can fully assess the implications of economic policies or business strategies.

The BEAR model used for this anlysis is an advanced policy simulation tools that traces detailed patterns of demand, supply, and resource allocation across a state, regional, or national economy, estimating economic outcomes annually over decades (usually to 2050 or 2060). It is a state-of-the-art economic forecasting tool, based on a system of equations from economic theory, calibrated to detailed economic data that simulate price directed interactions between firms and households in commodity and factor markets. The model is carried forward with numerical simulation to produce annual results, detailing pathways of adjustment over a given policy time horizon. A core feature of our model is a fully specified cap-and-trade (C&T) mechanism, including flexible annual emission constraints, coverage, and added instruments representing policy options such as offsets, alternative allowance and revenue allocation strategies, adjustment/transition assistance, etc.

The BEAR Oregon model is calibrated to detailed sectoral data from the Bureau of Economic Analysis, Bureau of Labor Statistics, using supporting spatial data from the US Census, IMPLAN, and official state sources. Baseline dynamics have been calibrated to the Oregon Office of Economic Analysis economic and demographic forecasts.

2.1 Overview of Previous Research

The existing literature concerning the economic impacts of a cap-and-trade (or carbon tax) program in Oregon finds mixed results. Ambiguous results are common throughout the climate policy literature and are by no means unique to Oregon. That is because whether the effects are estimated to be positive or negative depends both on the specific policy in question and also on the assumptions used in modeling. For example, studies often find negative benefits if they fail to account for co-benefits (such as the effects to health from the improvement in air quality) or don't account for mitigation of increased energy prices via revenue recycling effects. Conversely, studies typically find positive effects when they account for investment in local jobs and energy-saving measures.

Generally, these trends are reflected in the previous work in Oregon, which have found either positive or negative economic shocks depending on key assumptions. Although results are conflicting, the overall economic impacts of either a cap-and-trade or carbon tax policy in Oregon would be small relative to the state economy. For example, in the most extreme cases the overall effect to the Oregon economy is on the order of approximately 1% of gross state product. With the Oregon economy historically growing by 2.7% annually[1], this means even the most aggressive climate policies would still result in overall net positive economic growth.

2.1.1 NERC

To date there have been three studies of interest. The first study, released in December 2014 from Portland State University's Northwest Economic Research

[1] According to the US Bureau of Economic Analysis, Oregon real GDP averaged 2.7% growth over the 20 year period 1996-2016.

Center (NERC), considers the economic impacts of a carbon tax. This report was produced in response to the 2013 Oregon Legislature Regular Session, where SB306 (2013) was passed directing the state to conduct a study of the economic impacts of implementing a clean air tax or fee in Oregon. Thus, this report is largely a precursor to further efforts to consider the impact of cap-and-trade policy. Although both cap-and-trade and carbon tax establish a price on GHG emissions price carbon, there are crucial policy differences. A cap-and-trade policy sets an emissions reductions target and allows the price of carbon to adjust based on market demands. Conversely, a carbon tax sets the price of carbon but does not require specific emissions reductions.

The NERC report is comprised of two primary forecasts that span from 2012 - 2034. The first, emissions and revenue modeling, forecasts expected GHG emissions based on varying economic scenarios. The emissions and revenue modeling are an important first step to determine the appropriate size carbon tax to ensure policies are consistent with Oregon's climate goals.[2] The primary objective of an emissions model is to determine the impact of the carbon-tax on emissions levels relative to the baseline "business-as-usual" scenario. Additionally, this forecast also produces estimates on the revenues generated from carbon-taxes, which are later used as inputs into the economic model. The second forecast is the economic model, which considers the economic impact of various carbon taxes and revenue usage scenarios. NERC uses a six-region REMI model to analyze the effects of various carbon taxes and revenue usage scenarios across the state.

Starting first with the emissions forecast, NERC finds that the amount of emissions reductions depends on the size of the carbon tax rate. Table 2.1 below shows the relationship between various carbon tax rates and expected emission reductions in the year 2034. NERC's results suggest that carbon tax of $60/tCO2e or greater would likely be sufficient to meeting Oregon's 2020 goal of a 10% reduction in emissions below 1990 levels. However, even at the highest tax rate ($150/tCO2e), the longer-term goal of a 75% reduction by 2050 will not be achievable by 2034 without additional climate policies.

[2]These goals were set by the Governor's Advisory Group on Global Warming in 2004 and call for a 10% reduction below 1990 GHG levels by 2020 moving to a 75% reduction below 1990 GHG levels by 2050. The Oregon Legislature put the goals into law in 2007 with HB3543.

Table 2.1: Projected Average GHG Emissions (2034)

	Emissions (mmT CO_2e)	Reduction from baseline (%)	Change from 1990 levels (%)	Revenue (millions 2012 $)
Baseline case				
(no carbon tax)	53.1	0.0%	13.5%	0
Carbon tax scenarios				
$10/metric ton	49.2	7.4%	5.1%	490
$30/metric ton	45.1	15.0%	-3.6%	1350
$45/metric ton	41.6	21.7%	-11.1%	1870
$60/metric ton	39.2	26.2%	-16.2%	2350
$100/metric ton	34.5	35.1%	-26.4%	3450
$125/metric ton	32.2	39.4%	-31.3%	4020
$150/metric ton	30.3	42.9%	-35.2%	4550

Turning to the economic impacts, the size of the effect depends both on the price of carbon as well was revenue sharing assumptions. NERC considers 5 different revenue scenarios, which are as follows:

- **Scenario A – No Repatriation:** No repatriation of any revenues. Revenues would be allocated to one of three Oregon Reserve Funds: the Oregon Rainy Day Fund, the Education Stability Fund, the Small Legislative Ending Balance Fund.

- **Scenario B – Revenue Neutral:** True revenue neutral is complicated by the Oregon Constitution which requires revenues from transportation fuels to used only on transportation projects. Thus, NERC assumes that carbon tax revenues from transportation fuels could be used to offset existing fuel taxes. The additional revenue would be returned to households through either personal or corporate income tax cuts.

- **Scenario C – Revenue Neutral (Excluding Transportation Revenue):** Similar to scenario B, except transportation revenues are spent in the Highway Trust Fund. Spending from this fund results in a positive economic impact through road maintenance and construction activity as well as improved transit connections. Therefore, this scenario is revenue positive overall. Leftover revenue is used for cutting income taxes or direct income support.

- **Scenario D – Public Investment and Support:** A refinement of scenario C except includes other scenarios where carbon tax revenues are dedicated towards investment in other state goals. These include, low income/worker assistance and direct assistance to industries unduly impacted by the carbon tax.

- **Scenario E – Alternative Transportation-Related Carbon Tax Revenue Disbursement:** Uses a different allocation than the Highway Trust Fund would dictate. For example, this scenario considers distributing funds to regions based on unweighted VMT, which favors urban over rural transportation projects. It also considers the list of eligible projects in the Highway Trust Fund were expanded to other transport categories such as light rail or bike lines.

The main results of the economic analysis are found below in Table 2.2. Overall, NERC finds ambiguous results depending on the price of carbon and revenue scenario. The most dramatic impacts are found in Scenario A, which is a theoretical exercise where Oregon does not repatriate any of the revenues. Scenario C is overall the most likely, as transportation revenue would be used as indicated by the Highway Trust Fund and leftover revenue is earmarked for personal or corporate tax cuts. Excluding Scenario A, these results suggest output would fall roughly 0.3 – 0.5% depending on the price of carbon, while employment would decrease by 5,000 – 10,000 or increase by 5,000 – 7,000. Considering the size of Oregon's overall economy these effects are quite minimal.

Table 2.2: Annual Impacts of Various Carbon Prices and Revenue Scenarios (NERC)

		Maximum Level of Carbon Tax (per $mTCO_2e$)				
		$10	$30	$60	$100	$150
Emissions Impact		–7%	–15%	–26%	–35%	–43%
Tax Revenue[3]		$490M	$1,350M	$2,350M	$3,450M	$4,550M
Revenue Usage Scenarios: A	Employment	[redacted]	-15K to 25K	-27K	-37K	[redacted]
	Output	[redacted]	-0.6% to -0.4%	-1.1%	-1.35%	[redacted]
B	Employment	-1.1K	-4K	-8K	-9K	-14.5K
	Output	-0.05%	-0.2%	-0.5%	-0.5%	-0.7%
C	Employment	0	+4K	+7K	+5.5K	+2K
	Output	-0.02%	-0.05%	-0.3%	-0.3%	-0.7%
D	Employment	[redacted]	+5K	-13K to -9K	[redacted]	[redacted]
	Output	[redacted]	-0.3%	-0.5%	[redacted]	[redacted]
E	Employment	[redacted]	0	-5K	[redacted]	[redacted]
	Output	[redacted]	-0.3%	-0.5%	[redacted]	[redacted]

2.1.2 DEQ

The next relevant study was produced by the Oregon Department of Environmental Quality (DEQ). Much like the NERC report, this research was created in response to the 2016 Oregon Legislature Session, where SB 5701 (2016) calls for the DEQ to "study a market-based approach to controlling GHG emissions by providing economic incentives for achieving emissions reductions." Thus, this report has a wide-scope and begins with an overview of cap-and-trade programs and the considerations for Oregon, before moving into the economic impacts of such a program.

To conduct their analysis, DEQ retained the services of Energy and Environmental Economics (E3). Similar to the NERC report, E3 also used a two-step modeling process, first beginning with projections of economic and energy demand growth. This first model provides the baseline "business-as-usual" GHG emission scenario from which the necessary amount of emission reductions can be determined. Once the cap on emissions is established, E3 then considers the economic impacts of this policy relying on an IMPLAN input-output model of the Oregon economy.

Starting first with the emissions forecast, E3 modeled three scenarios from the period 2015 – 2050, with a focus on 2035, the midpoint between Oregon's 2020 and 2050 goals. The scenarios are as follows:

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.

Under these scenarios, E3 forecasts the level of emissions reductions both from complementary policies as well as the cap-and-trade policy. Complementary policies alone are expected to reduce some 8 to 15 million tCO2e for either the reference or aggressive policy scenarios respectively. This leaves a gap of 16 to 9 million tCO2e that will need to be reduced by cap-and-trade by 2035.

With emissions forecasts in place, E3 is able to model the economic impacts of the emission caps under several different scenarios. Their analysis tests four variables, under two outcomes, which in combination produces 16 scenarios:

1. **Policy Scenario:** Reference and Aggressive Policy
2. **Carbon Allowance Prices:** Low ($35/tCO2e) and High ($89/tCO2e)
3. **Loss Factor:** Low (15%) and High (30%)
4. **Allowance Allocation:** 100% Free Allocation to Emitters and 100% Auction with Revenue Recycling to consumers

The main results of E3's economic impacts are found below in Tables 2.3 and 2.4. Given the modeling assumptions, these results likely contain the range of expected impacts as the scenarios serve as bookends rather than expected policies. Thus, the purpose of these results is to inform the range in order to inform policy, rather than advocate for a specific policy. Much like the NERC report, the overall impacts to Oregon economy are projected to be low, from a reduction in state GDP of 0.08% to an increase of 0.19%. Similarly, estimates on the impacts to jobs are also small, ranging from a decrease of 1,500 to an increase of 6,500.

Table 2.3: Net Benefits to the Total Oregon Economy by Scenario (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 2.4: Direct Changes to Employment by Scenario (2035)

		$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%

2.1.3 FTI

The final report hails from the private consulting firm, FTI, who was retained by the business advocacy group Associated Oregon Industries (AOI). This report considers the economic impacts of SB 1574 (2016), which caps GHG emissions at 75% below 1990 levels by 2050 and applies to entities with annual emissions greater than 25,000 tCO2e. The FTI report is similar to the DEQ report in scope but uses a dynamic rather than static model and provides a greater level of spatial disaggregation. Thus, although many of the supporting assumptions and inputs are similar, the findings from the reports diverge.

Like the NERC and DEQ report, FTI uses emission forecasts based as an input to their economic model. However, unlike the other reports, FTI uses a combination of emissions forecasts from models of the electricity sector (PLEXOS) and gaseous and liquid sectors (CTAM). Compared to the DEQ report, FTI finds that forecasted GHG emissions across scenarios are lower. This may be explained by the more robust modeling of emissions, or that FTI uses a more recent Annual Energy Outlook (AEO) estimates.[3]

Turning to the economic impacts, FTI uses an 8-region REMI model and finds that cap-and-trade program suggested from SB1574 (2016) would reduce state GDP by almost $1.3 billion (or -0.4% of state GDP) relative to the baseline scenario by 2035. This scenario assumes a carbon price of $85/tCO2e, which is similar to the upper bound price ($89/tCO2e) used by DEQ. Thus, the 2035 findings present the most "apples-to-apples" comparison between reports. Although this effect is larger than what is found in the DEQ report, it is in line with the findings from the NERC report.

[3] FTI uses the 2017 AEO forecast, which has lower fuel consumption and emissions in the Pacific Region compared to the 2016 AEO forecast used in the DEQ report.

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FTI notes that their larger negative effect is likely justified by price effects (i.e. the influence of higher energy prices on consumers and business). The FTI analysis is also spatially disaggregated which reveals an interesting divergence between rural and urban areas. Specifically, rural areas such as coastal and eastern Oregon perform better on average, which is somewhat counterintuitive. The FTI report highlights four reasons for this rural/urban divide. First, rural Oregon is not a producer of fossil energy, and thus lower demand will not impact extraction in rural areas. Second, free allowances for emissions-intensive, trade-exposed (EITE) industries have a larger impact in rural areas. Third, the investor owned utilities are largely concentrated in urban areas and will have higher rate impacts. Fourth, rate impacts will lead to greater reductions in urban areas via induced spending where there is a higher proportion of spending in the service sector. In regard to employment, impacts are similar to those found for output, with urban areas faring worse than rural. Overall, FTI estimates a reduction of approximately 4,800 jobs in 2035 from the cap-and-trade policy.

FTI also forecasts to 2050 assuming a carbon price of $450/tCO2e. As neither the DEQ or NERC reports forecast this far it is impossible to make comparisons between reports. Using a high long-term GHG allowance price results in more drastic reductions in GDP and employment with output falling by $4.5 billion and employment by 16,900. Although these numbers are larger than the estimates from 2035, they still suggest overall growth in the Oregon economy would remain positive. The primary results are listed below in Table 2.5.

Table 2.5: Economic Impacts of Oregon Cap-and-Trade

Results	2035		2050	
	% from Baseline	*Absolute*	*% from Baseline*	*Absolute*
GDP	-0.4%	-$1.3 billion	-0.9%	-$4.5 billion
Employment	-0.2%	-4,800	-0.6%	-16,900
Real Income	-0.8%	-$1.8 billion	-2.0%	-$6.1 billion
Population	-0.7%	-31,400	-1.3%	-67,500

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3 POLICY SCENARIOS FOR CLIMATE ACTION

To assess prospects for cap-and-trade and other determined Oregon climate initiatives over the next three decades, the BEAR model was implemented with a variety of scenarios that reflect policy options being actively considered (Table 3.1).

Table 3.1: Cap-and-Trade Scenarios Evaluated in the Present Study

	Scenario	Description
1	**Reference**	A "Current Practice" or Reference Scenario with only existing policies in force over the scenario period. Key existing policies include the Renewable Portfolio Standard, “Coal-to-Clean”, and Clean Fuels program.
2	**Linear**	The basic mechanism: Placing an annual cap (Figure 1.1), reducing covered GHG emissions by a constant quantity (1.5MMT) annually from 2021 to 2050 when the 80% reduction below 1990 levels is achieved. Covered entities are required to obtain permits through auction for the emissions they contribute to the cap, except for allowances distributed at no direct cost (see Section 3.2 below). Revenues are allocated to state funds, with permit proceeds for emission from transport fuels dedicated to the State Highway Trust Fund. Assumes no linkage to the WCI.
3	**Interim Target**	Interim Target cap-and-trade: Same as the Linear scenario, but reducing covered GHG emissions by a constant yearly quantity across two intervals, -2MT annually over 2021-2035 and -1MT annually over 2036-2050.
4	**Core**	The Core Scenario for this assessment, reflecting the main features proposed in HB2020: This follows the Interim Target emission reduction scenario, but allows covered entities to claim 8% of their emissions against certifiable offsets.
6	**WCI-Low**	Core scenario, with a permit price at the California Auction Reserve Price (ARP) low level, also known as the floor price. We assume in all three WCI scenarios that Oregon is a price taker in the regional market, trading together at the assumed border price of permits, and retains all permit revenue within state coffers. Costless permit allocations follow the core scenario, as do offset rules.
7	**WCI-Med**	Core scenario, with a permit price following the California Energy Commission Mid-level pathway (Figure 5.1).
8	**WCI-High**	Core scenario, with a permit price following the WCI Ceiling.

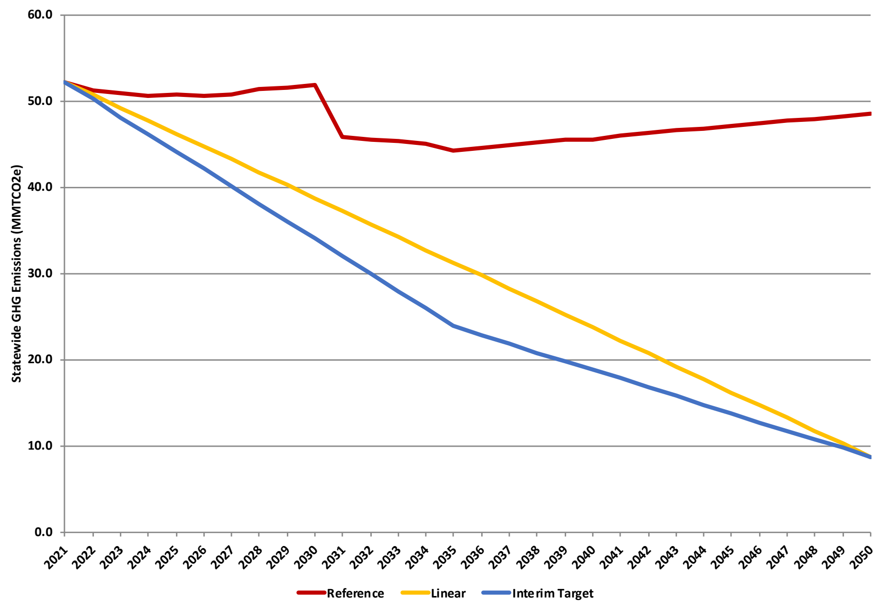
In addition to the Reference case, incorporating existing and committed policies (e.g. 50% RPS by 2040, Clean Fuels Program, Coal to Clean), we looked at several primary cap-and-trade design features: Alternative mitigation pathways, allowances to recognize adjustment needs, offsets, permit revenue allocation schemes, and participation in regional emissions markets. Each of these cap-and-trade design features would benefit in its own right from more detailed microeconomic assessment, but the present study focusses on macroeconomic impacts for the Oregon economy.

3.1 Cap-and-Trade Pathways

Although the policy has a brief history, Oregon's proposed cap-and-trade program (HB2020) is built upon solid experience nationally and globally, providing market based incentives for mitigation and innovation at relatively modest cost across a diverse economies. Should it become law, the statewide carbon cap will be the primary indicator of the state's mitigation objectives, leading Oregon to an 80% GHG reduction below 1990 levels by 2050. While the 2050 destination is an ambitious focal point, the pathway there is of course more relevant to today's stakeholders and decision makers. As the following figure suggests, that pathway chosen can also make a big difference to the primary determinants of local air quality and global warming, the stock of CO_2 and criteria co-pollutants in the atmosphere.

The two mitigation pathways we evaluate hit the same 2050 GHG target, but one reduces pollution more aggressively along the way. A more conservative Linear scenario (Linear) reduces the emissions cap in constant quantity steps (-1.5 $MMTCO_2e$), while the Interim Target pathway (Interim Target) prescribes constant pollution reductions over two intervals, -2 $MMTCO_2e$ annually from 2021 to 2035 and -1 $MMTCO_2e$ annually thereafter. If we follow the Interim Target rather than the Linear pathway, Oregon will contribute about 15% less to local and global atmospheric pollution. The question we ask is, can these environmental benefits be achieved at reasonable cost, and what would be the differences between them in macroeconomic terms?

Figure 3.1: Oregon Emissions Pathways



The scenarios we evaluate include several other policy "design" characteristics to accompany the basic cap-and-trade mechanism. In addition to setting a limit on total emissions of entities covered by the program, we include complementary measures designed to improve compliance and mitigate adjustment costs.

Generally speaking, complementary policies fall into three categories. The first are policies targeting individual agent's behavior, e.g. sector-specific incentives for compliance like the decoupling policies developed in collaboration with utilities in other states. A second category addresses situations where prices alone cannot achieve the intended mitigation, such as miles per gallon (mpg) and other efficiency standards. Finally, a broader set of complementary policies, such as the proposed offset, creates system flexibility that can push down allowance prices and help preserve the competitiveness of Oregon goods and services in the national economy. It is not difficult to develop a laundry list of such measures, but careful research is needed to determine their real potential and appropriate implementation. In the present study, most complementary policies are included in the Reference case. Exceptions are concessionary allocation of pollution permits and offset allowances, which are design characteristics of cap-and-trade itself.

3.2 Permit Allocation in all Cap-and-Trade Scenarios

In recognition of adjustment needs in the electric power sector, proposed cap-and-trade legislation allows for allocation of emission permits to utilities at no direct cost. Allocation through 2030 will be based on 100% of their forecast emissions for all electricity serving Oregon ratepayers from sources inside and outside (imported) the state. Thus, the anticipated compliance obligations of these companies for serving Oregon load would be covered via this direct allocation. It would not be consigned, but could be used for compliance, thus averting rate impacts. After 2030, this allocation would be reduced gradually and in a prescribed manner consistent with decline of the overall emissions cap across the Oregon economy.

Natural gas utilities would receive direct allocations of allowances in an amount necessary to account for emissions associated with their low-income residential load.@for how long?

Emissions-intensive, trade-exposed (EITE) industries would receive direct allocations of emissions permits, beginning at their initial level of emissions, which is aligned with their product output. Each year thereafter, allocations are adjusted based on their product output, while also declining at the rate of the overall allowance budget.

3.3 Emission Offsets

It is well known that many opportunities for mitigation exist outside the direct activities of covered entities, including measures to reduce ambient emissions by sequestration (e.g. afforestation). In cases where these reductions may be more cost-effective than emission reductions by a covered entity, recognition of verifiable and additional offsets can be more economically efficient for enterprises and society. While offsets may not solve problems of local emission concentration, they still achieve the important objective of reducing overall GHG emissions and offer some adjustment assistance to covered entities. For these reasons, Oregon proposes to allow up to 8% of compliance to be offset in this manner. In our scenarios, we make the conservative assumption that covered entities use their full offset allowance in each year and pay a price for indirect mitigation that is equal to that year's permit price. To the extent that they could find less expensive mitigation, the aggregate economic benefits of the program would be greater. Thus we assume offsets to be cost-neutral to covered entities, but they reduce their individual allowance demand by this amount.

4 ASSESSMENT RESULTS

Our assessment of the five types of cap-and-trade policy scenarios set forth above (Table 3.1), evaluated over the period 2016 – 2050, yields five main findings, summarized in the following table.

Table 4.1: Main Findings

1. Oregon can meet its 2050 climate goals in ways that achieve higher aggregate economic growth and employment. The more aggressive GHG mitigation pathway, reducing 2035 emissions 45% below 1990 levels, will confer greater benefits on the state economy, adding about 1% to GDP and about 17,000 new jobs. Sustaining these reductions to 80% below 1990 by 2050 would increase GDP over 2.5% and add about 50,000 new jobs.
2. Energy efficiency and renewable electrification offer broad-based savings to enterprises and households, which can be a potent catalyst for more inclusive economic growth and job creation.
3. To do this will require a fundamental restructuring of the state's energy system, including electrification of at least the light vehicle fleet, deep decarbonization of the electrical sector, and dramatically reduced direct use of natural gas in heating and industrial applications.
4. Recognizing sector needs for short and medium term flexibility, adjustment costs for this economic transition can be substantially reduced. Limited directly allocated emissions permit allowances are an important part of this strategy.
5. Economic benefits of improved air quality, in terms of averted medical costs and premature mortality, are substantial, contributing about 1/3 to overall economic growth.

When the BEAR model was applied to the alternative policy scenarios, aggregate economic impacts indicate that the state can achieve its medium and long term climate goals while promoting economic growth (Table 4.2). Put differently, the

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aggregate net economic benefits are positive under all climate action scenarios considered. As will be apparent in the discussion below, the primary drivers of these growth dividends are efficiency gains, multiplier effects from economy wide energy savings, and public health benefits. In the medium and long term, these savings outweigh the costs of new technology adoption, and those net savings are passed on by households and enterprises to the rest of the state economy, stimulating indirect income and job creation. Because aggregate gains are based on the scope of distributed efficiency measures, the benefits compound over time and with the degree of emissions reduction, conferring the largest dividends by 2050.

Table 4.2: Macroeconomic Impacts of Cap-and-Trade

2030 Results

	Ref (levels)	Linear	Interim Target	**Core**
GDP ($B)	$366.0	1.08%	0.93%	1.08%
Consumption	$184.5	1.07%	0.91%	1.07%
Jobs (%)	-	0.50%	0.44%	0.50%
Wages	-	0.22%	0.20%	0.22%
FTE ('000)	3,360	17	15	17
GHG (%)	-	-29%	-46%	-46%
GHG ($MMTCO_2e$)	44.2	31.2	23.9	23.9

2050 Results

	Ref (levels)	Linear	Interim Target	**Core**
GDP ($B)	$526.2	2.55%	2.19%	2.55%
Consumption	$266.3	2.40%	2.02%	2.40%
Jobs	-	1.08%	0.93%	1.08%
Wages	-	0.46%	0.42%	0.46%
FTE ('000)	4,393	48	41	48
GHG (%)	-	-82%	-82%	-82%
GHG ($MMTCO_2e$)	48.5	8.7	8.7	8.7

Notes: All entries except those in the Reference column represent changes from the Reference scenario during the year indicated, in percentage or the units given in parantheses. Gross Domestic Product (GDP, value added) and real household Consumption are measured in constant (2016) dollars. Employment chages are measured in thousands of Full Time Equivalent (FTE) annual jobs. GHG measures annual Oregon covered emission changes (% from Reference) and levels ($MMTCO_2e$) for the given year and scenario.

4.1 Spatial Impacts

The BEAR model produces personal income and job impact estimates measured as total real (2016 dollar) household incomes and Full Time Equivalent (FTE) jobs. At the statewide level, Figure 4.1 breaks down income effects by Bureau of Labor Statistics tax brackets. Salient features of these results include the fact that the lowest income groups benefit significantly. This is because energy costs are a larger percent of their incomes. After this, real income gains are driven by two forces, energy efficiency savings (increasing with household income) and job creation/wage appreciation driven by the stimulus of expenditure shifting.

These impacts can then be downscaled from the state to the census tract or county using occupational and sector employment information in the census. We use 5-year American Community Survey estimates (2012-2016) of the share of households with residents employed in each sector and each occupation. We assume that wages within sectors and occupations are uniform across the state, and that Oregon is one labor market. These labor mobility and competitiveness assumptions may not apply precisely in all cases, but the results we obtain are qualitatively robust.

Direct employment is distinguished from indirect and induced employment using employment intensities for the sectors directly impacted by the cap-and-trade decarbonization scenarios. These direct effects are then netted out to determine the indirect and induced employment impacts of the decarbonization scenario. The following figures illustrate the spatial impacts of our Core scenario on income and jobs, estimated at the county and census tract level.[4]

[4] It should be noted that we do not have enough information to predict the exact location of new jobs, so we assume that future jobs will be created in the locations where current jobs exist. Therefore, we are assuming that future jobs, within a given sector and occupation, are uniformly spatially distributed across the locations of current workers. Relying on this assumption allows us to allocate total job changes at the state level evenly to households within that sector and occupation. For example, we are assuming that construction jobs in 2030 are in the same locations that they are now so all new 2030 construction jobs are assigned to each census tract proportionally to the number of current construction workers. If new construction jobs are generated in places that do not currently have construction jobs, those jobs would be captured in our macro estimates but would not be assigned to the correct census tracts.

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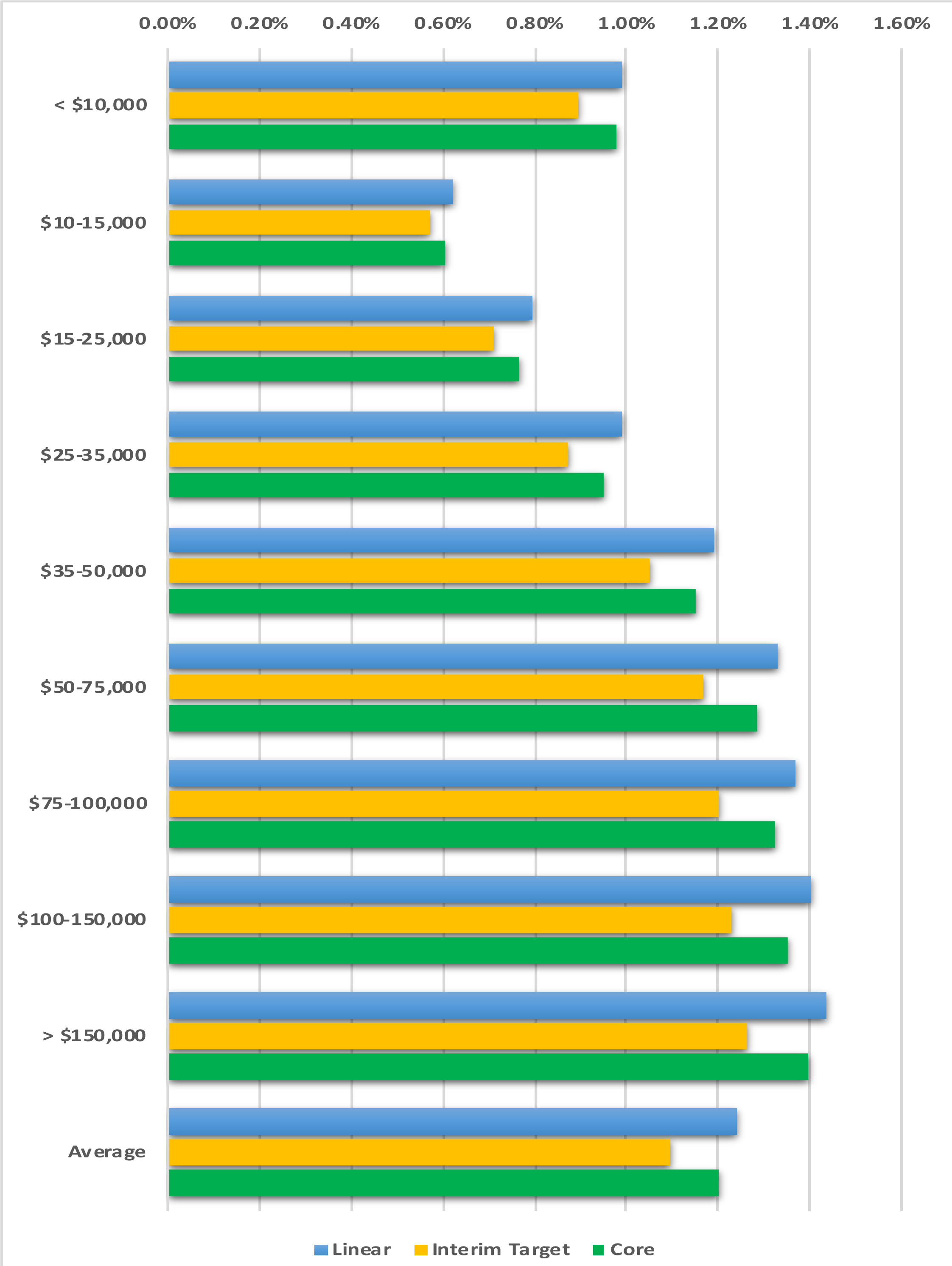
Figure 4.1: Household Income Effects by Income Level (BLS tax brackets, percent change from Reference in 2050)



For incomes, level changes are largely proportional to average incomes, so we are effectively seeing the initial income distribution in Figure 4.2, i.e. higher absolute gains in higher income counties. More interesting is Figure 4.3, where we see that percentage gains in income are much more widely distributed across the state. The same holds for job creation, revealing one fundamental aspect of our findings – energy savings and multipliers from expenditure diversion create much more inclusive income and job growth. More dramatically, we see in Figures 4.4 and 4.7 that income and job creation among the lower quintile of Oregon households is concentrated in rural areas. This is a testament to the economic benefit of adopting energy efficient technology. As already noted, these households are relatively more energy dependent as a percent of their income, so they benefit more from the adoption of cost saving technologies by utilities, vehicle owners, and manufacturers.

Figure 4.2: Median Household Income Level Change by County

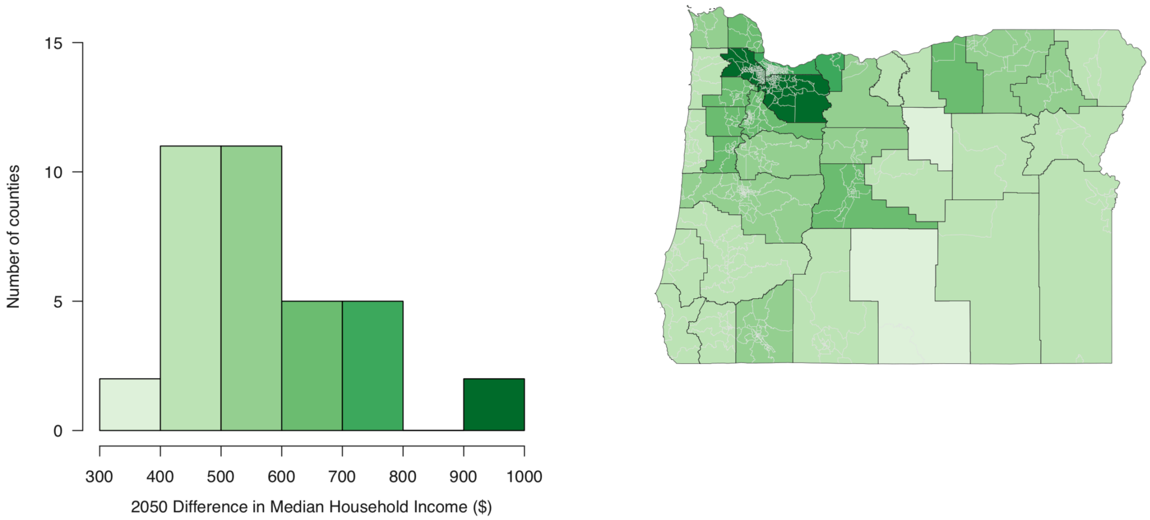


Figure 4.3: Median Household Income Percent Change by County

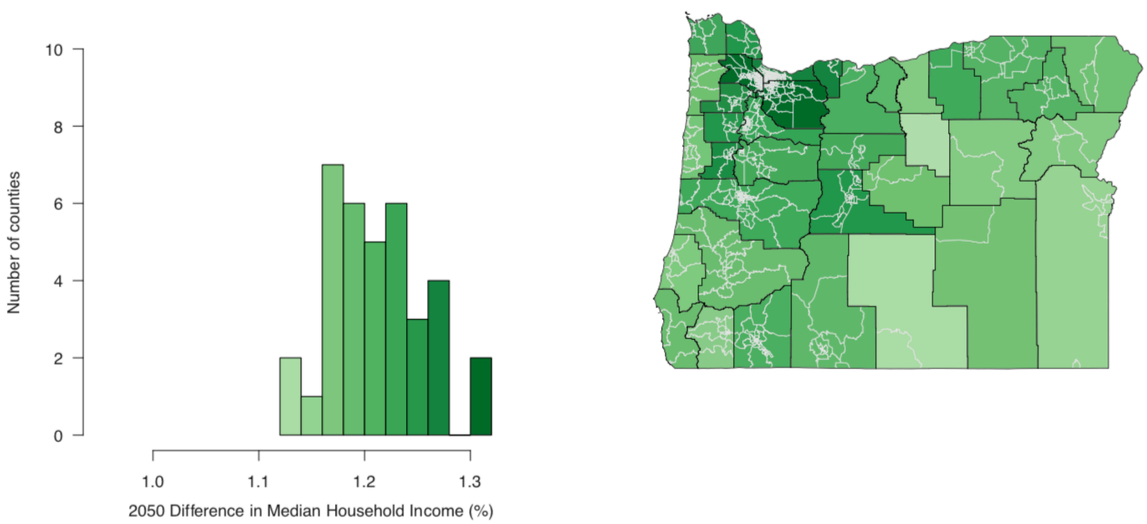
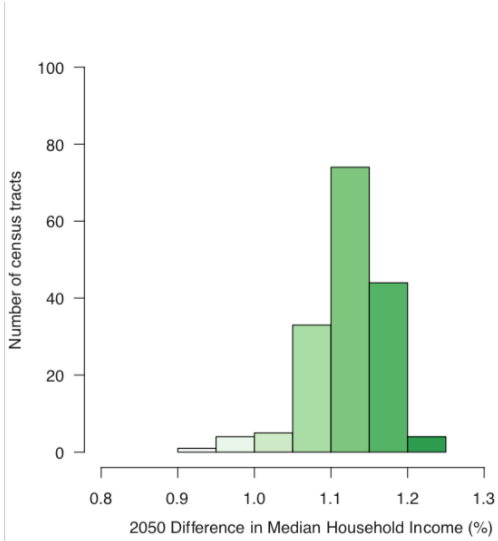


Figure 4.4: Median Low Income (quintile) Income Percent Change



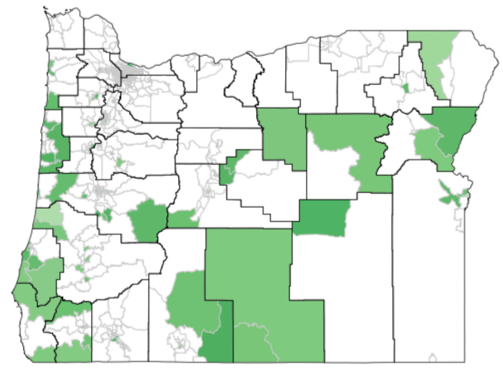
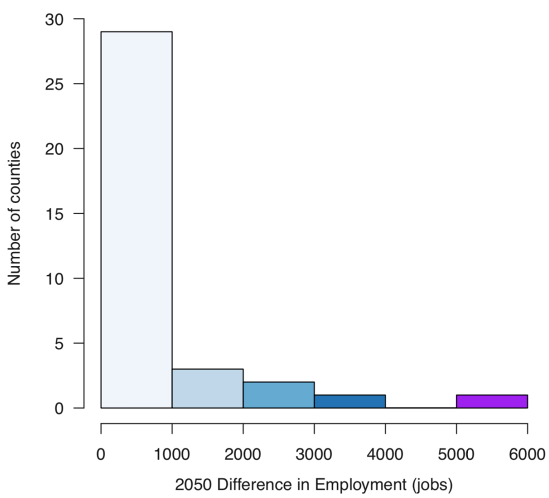


Figure 4.5: Net Job Creation by County (FTE change)



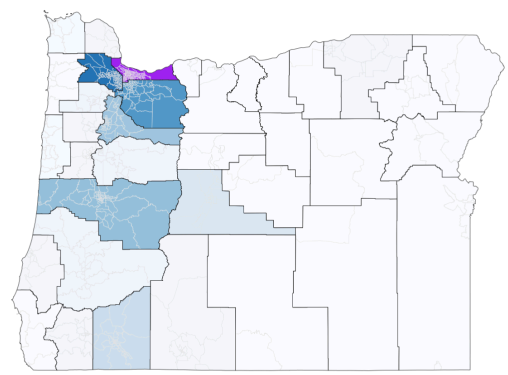


Figure 4.6: Net Job Creation by County (percent change)

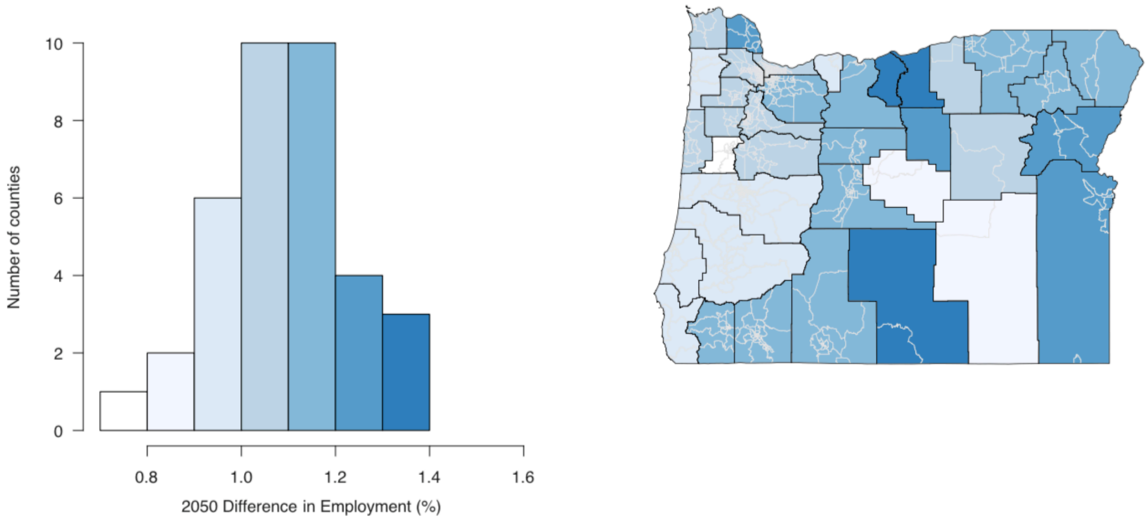
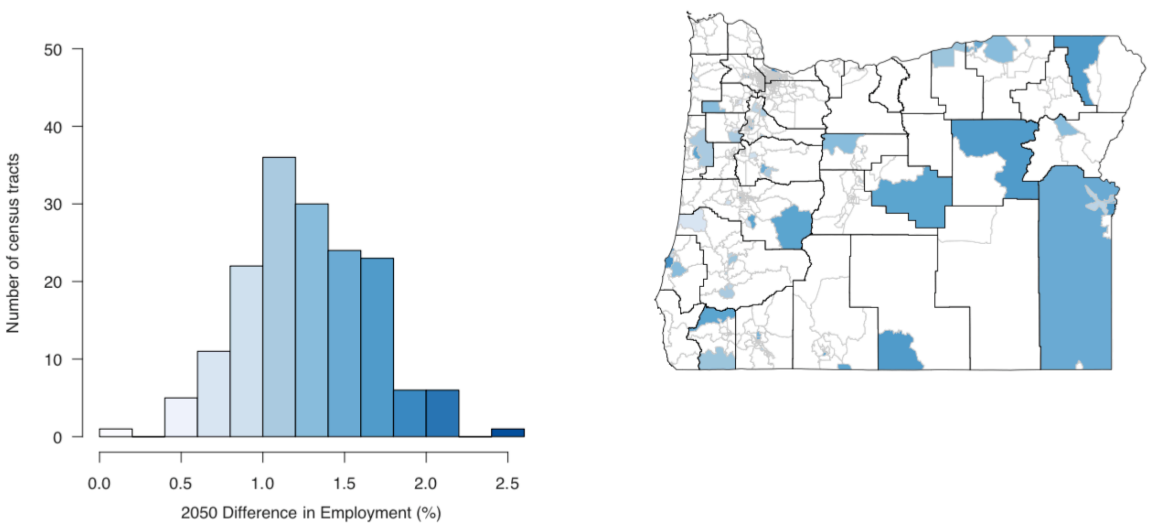


Figure 4.7: Net Low Income (quintile) Job Creation (percent change)



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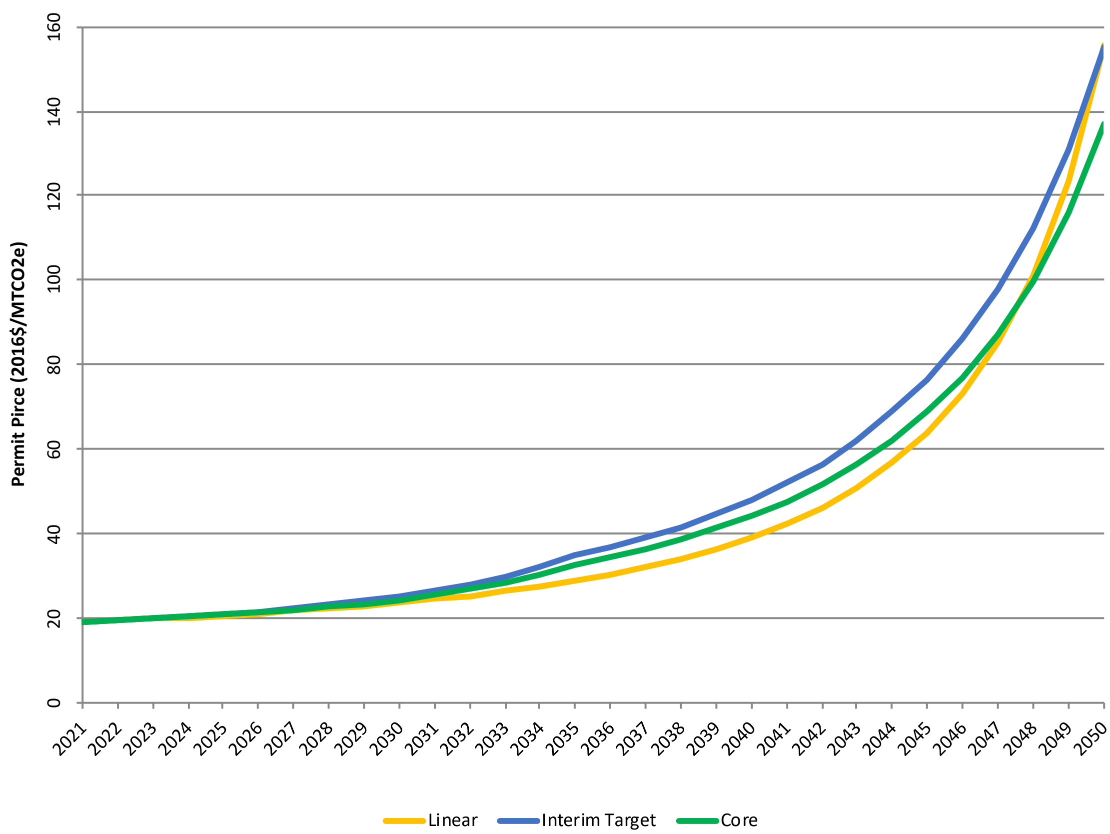
4.2 Permit Prices

Another important feature of our results is explicit projection of permit prices that would result from cap-and-trade operating under the scenarios considered. Figure 4.8 illustrates these estimates in 2016 dollars per $MTCO_2e$, and several salient features are immediately apparent. Firstly, permit prices are generally relatively low, reflecting experience in other markets and suggesting that direct (permit) and indirect (investment) compliance costs are manageable, even under the more ambitious Interim Target mitigation pathway. In all scenarios reported in Figure 4.8, the Oregon market is not linked with the WCI.

Figure 4.8: Estimated Permit Prices Rise Slowly Until Nearly 2040



There is understandable concern among stakeholders about the effect of cap-and-trade on end user energy prices. Our permit price estimates reflect the fact that decarbonization will be driven by adoption of cost saving technologies, not higher fuel prices, in the electric power and transportation sectors. As we explain below, these two primary sources of GHG emissions already offer technology choices that can save energy and return those savings to ratepayers and vehicle owners. In both sectors, diffusion of these technologies will keep prices relatively stable. For example, we do not envision gasoline prices rising by more than 15-25 cents per gallon during this period.[5] During the second half of the process, pressure from permit prices may increase because of the challenge posed by natural gas heating in the building stock, but this should provide strong impetus to the innovation community.

Second, it is clear that a more flexible approach to recognizing mitigation can be cost-effective for Oregon. Note that we have assumed for the sake of this scenario that offset mitigation credits are relatively costly, i.e. equal to the price of in-state emission permits obtained at auction. In reality, there are likely to be abundant sources of in-state, domestic, and regional (WCI), and even international mitigation that are cheaper than GHG reductions in Oregon.[6] Even in the (unlikely) event that offsets credits are the same price as HB2020 auction permits, access to offsets would eventually reduce direct compliance costs by about 12 percent for the Core policy scenario.

The reason auction prices are lower, even though external credits are priced at parity to them, is because the credit allowances effectively loosen the cap by diverting permit demand, increasing availability for those who buy in-state permits. Of course it should be emphasized that the same GHG mitigation is achieved globally, and we have chosen to eliminate credit allowances by 2050, meaning Oregon meets its ultimate mitigation goal within the state. Third, note that permit prices are relatively stable for the first 15 years, even with the ambitious Interim Targets of the Core scenario rise sharply for the more ambitious pathway because they share the same 2050 target.

Permit prices under the cap-and-trade scenario are likely to be considerably lower thanks to the existence of complementary regulatory policies such as the RPS and

---

[5] Actual market price estimation should be done with detailed econometric evidence, not macro models. Our basic calculation here is based on the fact that it requires 108 gallons of gasoline and 99 gallons of diesel to emit 1MT of CO_2. At a permit price of $20, with 100% passthrough to end users, this translates into current retail price increases of $.18 and $.20 per gallon, respectively. Future MPG improvements are expected to progress faster than this, which would lead to lower rather than higher fuel expenditures.

[6] For example, the International Commercial Airline Association (representing 90% of global passenger capacity) has announced that the plan to securitized 100% if their GHG emissions by 2025. Their own auditors estimated that the cost of this (from existing offset sources) would equal just 1% of revenue.

the Clean Fuels Program. Conversely, economic impacts towards the end of the forecast period are likely to be sensitive to the effectiveness of existing complementary policies. For example, if policies such as the RPS and the Zero Emissions Vehicle mandate are more effective than anticipated, the reported economic effects are likely to represent a conservative estimate of the true economic impacts of the cap-and-trade program. If the existing regulatory programs are less effective than expected, it is likely the results reported here will underestimate the economy-wide costs of the proposed cap-and-trade program. Furthermore, this analysis extends beyond the time period of certain existing regulatory policies, although we have assumed that these policies continue out to 2050. This creates some uncertainty around how much the cap-and-trade program itself will be responsible for reducing emissions, as opposed to complementary policies.

According to our estimates, Oregon in the aggregate will be able to achieve relatively cost-effective mitigation, limiting demand for permits to levels that generate low prices in the early years, rising in later years significantly, but still only to median expectations. That being said, not all economic actors will benefit equally. Some entities may experience difficulties associated with paying higher carbon prices. It should also be emphasized that, like all forecasts, these estimates can be taken with higher confidence in the early years. This is important, as our data reflect costs and benefits of adopting existing or on-the-shelf technologies, extrapolated at historically established rates of innovation and efficiency improvement (more on this below). Thus, our estimates indicate that diffusion of available technology can cost-effectively meet the state's emission objectives for the next one or two decades, but marginal pollution abatement costs will rise significantly (but affordably) in the later years. This pattern reflects uncertainty about the potential for further innovation.

The composition of energy cost impacts has two primary dimensions. The first divides the energy supply between its main end-user sources, electric power, natural gas, transport fuels. In the case of electric power, our results show the potential for renewable substitution to lower utility costs and enable reductions for Oregon ratepayers. Our macro model assumes that utilities invest in the most cost-effective non-coal sources of power and pass their cost savings on to ratepayers.

For electric power users his means long-term savings from combined renewable deployment and more efficient use technologies.[7]

Natural gas users are quite diverse and span the entire enterprise and household communities. Apart from the electric power sector, whose primary decarbonization pathway is renewable energy deployment, the major categories of end use are industrial processes and heating of residential and commercial buildings. Industrial gas transition will be a case-by-case experience, one that can be facilitated by both technology adoption and flexible permit allocation to bridge financing requirements. These sectors should be closely watched to promote efficient solutions to the adoption challenges they face. In the context of heating, electrification solutions exist but will take time because of slow turnover of the capital stock and the need for relatively long-term financing. Again, supporting policies can be considered in this case, but in the absence of significant innovation we estimate that this late stage decarbonization will increase permit prices through the last 10-15 years of the period considered (Figure 4.8).

For transport fuels, the picture is different. Conventional fuels like gasoline will experience increasing marginal costs from cap-and-trade permit prices, but the main determinant will be global oil markets, over which Oregon has no control. In this context the decarbonization incentives of the permit system can promote energy security and limit fluctuations in transportation costs. Permit-induced increases are estimated to be much smaller than historical oil price volatility, in the range of 15-25 cents more per gallon in the early years, but declining in importance with reduced dependence on conventional fuels. Having said this, vehicle owner's vulnerability to these price increases depending on many factors. Although some households spend more on transport fuel than others, the statewide average is a low single-digit percentage of total consumption. This reasoning assumes, however, that vehicle technology remains constant. We argue the opposite below, that Oregonians already have important opportunities from new vehicle technologies, holding the potential for substantial savings at today's fuel prices. If the next thirty years sees them respond to these incentives, conventional fuel prices will have negligible impact on their future. Instead, as in the past, technological change will be improving their economic prospects and their quality of life.

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[7] In their own cost projection compliance documents, Oregon utilities are already reporting expected cost savings from renewable deployment.

The second dimension of energy impacts relates to intensity of energy use. Households can be diverse in this respect, but industries vary much more in their energy intensity per unit of output and (especially) in the intensity of particular uses by source of energy. The category of emissions-intensive and trade-exposed (EITE) sectors exemplifies this, identifying sectors with high compliance costs as a percentage of total cost and dependence on export activities which could be undermined by higher compliance costs.

While EITE enterprises are of course essential to their owners, employees, and local communities, they comprise a modest share of the state's GDP (Figure 4.9). This suggests that we should look for complementary policies that can take account of their adjustment needs without sacrificing the overall economic and environmental benefits of cap-and-trade. This reasoning is a primary justification for HB2020's permit allocation rules to EITE sectors.

In summary, the estimated permit price pathways indicate a relatively smooth transition is ahead for the first one or two decades of cap-and-trade, and we hope innovation can simply extend this by reducing the cost of use technologies even further. We have not assumed this will happen, but historical evidence certainly supports optimism in this regard. To see how dramatic the difference can be between expected and actual adjustment costs, it is worth recalling the first years of California's cap-and-trade system. In the legislative runup to AB32, many stakeholders claimed permit prices would exceed $100-150 at opening, and one study by a respected consultancy estimated prices over $400 per MT. The real evidence is now available (Figure 4.9) and, after initial market "disagreement" (volatility) in the first year, the price has settled into the low teens. Surely it won't stay at such a low level indefinitely, but this experience is testimony to the important of testing market hypotheses.

Figure 4.9: California's Recent Permit Price History

5-day moving average price and volume of California Carbon Allowance Futures over time from ICE End of Day Reports. Daily trading volume units are 1000 allowance futures. Download data.

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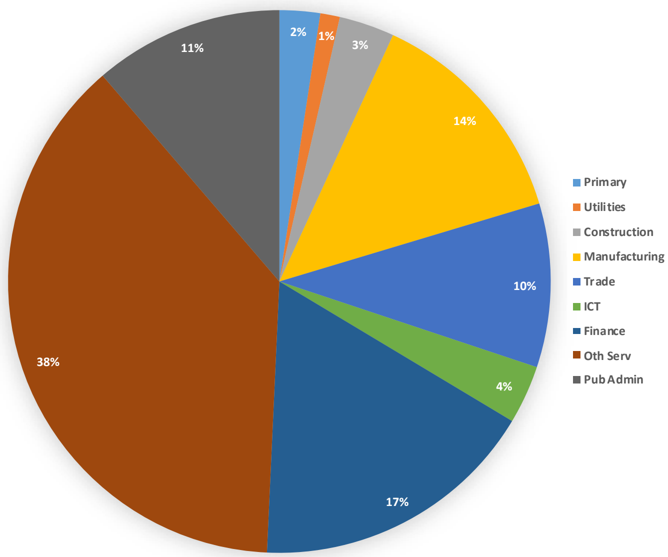
Figure 4.10: Composition of Oregon Gross State Product by Activity (2016 percentages)



Source: US Bureau of Economic Statistics

4.3 Permit Revenues

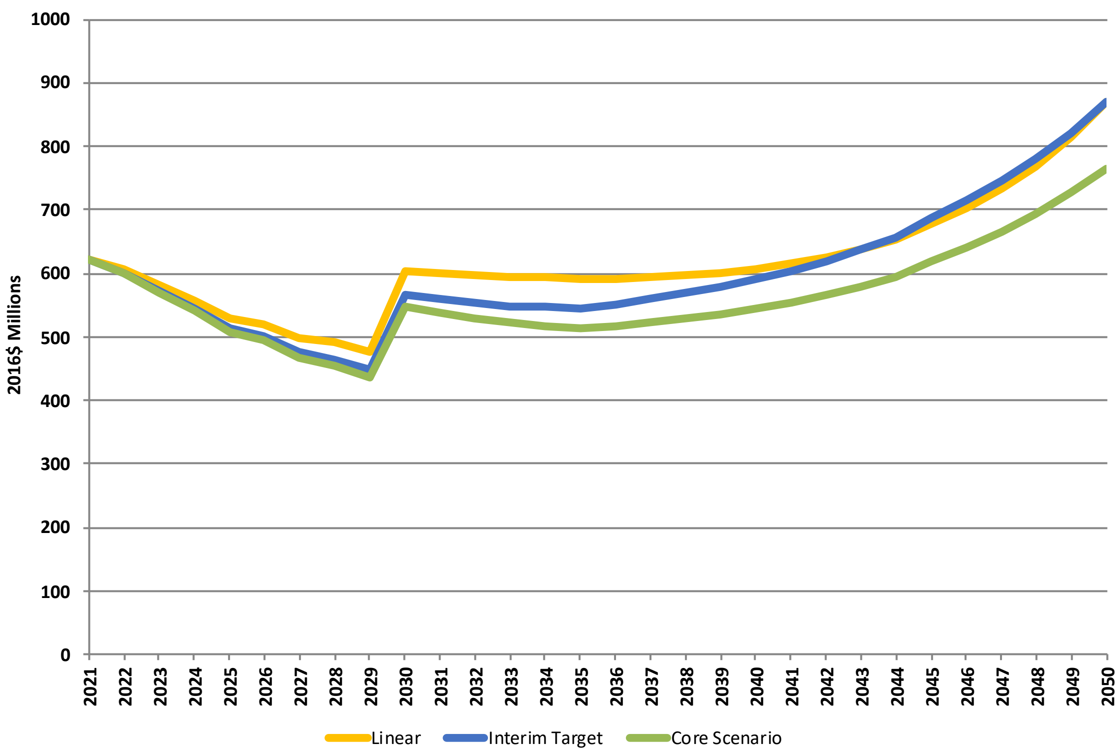
Figures 4.11 and 4.12 show, for our three main cap-and-trade scenarios, expected total auction revenue and allocation of that revenue. Figure 4.11 reveals three main features of the scenarios:

1. Auction revenue falls with reduced permit issuance (at relatively stable permit prices), rises sharply with allowance reduction and coal retirement, and then rises steadily as permit price profile steepens in the latter half of the scenario interval.

2. Quantity effects dominate this market, i.e. the more stringent Interim Target and Core scenarios yield lower revenue because permit supplies fall faster than prices rise, at least until the last decade.

3. Offsets provide adjustment assistance to the entire market by depressing permit prices (up to about 12% by the last decade).

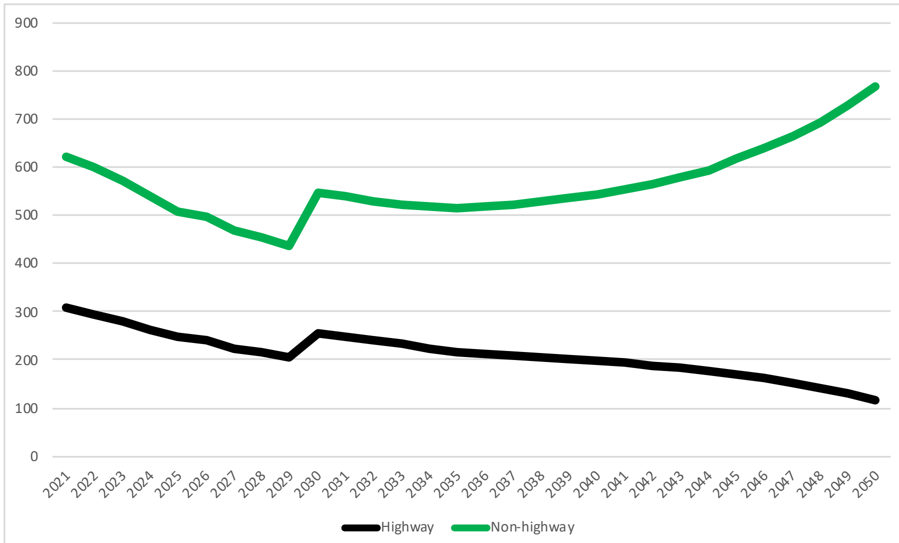
Figure 4.11: Estimated Permit Revenues by Mitigation Pathway



Source: Author estimates.

Revenues from auctioned permits are received by the state and allocated to two basic categories: funds from transport-related revenue and other funds. For cap-and-trade, the first category includes revenue from all permits sold to cover transport emissions, with which funds are currently mandated to Oregon highway maintenance, construction, and related projects. Because of the share of transport in total emissions and the fact that they receive no concessional permit allocation, about half of cumulative revenues would initially be assigned to the Highway Fund. However, over the next 30 years electrification of the vehicle fleet is projected to reduce fuel use by more than 80%. Despite rising permit prices, we estimate that this will reduce the Highway Fund share of revenues to about 100 million (2016) dollars by 2050.

Figure 4.12: Estimated Permit Revenue Allocation - Core Scenario (cumulative)

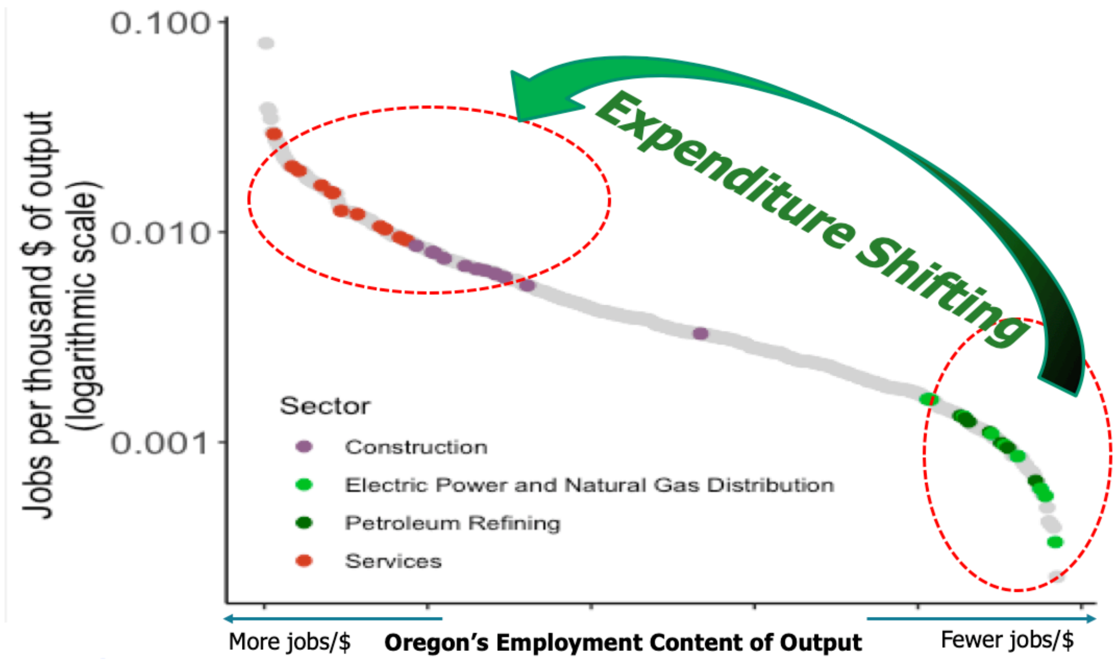


Source: Author estimates.

4.4 Macroeconomic Impacts from Cap-and-Trade

Using a state-of-the-art behavioral model, the BEAR model is calibrated to the most up-to-date information on the Oregon economy, emissions, and technology costs. This forecasting tool tracks interactions between multiple sectors and attendant patterns of demand, supply, employment, trade, investment, and many other variables, forecasting annually over a 34-year period. Despite many technical details, however, the macroeconomic impacts we estimate from cap-and-trade are consistent with straightforward economic reasoning: Technology adoption allows enterprises and households to save money on conventional energy resources, and these savings are recycled to stimulate more job-intensive employment and income growth.

Figure 4.13: How Energy Efficiency Creates Jobs



Source: US Bureau of Labor Statistics.

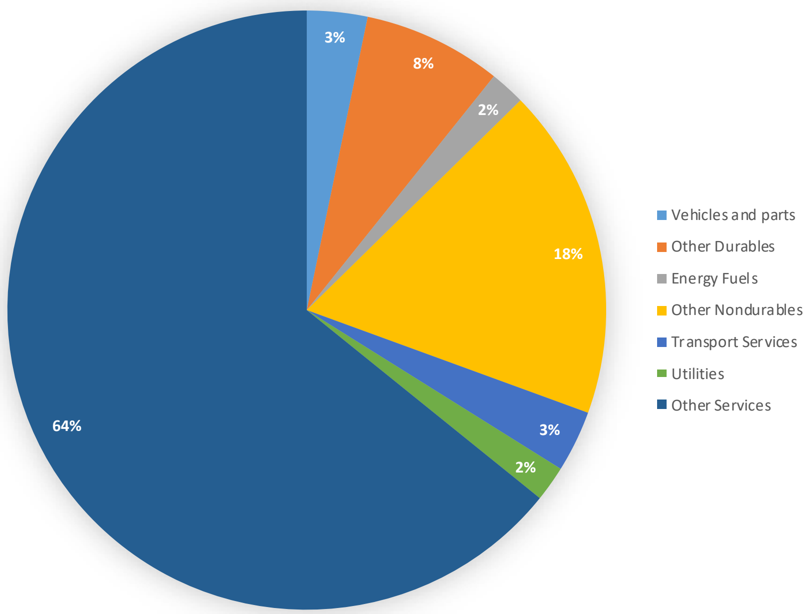
Energy efficiency results in economic savings if the economic benefit of reduced energy use outweighs the cost of adopting the more efficient technology. The best evidence available on this is California, which has maintained a combination of appliance and building standards and utility incentive programs since the early 1970's. In response to this, and even before AB32, the state went from parity to household electricity use levels that were 40% below the national average. These savings diverted household and enterprise expenditure from the carbon fuel supply chain to (mainly) services and manufactures, both of which are significantly more job intensive (Figure 4.13). If renewable penetration goes forward as expected, these savings can be compounded by declining unit costs of electricity supply, after discounting for and "rebound effect" that results from increased demand.[8]

To assess the economy-wide impacts of our efficiency and electric vehicle scenarios, we calibrated our model to the most recent information on present and future energy technology costs. These estimates, produced by ICF (2014) and E3 (2015), show net long term savings for both those who adopt electric vehicles and, because of capacity grid adjustments resulting from large scale EV adoption, reduced system wide electricity rates. Including their estimates of these

[8] There is general agreement the rebound effects in electricity demand are less than 20%, meaning the at least 80% of price reductions in electricity translate into ratepayer savings.

incremental microeconomic benefits in our economy-wide model leads to gains for individual households and enterprises, amplified by multiplier effects from recycling their energy savings into other expenditures. For Oregon, expenditure shifting also has strong potential for broad based job creation and inclusive economic growth. As the following figure makes clear, over two-thirds of real household consumption in Oregon goes to services.

Figure 4.14: Oregon Household Consumption Expenditure (2017 percent shares)



Source: US Bureau of Economic Statistics

Permit prices will certainly escalate the costs of transport fuels, but this will only increase the potential savings available from new vehicle technologies. In our discussion of vehicle electrification below, we show that even in the absence of cap-and-trade, Oregon drivers can realize significant savings from electric vehicles. Over the next three decades, the average light vehicle owner will replace their car or truck three times. This opportunity for technology change can be the key to saving money on personal transportation and lower carbon economic growth.

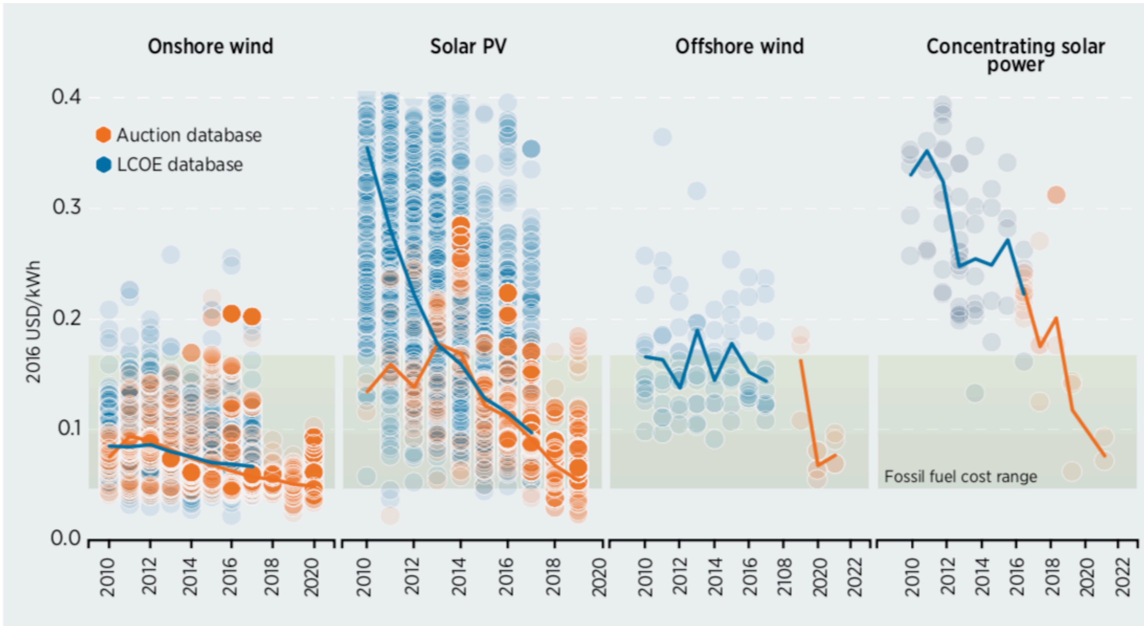
Taken together, these estimated effects suggest HB2020 and complementary policies would support higher and more inclusive long term economic growth for Oregon. The intuition behind this finding is the following: If you take a dollar out of the gas pump and give it to an average Oregon household, they will spend it on a diverse array of in-state goods and services that average 16 times the employment potential in terms of jobs per dollar of revenue.

4.5 Renewable Deployment

Renewable energy is playing a rapidly growing role in local, national, and global environmental policy, and Oregon set an ambitious 50% by 2040 Renewable Portfolio Standard (RPS) to affirm this fact. A large part of the renewable energy mix: solar, wind, and geothermal, represents a fundamentally new energy supply paradigm. Because they are exhaustible resources, fossil fuel supplies and prices are determined primarily by scarcity, while these renewables represent essentially boundless resources relative to today's energy requirements. In the latter case the constraint to supply is not scarcity, but technological change. Recent trends in renewable technology show that these costs can fall dramatically with scale and learning.

As mentioned above, the existing RPS commitment to 50% RPS by 2040 is incorporated into our Reference scenario. However, it must be recognized that, because of continuing trends in renewable competitiveness, cap-and-trade will certainly drive more diffusion of these technologies across the electric power sector. Indeed, this will be essential to achieving Oregon's 80% decarbonization target by 2050. Because of dramatic and continued reductions in renewable energy cost, solar and wind energy are now reaching the bottom of the price band for existing electric power from all fossil fuel sources (Figure 4.15).

Figure 4.15: Global Levelized Cost of Renewable Electricity and Auction Price Trends



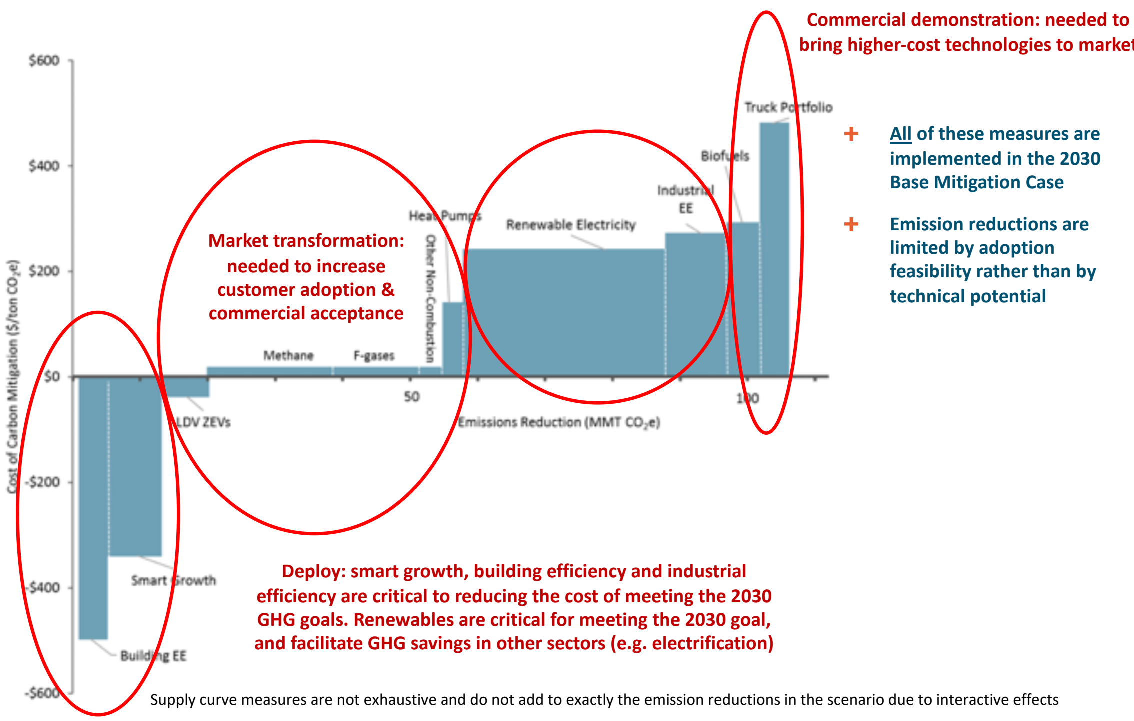
Source IRENA Renewable Cost Database

4.6 Mitigation Pathways

In a macroeconomic assessment like the present one, opportunities and actions for pollution reduction are generalized from average cost estimates, relative price changes, and responses of average enterprises across the Oregon economy. In this top-down framework, cost trends in renewable energy and energy efficient technologies facilitate parallel reductions in emissions and carbon fuel use, leading the economy toward its 2050 emission goals. The generality of this approach can be frustrating to those who might seek guidance about more detailed adjustment options and decisions by enterprises and stakeholders, but the fact is that every day the economy realizes and reconciles the independent decisions of millions of independent agents without a master planner in the background. More pointedly, economists can predict, but not dictate or even fully describe, all these activities.

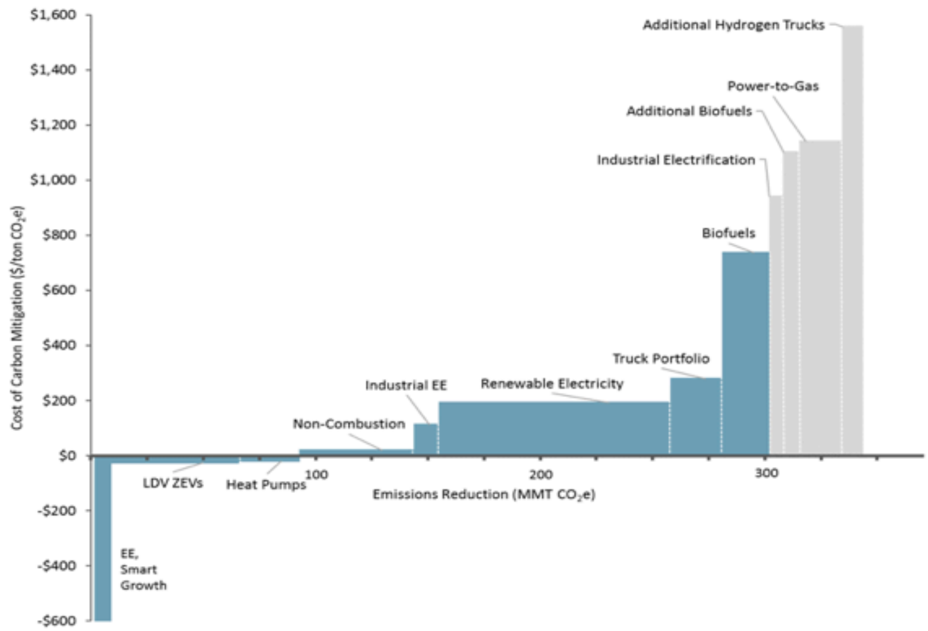
Having said this, we can still learn much about mitigation pathways by examining the opportunities presented by existing technologies. For example, Figure 4.16 illustrates mitigation technology options available to California, in order of average adoption cost, and up to the mitigation goals set by this state for 2030. Of course all the same options are open to Oregon, and most would have comparable costs. A few important insights can be drawn from this more detailed data. First, all but the last 5% of emissions reductions could be achieved with technologies available today. Second, net costs of the first 20% are currently negative and for the next 40% they are negligible. Third, although net costs then rise substantially with renewable deployment, these are among the most rapidly declining technology costs, having fallen since the E3 study and probably continuing to do so, making this decarbonization pathway ever more affordable, reducing demand (and prices) for pollution permits. Finally, the above facts make it clear that achieving the Interim Targets is a question of behavior, not underlying cost. This of course means that policy determination will be essential to achieving the economic and social benefits of decarbonization.

Figure 4.16: Technology Options for Oregon to Reach It's 2035 Emissions Targets (California Example)



Source: E3 (2017).

Figure 4.17: Technology Options for California to Reach 2050 Emission Targets



Source: E3 (2017).

For comparison, the same estimates are presented in Figure 4.17 for California's 2050 emission goal, like Oregon an 80% reduction in GHG emissions from the 1990 reference level. Here we see more "reach" technologies, which will have to prove their emission and efficiency potential over the next three decades. Apart from these, however, most of the needed technologies await adoption now, but will probably only decline in cost with time. Again, we see that policy determination to effectively promote these technologies, using public information and incentives if needed, may be needed if marketing and carbon permit costs are not sufficient to achieve the necessary adoption and diffusion of low carbon technologies. Averaging the estimated costs over technologies to both 2030 and 2050, however, we see net costs per MT of GHG are comparable to Oregon – relatively low and stable in the first 15 years, rising appreciably but not prohibitively in the second 15 years. Of course, the second half of this interval will be inhabited by many different actors and technologies. A consistent price on carbon will certainly arouse the former to improve the latter.

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4.7 Vehicle Technology Choice

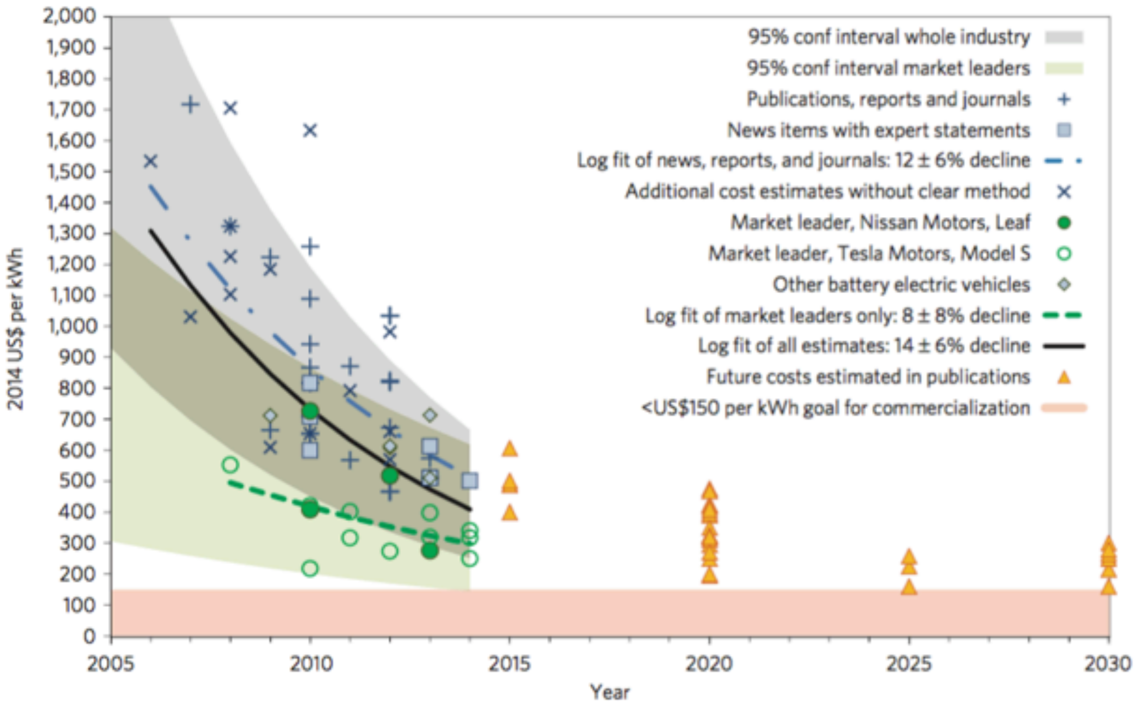
Along with electric power, the transportation sector is a primary driver of global warming pollution in Oregon, comprising about half of the state's overall GHG emissions inventory. On-road vehicles constituted over 77% of transportation sector emissions. Of this category, light duty passenger vehicles accounted for approximately 69% of transport emissions in 2012. These emissions varied over the last decade, with the greatest decrease occurring at the time of the recession. In the summer of 2008, fuel prices reached a historic maximum, followed by a significant decrease in the consumption of gasoline and diesel fuel. Total transportation fuel consumption declined in 2008 and continued falling until 2014, but may be trending upward now.

It is unlikely for Oregon to achieve 80% decarbonization without a fundamental transition of its transportation system to electric power. Alternative fuels can be important sources of mitigation in the near term, but they cannot displace enough conventional fuel emissions to meet reductions by 2050 with current population growth trends and known technologies for biofuel production and distribution. Hydrogen is an emerging technology that may play an important role, but we do not evaluate it here.

We begin this section with a description of our modeling approach and assumptions regarding electrification of the light vehicle fleet. This is followed with an overview of prospects and challenges for leading Oregon policies toward this important sector. Our assumptions regarding vehicles explicitly recognize innovation processes and changing vehicle standards over the time period considered. To this end, we assume Internal Combustion Engine (ICE) vehicles attain higher average mpg in accordance with state and Federal regulations, and that conformity with these confers modestly higher costs, reaching a $2,000 premium over average 2012 prices by 2030 (less than 0.5% annual price appreciation). For PEV vehicles, we built our IVC estimates from the bottom up, using the most up-to-date electric vehicle technology data available. Batteries are a primary cost component in all PEVs, and here we have assumed steady but moderate progress or "learning" in this technology (see e.g. McKinsey: 2009a). The result, as indicated in Figure 4.18, is a cost/efficiency improvement of about 80% over the next two decades.[9]

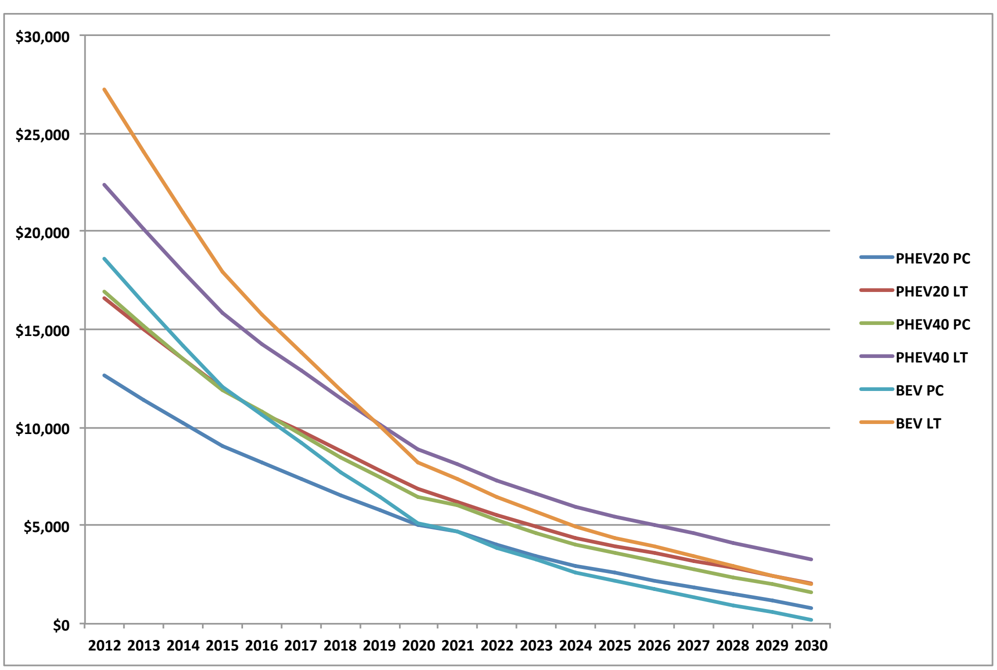
[9] The complete calculations are fully documented elsewhere, and can be made available up request.

Figure 4.18: Battery Cost/Efficiency: Look out below



Source: Nykvisk and Nilsson, Nature Climate Change.

Figure 4.19: Incremental Vehicle Costs, by Vehicle Type



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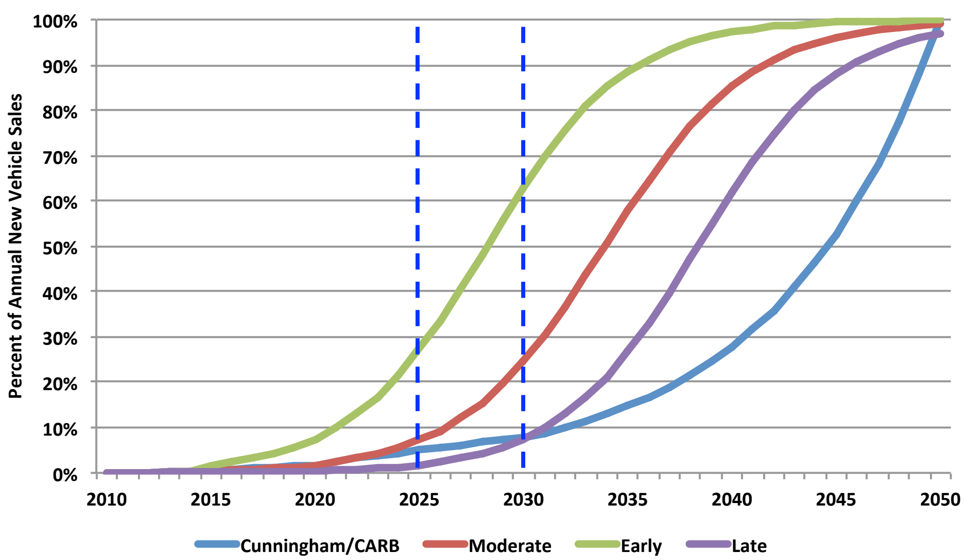
Sources: McKinsey, EPA, ARB, EPRI

After a review of the vehicle engineering literature and consultation with experts in this field, we have estimated incremental vehicle cost for PEVs using these battery cost profiles and a 30% mark-up on other power and drivetrain components. The resulting IVC trends for our analysis are summarized in Figure 4.20 for the six PEV vehicle types in our analysis (PC=passenger car, LT=light truck).

Figure 4.20: Scenarios for Battery Electric Vehicle Adoption



Our last scenario considers one of many possible adoption pathways for 100% light duty vehicle fleet electrification, or Battery Electric Vehicle (BEV) adoption, the Moderate profile in Figure 4.20. From a 2018 base of 4%, this calls for about 7% of new vehicles sales to be EV by 2025, increasing to 25% by 2030 and 100% by 2050.[10] For comparison, we also illustrate a California Air Resources Board proposal for more gradual early adoption, rapidly accelerating in the final decade.

Assuming the Moderate adoption profile for BEVs, along with an assumption of phasing out hybrid vehicles, we obtain the vehicle fleet transition implemented in the Core scenario and illustrated in Figure 4.21. With respect to current levels of BEV market penetration, this is a very different transportation sector, with far reaching implications for complementary technologies, infrastructure, electric power capacity, etc. All these issues require detailed evaluation to be most effectively supported by public policy and, in turn, for leading private stakeholders

[10] To its credit, Oregon already has the second highest rate of EV adoption in the nation, according to the US Alliance of Auto Manufacturers.

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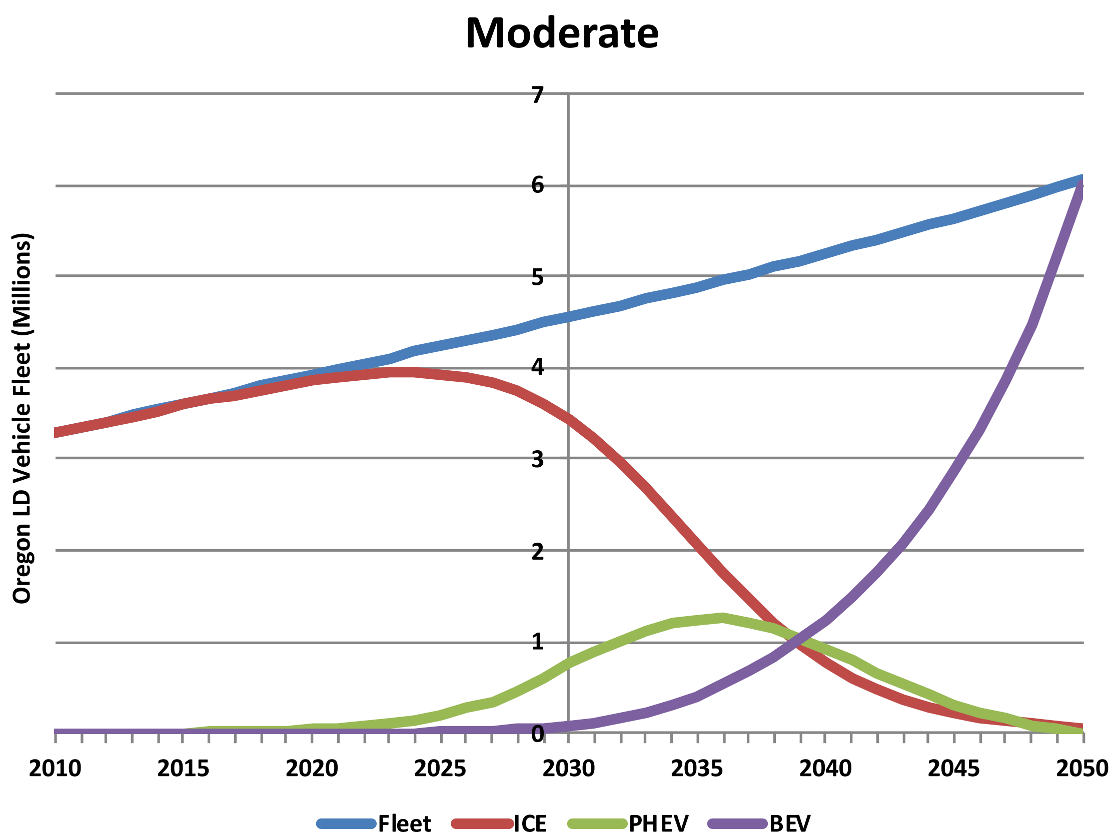
to effectively support climate policy. The state's ambitious goals have the best chance of success if they are based on this kind of constructive engagement.

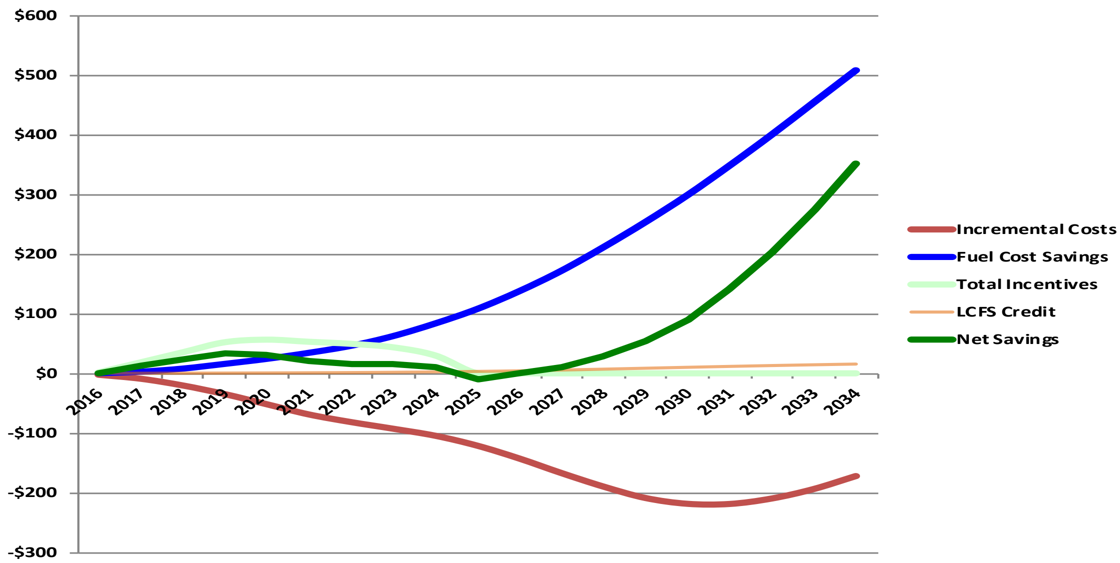
Figure 4.21: Oregon Vehicle Fleet – Moderate BEV Adoption Profile



Source: Author estimates. Vehicle classes are Internal Combustion Engine (ICE), Plug-in Hybrid Electric Vehicles (PHEV), and 100% electric or Battery Electric Vehicles (BEV)

Should the Moderate adoption pathway be achieved, the savings to Oregon drivers would be substantial. Figure 4.22 maps out aggregate vehicle costs and benefits for this adoption pathway, yielding nearly half a billion dollars in net savings by 2035. Via the expenditure shifting that these savings would enable, this would combine an important source of carbon mitigation with potential growth stimulus for the state economy.

Figure 4.22: Potential Benefits and Costs of BEV Adoption (2016 $ millions)



Source: Author estimates.

We now provide an overview of climate related policies directed at transportation. Generally, Oregon's long-term criteria pollutant and GHG emissions goals will require four transportation-oriented strategies: (1) improve vehicle efficiency and develop zero emission technologies, (2) reduce the carbon content of fuels and provide market support to get these lower-carbon fuels into the marketplace, (3) plan and build communities to reduce vehicular GHG emissions and provide more transportation options, and (4) improve the efficiency and throughput of existing transportation systems.

In summary,

- Light-duty vehicle electrification and vehicle fuel efficiency generally can be potent catalysts for Oregon's economic growth.

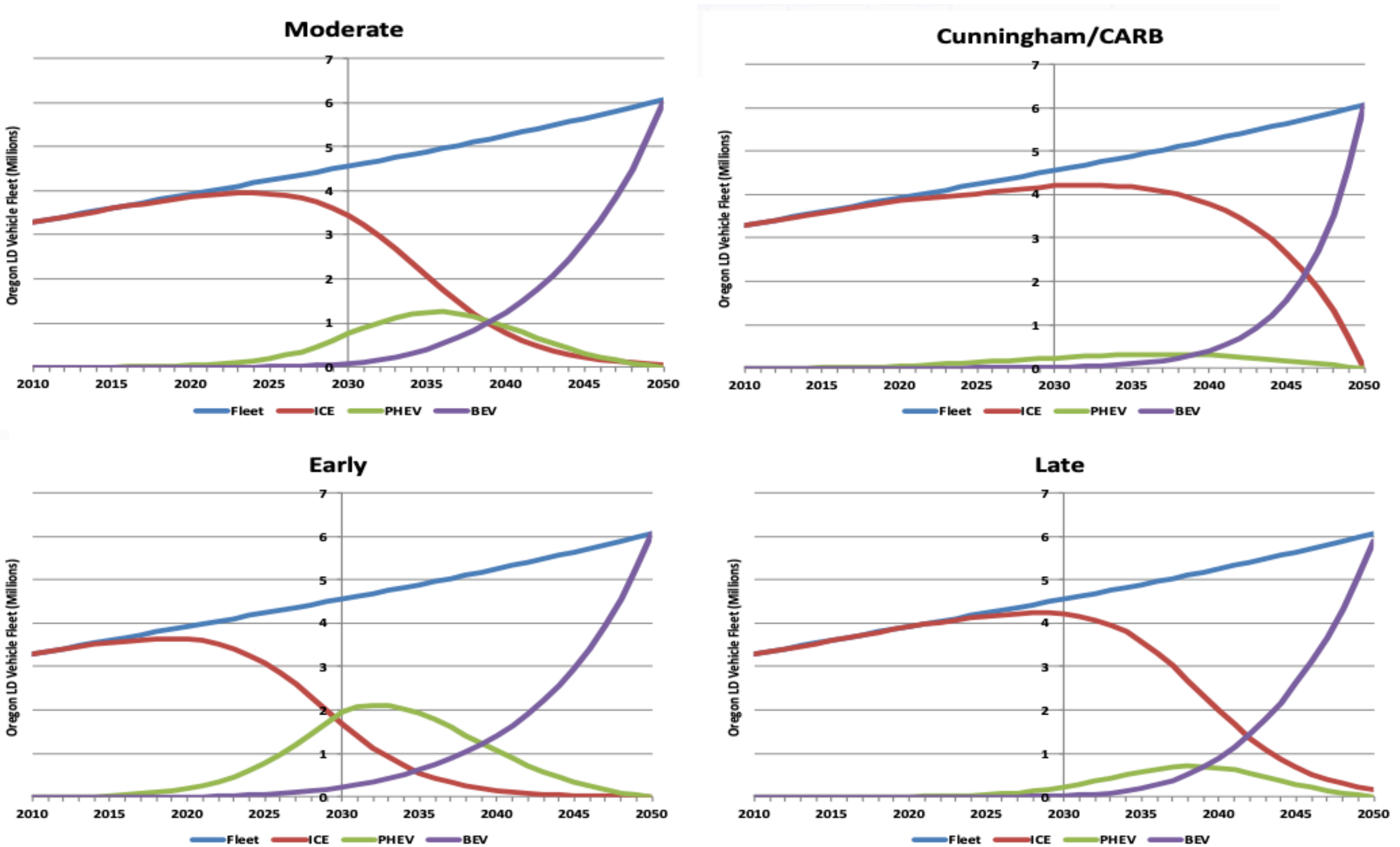
- Households and enterprises spend their fuel savings on new vehicle technology and a broad range of other goods and services, stimulating net employment growth across the state economy. On average, a dollar saved at the gas pump and spent on the other goods and services that households want creates 16 times more jobs.

- Unlike the fossil fuel supply chain, the majority of new demand financed by fuel efficient vehicle cost savings goes to in-state services, a source of diverse, bedrock jobs that cannot be outsourced.

- Individual Oregonians gain from economic growth associated with fuel cost savings due to vehicle electrification, whether they buy a new car or not. As a result of light-duty vehicle electrification, the average real wages and employment increase across the economy and incomes grow faster for low-income groups than for high-income groups.

- Creating a market to incubate the next generation of fuel efficient vehicles has could promote job growth across Oregon's economy while capturing national and global market opportunities for technology development.

Figure 4.23: Alternative Scenarios for EV Diffusion in the Oregon Light Duty Fleet



4.8 Air Quality Improvements

Much of the debate about cap-and-trade revolves around costs and benefits of energy and energy use technologies while many societal benefits of reduced environmental pollution go unmeasured. This study attempts to quantify reduced health costs from improved air quality, a real economic impact that would be directly added to other economic benefits. Building on a rapidly growing body of public health research on climate policy, we estimate the economic benefits (i.e., avoided health costs) of reducing hazardous co-pollutants (PM2.5 and Ozone) associated with carbon fuel consumption. These pollutants are not only associated with the electric power and industry, but are a serious health risk in transportation corridors and densely populated urban environments.

In order to estimate health benefits from the proposed cap-and-trade policies, we leverage recently published research that uses a meteorological model to model the spatial relationship between emissions and criteria pollutants in 50km x 50km grid cells across the United States (Zhang et al 2017). Using this model and scaling modeled changes in emissions in Oregon to reflect the proposed cap-and-trade policies allows us to estimate changes in criteria pollutants across the state under each policy scenario. The EPA's BenMAP model is then used to relate changes in criteria pollutants to changes in the number of excess deaths from pollution (EPA BenMap 2018). Excess deaths are valued according to the EPA's Value of a Statistical Life (VSL) and EPA estimates of the relationship between mortality and morbidity health costs are used to approximate the magnitude of total health benefits.

Using this approach, we estimate that the added public health benefits are substantial, comprising about 1/3 of total economic benefits from the proposed policies. However, in no scenario are they the determining factor that causes benefits to exceed costs. So while public health benefits are an addition to social wellbeing, including or excluding them from the analysis does not fundamentally change the cost-benefit calculation. These estimates are intended only to be indicative of the magnitude of potential health benefits from the proposed policies.

A detailed description of the methods used to estimate health benefits is included in an appendix below.

4.9 Trade Issues

Lower expenditures on conventional energy reduce Oregon's dependence on imports of raw energy fuels from other states and overseas. It is possible that the trade effect might reduce export opportunities in Oregon. However, conventional energy fuel imports will increase state employment as long as it results from efficiency. We have already observed that the carbon fuel supply chain has extremely low employment potential. For example, a dollar spent on Oregon gasoline generates less than 10% as many jobs as the average dollar of consumer spending ($.70 of which go to services). Even if Oregon's exports fell by an amount equal to the reduction in conventional energy fuel imports, the net job creation effect would be strongly positive. Since the state will likely rely on significant renewable energy imports (Wyoming wind in particular), this extreme outcome is unlikely.

Three other effects of fuel savings to households and enterprises are also likely to have an impact:

1. Spending fuel savings creates its own import demand. If Oregon imports are nearly 60% of GDP, this would offset about half the mercantile effect of reduced conventional energy imports.
2. Service spending has larger in-state multipliers than energy fuel spending.
3. Innovation benefits of new fuel and vehicle technologies increase state employment and income.

4.10 Market Failure Issues

Another type of skepticism regarding the benefits of HB2020 and related climate policies is based on a presumption of market efficiency. Simply put, this perspective holds that to justify intervention, we must identify specific market failures that are inhibiting otherwise voluntary mitigation efforts and/or technology adoption. Otherwise, markets know best and we are already using or pursuing the most cost-effective solutions.

In reality, of course, there are many market imperfections in the climate change context. Of course the most important one is the global carbon externality, an inconvenient disconnect between the private benefit of using energy services and the public cost of the greatest environmental risk in human history. If this isn't enough to justify intervention in today's energy systems, we might also acknowledge universal subsidies to conventional modes of transport, as well as oligopolies and/or local monopolies in vehicle, conventional fuel, and electric power sectors.

4.11 Employment Issues

The positive job creation resulting from our scenarios of course requires that supply conditions are conducive to new hiring. To be clear, BEAR is not a "full employment" model because Oregon historically has had an elastic supply of labor. Coming out of an adverse national macro cycle, the state had some structural unemployment and, like most economies, this will likely revisit the economy intermittently. Over the long term, however, Oregon has a higher-than-average elasticity of labor supply because of sustained inward migration. We take explicit account of this and, while it may not benefit the national economy, this kind of new job and income creation has always benefitted Oregon.[11]

[11] Borenstein: 2015 is among prominent experts who caution about the risk of overestimating national benefits from state-specific job creation. This skepticism is certainly well founded, but states tend to place self-interest first when it comes to jobs and income growth.

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5 ALTERNATIVE SCENARIOS

As indicated in Table 3.1, we also considered a few alternative policy scenarios, including two that allocate permit revenues for specific objectives and three different scenarios for Oregon's participation in the Western Climate Initiative (WCI). For convenience, these are restated in Table 5.1.

Table 5.1: Alternative Cap-and-Trade Policy Scenarios

	Scenario	Description
5	**Incentive**	Beginning with the Core scenario, distribute 94% of non-highway permit revenue equally in three categories: 1. Forestry and Working Lands to promote sequestration. 2. Household energy efficiency subsidies. 3. Enterprise energy efficiency subsidies.
6	**WCI-Low**	Core scenario, with a permit price at the California Auction Reserve Price (ARP) low level. We assume in all three WCI scenarios that Oregon is a price taker in the regional market, obligated at the assumed border price of permits, and retains all permit revenue within state coffers. Costless permit allocations follow the core scenario, as do offset rules.
7	**WCI-Med**	Core scenario, with a permit price following the California Energy Commission Mid-level pathway.
8	**WCI-High**	Core scenario, with a permit price following the WCI Ceiling.

The macroeconomic impacts of these policies are listed in Table 5.2 (for 2050 only).

Table 5.2: Macroeconomic Impacts of Cap-and-Trade

2050 Results

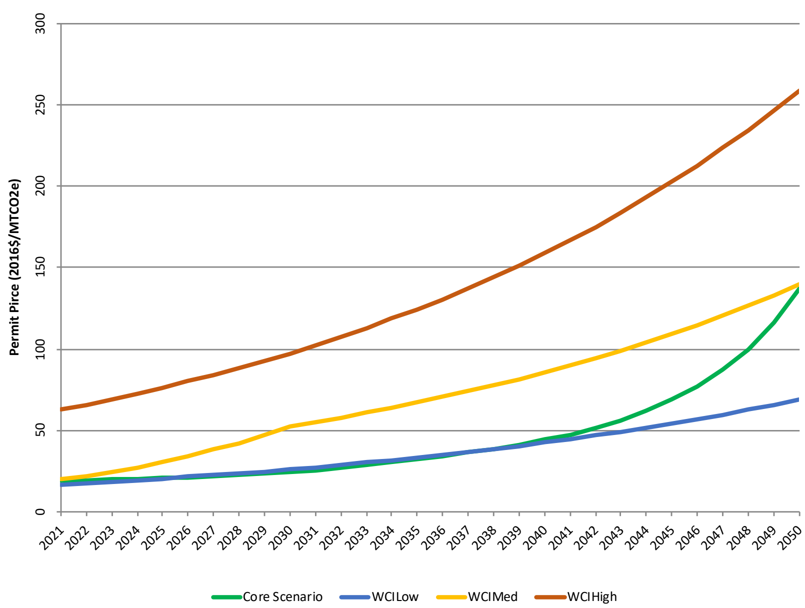
	Reference (levels)	Incentive	WCILow	WCIMed	WCIHigh
GSP ($B)	$526.2	2.53%	2.55%	2.53%	2.50%
Consumption	$266.3	2.17%	2.39%	2.38%	2.35%
Jobs	-	1.03%	1.08%	1.07%	1.05%
Wages	-	0.40%	0.47%	0.46%	0.44%
FTE ('000)	4,393	45	48	47	46
GHG (%)	-	-82%	-82%	-82%	-82%
GHG (MMTCO2e)	48.5	8.7	8.7	8.7	8.7

Notes: All entries except in Reference column represent changes from the Reference scenario in the year indicated, in percentage or the units given in parantheses. Gross Domestic Product

(GDP, value added) and real household Consumption are measured in constant (2016) dollars. Employment chages are measured in thousands of Full Time Equivalent (FTE) annual jobs. GHG measures annual Oregon covered emission changes (% from Reference) and levels (MMT) for the given year and scenario.

Generally speaking, these scenarios have limited impact from a macroeconomic perspective. In all cases this is because the permit program is very small as percent of state GDP. As was emphasized above, cost saving technology adoption is the primary driver of overall Oregon economic benefits from cap-and-trade. Even these gains are in the low single digit percentages of GDP after 30 years. By 2050, our Reference case estimates that Oregon will be a half-trillion-dollar economy. It is hardly surprising then that reallocating permit revenue, itself less 0.16% of GDP, would not move the aggregate economy. Directed revenue programs themselves can be expected to provide important direct and (by example) induced environmental benefits, but these are not captured in the BEAR model.

Figure 5.1: WCI Reference Prices and the Core Scenario



Source: Author estimates.

With respect to WCI options, Figure 5.1 shows our estimated permit price trajectory in the Core scenario, bracketed to reference cases used in the three scenarios. The lower range is the Auction Reserve Price or floor stipulated in the current WCI agreement, WCIMed corresponds the California Energy Commission Mid-level pathway, and the while the WCIHigh is a WCI recommended upper limit on what covered entities would have to pay. Macroeconomic impacts of these three are qualitatively consistent and logical (higher price pathways reduce growth potential) but the differences are again hundredths of a percent of GDP.

6 CONCLUSION

Oregon's proposed cap-and-trade Policy (HB2020) has established ambitious public commitments to energy efficiency, pollution mitigation, and long-term environmental security. Under the right conditions, these policies have potential to both limit resource waste and climate risk and promote development of the next generation of clean and energy efficient technologies.

Using a state-of-the-art economic forecasting model, this study presents evidence that Oregon can meet its 2050 climate goals in ways that achieve higher aggregate economic growth and employment. An aggressive GHG mitigation pathway, reducing 2035 emissions 45% below 1990 levels, will confer greater benefits on the state economy, adding about 1% to GDP and about 11,000 new jobs. Sustaining these reductions to 80% below 1990 by 2050 would increase GDP over 2.5% and add about 23,000 new jobs.

Available energy efficiency and renewable electrification offer broad-based savings to enterprises and households, which can be a potent catalyst for more inclusive economic growth and job creation. These savings can be even greater if Cap-and-Trade and complimentary have their intended incentive effects on new technology investment and innovation.

To reach Oregon's goal of deep decarbonization will require a fundamental restructuring of the state's energy system, including electrification of at least the light vehicle fleet, deep decarbonization of the electrical sector, and dramatically reduced direct use of natural gas in heating and industrial applications

Recognizing sector needs for short and medium term flexibility, adjustment costs for this economic transition can be substantially reduced. Limited directly allocated emissions permit allowances are an important part of this strategy, and BH2020 explicitly recognizes this in its treatment of electric power, Emissions Intensive Export Exposed industries, and selected large natural gas users.

Economic benefits of improved air quality, in terms of averted medical costs and premature mortality, are substantial, contributing about 1/3 to overall economic benefits from cap-and-trade driven reductions in toxic and criteria co-pollutants.

APPENDIX 1 – OVERVIEW OF THE BEAR MODEL

The Berkeley Energy and Resources (BEAR) model is in reality a constellation of research tools designed to elucidate economy-environment linkages in Oregon. The schematics in Figures A1.1 and A1.2 describe the four generic components of the modeling facility and their interactions. This section provides a brief summary of the formal structure of the BEAR model.[12] For the purposes of this report, the 2012 Oregon Social Accounting Matrix (SAM), was aggregated along certain dimensions. The current version of the model includes 50 activity sectors and ten households aggregated from the original Oregon SAM. The equations of the model are completely documented elsewhere (Roland-Holst: 2005), and for the present we only discuss its salient structural components.

1.1 Structure of the CGE Model

Technically, a CGE model is a system of simultaneous equations that simulate price-directed interactions between firms and households in commodity and factor markets. The role of government, capital markets, and other trading partners are also specified, with varying degrees of detail and passivity, to close the model and account for economy-wide resource allocation, production, and income determination.

The role of markets is to mediate exchange, usually with a flexible system of prices, the most important endogenous variables in a typical CGE model. As in a real market economy, commodity and factor price changes induce changes in the level and composition of supply and demand, production and income, and the remaining endogenous variables in the system. In CGE models, an equation system is solved for prices that correspond to equilibrium in markets and satisfy the accounting identities governing economic behavior. If such a system is precisely specified, equilibrium always exists and such a consistent model can be calibrated to a base period data set. The resulting calibrated general equilibrium model is then used to simulate the economy-wide (and regional) effects of alternative policies or external events.

The distinguishing feature of a general equilibrium model, applied or theoretical, is its closed-form specification of all activities in the economic system under study. This can be contrasted with more traditional partial equilibrium analysis, where

[12] See Roland-Holst (2015) for a complete model description.

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linkages to other domestic markets and agents are deliberately excluded from consideration. A large and growing body of evidence suggests that indirect effects (e.g., upstream and downstream production linkages) arising from policy changes are not only substantial, but may in some cases even outweigh direct effects. Only a model that consistently specifies economy-wide interactions can fully assess the implications of economic policies or business strategies. In a multi-country model like the one used in this study, indirect effects include the trade linkages between countries and regions which themselves can have policy implications.

The model we use for this work has been constructed according to generally accepted specification standards, implemented in the GAMS programming language, and calibrated to the new Oregon SAM estimated for the year 2012.[13] The result is a single economy model calibrated over the thirty-five year time path from 2015 to 2050. Using the very detailed accounts of the Oregon SAM, we include the following in the present model:

1.2 Production

All sectors are assumed to operate under constant returns to scale and cost optimization. Production technology is modeled by a nesting of constant-elasticity-of-substitution (CES) function.

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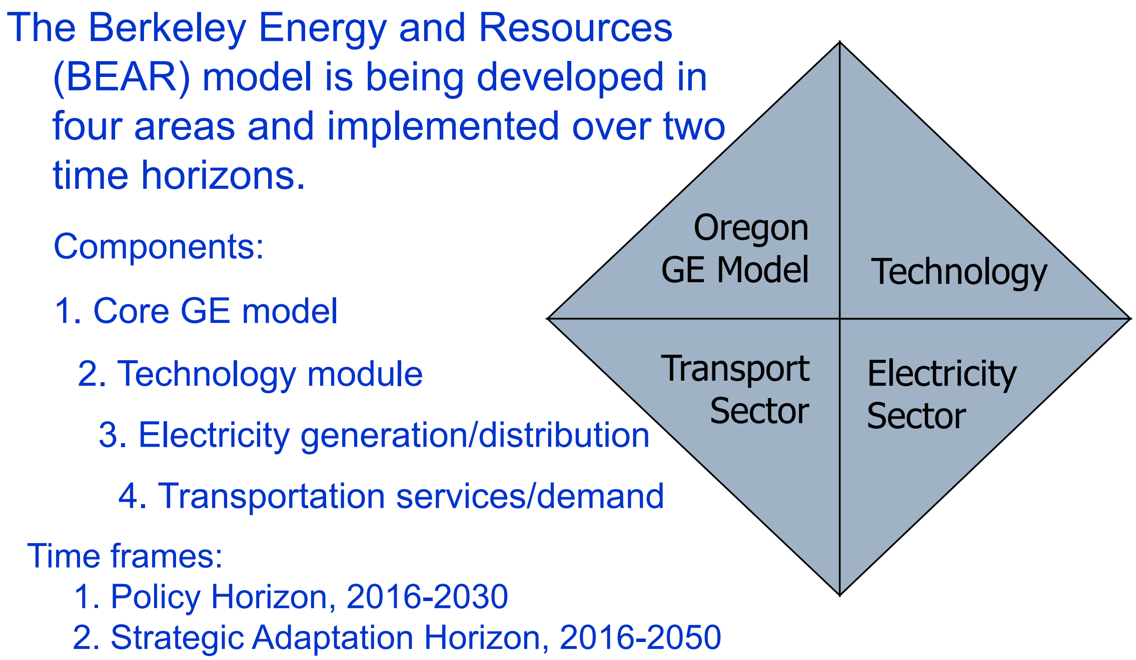
[13] See e.g. Meeraus et al (1992) for GAMS. Berck et al (2004) for discussion of the California SAM.

Figure A1.1: Component Structure of the Modeling Facility



In each period, the supply of primary factors — capital, land, and labor — is usually predetermined.[14] The model includes adjustment rigidities. An important feature is the distinction between old and new capital goods. In addition, capital is assumed to be partially mobile, reflecting differences in the marketability of capital goods across sectors.[15] Once the optimal combination of inputs is determined, sectoral output prices are calculated assuming competitive supply conditions in all markets.

1.3 Consumption and Closure Rule

All income generated by economic activity is assumed to be distributed to consumers. Each representative consumer allocates optimally his/her disposable income among the different commodities and saving. The consumption/saving decision is completely static: saving is treated as a “good” and its amount is determined simultaneously with the demand for the other commodities, the price of saving being set arbitrarily equal to the average price of consumer goods.

[14] Capital supply is to some extent influenced by the current period’s level of investment.
[15] For simplicity, it is assumed that old capital goods supplied in second-hand markets and new capital goods are homogeneous. This formulation makes it possible to introduce downward rigidities in the adjustment of capital without increasing excessively the number of equilibrium prices to be determined by the model.

The government collects income taxes, indirect taxes on intermediate inputs, outputs and consumer expenditures. The default closure of the model assumes that the government deficit/saving is exogenously specified.[16] The indirect tax schedule will shift to accommodate any changes in the balance between government revenues and government expenditures.

The current account surplus (deficit) is fixed in nominal terms. The counterpart of this imbalance is a net outflow (inflow) of capital, which is subtracted (added to) the domestic flow of saving. In each period, the model equates gross investment to net saving (equal to the sum of saving by households, the net budget position of the government and foreign capital inflows). This particular closure rule implies that investment is driven by saving.

1.4 Trade

Goods are assumed to be differentiated by region of origin. In other words, goods classified in the same sector are different according to whether they are produced domestically or imported. This assumption is frequently known as the *Armington* assumption. The degree of substitutability, as well as the import penetration shares are allowed to vary across commodities. The model assumes a single Armington agent. This strong assumption implies that the propensity to import and the degree of substitutability between domestic and imported goods is uniform across economic agents. This assumption reduces tremendously the dimensionality of the model. In many cases this assumption is imposed by the data. A symmetric assumption is made on the export side where domestic producers are assumed to differentiate the domestic market and the export market. This is modeled using a *Constant-Elasticity-of-Transformation* (CET) function.

1.5 Dynamic Features and Calibration

The current version of the model has a simple recursive dynamic structure as agents are assumed to be myopic and to base their decisions on static expectations about prices and quantities. Dynamics in the model originate in three sources: i) accumulation of productive capital and labor growth; ii) shifts in production technology; and iii) the putty/semi-putty specification of technology.

[16] In the reference simulation, the real government fiscal balance converges (linearly) towards 0 by the final period of the simulation.

1.6 Capital accumulation

In the aggregate, the basic capital accumulation function equates the current capital stock to the depreciated stock inherited from the previous period plus gross investment. However, at the sectoral level, the specific accumulation functions may differ because the demand for (old and new) capital can be less than the depreciated stock of old capital. In this case, the sector contracts over time by releasing old capital goods. Consequently, in each period, the new capital vintage available to expanding industries is equal to the sum of disinvested capital in contracting industries plus total saving generated by the economy, consistent with the closure rule of the model.

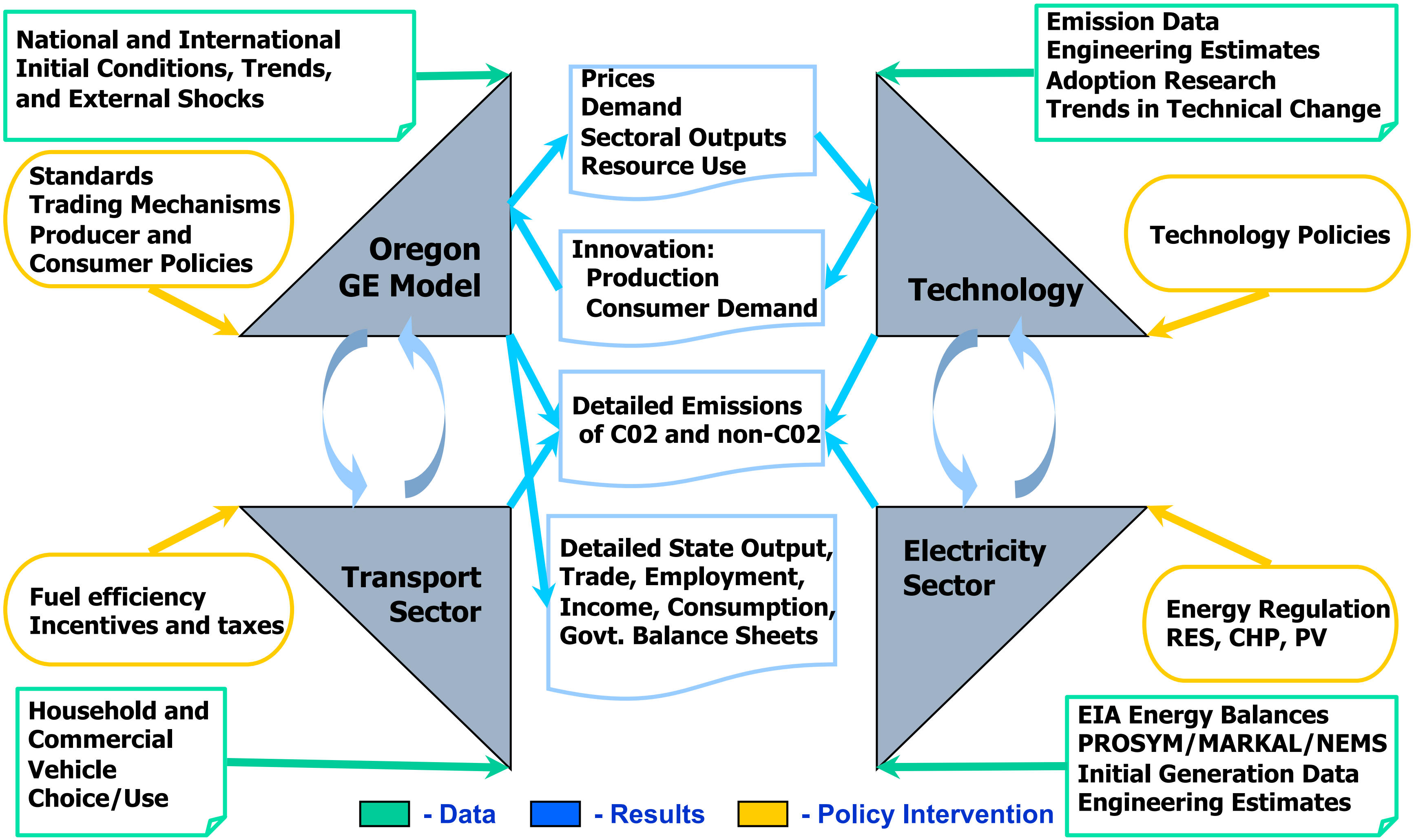
1.7 The putty/semi-putty specification

The substitution possibilities among production factors are assumed to be higher with the new than the old capital vintages — technology has a putty/semi-putty specification. Hence, when a shock to relative prices occurs (e.g. the imposition of an emissions fee), the demands for production factors adjust gradually to the long-run optimum because the substitution effects are delayed over time. The adjustment path depends on the values of the short-run elasticities of substitution and the replacement rate of capital. As the latter determines the pace at which new vintages are installed, the larger is the volume of new investment, the greater the possibility to achieve the long-run total amount of substitution among production factors.

1.8 Profits, Adjustment Costs, and Expectations

Firms output and investment decisions are modeled in accordance with the innovative approach of Goulder and co-authors (see e.g. Goulder et al: 2009 for technical details). In particular, we allow for the possibility that firms reap windfall profits from events such as free permit distribution. Absent more detailed information on ownership patterns, we assume that these profits accrue to US and foreign residents in proportion to equity shares of publically traded US corporations (16% in 2009, Swartz and Tillman:2010). Between Oregon and other US residents, the shares are assumed to be proportional to GDP in GDP.

Figure A1.2: Schematic Linkage between Model Components



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1.9 Dynamic calibration

The model is calibrated on exogenous growth rates of population, labor force, and GDP. In the so-called Baseline scenario, the dynamics are calibrated in each region by imposing the assumption of a balanced growth path. This implies that the ratio between labor and capital (in efficiency units) is held constant over time.[17] When alternative scenarios around the baseline are simulated, the technical efficiency parameter is held constant, and the growth of capital is endogenously determined by the saving/investment relation.

1.10 Modelling Emissions

The BEAR model captures emissions from production activities in agriculture, industry, and services, as well as in final demand and use of final goods (e.g. appliances and autos). This is done by calibrating emission functions to each of these activities that vary depending upon the emission intensity of the inputs used for the activity in question. We model both CO2 and the other primary greenhouse gases, which are converted to CO2 equivalent. Following standards set in the research literature, emissions in production are modeled as factors inputs. The base version of the model does not have a full representation of emission reduction or abatement. Emissions abatement occurs by substituting additional labor or capital for emissions when an emissions tax is applied. This is an accepted modeling practice, although in specific instances it may either understate or overstate actual emissions reduction potential.[18] In this framework, emission levels have an underlying monotone relationship with production levels, but can be reduced by increasing use of other, productive factors such as capital and labor. The latter represent investments in lower intensity technologies, process cleaning activities, etc. An overall calibration procedure fits observed intensity levels to baseline activity and other factor/resource use levels. In some of the policy simulations we evaluate sectoral emission reduction scenarios, using specific cost

[17] This involves computing in each period a measure of Harrod-neutral technical progress in the capital-labor bundle as a residual. This is a standard calibration procedure in dynamic CGE modeling.
[18] See e.g. Babiker et al (2001) for details on a standard implementation of this approach.

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and emission reduction factors, based on our earlier analysis (Hanemann and Farrell: 2006).

The BEAR model has the capacity to track 13 categories of individual pollutants and consolidated emission indexes, each of which is listed in Table A1.1 below. Our focus in the current study is the emission of CO2 and other greenhouse gases, but the other effluents are of relevance to a variety of environmental policy issues. For more detail, please consult the full model documentation.

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Table A1.1: Emission Categories

Air Pollutants		
1.	Suspended particulates	PART
2.	Sulfur dioxide (SO_2)	SO2
3.	Nitrogen dioxide (NO_2)	NO2
4.	Volatile organic compounds	VOC
5.	Carbon monoxide (CO)	CO
6.	Toxic air index	TOXAIR
7.	Biological air index	BIOAIR
Water Pollutants		
8.	Biochemical oxygen demand	BOD
9.	Total suspended solids	TSS
10.	Toxic water index	TOXWAT
11.	Biological water index	BIOWAT
Land Pollutants		
12.	Toxic land index	TOXSOL
13.	Biological land index	BIOSOL

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**Table A1.2: Social Accounting Matrix for Oregon, 2016
Structural Characteristics**

1.	103 production activities
2.	103 commodities (includes trade and transport margins)
3.	24 factors of production
4.	22 labor categories
5.	Capital
6.	Land
7.	9 Household types, defined by BLS income tax bracket
8.	Enterprises
9.	Federal Government (7 fiscal accounts)
10.	State Government (27 fiscal accounts)
11.	Local Government (11 fiscal accounts)
12.	Consolidated capital account
13.	External Trade Account

These data enable us to trace the effects of responses to climate change and other policies at unprecedented levels of detail, tracing linkages across the economy and clearly indicating the indirect benefits and tradeoffs that might result from comprehensive policies pollution taxes or trading systems. As we shall see in the results section, the effects of climate policy can be quite complex. In particular, cumulative indirect effects often outweigh direct consequences, and affected groups are often far from the policy target group. For these reasons, it is essential for policy makers to anticipate linkage effects like those revealed in a general equilibrium model and dataset like the ones used here.

It should be noted that the SAM used with BEAR departs in a few substantive respects from the original 2016 Oregon SAM. The two main differences have to do with the structure of production, as reflected in the input-output accounts, and with consumption good aggregation. To specify production technology in the BEAR model, we rely on both activity and commodity accounting, while the original SAM has consolidated activity accounts. We chose to maintain separate activity and

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commodity accounts to maintain transparency in the technology of emissions and patterns of tax incidence. The difference is non-trivial and considerable additional effort was needed to reconcile use and make tables separately. This also facilitated the second SAM extension, however, where we maintained final demand at the full 119 commodity level of aggregation, rather than adopting six aggregate commodities like the original SAM.

Emissions Data

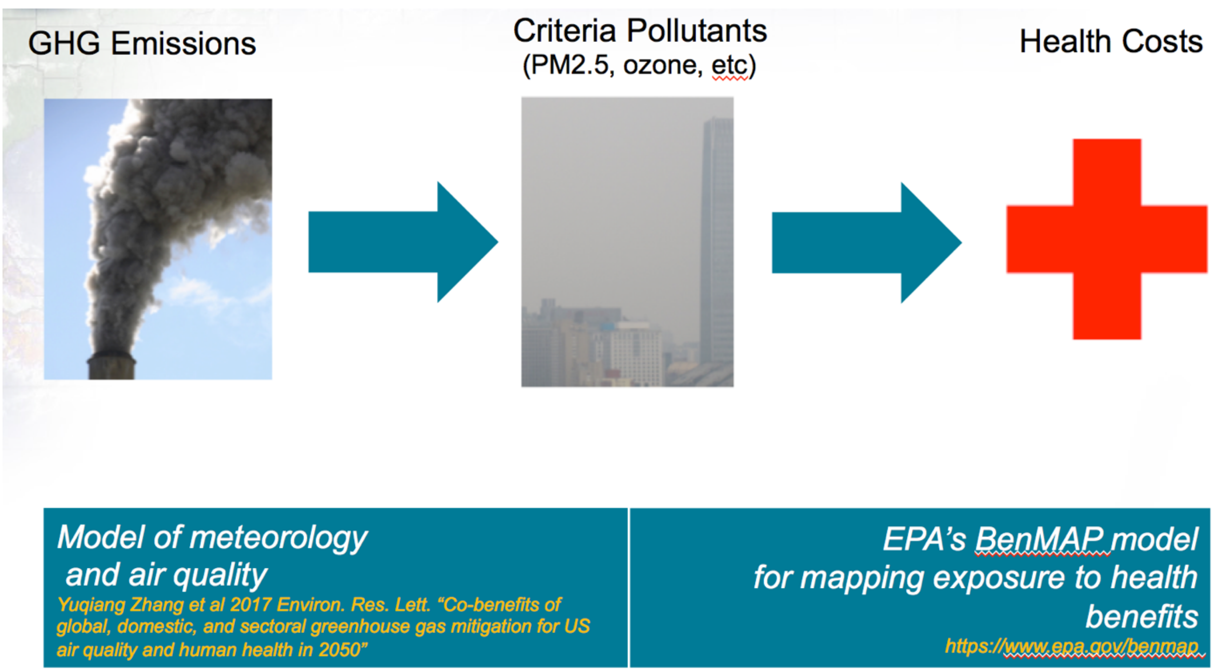
Emissions data were obtained form Oregon's own detailed emissions inventory. In most of the primary pollution databases like this, measured emissions are directly associated with the volume of output. This has several consequences. First, from a behavioral perspective, the only way to reduce emissions, with a given technology, is to reduce output. This obviously biases results by exaggerating the abatement-growth tradeoff and sends a misleading and unwelcome message to policy makers.

More intrinsically, output based pollution modeling does not reflect the observed pattern of abatement behavior. Generally, firms respond to abatement incentives and penalties in much more complex and sophisticated ways by varying internal conditions of production. These responses include varying the sources, quality, and composition of inputs, choice of technology, etc. The third shortcoming of the output approach is that it give us no guidance about other important pollution sources outside the production process, especially pollution in use of final goods. The most important example of this category is household consumption. The BEAR model estimates pollution in both production and consumption (e.g. fuel and energy use). In all cases, we calibrate to the Oregon inventory for initial emission intensity, but going forward the model captures price sensitive fuel and technology substitution by enterprises and households. This is more consistent with observed reality.

APPENDIX 2 – MEASURING HEALTH BENEFITS FROM REDUCTION IN GHG EMISSIONS

Poor air quality imposes substantial public health costs across the state. Conversely, averting such costs is an important co-benefit of reductions in GHG emissions and associated improvements in air quality. As part of this study, we present an exploratory analysis to quantify the value of health benefits (i.e., avoided health costs) associated with a reduction in GHG emissions from Oregon's proposed cap-and-trade policies. We do this in three sequential steps.

Figure A2.1: Broad overview of health benefits analysis



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Step 1: Estimating how reductions in GHG emissions reduce concentrations of criteria pollutants

Air quality is negatively correlated with GHG emissions, and criteria pollutants (e.g. PM2.5 and Ozone) have been linked to harmful effects on human health. However, the relationship between reduced GHG and criteria emissions is not 1:1 (i.e., a 5% reduction in GHG emissions does not necessarily translate to a 5% reduction in PM2.5) and this relationship varies over time and space. Modeling the relationship between GHG emissions and criteria pollutants is therefore the important first step to estimating health benefits. Until recently this relationship has not been well understood, but new research has shed important light on these linkages.

We are not able to directly model how reductions in GHG emissions from cap-and-trade policies will specifically translate into lower criteria pollutant concentrations, however. Doing so would require an intensive modeling effort by physicists and environmental scientists and is far beyond the scope of the current project. Fortunately, we have been able to leverage recent work by Zhang et al 2017 on the link between GHG emissions and mortality risk across the United States. Their model evaluates the RCP 4.5 scenario (see Thomson et al 2011 for details), a generic suite of cost minimizing policies that reduce national GHG emissions. These emissions reductions come from across the economy and are modeled to the year 2050. The data from the Zhang et al study include ~50km x 50km gridded estimates of reductions in PM2.5 and Ozone across the United States for a given change in GHG emissions. We use this relationship between changes in emissions and changes in criteria pollutants over space to model how changes in GHG emissions from Oregon's proposed cap-and-trade policies will affect criteria pollutants.

Step 2: Estimating the effects of lower criteria pollutant concentrations on avoided pre-mature deaths

The Zhang et al data also include 50x50km gridded estimates for the number of avoided pre-mature deaths due to avoided PM2.5 exposure and the number of avoided pre-mature deaths due to avoided Ozone exposure. The avoided pre-mature deaths estimates were derived from the EPA's BenMAP model. This model takes as inputs criteria pollution concentrations and outputs mortality risk estimates

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so it can be used to input the predicted reductions in PM2.5 and Ozone concentrations and output estimates for reductions in pre-mature deaths (EPA BenMAP 2018).

Step 3: Valuing mortality and morbidity

The standard approach for valuing the cost of an avoided pre-mature death is to use a concept known as the Value of a Statistical Life (VSL). We utilize the EPA's Value of a Statistical Life ($9.2M in 2018 dollars), which also represents a de facto consensus from legal actuaries. This value does not mean that the EPA places a dollar value on individual lives. It represents a survey based estimate of how much people are willing to pay for small reductions in their risk of dying from adverse health conditions that may be caused by environmental hazards and scale these estimates to represent a death.[19]

Multiplying the number of avoided pre-mature deaths by the EPA's VSL provides an estimate of the value of avoided pre-mature deaths, however, it ignores the costs associated with morbidity from air pollution. These comprise all averted medical costs due to lower incidence of respiratory and other air pollution related illness (e.g. asthma) which for OECD populations is normally estimated to be larger than mortality costs. Note however, that this estimate is still conservative because it does not value non-medical costs like absenteeism, reduced effort, productivity, etc.

Directly estimating morbidity costs would require extensive information health costs incurred by cause, again outside this study and in many cases unavailable. We therefore rely on the EPA's regulatory assessment for the Review of the Particulate Matter National Ambient Air Quality Standards (NAAQS) to get an idea about the ratio of total health costs (mortality + morbidity) to mortality costs alone. In this regulatory assessment, the EPA estimated morbidity benefits to be 2.5x larger than mortality benefits. Scaling our benefits estimates by a factor of 2.5 we estimate the value of total health benefits associated with the volume of reductions in GHG emissions forecast from Oregon's proposed cap-and-trade policies in 2050.

[19] https://www.epa.gov/environmental-economics/mortality-risk-valuation

Caveats

These estimates rely on nationally modeled 50x50km gridded health benefits estimates from GHG emissions reductions and are intended to be illustrative of the potential magnitude of benefits. However, studies devoted specifically to analyzing policies at the local level are required in order to illuminate highly localized effects.

Another main caveat is that we are not specifically modeling detailed GHG reductions from cap-and-trade policies. Zhang et al model benefits from GHG reductions due to transformations in the energy, transport, and industry sectors including changes in electric power generation and energy extraction and transformation. We then scale these emissions to reflect the expected emissions reductions from the proposed cap-and-trade policies. We are therefore assuming that the spatial patterns of criteria pollutant reduction from changes modeled by Zhang et al are the same as the spatial patterns of criteria pollutant reductions from the proposed cap-and-trade policies.

The other main assumption is that total health benefits and avoided pre-mature deaths conform to a 2.5 multiple relationship observed at the national level. This assumption is based on previous work by the EPA and takes averages from estimates in the EPA regulatory assessment for the National Ambient Air Quality Standards. It should be noted, however, that EPA estimates of morbidity costs in this study range widely and while we take the average, other estimates within the confidence interval would result in some variation of total avoided health cost estimates.

Additional assumptions include the following:

- Value of a statistical life is $9.2M,
- BenMAP, a national assessment tool, appropriately estimates the number of avoided deaths from reductions in criteria pollutants[20],
- The total number of avoided deaths in a 50x50km area will be realized proportionately to population within that area

[20] See https://www.epa.gov/benmap/how-benmap-ce-estimates-health-and-economic-effects-air-pollution for more details

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Lastly, we have assumed that, because most of the cap-and-trade policies affect dispersed pollutants, mitigation is achieved uniformly across the state. Criteria pollutants can be more localized, but we currently lack data on how cap-and-trade policies would affect these patterns.

In addition to the caveats above, it should also be noted that this study does not cover all potential co-benefits from GHG emissions reductions.[21]

[21] For more information on non-health co-benefits from reductions in GHG emissions, including examples of studies estimating damages to each of the mentioned outcomes (and more), see Carleton and Hsiang "Social and economic impacts of climate", Science 2016.

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8 STATISTICAL APPENDIX

To clarify annual details and provide source information, this appendix reproduces the data used for all figures in the report. Each of the following tables is numbered to match its corresponding Figure in the main body of the report. Requests for any other background data relevant to this analysis, as well as questions for clarification, can be directed to the authors.

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Table A3.1: Oregon Emissions Pathways (MMTCO2e)

	Reference	Linear	Interim Target
2021	52.2	52.2	52.2
2022	51.1	50.7	50.2
2023	50.9	49.2	48.1
2024	50.5	47.7	46.1
2025	50.7	46.2	44.1
2026	50.6	44.7	42.1
2027	50.8	43.2	40.1
2028	51.4	41.7	38.0
2029	51.5	40.2	36.0
2030	51.8	38.7	34.0
2031	45.8	37.2	32.0
2032	45.5	35.7	29.9
2033	45.3	34.2	27.9
2034	44.9	32.7	25.9
2035	44.2	31.2	23.9
2036	44.5	29.7	22.8
2037	44.8	28.2	21.8
2038	45.2	26.7	20.8
2039	45.5	25.2	19.8
2040	45.6	23.7	18.8
2041	45.9	22.2	17.8
2042	46.2	20.7	16.8
2043	46.5	19.2	15.8
2044	46.8	17.7	14.7
2045	47.1	16.2	13.7
2046	47.4	14.7	12.7
2047	47.7	13.2	11.7
2048	47.8	11.7	10.7
2049	48.1	10.2	9.7
2050	48.5	8.7	8.7

Source: Oregon Carbon Policy Office

Table A4.1: Household Income Effects by Income Level and Scenario (BLS tax brackets, percent change from Reference in 2050)

	Linear	Interim Target	Core
< $10,000	0.99%	0.89%	0.98%
$10-15,000	0.62%	0.57%	0.61%
$15-25,000	0.80%	0.71%	0.77%
$25-35,000	0.99%	0.87%	0.95%
$35-50,000	1.19%	1.05%	1.15%
$50-75,000	1.33%	1.17%	1.28%
$75-100,000	1.37%	1.20%	1.32%
$100-150,000	1.40%	1.23%	1.35%
> $150,000	1.43%	1.26%	1.39%
Average	1.24%	1.09%	1.20%

Source: Author estimates from the BEAR model.

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Table A4.2: Median Household Income Level Change by County, Core Scenario
(median 2016$ change from Reference scenario in 2050)

County	Census Code	Income Change (2016$)
Baker	1	496.74
Benton	3	690.60
Clackamas	5	954.22
Clatsop	7	607.14
Columbia	9	700.60
Coos	11	461.27
Crook	13	467.54
Curry	15	474.81
Deschutes	17	710.95
Douglas	19	510.26
Gilliam	21	471.84
Grant	23	461.05
Harney	25	458.29
Hood River	27	731.59
Jackson	29	572.93
Jefferson	31	580.45
Josephine	33	453.04
Klamath	35	521.28
Lake	37	387.32
Lane	39	584.65
Lincoln	41	495.62
Linn	43	587.32
Malheur	45	429.85
Marion	47	642.76
Morrow	49	667.96
Multnomah	51	781.74
Polk	53	670.33
Sherman	55	497.01
Tillamook	57	524.53
Umatilla	59	591.98
Union	61	566.07
Wallowa	63	507.97
Wasco	65	577.22
Washington	67	959.44
Wheeler	69	376.21
Yamhill	71	709.46

Source: Author estimates from the BEAR model.

Table A4.3: Median Household Income Percent Change by County (median change from Reference scenario in 2050)

County	Census Code	Percent Income Change
Baker	1	1.16
Benton	3	1.26
Clackamas	5	1.30
Clatsop	7	1.23
Columbia	9	1.25
Coos	11	1.17
Crook	13	1.18
Curry	15	1.19
Deschutes	17	1.25
Douglas	19	1.19
Gilliam	21	1.16
Grant	23	1.16
Harney	25	1.18
Hood River	27	1.27
Jackson	29	1.22
Jefferson	31	1.22
Josephine	33	1.16
Klamath	35	1.19
Lake	37	1.13
Lane	39	1.23
Lincoln	41	1.18
Linn	43	1.22
Malheur	45	1.15
Marion	47	1.24
Morrow	49	1.23
Multnomah	51	1.27
Polk	53	1.25
Sherman	55	1.20
Tillamook	57	1.18
Umatilla	59	1.21
Union	61	1.20
Wallowa	63	1.18
Wasco	65	1.22
Washington	67	1.31
Wheeler	69	1.13
Yamhill	71	1.26

Source: Author estimates from the BEAR model.

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Table A4.4: Median Low Income (quintile) Income Percent Change (median change from Reference scenario in 2050)

County	Census Code	Census Tract	Percent Income Change
Baker	1	950300.00	1.122732703
Benton	3	1001.00	1.136472202
Benton	3	1002.00	NA
Clackamas	5	20302.00	NA
Clackamas	5	20900.00	NA
Clackamas	5	22602.00	NA
Clatsop	7	950100.00	NA
Clatsop	7	951100.00	NA
Coos	11	300.00	NA
Deschutes	17	500.00	NA
Douglas	19	60000.00	NA
Douglas	19	110000.00	NA
Douglas	19	180000.00	NA
Grant	23	960200.00	NA
Hood River	27	950100.00	NA
Jackson	29	403.00	NA
Jackson	29	2100.00	NA
Jackson	29	2600.00	NA
Jackson	29	3002.00	NA
Josephine	33	360100.00	1.147442107
Josephine	33	361500.00	NA
Josephine	33	361600.00	1.122120153
Klamath	35	970300.00	NA
Lake	37	960100.00	1.122662748
Lane	39	705.00	1.127712207
Lane	39	902.00	NA
Lane	39	1904.00	1.093157046
Lincoln	41	950601.00	1.163573744
Lincoln	41	951700.00	1.169117497
Linn	43	20500.00	1.083873108
Linn	43	30300.00	NA
Linn	43	30903.00	1.170360943
Malheur	45	970600.00	1.164068958
Marion	47	1200.00	NA
Marion	47	10501.00	NA
Multnomah	51	301.00	NA
Multnomah	51	1701	NA
Multnomah	51	2901.00	NA
Multnomah	51	3501.00	NA
Multnomah	51	4900.00	1.147849504
Multnomah	51	6601.00	NA
Multnomah	51	6701.00	NA
Multnomah	51	9606.00	1.113570128

Multnomah	51	9701.00	NA
Multnomah	51	10002.00	NA
Tillamook	57	960100.00	NA
Tillamook	57	960400.00	NA
Umatilla	59	950500.00	NA
Union	61	970600.00	NA
Wallowa	63	960300.00	NA
Wasco	65	970800.00	NA
Washington	67	30401.00	NA
Washington	67	31004.00	NA
Washington	67	31512.00	NA
Washington	67	31706.00	NA
Washington	67	31911.00	NA
Washington	67	32409.00	1.11519962
Yamhill	71	30802.00	NA
Benton	3	10702.00	1.092249719
Clackamas	5	20304.00	NA
Clackamas	5	21300.00	NA
Clackamas	5	21802.00	NA
Clackamas	5	22907.00	NA
Clackamas	5	23300.00	NA
Clackamas	5	23800.00	NA
Clackamas	5	24000.00	NA
Clackamas	5	980000.00	NA
Clatsop	7	951200.00	NA
Columbia	9	970500.00	NA
Coos	11	200.00	NA
Coos	11	503.00	NA
Coos	11	900.00	1.155992418
Deschutes	17	600.00	NA
Deschutes	17	1500	NA
Douglas	19	10000.00	1.069689652
Douglas	19	30000.00	NA
Douglas	19	70000.00	NA
Douglas	19	100000.00	NA
Jackson	29	404.00	NA
Jackson	29	2000.00	NA
Jackson	29	2500.00	NA
Jackson	29	2700.00	NA
Jefferson	31	940000.00	NA
Jefferson	31	960302.00	NA
Klamath	35	970100.00	NA
Klamath	35	970200.00	1.143907934
Klamath	35	970400.00	NA
Klamath	35	970600.00	NA
Klamath	35	971200.00	1.076359135
Lake	37	960200.00	1.134375328

Lane	39	500.00	1.154765379
Lane	39	800.00	NA
Lane	39	1400.00	NA
Lane	39	1600.00	NA
Lane	39	1903.00	NA
Lane	39	2102.00	1.082340056
Lane	39	3201.00	1.142450102
Lane	39	3900.00	0.95600855
Lane	39	4502.00	1.118779285
Lane	39	4600.00	NA
Linn	43	20400.00	1.10357939
Linn	43	30200.00	NA
Linn	43	30402.00	NA
Malheur	45	970700.00	NA
Malheur	45	970900.00	NA
Marion	47	300.00	1.126003612
Marion	47	2303.00	NA
Marion	47	10502.00	NA
Marion	47	10600.00	NA
Multnomah	51	200.00	NA
Multnomah	51	401	NA
Multnomah	51	702.00	NA
Multnomah	51	1301.00	NA
Multnomah	51	1500.00	NA
Multnomah	51	2203.00	NA
Multnomah	51	2702.00	NA
Multnomah	51	3301.00	NA
Multnomah	51	4001.00	1.169944807
Multnomah	51	4800.00	NA
Multnomah	51	7500.00	NA
Multnomah	51	7600.00	NA
Multnomah	51	8002.00	NA
Multnomah	51	8500.00	NA
Multnomah	51	9604.00	1.11084464
Multnomah	51	9801.00	1.083956304
Multnomah	51	10001.00	1.12697947
Multnomah	51	10410.00	NA
Polk	53	20203.00	1.125533744
Tillamook	57	960300.00	NA
Umatilla	59	951200.00	NA
Union	61	970300.00	NA
Union	61	970700.00	1.111743351
Wallowa	63	960200.00	1.087505846
Wasco	65	970700.00	NA
Washington	67	30101.00	NA
Washington	67	30801.00	NA
Washington	67	31006.00	NA

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Washington	67	31511.00	NA
Washington	67	31611.00	NA
Washington	67	32004.00	NA
Washington	67	32607.00	NA
Yamhill	71	30201.00	NA
Yamhill	71	30501.00	NA
Yamhill	71	30702.00	NA
Benton	3	1101.00	0.98839339
Clackamas	5	21801.00	NA
Clackamas	5	23901.00	NA
Clatsop	7	950400	NA
Douglas	19	50001.00	NA
Douglas	19	200000.00	NA
Lane	39	100.00	NA
Lane	39	2600.00	NA
Lane	39	4501.00	1.124302426
Lincoln	41	951800.00	1.171436977
Marion	47	2201.00	NA
Multnomah	51	2801.00	NA
Multnomah	51	5500.00	1.075486773
Multnomah	51	9804.00	1.205375971
Wasco	65	970300.00	NA
Washington	67	31100.00	1.156646349
Washington	67	32606.00	NA
Clackamas	5	21601.00	NA
Lane	39	200.00	NA
Washington	67	32502.00	NA
Douglas	19	20000.00	1.129206219
Grant	23	960100.00	1.13149248
Multnomah	51	3901.00	NA
Deschutes	17	200.00	1.14534041
Washington	67	32410.00	NA
Baker	1	950100.00	NA
Benton	3	1102.00	1.064791343
Clackamas	5	24400.00	NA
Coos	11	1100.00	1.113267089
Douglas	19	170000.00	NA
Jackson	29	201.00	1.023032942
Jackson	29	1002.00	NA
Jackson	29	2300.00	NA
Lane	39	2201.00	NA
Marion	47	400.00	1.072351037
Multnomah	51	3000.00	NA
Multnomah	51	6502.00	NA
Wallowa	63	960100.00	NA
Washington	67	31617.00	NA
Washington	67	32609.00	NA

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Lane	39	1500	1.158422039
Lane	39	708.00	NA
Marion	47	701.00	1.10015286
Benton	3	10300.00	NA
Clackamas	5	21100.00	NA
Clatsop	7	950900.00	1.09475472
Crook	13	950400.00	NA
Jackson	29	406.00	NA
Klamath	35	971900.00	1.100357082
Lane	39	1902.00	1.168972045
Lane	39	2903.00	NA
Marion	47	2600.00	NA
Marion	47	10307.00	NA
Multnomah	51	3302.00	NA
Multnomah	51	3902.00	NA
Multnomah	51	9903.00	NA
Sherman	55	950100.00	NA
Washington	67	30300.00	NA
Columbia	9	970400.00	NA
Columbia	9	971100.00	NA
Coos	11	600.00	NA
Marion	47	10503.00	NA
Multnomah	51	100.00	NA
Multnomah	51	402.00	NA
Multnomah	51	902.00	NA
Multnomah	51	1101.00	1.050403022
Multnomah	51	1302.00	NA
Multnomah	51	1601.00	NA
Multnomah	51	2303.00	NA
Multnomah	51	2402.00	NA
Coos	11	502.00	1.162153499
Crook	13	950200.00	1.161362726
Multnomah	51	2600.00	NA
Multnomah	51	3200.00	NA
Multnomah	51	3401.00	NA
Multnomah	51	3701.00	NA
Multnomah	51	3802.00	NA
Multnomah	51	4500	NA
Multnomah	51	4602.00	NA
Multnomah	51	5100.00	NA
Multnomah	51	5200.00	1.1828881
Multnomah	51	5700.00	NA
Multnomah	51	5800.00	NA
Multnomah	51	5900.00	NA
Deschutes	17	300.00	NA
Deschutes	17	1001.00	NA
Deschutes	17	1400.00	NA

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Deschutes	17	1600.00	1.137376196
Multnomah	51	6001.00	NA
Multnomah	51	6300.00	NA
Multnomah	51	6402.00	NA
Multnomah	51	6404.00	NA
Multnomah	51	6501.00	NA
Multnomah	51	6801.00	NA
Multnomah	51	7000.00	NA
Multnomah	51	7700.00	NA
Deschutes	17	1901.00	NA
Douglas	19	90000.00	NA
Douglas	19	130000.00	NA
Douglas	19	140000.00	NA
Multnomah	51	8100.00	1.105052384
Multnomah	51	8202.00	1.136997621
Multnomah	51	8600.00	NA
Multnomah	51	9501.00	NA
Multnomah	51	9603.00	NA
Multnomah	51	9904.00	NA
Multnomah	51	9907.00	NA
Multnomah	51	10305.00	NA
Multnomah	51	10405.00	NA
Multnomah	51	10411.00	NA
Polk	53	5201.00	NA
Douglas	19	160000.00	1.12342644
Douglas	19	190000.00	1.146530154
Hood River	27	950200.00	NA
Hood River	27	950300	NA
Polk	53	5300.00	NA
Polk	53	20204.00	NA
Jackson	29	100.00	0.931217009
Jackson	29	202.00	1.062757149
Jackson	29	405.00	NA
Jackson	29	602.00	1.20268165
Jackson	29	900.00	NA
Jackson	29	1301.00	NA
Jackson	29	1602.00	1.187674925
Washington	67	31909.00	NA
Washington	67	31910.00	NA
Washington	67	32005.00	1.170444678
Washington	67	32107.00	NA
Washington	67	32300.00	NA
Washington	67	32501.00	1.136621628
Jackson	29	1800.00	NA
Jackson	29	2800.00	NA
Jefferson	31	960301.00	NA
Josephine	33	360701.00	1.096756055

Josephine	33	361100.00	1.113446156
Klamath	35	971300.00	NA
Klamath	35	971600.00	1.036465656
Tillamook	57	960600.00	NA
Umatilla	59	940000.00	NA
Umatilla	59	951000.00	NA
Klamath	35	971800.00	1.145350462
Lane	39	404.00	NA
Lane	39	707.00	1.149808265
Lane	39	904.00	1.155909854
Washington	67	32603.00	NA
Washington	67	32700.00	NA
Washington	67	32902.00	NA
Washington	67	33400.00	NA
Lane	39	1101.00	NA
Lane	39	1302.00	1.13832503
Lane	39	1801.00	NA
Lane	39	1804	NA
Lane	39	2301.00	1.129307146
Lane	39	2403.00	NA
Lane	39	2800.00	NA
Lane	39	3101.00	NA
Lane	39	3202.00	NA
Lane	39	3600.00	NA
Lane	39	4100.00	NA
Lane	39	4404.00	NA
Lane	39	4900.00	NA
Lane	39	5400.00	NA
Umatilla	59	951300.00	NA
Union	61	970400.00	NA
Wasco	65	970500.00	NA
Washington	67	30803.00	NA
Washington	67	30900.00	1.150403657
Baker	1	950200.00	NA
Benton	3	100.00	NA
Benton	3	202.00	NA
Benton	3	600.00	1.130671054
Benton	3	900.00	NA
Lincoln	41	950100.00	NA
Lincoln	41	950303.00	NA
Lincoln	41	950900.00	NA
Lincoln	41	951000.00	1.061145118
Wheeler	69	960100.00	1.126368487
Yamhill	71	30301.00	NA
Benton	3	10200.00	NA
Benton	3	10800.00	NA
Clackamas	5	20303.00	NA

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Clackamas	5	20501.00	NA
Clackamas	5	20700.00	NA
Lincoln	41	951100.00	NA
Lincoln	41	951200.00	NA
Lincoln	41	951600.00	NA
Lincoln	41	990100.00	NA
Clackamas	5	21200.00	NA
Clackamas	5	21400	NA
Clackamas	5	22000.00	NA
Clackamas	5	22103.00	NA
Clackamas	5	22108.00	1.12088679
Clackamas	5	22208.00	NA
Clackamas	5	22605.00	NA
Clackamas	5	22710.00	NA
Clackamas	5	22904.00	NA
Linn	43	20200.00	NA
Linn	43	30100.00	NA
Washington	67	31300.00	NA
Washington	67	31404.00	NA
Washington	67	31606.00	NA
Washington	67	31610.00	NA
Washington	67	31613.00	NA
Washington	67	31703.00	NA
Washington	67	31705.00	NA
Washington	67	31804.00	NA
Washington	67	31806.00	NA
Washington	67	31812.00	NA
Washington	67	31813.00	NA
Clackamas	5	23002.00	NA
Clackamas	5	23404.00	NA
Clackamas	5	23700.00	NA
Linn	43	30700.00	NA
Malheur	45	970400.00	1.057975425
Marion	47	200.00	1.137879979
Marion	47	900.00	NA
Marion	47	1401.00	NA
Marion	47	1502.00	NA
Yamhill	71	30601.00	1.173552661
Yamhill	71	30701.00	NA
Yamhill	71	31000.00	NA
Clackamas	5	24100.00	NA
Clatsop	7	951300.00	NA
Marion	47	1702.00	NA
Marion	47	1802.00	NA
Marion	47	2301	NA
Marion	47	2800.00	NA
Marion	47	10304.00	NA

Marion	47	10306.00	1.156756952
Clatsop	7	950600.00	NA
Lane	39	3800.00	0.965505003
Multnomah	51	7900.00	NA
Marion	47	1701.00	1.133827765
Columbia	9	970700.00	NA
Clackamas	5	23202.00	NA
Clackamas	5	23500.00	NA
Clackamas	5	23902.00	NA
Clackamas	5	24200.00	NA
Clatsop	7	950200.00	1.180311286
Clatsop	7	950300.00	NA
Clatsop	7	950500.00	NA
Clatsop	7	950700.00	NA
Columbia	9	970200.00	NA
Columbia	9	970300.00	NA
Columbia	9	971000.00	NA
Coos	11	100.00	NA
Coos	11	400.00	NA
Coos	11	700.00	NA
Coos	11	1000.00	1.118039781
Crook	13	950300.00	1.171884139
Josephine	33	360300.00	NA
Josephine	33	360600.00	NA
Curry	15	950302.00	1.181988528
Deschutes	17	401.00	NA
Deschutes	17	402.00	NA
Deschutes	17	1002.00	NA
Deschutes	17	1200.00	NA
Deschutes	17	1300.00	NA
Deschutes	17	1700.00	NA
Deschutes	17	2100.00	NA
Douglas	19	120000.00	1.119468207
Jackson	29	203.00	1.152211678
Jackson	29	300	1.123355407
Jackson	29	501.00	1.158361264
Jackson	29	601.00	NA
Jackson	29	700.00	NA
Jackson	29	800.00	NA
Jackson	29	1200.00	NA
Jackson	29	1302.00	NA
Jackson	29	1500.00	NA
Jackson	29	1601.00	1.151637497
Benton	3	10100.00	NA
Benton	3	10600.00	1.075320025
Clackamas	5	20200.00	NA
Clackamas	5	20404.00	NA

Clackamas	5	20503.00	NA
Clackamas	5	20600.00	NA
Clackamas	5	20800.00	NA
Clackamas	5	21000.00	NA
Clackamas	5	21500.00	NA
Jackson	29	1700.00	1.087576196
Jackson	29	2400.00	NA
Clackamas	5	21700.00	NA
Clackamas	5	21900.00	NA
Clackamas	5	22107.00	NA
Clackamas	5	22201.00	1.146914544
Clackamas	5	22206.00	NA
Clackamas	5	22301.00	NA
Clackamas	5	22400.00	NA
Clackamas	5	22500.00	NA
Clackamas	5	22606.00	NA
Clackamas	5	22702.00	NA
Clackamas	5	22708.00	NA
Douglas	19	40000.00	NA
Douglas	19	50002.00	1.126258415
Clackamas	5	22800.00	NA
Clackamas	5	22901.00	NA
Clackamas	5	23001.00	NA
Clackamas	5	23100.00	NA
Jackson	29	2900	NA
Jefferson	31	960201.00	1.098068503
Jefferson	31	960202.00	NA
Marion	47	10400.00	NA
Marion	47	10701.00	NA
Marion	47	10801.00	NA
Lane	39	1001.00	NA
Morrow	49	970200.00	NA
Multnomah	51	302.00	NA
Multnomah	51	501.00	NA
Multnomah	51	602.00	NA
Multnomah	51	802.00	NA
Multnomah	51	901.00	NA
Multnomah	51	1000.00	NA
Multnomah	51	1400.00	NA
Multnomah	51	1602.00	NA
Multnomah	51	1702.00	NA
Multnomah	51	1900.00	NA
Josephine	33	360800.00	NA
Josephine	33	361000.00	NA
Josephine	33	361200.00	1.149001675
Lane	39	1002.00	NA
Lane	39	1102.00	NA

Multnomah	51	2100.00	NA
Multnomah	51	2501.00	NA
Multnomah	51	2502.00	NA
Multnomah	51	2902.00	NA
Multnomah	51	2903.00	NA
Multnomah	51	3100.00	NA
Multnomah	51	3502.00	NA
Multnomah	51	3601.00	NA
Multnomah	51	3702.00	NA
Klamath	35	970900.00	NA
Klamath	35	971000.00	NA
Lane	39	1301.00	1.177157607
Lane	39	1700.00	NA
Lane	39	1803.00	NA
Lane	39	2001	NA
Klamath	35	971400.00	NA
Klamath	35	971700.00	0.995995048
Klamath	35	972000.00	NA
Lane	39	300.00	NA
Lane	39	2101.00	NA
Lane	39	2202.00	NA
Lane	39	2404.00	NA
Lane	39	2503.00	NA
Lane	39	2504.00	NA
Lane	39	2902.00	NA
Lane	39	3000.00	NA
Lane	39	3102.00	1.129769972
Lane	39	3301.00	1.154775587
Lane	39	3400.00	NA
Lane	39	3700.00	1.079046662
Lane	39	702.00	NA
Lane	39	903.00	NA
Lane	39	4000.00	1.015769014
Lane	39	4200.00	1.070655757
Lane	39	4401.00	1.11334951
Lane	39	4405.00	NA
Lane	39	4800.00	1.11423212
Lane	39	5000.00	NA
Lane	39	5300.00	NA
Linn	43	20300.00	NA
Linn	43	20600.00	NA
Linn	43	20801.00	1.065217027
Linn	43	30401.00	1.124156208
Linn	43	30902.00	NA
Linn	43	30904.00	1.211377837
Malheur	45	970200.00	1.148158025
Marion	47	501.00	NA

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Marion	47	502.00	1.039870646
Marion	47	1100.00	NA
Marion	47	1300.00	NA
Marion	47	1402.00	NA
Marion	47	1503	1.155172611
Marion	47	1602.00	1.130667539
Marion	47	1603.00	NA
Marion	47	1801.00	NA
Marion	47	2101.00	1.152981997
Marion	47	2102.00	NA
Marion	47	2202.00	NA
Marion	47	2304.00	NA
Marion	47	2501.00	NA
Marion	47	2700.00	NA
Marion	47	10100.00	NA
Marion	47	10202.00	NA
Marion	47	10303.00	NA
Marion	47	10305.00	NA
Josephine	33	360702.00	1.115622816
Washington	67	31005.00	NA
Washington	67	31200.00	NA
Washington	67	31402.00	NA
Washington	67	31504.00	NA
Washington	67	31507.00	NA
Washington	67	31508.00	NA
Washington	67	31513.00	NA
Washington	67	31609.00	NA
Washington	67	31612.00	NA
Washington	67	31614.00	NA
Washington	67	31616.00	NA
Washington	67	32104.00	NA
Yamhill	71	30101.00	NA
Yamhill	71	30202.00	NA
Yamhill	71	30502.00	NA
Washington	67	32108.00	NA
Washington	67	32110.00	NA
Washington	67	32407.00	NA
Washington	67	32503.00	NA
Washington	67	32604.00	NA
Washington	67	32608.00	NA
Washington	67	32800.00	NA
Yamhill	71	30602	NA
Yamhill	71	30900.00	NA
Multnomah	51	3801.00	NA
Multnomah	51	3803.00	NA
Multnomah	51	4101.00	NA
Multnomah	51	4200.00	NA

Multnomah	51	4300.00	NA
Multnomah	51	4601.00	NA
Multnomah	51	5000.00	NA
Multnomah	51	6702.00	NA
Multnomah	51	6802.00	NA
Multnomah	51	7100.00	NA
Multnomah	51	7300.00	1.205751826
Multnomah	51	7800.00	NA
Multnomah	51	8001.00	NA
Multnomah	51	8301.00	1.075835493
Multnomah	51	8302.00	1.129864058
Multnomah	51	8700.00	NA
Multnomah	51	8800.00	NA
Multnomah	51	9101.00	1.088116637
Multnomah	51	9102.00	NA
Multnomah	51	9302.00	NA
Multnomah	51	9400.00	NA
Multnomah	51	9605.00	1.142027438
Multnomah	51	9803.00	NA
Multnomah	51	9905.00	NA
Multnomah	51	9906.00	NA
Multnomah	51	10100.00	NA
Multnomah	51	10200.00	NA
Multnomah	51	10402.00	NA
Multnomah	51	10407.00	NA
Multnomah	51	10500.00	NA
Multnomah	51	980000.00	NA
Polk	53	5202.00	NA
Polk	53	20302.00	NA
Polk	53	20304.00	NA
Polk	53	20400.00	NA
Tillamook	57	960500	1.16279737
Tillamook	57	960800.00	1.156603522
Umatilla	59	950100.00	NA
Umatilla	59	950300.00	NA
Umatilla	59	950400.00	NA
Umatilla	59	950800.00	NA
Umatilla	59	950900.00	NA
Umatilla	59	951100.00	NA
Umatilla	59	951400.00	NA
Union	61	970500.00	NA
Union	61	970800.00	1.159982916
Washington	67	33000.00	NA
Wasco	65	970200.00	NA
Wasco	65	970400.00	NA
Wasco	65	970600.00	NA
Washington	67	30402.00	NA

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Washington	67	30502.00	NA
Washington	67	30600.00	NA
Washington	67	30805.00	NA
Washington	67	31003.00	NA
Washington	67	33102.00	NA
Washington	67	33200.00	1.125785422
Washington	67	33500.00	NA
Washington	67	33600.00	NA
Washington	67	31805.00	NA
Jackson	29	502.00	1.085958085
Malheur	45	940000.00	NA
Marion	47	600.00	NA
Marion	47	1601.00	NA
Baker	1	950400.00	1.136067155
Benton	3	400.00	NA
Clackamas	5	20100.00	NA
Clackamas	5	20504.00	NA
Clackamas	5	22205.00	NA
Clackamas	5	22707.00	NA
Clackamas	5	23201.00	NA
Marion	47	10201.00	NA
Marion	47	10702	NA
Multnomah	51	1202.00	NA
Multnomah	51	2000.00	NA
Multnomah	51	3602.00	NA
Multnomah	51	4002.00	NA
Columbia	9	970600.00	NA
Coos	11	800.00	NA
Deschutes	17	100.00	NA
Multnomah	51	6002.00	NA
Multnomah	51	6403.00	NA
Multnomah	51	6602.00	NA
Multnomah	51	8400.00	1.122424347
Multnomah	51	9301.00	NA
Multnomah	51	10303.00	NA
Multnomah	51	10600.00	1.003198849
Polk	53	20500.00	NA
Deschutes	17	1100.00	NA
Harney	25	960100.00	1.179372936
Umatilla	59	950200.00	NA
Union	61	970100.00	NA
Washington	67	30501.00	NA
Washington	67	31509.00	NA
Washington	67	31615.00	NA
Washington	67	31704.00	NA
Hood River	27	950400.00	NA
Jackson	29	1400.00	NA

Washington	67	31814.00	NA
Washington	67	32003.00	NA
Washington	67	32406.00	NA
Washington	67	33301.00	NA
Yamhill	71	30400.00	NA
Josephine	33	361400.00	1.141010835
Klamath	35	971100.00	NA
Lane	39	2002.00	NA
Lane	39	3302.00	1.089914341
Lincoln	41	950304.00	NA
Lincoln	41	951300.00	NA
Linn	43	20700	NA
Multnomah	51	1102.00	NA
Washington	67	30806.00	NA
Washington	67	32001.00	NA
Washington	67	32610.00	NA
Baker	1	950500.00	NA
Clackamas	5	22906.00	NA
Lane	39	4700.00	NA
Clackamas	5	20505.00	NA
Clackamas	5	22105.00	NA
Lincoln	41	950602.00	NA
Marion	47	2400.00	NA
Multnomah	51	9201.00	1.15765585
Washington	67	30102.00	NA
Washington	67	31912.00	NA
Benton	3	10900.00	NA
Curry	15	950400.00	1.12441445
Deschutes	17	900.00	1.066180497
Deschutes	17	1800.00	1.17006957
Klamath	35	971500.00	1.121331366
Clackamas	5	23600.00	NA
Linn	43	30600.00	NA
Jackson	29	2200.00	NA
Lane	39	403.00	NA
Malheur	45	970500.00	NA
Multnomah	51	2401.00	NA
Multnomah	51	2802.00	NA
Multnomah	51	10409.00	NA
Polk	53	20202.00	NA
Tillamook	57	960200.00	1.129839588
Washington	67	30200.00	NA
Yamhill	71	30801.00	1.104678881
Lane	39	2401.00	NA
Linn	43	30800.00	NA
Marion	47	1703.00	NA
Multnomah	51	6900.00	NA

Multnomah	51	10304.00	1.168249315
Benton	3	500	NA
Clackamas	5	20401.00	NA
Clackamas	5	21602.00	NA
Clackamas	5	22302.00	NA
Clackamas	5	23401.00	NA
Josephine	33	360500.00	1.099195512
Columbia	9	970900.00	NA
Deschutes	17	700.00	NA
Deschutes	17	2000.00	NA
Harney	25	960200.00	NA
Klamath	35	970800.00	NA
Lane	39	402.00	NA
Lane	39	1201.00	NA
Lane	39	2904.00	NA
Lane	39	4300.00	1.125628311
Lincoln	41	950400.00	1.098760838
Lincoln	41	951400.00	NA
Linn	43	20100.00	NA
Linn	43	30500.00	NA
Marion	47	1604.00	NA
Marion	47	2502.00	NA
Marion	47	10802.00	NA
Multnomah	51	1802.00	NA
Multnomah	51	4102.00	NA
Multnomah	51	5600.00	1.130719749
Multnomah	51	6100.00	NA
Multnomah	51	7201.00	NA
Multnomah	51	8901.00	NA
Multnomah	51	9702.00	NA
Polk	53	20303.00	1.097583855
Umatilla	59	950700.00	NA
Washington	67	30700.00	1.127056792
Washington	67	31506.00	NA
Washington	67	31807.00	NA
Washington	67	31907.00	NA
Washington	67	32109.00	NA
Yamhill	71	30102.00	NA
Lincoln	41	950800	NA
Washington	67	31908.00	NA
Douglas	19	150000.00	NA
Marion	47	1501.00	NA
Marion	47	1803.00	NA
Washington	67	32200.00	NA
Morrow	49	970100.00	NA
Multnomah	51	601.00	NA
Multnomah	51	1801.00	NA

Multnomah	51	2701.00	NA
Lane	39	1202.00	1.19370761
Umatilla	59	950600.00	NA
Wasco	65	970100.00	NA
Washington	67	31403.00	NA
Washington	67	31514.00	NA
Lane	39	2302.00	NA
Lane	39	3500.00	NA
Lane	39	4403.00	1.124613067
Linn	43	20802.00	1.078060214
Malheur	45	970300.00	1.059213814
Marion	47	1000.00	1.117323539
Washington	67	32103.00	NA
Washington	67	32408.00	NA
Washington	67	32901.00	NA
Multnomah	51	4700.00	NA
Multnomah	51	7202.00	NA
Multnomah	51	8902.00	NA
Multnomah	51	9502.00	NA
Douglas	19	80000.00	NA
Jackson	29	1100.00	NA
Jackson	29	1900.00	1.137115371
Clackamas	5	20403.00	NA
Clackamas	5	22101.00	NA
Clackamas	5	22603.00	NA
Jackson	29	3001.00	NA
Josephine	33	360400.00	NA
Clackamas	5	22905.00	NA
Clackamas	5	23403	NA
Clackamas	5	24303.00	NA
Columbia	9	970800.00	NA
Coos	11	504.00	1.12958834
Deschutes	17	800.00	NA
Josephine	33	361300.00	NA
Klamath	35	970700.00	NA
Lane	39	706.00	1.166683107
Deschutes	17	1902.00	NA
Multnomah	51	10306.00	NA
Polk	53	5100.00	1.127133652
Washington	67	33302.00	NA
Yamhill	71	30302.00	NA
Multnomah	51	8201.00	NA
Baker	1	950600.00	1.163158689
Clackamas	5	24302.00	NA
Curry	15	950301.00	NA
Douglas	19	210000.00	NA
Jefferson	31	960100.00	NA

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Lane	39	2501.00	NA
Lincoln	41	951500.00	1.181777591
Marion	47	2000.00	NA
Multnomah	51	6200.00	NA
Washington	67	33101.00	NA
Multnomah	51	7400.00	1.160804981
Multnomah	51	10408.00	NA
Clackamas	5	24304.00	NA
Crook	13	950100.00	NA
Jackson	29	1001.00	NA
Multnomah	51	502.00	NA
Lane	39	2700.00	NA
Multnomah	51	9202.00	NA
Multnomah	51	801.00	NA
Multnomah	51	3402.00	NA
Clackamas	5	22207.00	NA
Curry	15	950200.00	NA
Multnomah	51	3603.00	NA
Tillamook	57	960700	NA
Washington	67	32404.00	NA
Washington	67	31904.00	NA
Klamath	35	970500.00	1.18463021
Multnomah	51	1201.00	NA
Lane	39	5100.00	NA
Benton	3	10400.00	NA
Curry	15	950100.00	1.118726716
Gilliam	21	960100.00	NA
Josephine	33	360900.00	NA
Lane	39	5200.00	NA
Multnomah	51	701.00	NA
Multnomah	51	9000.00	1.178978941
Washington	67	31815.00	NA
Union	61	970200.00	NA

Source: Author estimates from the BEAR model.

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Table A4.5: Net Job Creation by County (median FTE change from Reference scenario in 2050)

County	Census Code	Employment Change (FTE)
Baker	1	100.32
Benton	3	371.68
Clackamas	5	2817.72
Clatsop	7	225.42
Columbia	9	330.50
Coos	11	305.49
Crook	13	97.46
Curry	15	95.20
Deschutes	17	1120.33
Douglas	19	518.16
Gilliam	21	12.36
Grant	23	40.39
Harney	25	33.89
Hood River	27	126.83
Jackson	29	1313.13
Jefferson	31	121.70
Josephine	33	457.71
Klamath	35	386.39
Lake	37	50.36
Lane	39	2037.49
Lincoln	41	249.78
Linn	43	668.02
Malheur	45	172.12
Marion	47	1916.52
Morrow	49	66.70
Multnomah	51	5183.94
Polk	53	461.56
Sherman	55	12.97
Tillamook	57	126.13
Umatilla	59	489.46
Union	61	160.25
Wallowa	63	41.49
Wasco	65	157.93
Washington	67	3589.38
Wheeler	69	8.52
Yamhill	71	603.71

Source: Author estimates from the BEAR model.

Table A4.6: Net Job Creation by County (median percent change from Reference scenario in 2050)

County	Census Code	Employment Change (%)
Baker	1	1.25
Benton	3	0.71
Clackamas	5	1.16
Clatsop	7	1.03
Columbia	9	1.23
Coos	11	0.98
Crook	13	0.89
Curry	15	0.95
Deschutes	17	1.12
Douglas	19	0.98
Gilliam	21	1.34
Grant	23	1.06
Harney	25	0.84
Hood River	27	0.91
Jackson	29	1.13
Jefferson	31	1.13
Josephine	33	1.18
Klamath	35	1.14
Lake	37	1.32
Lane	39	0.97
Lincoln	41	1.05
Linn	43	1.03
Malheur	45	1.22
Marion	47	1.05
Morrow	49	1.09
Multnomah	51	1.00
Polk	53	1.06
Sherman	55	1.35
Tillamook	57	1.00
Umatilla	59	1.19
Union	61	1.14
Wallowa	63	1.14
Wasco	65	1.12
Washington	67	1.00
Wheeler	69	1.26
Yamhill	71	1.05

Source: Author estimates from the BEAR model.

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Table A4.7: Net Low Income (quintile) Job Creation (median percent change from Reference scenario in 2050)

County	Census Code	Census Tract	Employment Change (%)
Baker	1	950300	NA
Benton	3	1001	0.66
Benton	3	1002	NA
Clackamas	5	20302	NA
Clackamas	5	20900	NA
Clackamas	5	22602	NA
Clatsop	7	950100	NA
Clatsop	7	951100	NA
Coos	11	300	NA
Deschutes	17	500	NA
Douglas	19	60000	NA
Douglas	19	110000	NA
Douglas	19	180000	NA
Grant	23	960200	NA
Hood River	27	950100	NA
Jackson	29	403	NA
Jackson	29	2100	NA
Jackson	29	2600	NA
Jackson	29	3002	NA
Josephine	33	360100	1.67
Josephine	33	361500	NA
Josephine	33	361600	1.23
Klamath	35	970300	NA
Lake	37	960100	NA
Lane	39	705	NA
Lane	39	902	NA
Lane	39	1904	1.02
Lincoln	41	950601	NA
Lincoln	41	951700	NA
Linn	43	20500	NA
Linn	43	30300	NA
Linn	43	30903	NA
Malheur	45	970600	1.05
Marion	47	1200	NA
Marion	47	10501	NA
Multnomah	51	301	NA
Multnomah	51	1701	NA
Multnomah	51	2901	NA
Multnomah	51	3501	NA
Multnomah	51	4900	NA

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Multnomah	51	6601	NA
Multnomah	51	6701	NA
Multnomah	51	9606	1.95
Multnomah	51	9701	1.57
Multnomah	51	10002	NA
Tillamook	57	960100	NA
Tillamook	57	960400	NA
Umatilla	59	950500	NA
Union	61	970600	NA
Wallowa	63	960300	NA
Wasco	65	970800	NA
Washington	67	30401	NA
Washington	67	31004	NA
Washington	67	31512	NA
Washington	67	31706	NA
Washington	67	31911	NA
Washington	67	32409	0.75
Yamhill	71	30802	0.98
Benton	3	10702	0.19
Clackamas	5	20304	NA
Clackamas	5	21300	NA
Clackamas	5	21802	NA
Clackamas	5	22907	1.36
Clackamas	5	23300	NA
Clackamas	5	23800	NA
Clackamas	5	24000	NA
Clackamas	5	980000	NA
Clatsop	7	951200	NA
Columbia	9	970500	NA
Coos	11	200	NA
Coos	11	503	0.77
Coos	11	900	1.38
Deschutes	17	600	NA
Deschutes	17	1500	NA
Douglas	19	10000	0.77
Douglas	19	30000	NA
Douglas	19	70000	NA
Douglas	19	100000	NA
Jackson	29	404	NA
Jackson	29	2000	NA
Jackson	29	2500	NA
Jackson	29	2700	NA
Jefferson	31	940000	1.35
Jefferson	31	960302	NA
Klamath	35	970100	NA

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Klamath	35	970200	NA
Klamath	35	970400	NA
Klamath	35	970600	1.62
Klamath	35	971200	0.81
Lake	37	960200	1.77
Lane	39	500	NA
Lane	39	800	NA
Lane	39	1400	NA
Lane	39	1600	NA
Lane	39	1903	1.05
Lane	39	2102	1.24
Lane	39	3201	1.21
Lane	39	3900	0.72
Lane	39	4502	NA
Lane	39	4600	NA
Linn	43	20400	1.33
Linn	43	30200	NA
Linn	43	30402	1.12
Malheur	45	970700	NA
Malheur	45	970900	1.50
Marion	47	300	0.88
Marion	47	2303	NA
Marion	47	10502	NA
Marion	47	10600	NA
Multnomah	51	200	NA
Multnomah	51	401	NA
Multnomah	51	702	NA
Multnomah	51	1301	NA
Multnomah	51	1500	NA
Multnomah	51	2203	NA
Multnomah	51	2702	NA
Multnomah	51	3301	NA
Multnomah	51	4001	2.05
Multnomah	51	4800	NA
Multnomah	51	7500	NA
Multnomah	51	7600	NA
Multnomah	51	8002	NA
Multnomah	51	8500	1.55
Multnomah	51	9604	1.50
Multnomah	51	9801	2.11
Multnomah	51	10001	NA
Multnomah	51	10410	1.77
Polk	53	20203	0.95
Tillamook	57	960300	NA

Umatilla	59	951200	1.47
Union	61	970300	NA
Union	61	970700	0.75
Wallowa	63	960200	1.72
Wasco	65	970700	NA
Washington	67	30101	NA
Washington	67	30801	NA
Washington	67	31006	NA
Washington	67	31511	NA
Washington	67	31611	NA
Washington	67	32004	NA
Washington	67	32607	NA
Yamhill	71	30201	0.84
Yamhill	71	30501	NA
Yamhill	71	30702	NA
Benton	3	1101	0.58
Clackamas	5	21801	NA
Clackamas	5	23901	NA
Clatsop	7	950400	NA
Douglas	19	50001	NA
Douglas	19	200000	1.14
Lane	39	100	NA
Lane	39	2600	NA
Lane	39	4501	NA
Lincoln	41	951800	1.15
Marion	47	2201	NA
Multnomah	51	2801	NA
Multnomah	51	5500	NA
Multnomah	51	9804	0.86
Wasco	65	970300	NA
Washington	67	31100	1.21
Washington	67	32606	NA
Clackamas	5	21601	1.72
Lane	39	200	NA
Washington	67	32502	NA

Douglas	19	20000	NA
Grant	23	960100	1.80
Multnomah	51	3901	NA
Deschutes	17	200	NA
Washington	67	32410	NA
Baker	1	950100	NA
Benton	3	1102	0.78
Clackamas	5	24400	NA
Coos	11	1100	NA
Douglas	19	170000	NA
Jackson	29	201	1.47
Jackson	29	1002	1.47
Jackson	29	2300	NA
Lane	39	2201	NA
Marion	47	400	1.66
Multnomah	51	3000	NA
Multnomah	51	6502	NA
Wallowa	63	960100	NA
Washington	67	31617	NA
Washington	67	32609	NA
Lane	39	1500	1.65
Lane	39	708	NA
Marion	47	701	1.33
Benton	3	10300	NA
Clackamas	5	21100	NA
Clatsop	7	950900	NA
Crook	13	950400	1.66
Jackson	29	406	NA
Klamath	35	971900	1.12
Lane	39	1902	1.18
Lane	39	2903	NA
Marion	47	2600	NA
Marion	47	10307	NA
Multnomah	51	3302	NA
Multnomah	51	3902	NA

Multnomah	51	9903	NA
Sherman	55	950100	NA
Washington	67	30300	NA
Columbia	9	970400	NA
Columbia	9	971100	NA
Coos	11	600	NA
Marion	47	10503	NA
Multnomah	51	100	NA
Multnomah	51	402	NA
Multnomah	51	902	NA
Multnomah	51	1101	NA
Multnomah	51	1302	NA
Multnomah	51	1601	NA
Multnomah	51	2303	NA
Multnomah	51	2402	NA
Coos	11	502	1.84
Crook	13	950200	NA
Multnomah	51	2600	NA
Multnomah	51	3200	NA
Multnomah	51	3401	NA
Multnomah	51	3701	NA
Multnomah	51	3802	NA
Multnomah	51	4500	NA
Multnomah	51	4602	NA
Multnomah	51	5100	NA
Multnomah	51	5200	NA
Multnomah	51	5700	NA
Multnomah	51	5800	NA
Multnomah	51	5900	NA
Deschutes	17	300	NA
Deschutes	17	1001	NA
Deschutes	17	1400	NA
Deschutes	17	1600	NA
Multnomah	51	6001	NA
Multnomah	51	6300	NA
Multnomah	51	6402	NA
Multnomah	51	6404	NA
Multnomah	51	6501	NA
Multnomah	51	6801	NA
Multnomah	51	7000	NA
Multnomah	51	7700	1.30
Deschutes	17	1901	NA

Douglas	19	90000	1.27
Douglas	19	130000	NA
Douglas	19	140000	NA
Multnomah	51	8100	1.34
Multnomah	51	8202	1.34
Multnomah	51	8600	1.99
Multnomah	51	9501	NA
Multnomah	51	9603	NA
Multnomah	51	9904	NA
Multnomah	51	9907	NA
Multnomah	51	10305	NA
Multnomah	51	10405	NA
Multnomah	51	10411	NA
Polk	53	5201	NA
Douglas	19	160000	NA
Douglas	19	190000	1.03
Hood River	27	950200	NA
Hood River	27	950300	NA
Polk	53	5300	NA
Polk	53	20204	NA
Jackson	29	100	1.63
Jackson	29	202	1.35
Jackson	29	405	1.18
Jackson	29	602	NA
Jackson	29	900	NA
Jackson	29	1301	1.43
Jackson	29	1602	NA
Washington	67	31909	NA
Washington	67	31910	NA
Washington	67	32005	NA
Washington	67	32107	NA
Washington	67	32300	NA
Washington	67	32501	0.83
Jackson	29	1800	NA
Jackson	29	2800	NA

Jefferson	31	960301	NA
Josephine	33	360701	1.23
Josephine	33	361100	NA
Klamath	35	971300	NA
Klamath	35	971600	1.32
Tillamook	57	960600	NA
Umatilla	59	940000	NA
Umatilla	59	951000	1.45
Klamath	35	971800	2.13
Lane	39	404	NA
Lane	39	707	NA
Lane	39	904	0.87
Washington	67	32603	NA
Washington	67	32700	NA
Washington	67	32902	1.56
Washington	67	33400	NA
Lane	39	1101	NA
Lane	39	1302	0.79
Lane	39	1801	NA
Lane	39	1804	NA
Lane	39	2301	0.92
Lane	39	2403	NA
Lane	39	2800	NA
Lane	39	3101	NA
Lane	39	3202	NA
Lane	39	3600	NA
Lane	39	4100	NA
Lane	39	4404	NA
Lane	39	4900	NA
Lane	39	5400	NA
Umatilla	59	951300	NA
Union	61	970400	NA
Wasco	65	970500	0.85
Washington	67	30803	NA
Washington	67	30900	1.36

Baker	1	950200	NA
Benton	3	100	NA
Benton	3	202	NA
Benton	3	600	NA
Benton	3	900	NA
Lincoln	41	950100	NA
Lincoln	41	950303	NA
Lincoln	41	950900	NA
Lincoln	41	951000	1.99
Wheeler	69	960100	NA
Yamhill	71	30301	NA
Benton	3	10200	NA
Benton	3	10800	NA
Clackamas	5	20303	NA
Clackamas	5	20501	NA
Clackamas	5	20700	NA
Lincoln	41	951100	NA
Lincoln	41	951200	NA
Lincoln	41	951600	NA
Lincoln	41	990100	NaN
Clackamas	5	21200	NA
Clackamas	5	21400	NA
Clackamas	5	22000	NA
Clackamas	5	22103	NA
Clackamas	5	22108	2.12
Clackamas	5	22208	NA
Clackamas	5	22605	NA
Clackamas	5	22710	NA
Clackamas	5	22904	NA
Linn	43	20200	NA
Linn	43	30100	NA
Washington	67	31300	NA
Washington	67	31404	NA
Washington	67	31606	NA
Washington	67	31610	NA
Washington	67	31613	NA
Washington	67	31703	NA
Washington	67	31705	NA
Washington	67	31804	NA
Washington	67	31806	NA
Washington	67	31812	NA
Washington	67	31813	NA
Clackamas	5	23002	NA

Clackamas	5	23404	NA
Clackamas	5	23700	NA
Linn	43	30700	NA
Malheur	45	970400	1.68
Marion	47	200	NA
Marion	47	900	1.23
Marion	47	1401	NA
Marion	47	1502	1.46
Yamhill	71	30601	0.61
Yamhill	71	30701	NA
Yamhill	71	31000	NA
Clackamas	5	24100	NA
Clatsop	7	951300	NA
Marion	47	1702	1.18
Marion	47	1802	0.84
Marion	47	2301	NA
Marion	47	2800	NA
Marion	47	10304	0.94
Marion	47	10306	0.92
Clatsop	7	950600	NA
Lane	39	3800	0.50
Multnomah	51	7900	NA
Marion	47	1701	1.01
Columbia	9	970700	1.49
Clackamas	5	23202	NA
Clackamas	5	23500	NA
Clackamas	5	23902	NA
Clackamas	5	24200	NA
Clatsop	7	950200	NA
Clatsop	7	950300	NA
Clatsop	7	950500	NA
Clatsop	7	950700	NA
Columbia	9	970200	NA
Columbia	9	970300	NA

Columbia	9	971000	NA
Coos	11	100	NA
Coos	11	400	NA
Coos	11	700	NA
Coos	11	1000	NA
Crook	13	950300	NA
Josephine	33	360300	NA
Josephine	33	360600	NA
Curry	15	950302	NA
Deschutes	17	401	NA
Deschutes	17	402	NA
Deschutes	17	1002	NA
Deschutes	17	1200	NA
Deschutes	17	1300	NA
Deschutes	17	1700	NA
Deschutes	17	2100	NA
Douglas	19	120000	NA
Jackson	29	203	1.49
Jackson	29	300	1.28
Jackson	29	501	NA
Jackson	29	601	NA
Jackson	29	700	NA
Jackson	29	800	NA
Jackson	29	1200	1.59
Jackson	29	1302	NA
Jackson	29	1500	NA
Jackson	29	1601	1.99
Benton	3	10100	NA
Benton	3	10600	0.68
Clackamas	5	20200	NA
Clackamas	5	20404	NA
Clackamas	5	20503	NA
Clackamas	5	20600	NA
Clackamas	5	20800	NA
Clackamas	5	21000	NA
Clackamas	5	21500	NA
Jackson	29	1700	1.07
Jackson	29	2400	NA
Clackamas	5	21700	NA

Clackamas	5	21900	NA
Clackamas	5	22107	NA
Clackamas	5	22201	NA
Clackamas	5	22206	NA
Clackamas	5	22301	NA
Clackamas	5	22400	NA
Clackamas	5	22500	NA
Clackamas	5	22606	NA
Clackamas	5	22702	NA
Clackamas	5	22708	NA
Douglas	19	40000	NA
Douglas	19	50002	1.08
Clackamas	5	22800	NA
Clackamas	5	22901	NA
Clackamas	5	23001	NA
Clackamas	5	23100	NA
Jackson	29	2900	NA
Jefferson	31	960201	1.27
Jefferson	31	960202	NA
Marion	47	10400	1.10
Marion	47	10701	1.15
Marion	47	10801	NA
Lane	39	1001	NA
Morrow	49	970200	NA
Multnomah	51	302	NA
Multnomah	51	501	NA
Multnomah	51	602	1.22
Multnomah	51	802	NA
Multnomah	51	901	NA
Multnomah	51	1000	NA
Multnomah	51	1400	NA
Multnomah	51	1602	NA
Multnomah	51	1702	NA
Multnomah	51	1900	NA
Josephine	33	360800	NA
Josephine	33	361000	NA
Josephine	33	361200	1.19
Lane	39	1002	NA
Lane	39	1102	NA

Multnomah	51	2100	NA
Multnomah	51	2501	NA
Multnomah	51	2502	NA
Multnomah	51	2902	NA
Multnomah	51	2903	NA
Multnomah	51	3100	NA
Multnomah	51	3502	NA
Multnomah	51	3601	NA
Multnomah	51	3702	NA
Klamath	35	970900	NA
Klamath	35	971000	NA
Lane	39	1301	1.60
Lane	39	1700	NA
Lane	39	1803	NA
Lane	39	2001	NA
Klamath	35	971400	NA
Klamath	35	971700	1.03
Klamath	35	972000	NA
Lane	39	300	NA
Lane	39	2101	NA
Lane	39	2202	NA
Lane	39	2404	NA
Lane	39	2503	NA
Lane	39	2504	NA
Lane	39	2902	NA
Lane	39	3000	NA
Lane	39	3102	NA
Lane	39	3301	1.08
Lane	39	3400	1.07
Lane	39	3700	0.42
Lane	39	702	NA
Lane	39	903	NA
Lane	39	4000	NA
Lane	39	4200	0.85
Lane	39	4401	NA
Lane	39	4405	NA
Lane	39	4800	0.45
Lane	39	5000	NA

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Lane	39	5300	NA
Linn	43	20300	NA
Linn	43	20600	NA
Linn	43	20801	2.19
Linn	43	30401	1.57
Linn	43	30902	NA
Linn	43	30904	1.00
Malheur	45	970200	1.15
Marion	47	501	0.86
Marion	47	502	1.47
Marion	47	1100	NA
Marion	47	1300	NA
Marion	47	1402	NA
Marion	47	1503	1.26
Marion	47	1602	1.43
Marion	47	1603	1.48
Marion	47	1801	1.72
Marion	47	2101	NA
Marion	47	2102	NA
Marion	47	2202	NA
Marion	47	2304	NA
Marion	47	2501	NA
Marion	47	2700	NA
Marion	47	10100	NA
Marion	47	10202	NA
Marion	47	10303	1.04
Marion	47	10305	0.75
Josephine	33	360702	NA
Washington	67	31005	NA
Washington	67	31200	NA
Washington	67	31402	NA
Washington	67	31504	NA
Washington	67	31507	NA

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Washington	67	31508	NA
Washington	67	31513	NA
Washington	67	31609	NA
Washington	67	31612	NA
Washington	67	31614	NA
Washington	67	31616	NA
Washington	67	32104	NA
Yamhill	71	30101	NA
Yamhill	71	30202	1.58
Yamhill	71	30502	1.35
Washington	67	32108	NA
Washington	67	32110	NA
Washington	67	32407	NA
Washington	67	32503	NA
Washington	67	32604	NA
Washington	67	32608	NA
Washington	67	32800	NA
Yamhill	71	30602	NA
Yamhill	71	30900	NA
Multnomah	51	3801	NA
Multnomah	51	3803	NA
Multnomah	51	4101	NA
Multnomah	51	4200	NA
Multnomah	51	4300	NA
Multnomah	51	4601	NA
Multnomah	51	5000	NA
Multnomah	51	6702	NA
Multnomah	51	6802	NA
Multnomah	51	7100	NA
Multnomah	51	7300	1.92
Multnomah	51	7800	NA
Multnomah	51	8001	NA
Multnomah	51	8301	1.12
Multnomah	51	8302	1.17
Multnomah	51	8700	NA
Multnomah	51	8800	NA
Multnomah	51	9101	1.65
Multnomah	51	9102	2.14

Multnomah	51	9302	NA
Multnomah	51	9400	NA
Multnomah	51	9605	2.46
Multnomah	51	9803	1.60
Multnomah	51	9905	NA
Multnomah	51	9906	NA
Multnomah	51	10100	NA
Multnomah	51	10200	NA
Multnomah	51	10402	NA
Multnomah	51	10407	NA
Multnomah	51	10500	NA
Multnomah	51	980000	NaN
Polk	53	5202	NA
Polk	53	20302	1.14
Polk	53	20304	1.00
Polk	53	20400	NA
Tillamook	57	960500	0.87
Tillamook	57	960800	NA
Umatilla	59	950100	NA
Umatilla	59	950300	NA
Umatilla	59	950400	1.39
Umatilla	59	950800	1.55
Umatilla	59	950900	NA
Umatilla	59	951100	NA
Umatilla	59	951400	NA
Union	61	970500	NA
Union	61	970800	NA
Washington	67	33000	NA
Wasco	65	970200	0.99
Wasco	65	970400	NA
Wasco	65	970600	NA
Washington	67	30402	NA
Washington	67	30502	NA
Washington	67	30600	NA
Washington	67	30805	NA
Washington	67	31003	NA
Washington	67	33102	NA

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Washington	67	33200	1.12
Washington	67	33500	NA
Washington	67	33600	NA
Washington	67	31805	NA
Jackson	29	502	1.09
Malheur	45	940000	NaN
Marion	47	600	NA
Marion	47	1601	NA
Baker	1	950400	NA
Benton	3	400	NA
Clackamas	5	20100	NA
Clackamas	5	20504	NA
Clackamas	5	22205	NA
Clackamas	5	22707	NA
Clackamas	5	23201	NA
Marion	47	10201	NA
Marion	47	10702	NA
Multnomah	51	1202	NA
Multnomah	51	2000	NA
Multnomah	51	3602	NA
Multnomah	51	4002	NA
Columbia	9	970600	NA
Coos	11	800	NA
Deschutes	17	100	NA
Multnomah	51	6002	NA
Multnomah	51	6403	NA
Multnomah	51	6602	NA
Multnomah	51	8400	1.27
Multnomah	51	9301	1.18
Multnomah	51	10303	NA
Multnomah	51	10600	NA
Polk	53	20500	NA
Deschutes	17	1100	NA
Harney	25	960100	NA
Umatilla	59	950200	1.24
Union	61	970100	NA
Washington	67	30501	NA
Washington	67	31509	NA
Washington	67	31615	NA
Washington	67	31704	NA

Hood River	27	950400	NA
Jackson	29	1400	NA
Washington	67	31814	NA
Washington	67	32003	NA
Washington	67	32406	NA
Washington	67	33301	NA
Yamhill	71	30400	NA
Josephine	33	361400	NA
Klamath	35	971100	NA
Lane	39	2002	NA
Lane	39	3302	0.84
Lincoln	41	950304	NA
Lincoln	41	951300	NA
Linn	43	20700	NA
Multnomah	51	1102	NA
Washington	67	30806	NA
Washington	67	32001	NA
Washington	67	32610	NA
Baker	1	950500	1.31
Clackamas	5	22906	NA
Lane	39	4700	NA
Clackamas	5	20505	NA
Clackamas	5	22105	NA
Lincoln	41	950602	NA
Marion	47	2400	NA
Multnomah	51	9201	NA
Washington	67	30102	NA
Washington	67	31912	NA
Benton	3	10900	NA
Curry	15	950400	NA
Deschutes	17	900	0.89
Deschutes	17	1800	NA
Klamath	35	971500	1.64
Clackamas	5	23600	NA
Linn	43	30600	NA
Jackson	29	2200	NA
Lane	39	403	NA
Malheur	45	970500	1.76
Multnomah	51	2401	NA
Multnomah	51	2802	NA

Multnomah	51	10409	NA
Polk	53	20202	NA
Tillamook	57	960200	NA
Washington	67	30200	NA
Yamhill	71	30801	1.22
Lane	39	2401	NA
Linn	43	30800	0.84
Marion	47	1703	NA
Multnomah	51	6900	NA
Multnomah	51	10304	0.92
Benton	3	500	NA
Clackamas	5	20401	NA
Clackamas	5	21602	NA
Clackamas	5	22302	NA
Clackamas	5	23401	NA
Josephine	33	360500	1.14
Columbia	9	970900	NA
Deschutes	17	700	NA
Deschutes	17	2000	NA
Harney	25	960200	NA
Klamath	35	970800	NA
Lane	39	402	NA
Lane	39	1201	NA
Lane	39	2904	NA
Lane	39	4300	1.64
Lincoln	41	950400	1.22
Lincoln	41	951400	1.68
Linn	43	20100	NA
Linn	43	30500	NA
Marion	47	1604	1.16
Marion	47	2502	NA
Marion	47	10802	NA
Multnomah	51	1802	NA
Multnomah	51	4102	NA
Multnomah	51	5600	NA
Multnomah	51	6100	NA
Multnomah	51	7201	NA

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Multnomah	51	8901	NA
Multnomah	51	9702	1.64
Polk	53	20303	0.56
Umatilla	59	950700	NA
Washington	67	30700	NA
Washington	67	31506	NA
Washington	67	31807	NA
Washington	67	31907	NA
Washington	67	32109	NA
Yamhill	71	30102	NA
Lincoln	41	950800	NA
Washington	67	31908	NA
Douglas	19	150000	1.08
Marion	47	1501	NA
Marion	47	1803	1.68
Washington	67	32200	NA
Morrow	49	970100	1.28
Multnomah	51	601	1.70
Multnomah	51	1801	NA
Multnomah	51	2701	NA
Lane	39	1202	NA
Umatilla	59	950600	NA
Wasco	65	970100	NA
Washington	67	31403	NA
Washington	67	31514	NA
Lane	39	2302	NA
Lane	39	3500	NA
Lane	39	4403	NA
Linn	43	20802	1.01
Malheur	45	970300	1.52
Marion	47	1000	1.46
Washington	67	32103	NA
Washington	67	32408	NA
Washington	67	32901	NA
Multnomah	51	4700	NA
Multnomah	51	7202	NA

Multnomah	51	8902	NA
Multnomah	51	9502	NA
Douglas	19	80000	NA
Jackson	29	1100	NA
Jackson	29	1900	1.15
Clackamas	5	20403	NA
Clackamas	5	22101	NA
Clackamas	5	22603	NA
Jackson	29	3001	NA
Josephine	33	360400	NA
Clackamas	5	22905	NA
Clackamas	5	23403	NA
Clackamas	5	24303	NA
Columbia	9	970800	NA
Coos	11	504	0.90
Deschutes	17	800	NA
Josephine	33	361300	NA
Klamath	35	970700	NA
Lane	39	706	NA
Deschutes	17	1902	NA
Multnomah	51	10306	NA
Polk	53	5100	1.56
Washington	67	33302	NA
Yamhill	71	30302	NA
Multnomah	51	8201	NA
Baker	1	950600	NA
Clackamas	5	24302	NA
Curry	15	950301	NA
Douglas	19	210000	NA
Jefferson	31	960100	NA
Lane	39	2501	NA
Lincoln	41	951500	NA
Marion	47	2000	NA
Multnomah	51	6200	NA
Washington	67	33101	NA
Multnomah	51	7400	1.16
Multnomah	51	10408	NA
Clackamas	5	24304	NA
Crook	13	950100	NA
Jackson	29	1001	NA
Multnomah	51	502	NA

Lane	39	2700	NA
Multnomah	51	9202	NA
Multnomah	51	801	NA
Multnomah	51	3402	NA
Clackamas	5	22207	NA
Curry	15	950200	NA
Multnomah	51	3603	NA
Tillamook	57	960700	NA
Washington	67	32404	NA
Washington	67	31904	NA
Klamath	35	970500	NA
Multnomah	51	1201	NA
Lane	39	5100	NA
Benton	3	10400	NA
Curry	15	950100	NA
Gilliam	21	960100	NA
Josephine	33	360900	NA
Lane	39	5200	NA
Multnomah	51	701	NA
Multnomah	51	9000	1.40
Washington	67	31815	NA
Union	61	970200	NA

Source: Author estimates from the BEAR model.

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Table A4.8: Estimated Permit Prices by Scenario and Year (2016$/MTCO2e)

	Linear	Interim Target	Core
2021	$ 19.21	$ 19.21	$ 19.21
2022	$ 19.53	$ 19.59	$ 19.54
2023	$ 19.89	$ 20.03	$ 19.93
2024	$ 20.29	$ 20.51	$ 20.35
2025	$ 20.72	$ 21.06	$ 20.83
2026	$ 21.20	$ 21.68	$ 21.37
2027	$ 21.73	$ 22.39	$ 21.98
2028	$ 22.31	$ 23.22	$ 22.71
2029	$ 22.96	$ 24.16	$ 23.52
2030	$ 23.68	$ 25.25	$ 24.47
2031	$ 24.49	$ 26.52	$ 25.57
2032	$ 25.40	$ 28.09	$ 26.93
2033	$ 26.42	$ 29.90	$ 28.50
2034	$ 27.58	$ 32.09	$ 30.39
2035	$ 28.89	$ 34.76	$ 32.71
2036	$ 30.39	$ 36.87	$ 34.53
2037	$ 32.12	$ 39.13	$ 36.49
2038	$ 34.12	$ 41.71	$ 38.72
2039	$ 36.45	$ 44.66	$ 41.27
2040	$ 39.19	$ 48.05	$ 44.21
2041	$ 42.43	$ 51.98	$ 47.61
2042	$ 46.31	$ 56.57	$ 51.58
2043	$ 51.02	$ 61.96	$ 56.24
2044	$ 56.80	$ 68.86	$ 62.21
2045	$ 64.02	$ 76.64	$ 68.94
2046	$ 73.20	$ 86.10	$ 77.11
2047	$ 85.15	$ 97.74	$ 87.17
2048	$ 101.15	$ 112.30	$ 99.76
2049	$ 123.35	$ 130.88	$ 115.82
2050	$ 155.61	$ 155.13	$ 136.78

Source: Author estimates from the BEAR model.

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Table A4.10: Composition of Oregon Gross State Product by Activity (2016 percentages)

	GDP	Share
Primary	5,449	2%
Utilities	2,627	1%
Construction	7,430	3%
Manufacturing	30,370	13%
Trade	21,990	10%
ICT	7,849	3%
Finance	38,613	17%
Oth Serv	85,582	38%
Pub Admin	25,451	11%
Total	225,361	100%

Source: US Bureau of Economic Analysis

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Table A4.11: Estimated Permit Revenues by Mitigation Scenario (millions of 2016 dollars)

	Linear	Interim Target	Core
2021	622.242	622.242	622.242
2022	605.504	601.225	599.756
2023	582.902	573.814	570.848
2024	557.894	545.221	540.837
2025	530.528	514.732	508.981
2026	521.477	502.307	495.019
2027	497.525	475.840	467.211
2028	490.820	465.542	455.214
2029	475.250	447.839	436.006
2030	603.893	565.625	548.108
2031	600.013	558.975	538.929
2032	596.839	552.804	529.971
2033	594.437	548.779	523.034
2034	592.883	546.386	517.484
2035	592.262	545.918	513.584
2036	592.677	551.951	516.917
2037	594.247	559.657	521.857
2038	597.106	568.605	527.869
2039	601.424	578.932	535.064
2040	607.382	590.779	543.565
2041	615.225	604.319	553.521
2042	625.231	619.758	565.106
2043	637.745	637.328	578.523
2044	653.215	657.664	594.142
2045	678.584	687.061	617.991
2046	702.692	714.097	639.566
2047	732.257	745.037	664.506
2048	768.707	780.550	693.389
2049	814.080	821.459	726.923
2050	871.433	868.751	765.958

Source: Author estimates from the BEAR model.

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Table A4.12: Estimated Permit Revenue Allocation (millions of 2016 dollars)

	Highway	Non-highway
2021	306.752	315.490
2022	294.715	305.041
2023	279.603	291.245
2024	263.741	277.096
2025	247.162	261.819
2026	239.109	255.911
2027	224.234	242.977
2028	216.723	238.491
2029	205.705	230.301
2030	255.805	292.303
2031	248.251	290.678
2032	240.048	289.923
2033	232.245	290.789
2034	224.147	293.337
2035	215.592	297.992
2036	212.218	304.700
2037	209.204	312.653
2038	205.880	321.988
2039	202.192	332.872
2040	198.080	345.485
2041	193.482	360.040
2042	188.333	376.773
2043	182.560	395.963
2044	175.129	419.013
2045	169.394	448.598
2046	161.242	478.324
2047	152.096	512.410
2048	141.855	551.534
2049	130.421	596.502
2050	117.703	648.254

Source: Author estimates from the BEAR model.

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Table A4.13: How Energy Efficiency Creates Jobs – Data

Industry Code	Description	Employment (FTE headcount)	Output ($Millions)	Employee Compensation ($Millions)	Average Wage Income ($/yr)
	Total	2,435,638	$ 389,477	$ 117,345	$ 48,178
1	Oilseed farming	7	$ 4	$ 0	$ 3,534
2	Grain farming	860	$ 242	$ 5	$ 6,093
3	Vegetable and melon farming	3,451	$ 458	$ 102	$ 29,441
4	Fruit farming	11,486	$ 614	$ 191	$ 16,641
5	Tree nut farming	1,282	$ 128	$ 46	$ 35,896
6	Greenhouse, nursery, and floriculture production	9,097	$ 848	$ 310	$ 34,095
7	Tobacco farming	-	$ -	$ -	
8	Cotton farming	-	$ -	$ -	
9	Sugarcane and sugar beet farming	87	$ 15	$ 4	$ 50,468
10	All other crop farming	21,762	$ 953	$ 295	$ 13,558
11	Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming	6,972	$ 794	$ 21	$ 3,030
12	Dairy cattle and milk production	1,491	$ 469	$ 31	$ 20,607
13	Poultry and egg production	311	$ 160	$ 13	$ 42,759
14	Animal production, except cattle and poultry and eggs	779	$ 68	$ 7	$ 9,612
15	Forestry, forest products, and timber tract production	693	$ 78	$ 40	$ 57,012
16	Commercial logging	8,897	$ 851	$ 388	$ 43,596
17	Commercial fishing	3,468	$ 202	$ 43	$ 12,530
18	Commercial hunting and trapping	296	$ 47	$ 1	$ 3,192
19	Support activities for agriculture and forestry	19,720	$ 998	$ 627	$ 31,806
20	Extraction of natural gas and crude petroleum	2,031	$ 129	$ 0	$ 197
21	Extraction of natural gas liquids	-	$ -	$ -	
22	Coal mining	-	$ -	$ -	
23	Iron ore mining	-	$ -	$ -	

24	Gold ore mining	156	$ 37	$ 1	$ 4,183
25	Silver ore mining	-	$ -	$ -	
26	Lead and zinc ore mining	-	$ -	$ -	
27	Copper ore mining	-	$ -	$ -	
28	Uranium-radium-vanadium ore mining	-	$ -	$ -	
29	Other metal ore mining	50	$ 26	$ 1	$ 12,235
30	Stone mining and quarrying	1,186	$ 215	$ 35	$ 29,761
31	Sand and gravel mining	1,271	$ 351	$ 63	$ 49,887
32	Other clay, ceramic, refractory minerals mining	74	$ 12	$ 1	$ 19,979
33	Potash, soda, and borate mineral mining	-	$ -	$ -	
34	Phosphate rock mining	-	$ -	$ -	
35	Other chemical and fertilizer mineral mining	-	$ -	$ -	
36	Other nonmetallic minerals	250	$ 44	$ 11	$ 42,255
37	Drilling oil and gas wells	319	$ 38	$ 0	$ 1,043
38	Support activities for oil and gas operations	90	$ 5	$ 0	$ 2,603
39	Metal mining services	17	$ 3	$ 1	$ 35,855
40	Other nonmetallic minerals services	72	$ 10	$ 3	$ 48,404
41	Electric power generation - Hydroelectric	219	$ 166	$ 23	$ 105,927
42	Electric power generation - Fossil †fuel	282	$ 508	$ 46	$ 164,528
43	Electric power generation - Nuclear	47	$ 55	$ 8	$ 176,635
44	Electric power generation - Solar	-	$ -	$ -	
45	Electric power generation - Wind	260	$ 778	$ 30	$ 114,159
46	Electric power generation - Geothermal	15	$ 14	$ 2	$ 120,221
47	Electric power generation - Biomass	53	$ 55	$ 1	$ 18,149
48	Electric power generation - All other	3	$ 2	$ 0	$ 140,533
49	Electric power transmission and distribution	2,164	$ 3,603	$ 308	$ 142,368
50	Natural gas distribution	1,232	$ 770	$ 164	$ 132,734
51	Water, sewage and other systems	635	$ 159	$ 25	$ 38,889
52	Construction of new health care structures	2,979	$ 454	$ 139	$ 46,579
53	Construction of new manufacturing structures	6,928	$ 806	$ 373	$ 53,835
54	Construction of new power and communication structures	10,075	$ 1,263	$ 407	$ 40,422

55	Construction of new educational and vocational structures	5,624	$ 1,010	$ 220	$ 39,190
56	Construction of new highways and streets	6,860	$ 1,127	$ 324	$ 47,256
57	Construction of new commercial structures, including farm structures	13,283	$ 1,655	$ 668	$ 50,313
58	Construction of other new nonresidential structures	18,260	$ 2,437	$ 837	$ 45,855
59	Construction of new single-family residential structures	18,188	$ 2,636	$ 788	$ 43,319
60	Construction of new multifamily residential structures	4,429	$ 699	$ 201	$ 45,348
61	Construction of other new residential structures	11,446	$ 3,489	$ 84	$ 7,360
62	Maintenance and repair construction of nonresidential structures	16,313	$ 2,449	$ 718	$ 44,030
63	Maintenance and repair construction of residential structures	6,939	$ 1,104	$ 318	$ 45,846
64	Maintenance and repair construction of highways, streets, bridges, and tunnels	5,540	$ 832	$ 244	$ 44,030
65	Dog and cat food manufacturing	49	$ 66	$ 2	$ 42,877
66	Other animal food manufacturing	272	$ 336	$ 15	$ 56,327
67	Flour milling	460	$ 629	$ 41	$ 89,133
68	Rice milling	-	$ -	$ -	
69	Malt manufacturing	16	$ 22	$ 1	$ 81,231
70	Wet corn milling	-	$ -	$ -	
71	Soybean and other oilseed processing	33	$ 143	$ 2	$ 63,049
72	Fats and oils refining and blending	62	$ 102	$ 3	$ 56,877
73	Breakfast cereal manufacturing	340	$ 242	$ 19	$ 57,144
74	Beet sugar manufacturing	-	$ -	$ -	
75	Sugar cane mills and refining	-	$ -	$ -	
76	Nonchocolate confectionery manufacturing	425	$ 150	$ 14	$ 32,031
77	Chocolate and confectionery manufacturing from cacao beans	52	$ 29	$ 1	$ 15,279

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78	Confectionery manufacturing from purchased chocolate	431	$	129	$	10	$	22,112
79	Frozen fruits, juices and vegetables manufacturing	5,631	$	2,416	$	254	$	45,144
80	Frozen specialties manufacturing	2,399	$	868	$	113	$	47,168
81	Canned fruits and vegetables manufacturing	1,792	$	891	$	80	$	44,698
82	Canned specialties	45	$	38	$	3	$	74,027
83	Dehydrated food products manufacturing	1,513	$	781	$	123	$	81,548
84	Fluid milk manufacturing	883	$	692	$	65	$	73,758
85	Creamery butter manufacturing	23	$	36	$	1	$	56,985
86	Cheese manufacturing	941	$	901	$	59	$	62,901
87	Dry, condensed, and evaporated dairy product manufacturing	46	$	65	$	4	$	82,163
88	Ice cream and frozen dessert manufacturing	526	$	216	$	28	$	53,682
89	Animal, except poultry, slaughtering	596	$	406	$	26	$	43,745
90	Meat processed from carcasses	1,170	$	605	$	59	$	50,467
91	Rendering and meat byproduct processing	4	$	2	$	0	$	74,580
92	Poultry processing	72	$	22	$	3	$	45,531
93	Seafood product preparation and packaging	1,169	$	395	$	47	$	40,212
94	Bread and bakery product, except frozen, manufacturing	6,765	$	871	$	254	$	37,616
95	Frozen cakes and other pastries manufacturing	544	$	91	$	18	$	33,394
96	Cookie and cracker manufacturing	654	$	260	$	49	$	74,308
97	Dry pasta, mixes, and dough manufacturing	203	$	111	$	10	$	47,929
98	Tortilla manufacturing	464	$	88	$	18	$	38,096
99	Roasted nuts and peanut butter manufacturing	85	$	62	$	3	$	32,383
100	Other snack food manufacturing	914	$	578	$	50	$	54,251
101	Coffee and tea manufacturing	1,371	$	896	$	55	$	39,914
102	Flavoring syrup and concentrate manufacturing	122	$	298	$	10	$	80,877
103	Mayonnaise, dressing, and sauce manufacturing	404	$	228	$	17	$	41,522
104	Spice and extract manufacturing	173	$	79	$	5	$	29,967
105	All other food manufacturing	2,716	$	884	$	106	$	38,971
106	Bottled and canned soft drinks & water	416	$	341	$	28	$	66,960

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107	Manufactured ice	83	$	10	$	3	$	35,864
108	Breweries	2,551	$	1,412	$	120	$	47,079
109	Wineries	3,653	$	1,134	$	142	$	38,792
110	Distilleries	322	$	330	$	12	$	38,460
111	Tobacco product manufacturing	6	$	16	$	0	$	40,000
112	Fiber, yarn, and thread mills	76	$	21	$	1	$	6,716
113	Broadwoven fabric mills	72	$	17	$	2	$	31,968
114	Narrow fabric mills and schiffli machine embroidery	-	$	-	$	-		
115	Nonwoven fabric mills	-	$	-	$	-		
116	Knit fabric mills	-	$	-	$	-		
117	Textile and fabric finishing mills	80	$	17	$	2	$	22,868
118	Fabric coating mills	-	$	-	$	-		
119	Carpet and rug mills	53	$	18	$	3	$	50,494
120	Curtain and linen mills	314	$	57	$	11	$	34,083
121	Textile bag and canvas mills	388	$	56	$	12	$	31,667
122	Rope, cordage, twine, tire cord and tire fabric mills	4	$	1	$	0	$	37,500
123	Other textile product mills	590	$	75	$	18	$	31,013
124	Hosiery and sock mills	-	$	-	$	-		
125	Other apparel knitting mills	66	$	16	$	2	$	25,993
126	Cut and sew apparel contractors	560	$	27	$	9	$	15,256
127	Mens and boys cut and sew apparel manufacturing	373	$	55	$	13	$	34,745
128	Womens and girls cut and sew apparel manufacturing	262	$	55	$	6	$	24,088
129	Other cut and sew apparel manufacturing	219	$	23	$	3	$	11,478
130	Apparel accessories and other apparel manufacturing	195	$	23	$	3	$	17,277
131	Leather and hide tanning and finishing	47	$	19	$	1	$	14,273
132	Footwear manufacturing	347	$	58	$	19	$	53,381
133	Other leather and allied product manufacturing	290	$	37	$	6	$	20,628
134	Sawmills	6,251	$	1,810	$	420	$	67,196

135	Wood preservation	621	$	346	$	32	$	51,878
136	Veneer and plywood manufacturing	6,099	$	1,784	$	380	$	62,255
137	Engineered wood member and truss manufacturing	1,603	$	343	$	88	$	55,031
138	Reconstituted wood product manufacturing	1,232	$	599	$	82	$	66,761
139	Wood windows and door manufacturing	2,115	$	483	$	109	$	51,587
140	Cut stock, resawing lumber, and planing	2,519	$	636	$	120	$	47,645
141	Other millwork, including flooring	880	$	201	$	43	$	48,372
142	Wood container and pallet manufacturing	954	$	146	$	34	$	35,481
143	Manufactured home (mobile home) manufacturing	1,006	$	214	$	51	$	50,658
144	Prefabricated wood building manufacturing	243	$	46	$	12	$	47,504
145	All other miscellaneous wood product manufacturing	478	$	81	$	16	$	34,398
146	Pulp mills	3	$	2	$	0	$	97,907
147	Paper mills	1,188	$	993	$	115	$	96,569
148	Paperboard mills	790	$	706	$	89	$	112,895
149	Paperboard container manufacturing	1,023	$	484	$	79	$	77,046
150	Paper bag and coated and treated paper manufacturing	771	$	356	$	48	$	62,560
151	Stationery product manufacturing	351	$	152	$	29	$	82,937
152	Sanitary paper product manufacturing	6	$	6	$	1	$	101,704
153	All other converted paper product manufacturing	126	$	47	$	13	$	100,589
154	Printing	6,498	$	1,035	$	284	$	43,758
155	Support activities for printing	300	$	36	$	15	$	50,174
156	Petroleum refineries	-	$	-	$	-		
157	Asphalt paving mixture and block manufacturing	127	$	95	$	9	$	70,382
158	Asphalt shingle and coating materials manufacturing	380	$	384	$	45	$	118,621
159	Petroleum lubricating oil and grease manufacturing	31	$	33	$	2	$	75,177

160	All other petroleum and coal products manufacturing	-	$ -	$ -	
161	Petrochemical manufacturing	-	$ -	$ -	
162	Industrial gas manufacturing	211	$ 190	$ 24	$ 113,348
163	Synthetic dye and pigment manufacturing	222	$ 177	$ 27	$ 119,868
164	Other basic inorganic chemical manufacturing	141	$ 109	$ 14	$ 99,058
165	Other basic organic chemical manufacturing	406	$ 620	$ 35	$ 86,833
166	Plastics material and resin manufacturing	195	$ 250	$ 19	$ 99,052
167	Synthetic rubber manufacturing	17	$ 16	$ 2	$ 106,075
168	Artificial and synthetic fibers and filaments manufacturing	-	$ -	$ -	
169	Nitrogenous fertilizer manufacturing	153	$ 194	$ 13	$ 85,709
170	Phosphatic fertilizer manufacturing	-	$ -	$ -	
171	Fertilizer mixing	256	$ 161	$ 16	$ 62,368
172	Pesticide and other agricultural chemical manufacturing	93	$ 124	$ 9	$ 91,797
173	Medicinal and botanical manufacturing	220	$ 82	$ 12	$ 52,718
174	Pharmaceutical preparation manufacturing	410	$ 476	$ 27	$ 65,208
175	In-vitro diagnostic substance manufacturing	77	$ 29	$ 7	$ 91,051
176	Biological product (except diagnostic) manufacturing	47	$ 27	$ 5	$ 100,163
177	Paint and coating manufacturing	525	$ 382	$ 40	$ 76,371
178	Adhesive manufacturing	150	$ 103	$ 16	$ 103,414
179	Soap and other detergent manufacturing	195	$ 175	$ 7	$ 38,057
180	Polish and other sanitation good manufacturing	77	$ 43	$ 4	$ 49,113
181	Surface active agent manufacturing	-	$ -	$ -	
182	Toilet preparation manufacturing	393	$ 277	$ 12	$ 31,743
183	Printing ink manufacturing	35	$ 16	$ 2	$ 66,874
184	Explosives manufacturing	8	$ 3	$ 0	$ 1,411
185	Custom compounding of purchased resins	34	$ 18	$ 2	$ 67,042
186	Photographic film and chemical manufacturing	325	$ 219	$ 25	$ 75,415
187	Other miscellaneous chemical product manufacturing	145	$ 77	$ 6	$ 42,376

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188	Plastics packaging materials and unlaminated film and sheet manufacturing	350	$	158	$	26	$	75,461
189	Unlaminated plastics profile shape manufacturing	185	$	64	$	9	$	46,073
190	Plastics pipe and pipe fitting manufacturing	216	$	107	$	14	$	65,295
191	Laminated plastics plate, sheet (except packaging), and shape manufacturing	191	$	64	$	11	$	60,137
192	Polystyrene foam product manufacturing	17	$	5	$	1	$	41,830
193	Urethane and other foam product (except polystyrene) manufacturing	253	$	91	$	13	$	52,609
194	Plastics bottle manufacturing	27	$	12	$	2	$	61,091
195	Other plastics product manufacturing	3,726	$	1,006	$	214	$	57,505
196	Tire manufacturing	195	$	72	$	9	$	45,198
197	Rubber and plastics hoses and belting manufacturing	31	$	6	$	1	$	22,897
198	Other rubber product manufacturing	511	$	154	$	25	$	49,527
199	Pottery, ceramics, and plumbing fixture manufacturing	343	$	50	$	14	$	39,468
200	Brick, tile, and other structural clay product manufacturing	413	$	91	$	18	$	43,241
201	Flat glass manufacturing	222	$	74	$	9	$	41,997
202	Other pressed and blown glass and glassware manufacturing	345	$	89	$	18	$	52,142
203	Glass container manufacturing	203	$	80	$	16	$	76,746
204	Glass product manufacturing made of purchased glass	1,429	$	340	$	70	$	48,713
205	Cement manufacturing	82	$	56	$	9	$	105,347
206	Ready-mix concrete manufacturing	1,040	$	390	$	65	$	62,602
207	Concrete block and brick manufacturing	283	$	82	$	16	$	55,249
208	Concrete pipe manufacturing	76	$	25	$	6	$	77,167
209	Other concrete product manufacturing	468	$	105	$	27	$	57,276
210	Lime manufacturing	75	$	42	$	7	$	89,468
211	Gypsum product manufacturing	126	$	73	$	9	$	72,822

212	Abrasive product manufacturing	145	$	61	$	12	$	81,235
213	Cut stone and stone product manufacturing	401	$	56	$	19	$	46,603
214	Ground or treated mineral and earth manufacturing	107	$	62	$	9	$	83,027
215	Mineral wool manufacturing	81	$	33	$	6	$	71,944
216	Miscellaneous nonmetallic mineral products manufacturing	24	$	9	$	1	$	58,405
217	Iron and steel mills and ferroalloy manufacturing	903	$	794	$	89	$	98,875
218	Iron, steel pipe and tube manufacturing from purchased steel	127	$	55	$	11	$	85,733
219	Rolled steel shape manufacturing	-	$	-	$	-		
220	Steel wire drawing	-	$	-	$	-		
221	Alumina refining and primary aluminum production	4	$	2	$	0	$	33,162
222	Secondary smelting and alloying of aluminum	137	$	118	$	6	$	44,684
223	Aluminum sheet, plate, and foil manufacturing	-	$	-	$	-		
224	Other aluminum rolling, drawing and extruding	429	$	184	$	26	$	61,445
225	Nonferrous metal (exc aluminum) smelting and refining	954	$	1,039	$	96	$	100,920
226	Copper rolling, drawing, extruding and alloying	111	$	108	$	8	$	75,754
227	Nonferrous metal, except copper and aluminum, shaping	18	$	7	$	1	$	47,211
228	Secondary processing of other nonferrous metals	5	$	4	$	0	$	1,968
229	Ferrous metal foundries	3,294	$	1,126	$	325	$	98,599
230	Nonferrous metal foundries	2,664	$	658	$	189	$	70,969
231	Iron and steel forging	74	$	26	$	4	$	54,755
232	Nonferrous forging	13	$	6	$	1	$	85,201
233	Custom roll forming	48	$	26	$	2	$	52,104
234	Crown and closure manufacturing and metal stamping	218	$	46	$	12	$	53,942
235	Cutlery, utensil, pot, and pan manufacturing	807	$	439	$	57	$	70,638

236	Handtool manufacturing	1,342	$	348	$	109	$	81,376
237	Prefabricated metal buildings and components manufacturing	388	$	105	$	23	$	60,392
238	Fabricated structural metal manufacturing	1,230	$	402	$	90	$	73,180
239	Plate work manufacturing	360	$	76	$	26	$	72,167
240	Metal window and door manufacturing	319	$	72	$	17	$	53,911
241	Sheet metal work manufacturing	1,140	$	226	$	63	$	55,175
242	Ornamental and architectural metal work manufacturing	917	$	176	$	49	$	53,075
243	Power boiler and heat exchanger manufacturing	162	$	45	$	10	$	64,621
244	Metal tank (heavy gauge) manufacturing	349	$	91	$	25	$	72,624
245	Metal cans manufacturing	6	$	5	$	0	$	71,836
246	Metal barrels, drums and pails manufacturing	318	$	97	$	16	$	50,300
247	Hardware manufacturing	70	$	21	$	3	$	47,054
248	Spring and wire product manufacturing	444	$	108	$	26	$	58,341
249	Machine shops	3,859	$	540	$	215	$	55,636
250	Turned product and screw, nut, and bolt manufacturing	520	$	125	$	31	$	59,126
251	Metal heat treating	184	$	55	$	12	$	66,415
252	Metal coating and nonprecious engraving	698	$	154	$	31	$	44,129
253	Electroplating, anodizing, and coloring metal	703	$	95	$	35	$	49,332
254	Valve and fittings, other than plumbing, manufacturing	138	$	42	$	9	$	62,833
255	Plumbing fixture fitting and trim manufacturing	98	$	54	$	6	$	58,575
256	Ball and roller bearing manufacturing	-	$	-	$	-		
257	Small arms ammunition manufacturing	233	$	69	$	13	$	56,035
258	Ammunition, except for small arms, manufacturing	-	$	-	$	-		
259	Small arms, ordnance, and accessories manufacturing	139	$	37	$	5	$	34,293
260	Fabricated pipe and pipe fitting manufacturing	541	$	133	$	33	$	60,561
261	Other fabricated metal manufacturing	1,970	$	395	$	98	$	49,688
262	Farm machinery and equipment manufacturing	775	$	402	$	51	$	66,416

263	Lawn and garden equipment manufacturing	82	$	46	$	4	$	51,700
264	Construction machinery manufacturing	447	$	305	$	33	$	73,329
265	Mining machinery and equipment manufacturing	59	$	19	$	4	$	64,871
266	Oil and gas field machinery and equipment manufacturing	47	$	19	$	3	$	65,953
267	Food product machinery manufacturing	427	$	126	$	26	$	61,371
268	Semiconductor machinery manufacturing	2,059	$	1,027	$	287	$	139,152
269	Sawmill, woodworking, and paper machinery	1,062	$	261	$	75	$	70,387
270	Printing machinery and equipment manufacturing	30	$	7	$	2	$	64,459
271	All other industrial machinery manufacturing	565	$	147	$	36	$	63,621
272	Optical instrument and lens manufacturing	1,043	$	320	$	91	$	87,470
273	Photographic and photocopying equipment manufacturing	49	$	14	$	2	$	40,308
274	Other commercial service industry machinery manufacturing	513	$	194	$	36	$	69,280
275	Air purification and ventilation equipment manufacturing	488	$	138	$	36	$	73,470
276	Heating equipment (except warm air furnaces) manufacturing	167	$	51	$	12	$	74,258
277	Air conditioning, refrigeration, and warm air heating equipment manufacturing	310	$	121	$	18	$	59,664
278	Industrial mold manufacturing	306	$	44	$	15	$	49,959
279	Special tool, die, jig, and fixture manufacturing	195	$	26	$	9	$	45,445
280	Cutting tool and machine tool accessory manufacturing	232	$	38	$	11	$	47,964
281	Machine tool manufacturing	242	$	59	$	16	$	66,128
282	Rolling mill and other metalworking machinery manufacturing	31	$	7	$	2	$	63,542
283	Turbine and turbine generator set units manufacturing	31	$	14	$	3	$	94,592

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284	Speed changer, industrial high-speed drive, and gear manufacturing	43	$	12	$	4	$	86,292
285	Mechanical power transmission equipment manufacturing	235	$	68	$	17	$	71,174
286	Other engine equipment manufacturing	65	$	58	$	4	$	54,732
287	Pump and pumping equipment manufacturing	487	$	227	$	41	$	84,597
288	Air and gas compressor manufacturing	106	$	51	$	9	$	86,654
289	Measuring and dispensing pump manufacturing	-	$	-	$	-		
290	Elevator and moving stairway manufacturing	-	$	-	$	-		
291	Conveyor and conveying equipment manufacturing	779	$	206	$	53	$	67,738
292	Overhead cranes, hoists, and monorail systems manufacturing	303	$	124	$	19	$	63,954
293	Industrial truck, trailer, and stacker manufacturing	714	$	311	$	61	$	85,785
294	Power-driven handtool manufacturing	288	$	143	$	20	$	67,814
295	Welding and soldering equipment manufacturing	19	$	6	$	1	$	66,683
296	Packaging machinery manufacturing	15	$	3	$	0	$	24,209
297	Industrial process furnace and oven manufacturing	57	$	14	$	4	$	70,826
298	Fluid power cylinder and actuator manufacturing	161	$	42	$	12	$	72,987
299	Fluid power pump and motor manufacturing	18	$	8	$	1	$	76,715
300	Scales, balances, and miscellaneous general purpose machinery manufacturing	244	$	63	$	14	$	56,222
301	Electronic computer manufacturing	341	$	597	$	40	$	116,378
302	Computer storage device manufacturing	91	$	231	$	9	$	100,981
303	Computer terminals and other computer peripheral equipment manufacturing	1,037	$	980	$	97	$	93,247
304	Telephone apparatus manufacturing	77	$	80	$	7	$	87,078
305	Broadcast and wireless communications equipment manufacturing	126	$	63	$	11	$	87,971

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306	Other communications equipment manufacturing	315	$	182	$	24	$	75,879
307	Audio and video equipment manufacturing	605	$	353	$	45	$	73,692
308	Bare printed circuit board manufacturing	721	$	216	$	40	$	55,383
309	Semiconductor and related device manufacturing	24,653	$	28,720	$	4,570	$	185,362
310	Capacitor, resistor, coil, transformer, and other inductor manufacturing	421	$	131	$	28	$	65,374
311	Electronic connector manufacturing	52	$	25	$	3	$	67,886
312	Printed circuit assembly (electronic assembly) manufacturing	1,190	$	496	$	70	$	58,620
313	Other electronic component manufacturing	703	$	285	$	58	$	82,954
314	Electromedical and electrotherapeutic apparatus manufacturing	660	$	458	$	48	$	73,274
315	Search, detection, and navigation instruments manufacturing	997	$	605	$	126	$	125,849
316	Automatic environmental control manufacturing	5	$	2	$	0	$	48,983
317	Industrial process variable instruments manufacturing	471	$	194	$	35	$	75,208
318	Totalizing fluid meter and counting device manufacturing	109	$	50	$	6	$	52,246
319	Electricity and signal testing instruments manufacturing	1,362	$	982	$	200	$	146,581
320	Analytical laboratory instrument manufacturing	839	$	712	$	146	$	174,564
321	Irradiation apparatus manufacturing	-	$	-	$	-		
322	Watch, clock, and other measuring and controlling device manufacturing	386	$	149	$	22	$	56,993
323	Blank magnetic and optical recording media manufacturing	-	$	-	$	-		
324	Software and other prerecorded and record reproducing	45	$	11	$	2	$	39,540
325	Electric lamp bulb and part manufacturing	64	$	24	$	6	$	86,286
326	Lighting fixture manufacturing	396	$	125	$	26	$	66,563

327	Small electrical appliance manufacturing	54	$	22	$	2	$	28,273
328	Household cooking appliance manufacturing	84	$	35	$	5	$	59,757
329	Household refrigerator and home freezer manufacturing	-	$	-	$	-		
330	Household laundry equipment manufacturing	-	$	-	$	-		
331	Other major household appliance manufacturing	-	$	-	$	-		
332	Power, distribution, and specialty transformer manufacturing	175	$	55	$	10	$	56,468
333	Motor and generator manufacturing	23	$	8	$	1	$	56,834
334	Switchgear and switchboard apparatus manufacturing	158	$	57	$	12	$	74,100
335	Relay and industrial control manufacturing	455	$	141	$	34	$	75,663
336	Storage battery manufacturing	405	$	176	$	38	$	94,580
337	Primary battery manufacturing	-	$	-	$	-		
338	Fiber optic cable manufacturing	129	$	70	$	8	$	61,477
339	Other communication and energy wire manufacturing	33	$	17	$	2	$	58,457
340	Wiring device manufacturing	276	$	111	$	26	$	93,031
341	Carbon and graphite product manufacturing	159	$	62	$	13	$	79,056
342	All other miscellaneous electrical equipment and component manufacturing	302	$	88	$	26	$	86,241
343	Automobile manufacturing	10	$	18	$	1	$	101,890
344	Light truck and utility vehicle manufacturing	6	$	13	$	1	$	97,214
345	Heavy duty truck manufacturing	765	$	905	$	61	$	79,630
346	Motor vehicle body manufacturing	229	$	74	$	13	$	58,010
347	Truck trailer manufacturing	378	$	124	$	24	$	63,478
348	Motor home manufacturing	240	$	103	$	14	$	57,244
349	Travel trailer and camper manufacturing	2,412	$	751	$	123	$	50,881
350	Motor vehicle gasoline engine and engine parts manufacturing	51	$	31	$	3	$	51,536
351	Motor vehicle electrical and electronic equipment manufacturing	358	$	174	$	27	$	74,523

352	Motor vehicle steering, suspension component (except spring), and brake systems manufacturing	215	$	111	$	14	$	64,281
353	Motor vehicle transmission and power train parts manufacturing	214	$	133	$	16	$	74,554
354	Motor vehicle seating and interior trim manufacturing	25	$	13	$	1	$	40,820
355	Motor vehicle metal stamping	170	$	70	$	11	$	65,658
356	Other motor vehicle parts manufacturing	578	$	322	$	36	$	61,436
357	Aircraft manufacturing	923	$	648	$	83	$	90,356
358	Aircraft engine and engine parts manufacturing	202	$	110	$	15	$	75,528
359	Other aircraft parts and auxiliary equipment manufacturing	2,394	$	717	$	268	$	112,126
360	Guided missile and space vehicle manufacturing	-	$	-	$	-		
361	Propulsion units and parts for space vehicles and guided missiles manufacturing	-	$	-	$	-		
362	Railroad rolling stock manufacturing	998	$	718	$	66	$	65,766
363	Ship building and repairing	1,434	$	365	$	127	$	88,676
364	Boat building	459	$	137	$	21	$	45,564
365	Motorcycle, bicycle, and parts manufacturing	413	$	264	$	19	$	44,853
366	Military armored vehicle, tank, and tank component manufacturing	-	$	-	$	-		
367	All other transportation equipment manufacturing	62	$	37	$	4	$	58,130
368	Wood kitchen cabinet and countertop manufacturing	3,650	$	499	$	142	$	38,871
369	Upholstered household furniture manufacturing	442	$	86	$	15	$	34,507
370	Nonupholstered wood household furniture manufacturing	410	$	51	$	15	$	35,690
371	Other household nonupholstered furniture manufacturing	36	$	9	$	0	$	12,857
372	Institutional furniture manufacturing	264	$	50	$	14	$	53,387
373	Wood office furniture manufacturing	81	$	15	$	3	$	33,175

374	Custom architectural woodwork and millwork	457	$ 69	$ 21	$ 45,211
375	Office furniture, except wood, manufacturing	242	$ 86	$ 14	$ 58,522
376	Showcase, partition, shelving, and locker manufacturing	1,095	$ 275	$ 93	$ 84,986
377	Mattress manufacturing	231	$ 94	$ 9	$ 39,570
378	Blind and shade manufacturing	-	$ -	$ -	
379	Surgical and medical instrument manufacturing	47	$ 17	$ 4	$ 75,070
380	Surgical appliance and supplies manufacturing	1,211	$ 444	$ 94	$ 77,756
381	Dental equipment and supplies manufacturing	1,283	$ 411	$ 114	$ 88,853
382	Ophthalmic goods manufacturing	327	$ 83	$ 20	$ 61,582
383	Dental laboratories	794	$ 71	$ 38	$ 47,278
384	Jewelry and silverware manufacturing	599	$ 112	$ 9	$ 15,554
385	Sporting and athletic goods manufacturing	1,461	$ 346	$ 68	$ 46,871
386	Doll, toy, and game manufacturing	281	$ 73	$ 8	$ 27,336
387	Office supplies (except paper) manufacturing	301	$ 65	$ 14	$ 45,622
388	Sign manufacturing	1,854	$ 208	$ 75	$ 40,389
389	Gasket, packing, and sealing device manufacturing	591	$ 124	$ 33	$ 55,528
390	Musical instrument manufacturing	314	$ 37	$ 10	$ 31,170
391	Fasteners, buttons, needles, and pins manufacturing	15	$ 2	$ 0	$ 6,456
392	Broom, brush, and mop manufacturing	354	$ 90	$ 18	$ 50,725
393	Burial casket manufacturing	39	$ 6	$ 2	$ 43,371
394	All other miscellaneous manufacturing	1,092	$ 162	$ 33	$ 29,826
395	Wholesale trade	86,401	$ 18,730	$ 6,072	$ 70,279
396	Retail - Motor vehicle and parts dealers	19,060	$ 2,018	$ 1,021	$ 53,557
397	Retail - Furniture and home furnishings stores	7,405	$ 718	$ 281	$ 37,944
398	Retail - Electronics and appliance stores	7,658	$ 391	$ 334	$ 43,652
399	Retail - Building material and garden equipment and supplies stores	17,560	$ 1,652	$ 656	$ 37,385
400	Retail - Food and beverage stores	40,026	$ 2,608	$ 1,173	$ 29,298
401	Retail - Health and personal care stores	11,637	$ 957	$ 419	$ 35,968
402	Retail - Gasoline stores	11,828	$ 710	$ 285	$ 24,129

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403	Retail - Clothing and clothing accessories stores	18,770	$	1,488	$	449	$	23,924
404	Retail - Sporting goods, hobby, musical instrument and book stores	13,541	$	659	$	260	$	19,173
405	Retail - General merchandise stores	41,601	$	2,693	$	1,340	$	32,208
406	Retail - Miscellaneous store retailers	24,534	$	838	$	340	$	13,868
407	Retail - Nonstore retailers	27,108	$	2,970	$	414	$	15,262
408	Air transportation	4,585	$	1,900	$	367	$	80,158
409	Rail transportation	2,319	$	818	$	254	$	109,473
410	Water transportation	492	$	400	$	59	$	120,009
411	Truck transportation	25,346	$	4,302	$	1,198	$	47,248
412	Transit and ground passenger transportation	8,780	$	703	$	174	$	19,824
413	Pipeline transportation	118	$	42	$	13	$	114,015
414	Scenic and sightseeing transportation and support activities for transportation	8,913	$	1,504	$	453	$	50,849
415	Couriers and messengers	11,488	$	1,265	$	409	$	35,588
416	Warehousing and storage	9,273	$	935	$	458	$	49,361
417	Newspaper publishers	2,559	$	307	$	108	$	42,134
418	Periodical publishers	1,145	$	285	$	54	$	46,776
419	Book publishers	725	$	268	$	32	$	44,066
420	Directory, mailing list, and other publishers	220	$	55	$	7	$	31,111
421	Greeting card publishing	19	$	3	$	1	$	32,092
422	Software publishers	12,345	$	3,750	$	1,298	$	105,106
423	Motion picture and video industries	6,004	$	1,236	$	225	$	37,559
424	Sound recording industries	475	$	132	$	8	$	15,856
425	Radio and television broadcasting	2,970	$	824	$	177	$	59,460
426	Cable and other subscription programming	440	$	509	$	27	$	60,927
427	Wired telecommunications carriers	5,984	$	2,544	$	440	$	73,463
428	Wireless telecommunications carriers (except satellite)	767	$	1,571	$	31	$	40,717
429	Satellite, telecommunications resellers, and all other telecommunications	751	$	61	$	27	$	35,778
430	Data processing, hosting, and related services	5,867	$	1,660	$	567	$	96,664

431	News syndicates, libraries, archives and all other information services	422	$	318	$	15	$	35,139
432	Internet publishing and broadcasting and web search portals	1,179	$	560	$	99	$	83,766
433	Monetary authorities and depository credit intermediation	19,097	$	4,446	$	1,399	$	73,234
434	Nondepository credit intermediation and related activities	9,228	$	1,656	$	835	$	90,442
435	Securities and commodity contracts intermediation and brokerage	6,990	$	727	$	484	$	69,184
436	Other financial investment activities	20,090	$	3,087	$	395	$	19,654
437	Insurance carriers	10,087	$	4,516	$	1,019	$	100,988
438	Insurance agencies, brokerages, and related activities	20,279	$	3,909	$	1,272	$	62,699
439	Funds, trusts, and other financial vehicles	5,503	$	1,317	$	201	$	36,613
440	Real estate	100,381	$	21,665	$	1,060	$	10,562
441	Owner-occupied dwellings	-	$	18,267	$	-		
442	Automotive equipment rental and leasing	2,639	$	517	$	84	$	31,951
443	General and consumer goods rental except video tapes and discs	2,747	$	219	$	84	$	30,513
444	Video tape and disc rental	386	$	88	$	7	$	17,566
445	Commercial and industrial machinery and equipment rental and leasing	2,920	$	541	$	74	$	25,420
446	Lessors of nonfinancial intangible assets	2,028	$	2,159	$	28	$	13,791
447	Legal services	17,424	$	2,684	$	1,100	$	63,112
448	Accounting, tax preparation, bookkeeping, and payroll services	17,450	$	1,528	$	724	$	41,467
449	Architectural, engineering, and related services	18,991	$	2,936	$	1,355	$	71,344
450	Specialized design services	8,442	$	687	$	170	$	20,196
451	Custom computer programming services	14,928	$	3,016	$	1,183	$	79,251
452	Computer systems design services	8,476	$	1,083	$	838	$	98,860
453	Other computer related services, including facilities management	4,097	$	621	$	351	$	85,748

454	Management consulting services	15,304	$	1,676	$	791	$	51,681
455	Environmental and other technical consulting services	11,087	$	881	$	504	$	45,436
456	Scientific research and development services	21,123	$	6,813	$	1,751	$	82,917
457	Advertising, public relations, and related services	9,926	$	2,353	$	561	$	56,569
458	Photographic services	4,436	$	233	$	27	$	6,002
459	Veterinary services	6,627	$	691	$	260	$	39,287
460	Marketing research and all other miscellaneous professional, scientific, and technical services	19,280	$	1,212	$	336	$	17,423
461	Management of companies and enterprises	46,107	$	11,782	$	6,098	$	132,250
462	Office administrative services	4,485	$	266	$	120	$	26,795
463	Facilities support services	1,082	$	151	$	26	$	24,454
464	Employment services	42,090	$	3,526	$	1,724	$	40,968
465	Business support services	17,931	$	1,029	$	632	$	35,266
466	Travel arrangement and reservation services	3,623	$	621	$	150	$	41,317
467	Investigation and security services	8,621	$	488	$	306	$	35,533
468	Services to buildings	24,761	$	1,041	$	367	$	14,841
469	Landscape and horticultural services	16,174	$	960	$	405	$	25,059
470	Other support services	6,953	$	642	$	277	$	39,785
471	Waste management and remediation services	5,690	$	1,185	$	331	$	58,187
472	Elementary and secondary schools	12,958	$	631	$	437	$	33,686
473	Junior colleges, colleges, universities, and professional schools	21,077	$	1,387	$	652	$	30,946
474	Other educational services	20,650	$	770	$	415	$	20,086
475	Offices of physicians	36,506	$	5,298	$	3,340	$	91,490
476	Offices of dentists	16,733	$	2,073	$	974	$	58,184
477	Offices of other health practitioners	24,821	$	2,148	$	710	$	28,604
478	Outpatient care centers	12,036	$	2,455	$	1,119	$	92,994
479	Medical and diagnostic laboratories	3,533	$	412	$	238	$	67,244
480	Home health care services	8,494	$	491	$	241	$	28,415
481	Other ambulatory health care services	3,964	$	412	$	185	$	46,736
482	Hospitals	58,117	$	9,619	$	4,833	$	83,166

483	Nursing and community care facilities	37,621	$	2,475	$	1,254	$	33,319
484	Residential mental retardation, mental health, substance abuse and other facilities	15,154	$	719	$	513	$	33,860
485	Individual and family services	19,925	$	797	$	523	$	26,224
486	Community food, housing, and other relief services, including rehabilitation services	10,999	$	1,171	$	386	$	35,131
487	Child day care services	19,731	$	907	$	304	$	15,402
488	Performing arts companies	4,097	$	450	$	82	$	20,056
489	Commercial Sports Except Racing	3,252	$	275	$	139	$	42,889
490	Racing and Track Operation	582	$	15	$	3	$	5,942
491	Promoters of performing arts and sports and agents for public figures	2,774	$	301	$	43	$	15,340
492	Independent artists, writers, and performers	20,823	$	601	$	26	$	1,240
493	Museums, historical sites, zoos, and parks	1,657	$	132	$	58	$	35,130
494	Amusement parks and arcades	527	$	40	$	11	$	20,543
495	Gambling industries (except casino hotels)	5,611	$	783	$	135	$	24,014
496	Other amusement and recreation industries	9,496	$	565	$	178	$	18,795
497	Fitness and recreational sports centers	9,340	$	421	$	137	$	14,615
498	Bowling centers	1,050	$	64	$	20	$	19,204
499	Hotels and motels, including casino hotels	17,608	$	1,822	$	462	$	26,257
500	Other accommodations	2,635	$	135	$	35	$	13,298
501	Full-service restaurants	72,900	$	3,620	$	1,759	$	24,127
502	Limited-service restaurants	63,528	$	5,409	$	1,191	$	18,749
503	All other food and drinking places	41,916	$	1,633	$	974	$	23,226
504	Automotive repair and maintenance, except car washes	22,607	$	2,092	$	958	$	42,397
505	Car washes	2,782	$	179	$	80	$	28,687
506	Electronic and precision equipment repair and maintenance	2,956	$	403	$	164	$	55,539
507	Commercial and industrial machinery and equipment repair and maintenance	5,533	$	833	$	391	$	70,718
508	Personal and household goods repair and maintenance	6,480	$	648	$	110	$	16,974

509	Personal care services	20,148	$	735	$	193	$	9,600
510	Death care services	1,224	$	113	$	44	$	36,008
511	Dry-cleaning and laundry services	3,323	$	237	$	115	$	34,578
512	Other personal services	15,340	$	512	$	113	$	7,360
513	Religious organizations	27,357	$	727	$	1,156	$	42,258
514	Grantmaking, giving, and social advocacy organizations	6,096	$	1,094	$	319	$	52,408
515	Business and professional associations	2,159	$	393	$	138	$	63,744
516	Labor and civic organizations	8,309	$	671	$	240	$	28,903
517	Private households	22,006	$	278	$	278	$	12,636
518	Postal service	6,806	$	655	$	557	$	81,836
519	Federal electric utilities	1,284	$	1,512	$	193	$	149,958
520	Other federal government enterprises	71	$	6	$	7	$	105,830
521	State government passenger transit	-	$	-	$	-		
522	State government electric utilities	-	$	-	$	-		
523	Other state government enterprises	65	$	21	$	7	$	101,272
524	Local government passenger transit	3,822	$	212	$	214	$	55,913
525	Local government electric utilities	937	$	551	$	117	$	124,384
526	Other local government enterprises	13,366	$	4,257	$	1,080	$	80,775
527	* Not an industry (Used and secondhand goods)	-	$	-	$	-		
528	* Not an industry (Scrap)	-	$	-	$	-		
529	* Not an industry (Rest of world adjustment)	-	$	-	$	-		
530	* Not an industry (Noncomparable foreign imports)	-	$	-	$	-		
531	* Employment and payroll of state govt, non-education	42,103	$	3,445	$	3,002	$	71,304
532	* Employment and payroll of state govt, education	151	$	8	$	7	$	45,052
533	* Employment and payroll of local govt, non-education	60,661	$	5,291	$	4,603	$	75,886
534	* Employment and payroll of local govt, education	119,800	$	10,055	$	8,749	$	73,032

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535	* Employment and payroll of federal govt, non-military	19,516	$	2,905	$	2,129	$	109,071
536	* Employment and payroll of federal govt, military	12,515	$	785	$	475	$	37,919

Source: US Bureau of Labor Statistics, US Bureau of Economic Analysis, and IMPLAN.

Table A4.14: Oregon Household Consumption Expenditure (2017 $Millions and percent shares)

	Household Consumption	Share
Vehicles and parts	$ 5,703	3%
Other Durables	$ 13,067	7%
Energy Fuels	$ 3,330	2%
Other Nondurables	$ 31,280	18%
Transport Services	$ 5,801	3%
Utilities	$ 3,340	2%
Other Services	$ 112,111	64%
Total	$ 174,630	100%

Source: US Bureau of Economic Analysis

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Table A4.19: Incremental Vehicle Costs, by Vehicle Type

	PHEV20	PHEV20	PHEV40	PHEV40	BEV	BEV
	Passenger Car	Light Truck	Passenger Car	Light Truck	Passenger Car	Light Truck
2012	$ 12,699	$ 16,612	$ 16,965	$ 22,374	$ 18,647	$ 27,233
2013	$ 11,434	$ 15,017	$ 15,206	$ 20,142	$ 16,380	$ 24,035
2014	$ 10,241	$ 13,477	$ 13,535	$ 17,977	$ 14,205	$ 20,937
2015	$ 9,086	$ 11,953	$ 11,916	$ 15,842	$ 12,089	$ 17,901
2016	$ 8,260	$ 10,763	$ 10,786	$ 14,255	$ 10,663	$ 15,747
2017	$ 7,381	$ 9,814	$ 9,612	$ 12,918	$ 9,196	$ 13,862
2018	$ 6,557	$ 8,796	$ 8,501	$ 11,521	$ 7,743	$ 11,923
2019	$ 5,787	$ 7,833	$ 7,456	$ 10,185	$ 6,448	$ 10,066
2020	$ 5,047	$ 6,884	$ 6,448	$ 8,873	$ 5,151	$ 8,251
2021	$ 4,690	$ 6,248	$ 6,012	$ 8,137	$ 4,683	$ 7,404
2022	$ 4,014	$ 5,528	$ 5,260	$ 7,321	$ 3,900	$ 6,479
2023	$ 3,464	$ 4,924	$ 4,636	$ 6,621	$ 3,252	$ 5,691
2024	$ 2,932	$ 4,342	$ 4,031	$ 5,946	$ 2,626	$ 4,929
2025	$ 2,585	$ 3,955	$ 3,613	$ 5,467	$ 2,183	$ 4,366
2026	$ 2,216	$ 3,614	$ 3,195	$ 5,064	$ 1,770	$ 3,920
2027	$ 1,854	$ 3,215	$ 2,785	$ 4,606	$ 1,365	$ 3,421
2028	$ 1,497	$ 2,822	$ 2,382	$ 4,156	$ 968	$ 2,935
2029	$ 1,145	$ 2,436	$ 1,986	$ 3,714	$ 579	$ 2,459
2030	$ 798	$ 2,055	$ 1,597	$ 3,280	$ 197	$ 1,995

Source: EIA (2017), EPA&NHTSA (2010), Winchester et al: 2010, and Bunch (2004).

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Table A4.20: Scenarios for Battery Electric Vehicle Adoption (EV percentage of the Light Duty vehicle fleet)

	Cunningham/CARB	Moderate	Early	Late
2010	0%	0%	0%	0%
2011	0%	0%	0%	0%
2012	0%	0%	0%	0%
2013	0%	0%	0%	0%
2014	0%	0%	0%	0%
2015	1%	0%	2%	0%
2016	1%	1%	2%	0%
2017	1%	1%	3%	0%
2018	1%	1%	4%	0%
2019	2%	1%	6%	0%
2020	2%	2%	8%	0%
2021	2%	2%	10%	1%
2022	3%	3%	13%	1%
2023	4%	4%	17%	1%
2024	4%	5%	22%	1%
2025	5%	7%	27%	2%
2026	6%	9%	34%	2%
2027	6%	12%	41%	3%
2028	7%	15%	48%	4%
2029	7%	20%	56%	6%
2030	8%	25%	63%	8%
2031	9%	30%	70%	10%
2032	10%	37%	76%	13%
2033	11%	44%	81%	17%
2034	13%	51%	85%	21%
2035	15%	58%	89%	27%
2036	17%	65%	91%	33%
2037	19%	71%	93%	40%
2038	22%	76%	95%	47%
2039	24%	81%	96%	55%
2040	28%	85%	97%	62%
2041	32%	89%	98%	69%
2042	36%	91%	98%	75%
2043	41%	93%	99%	80%
2044	46%	95%	99%	84%
2045	53%	96%	99%	88%
2046	60%	97%	100%	91%
2047	68%	98%	100%	93%
2048	77%	98%	100%	95%
2049	88%	99%	100%	96%
2050	100%	99%	100%	97%

Sources: EIA (2017), EPA&NHTSA (2010), Winchester et al: 2010, and Bunch (2004).ODOT (2012) and http://www.dot.ca.gov/hq/tsip/smb/documents/mvstaff/mvstaff08.pdf

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Table A4.21: Oregon Vehicle Fleet – Moderate BEV Adoption Profile (millions of Light Duty Vehicles)

	Fleet	ICE	PHEV	BEV
2010	3.287	3.287	0.000	0.000
2011	3.349	3.349	0.000	0.000
2012	3.413	3.413	0.000	0.000
2013	3.478	3.474	0.002	0.000
2014	3.544	3.530	0.008	0.000
2015	3.611	3.595	0.010	0.000
2016	3.673	3.651	0.013	0.000
2017	3.735	3.707	0.018	0.000
2018	3.799	3.760	0.024	0.001
2019	3.864	3.812	0.033	0.001
2020	3.930	3.860	0.044	0.001
2021	3.989	3.895	0.062	0.002
2022	4.050	3.922	0.084	0.004
2023	4.111	3.940	0.114	0.006
2024	4.173	3.945	0.153	0.010
2025	4.236	3.933	0.205	0.015
2026	4.299	3.899	0.271	0.022
2027	4.362	3.837	0.357	0.032
2028	4.425	3.742	0.465	0.046
2029	4.489	3.610	0.600	0.063
2030	4.552	3.436	0.763	0.086
2031	4.618	3.223	0.893	0.123
2032	4.684	2.970	1.018	0.171
2033	4.752	2.685	1.127	0.235
2034	4.820	2.378	1.207	0.315
2035	4.889	2.064	1.252	0.415
2036	4.959	1.755	1.255	0.534
2037	5.030	1.465	1.218	0.676
2038	5.103	1.202	1.145	0.840
2039	5.176	0.971	1.044	1.029
2040	5.250	0.775	0.925	1.245
2041	5.326	0.612	0.796	1.490
2042	5.402	0.479	0.667	1.769
2043	5.480	0.373	0.543	2.085
2044	5.558	0.289	0.428	2.446
2045	5.638	0.222	0.325	2.856
2046	5.719	0.171	0.236	3.326
2047	5.801	0.131	0.159	3.863
2048	5.885	0.100	0.095	4.478
2049	5.969	0.077	0.042	5.185
2050	6.055	0.058	0.000	5.997

Sources: EIA (2017), EPA&NHTSA (2010), Winchester et al: 2010, and Bunch (2004).ODOT (2012) and http://www.dot.ca.gov/hq/tsip/smb/documents/mvstaff/mvstaff08.pdf

Figure 4.22: Potential Benefits and Costs of BEV Adoption (2016 $ millions)

	Incremental Costs	Fuel Cost Savings	Total Incentives	LCFS Credit	Net Savings
2016	$ (0.645)	$ 0.233	$ 1.561	$ 0.005	$ 1.154
2017	$ (7.372)	$ 2.844	$ 18.275	$ 0.063	$ 13.810
2018	$ (18.743)	$ 8.074	$ 34.990	$ 0.174	$ 24.495
2019	$ (33.383)	$ 15.993	$ 51.704	$ 0.340	$ 34.654
2020	$ (50.569)	$ 24.436	$ 55.974	$ 0.560	$ 30.401
2021	$ (67.808)	$ 34.593	$ 52.456	$ 0.821	$ 20.063
2022	$ (80.668)	$ 46.363	$ 49.061	$ 1.158	$ 15.914
2023	$ (91.871)	$ 62.679	$ 43.244	$ 1.622	$ 15.674
2024	$ (103.726)	$ 83.836	$ 29.693	$ 2.283	$ 12.086
2025	$ (120.531)	$ 108.226	$ -	$ 3.081	$ (9.224)
2026	$ (142.275)	$ 138.121	$ -	$ 4.132	$ (0.022)
2027	$ (166.820)	$ 172.346	$ -	$ 5.423	$ 10.949
2028	$ (189.712)	$ 211.923	$ -	$ 6.892	$ 29.103
2029	$ (209.024)	$ 254.276	$ -	$ 8.447	$ 53.699
2030	$ (218.856)	$ 299.523	$ -	$ 10.007	$ 90.673
2031	$ (219.120)	$ 349.126	$ -	$ 11.511	$ 141.517
2032	$ (209.916)	$ 400.937	$ -	$ 12.924	$ 203.945
2033	$ (193.870)	$ 455.074	$ -	$ 14.226	$ 275.429
2034	$ (171.959)	$ 509.168	$ -	$ 15.433	$ 352.643

Sources: EIA (2017), EPA&NHTSA (2010), Winchester et al: 2010, and Bunch (2004). ODOT (2012) and http://www.dot.ca.gov/hq/tsip/smb/documents/mvstaff/mvstaff08.pdf

Table A4.23: Alternative Scenarios for EV Diffusion in the Oregon Light Duty Fleet

	Cunningham/CARB				Early					Late				
	Fleet	ICE	PHEV	BEV		Fleet	ICE	PHEV	BEV		Fleet	ICE	PHEV	BEV
2010	3.287	3.287	0.000	0.000	2010	3.287	3.287	0.000	0.000	2010	3.287	3.287	0.000	0.000
2011	3.349	3.349	0.000	0.000	2011	3.349	3.349	0.000	0.000	2011	3.349	3.349	0.000	0.000
2012	3.413	3.413	0.000	0.000	2012	3.413	3.413	0.000	0.000	2012	3.413	3.413	0.000	0.000
2013	3.478	3.474	0.002	0.000	2013	3.478	3.474	0.002	0.000	2013	3.478	3.474	0.002	0.000
2014	3.544	3.530	0.008	0.000	2014	3.544	3.530	0.008	0.000	2014	3.544	3.530	0.008	0.000
2015	3.611	3.588	0.014	0.000	2015	3.611	3.548	0.039	0.000	2015	3.611	3.608	0.002	0.000
2016	3.673	3.640	0.020	0.000	2016	3.673	3.586	0.054	0.001	2016	3.673	3.668	0.003	0.000
2017	3.735	3.693	0.026	0.000	2017	3.735	3.617	0.074	0.001	2017	3.735	3.729	0.004	0.000
2018	3.799	3.748	0.032	0.001	2018	3.799	3.638	0.101	0.002	2018	3.799	3.791	0.005	0.000
2019	3.864	3.803	0.038	0.001	2019	3.864	3.645	0.137	0.003	2019	3.864	3.852	0.007	0.000
2020	3.930	3.859	0.044	0.001	2020	3.930	3.634	0.186	0.005	2020	3.930	3.914	0.010	0.000
2021	3.989	3.891	0.064	0.002	2021	3.989	3.593	0.258	0.010	2021	3.989	3.967	0.014	0.001
2022	4.050	3.923	0.084	0.004	2022	4.050	3.523	0.348	0.017	2022	4.050	4.020	0.020	0.001
2023	4.111	3.956	0.104	0.006	2023	4.111	3.418	0.462	0.026	2023	4.111	4.070	0.027	0.002
2024	4.173	3.989	0.123	0.008	2024	4.173	3.274	0.604	0.039	2024	4.173	4.117	0.037	0.002
2025	4.236	4.024	0.143	0.011	2025	4.236	3.087	0.776	0.057	2025	4.236	4.160	0.051	0.004
2026	4.299	4.059	0.162	0.013	2026	4.299	2.858	0.977	0.080	2026	4.299	4.196	0.070	0.006
2027	4.362	4.094	0.182	0.016	2027	4.362	2.591	1.204	0.109	2027	4.362	4.222	0.095	0.009
2028	4.425	4.129	0.202	0.020	2028	4.425	2.298	1.449	0.142	2028	4.425	4.236	0.129	0.013
2029	4.489	4.165	0.221	0.023	2029	4.489	1.990	1.705	0.180	2029	4.489	4.233	0.174	0.018
2030	4.552	4.200	0.241	0.027	2030	4.552	1.685	1.959	0.222	2030	4.552	4.209	0.234	0.027

2031	4.618	4.212	0.260	0.036	2031	4.618	1.397	2.062	0.283	2031	4.618	4.161	0.293	0.040
2032	4.684	4.216	0.278	0.047	2032	4.684	1.136	2.107	0.355	2032	4.684	4.080	0.359	0.060
2033	4.752	4.212	0.294	0.061	2033	4.752	0.908	2.095	0.437	2033	4.752	3.960	0.432	0.090
2034	4.820	4.198	0.308	0.080	2034	4.820	0.715	2.029	0.530	2034	4.820	3.796	0.506	0.132
2035	4.889	4.172	0.318	0.105	2035	4.889	0.557	1.919	0.636	2035	4.889	3.584	0.578	0.191
2036	4.959	4.132	0.324	0.138	2036	4.959	0.430	1.774	0.755	2036	4.959	3.326	0.640	0.272
2037	5.030	4.077	0.326	0.181	2037	5.030	0.329	1.606	0.891	2037	5.030	3.026	0.684	0.380
2038	5.103	4.004	0.322	0.237	2038	5.103	0.251	1.424	1.045	2038	5.103	2.695	0.706	0.519
2039	5.176	3.909	0.314	0.310	2039	5.176	0.190	1.238	1.220	2039	5.176	2.347	0.702	0.692
2040	5.250	3.790	0.302	0.406	2040	5.250	0.144	1.055	1.421	2040	5.250	2.000	0.672	0.904
2041	5.326	3.642	0.284	0.532	2041	5.326	0.108	0.881	1.649	2041	5.326	1.668	0.618	1.156
2042	5.402	3.461	0.263	0.697	2042	5.402	0.082	0.721	1.912	2042	5.402	1.365	0.547	1.451
2043	5.480	3.242	0.238	0.914	2043	5.480	0.061	0.576	2.213	2043	5.480	1.098	0.466	1.789
2044	5.558	2.979	0.210	1.197	2044	5.558	0.046	0.448	2.558	2044	5.558	0.871	0.381	2.175
2045	5.638	2.665	0.179	1.568	2045	5.638	0.035	0.337	2.956	2045	5.638	0.682	0.298	2.614
2046	5.719	2.291	0.146	2.055	2046	5.719	0.026	0.242	3.413	2046	5.719	0.530	0.220	3.111
2047	5.801	1.849	0.111	2.692	2047	5.801	0.019	0.162	3.939	2047	5.801	0.408	0.151	3.674
2048	5.885	1.329	0.075	3.527	2048	5.885	0.015	0.096	4.545	2048	5.885	0.313	0.091	4.314
2049	5.969	0.717	0.038	4.621	2049	5.969	0.011	0.043	5.243	2049	5.969	0.238	0.041	5.043
2050	6.055	0.000	0.000	6.055	2050	6.055	0.008	0.000	6.047	2050	6.055	0.181	0.000	5.874

Sources: EIA (2017), EPA&NHTSA (2010), Winchester et al: 2010, and Bunch (2004). ODOT (2012) and http://www.dot.ca.gov/hq/tsip/smb/documents/mvstaff/mvstaff08.pdf

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Table A5.1: WCI Reference Prices and the Core Scenario

	Core Scenario	WCILow	WCIMed	WCIHigh
2021	$ 19.21	$ 16.82	$ 19.88	$ 62.80
2022	$ 19.54	$ 17.66	$ 22.16	$ 65.94
2023	$ 19.93	$ 18.54	$ 24.68	$ 69.24
2024	$ 20.35	$ 19.47	$ 27.50	$ 72.70
2025	$ 20.83	$ 20.45	$ 30.65	$ 76.34
2026	$ 21.37	$ 21.47	$ 34.16	$ 80.15
2027	$ 21.98	$ 22.54	$ 38.05	$ 84.16
2028	$ 22.71	$ 23.67	$ 42.37	$ 88.37
2029	$ 23.52	$ 24.85	$ 47.19	$ 92.79
2030	$ 24.47	$ 26.09	$ 52.56	$ 97.43
2031	$ 25.57	$ 27.40	$ 55.19	$ 102.29
2032	$ 26.93	$ 28.77	$ 57.94	$ 107.41
2033	$ 28.50	$ 30.21	$ 60.84	$ 112.78
2034	$ 30.39	$ 31.72	$ 63.88	$ 118.42
2035	$ 32.71	$ 33.30	$ 67.08	$ 124.34
2036	$ 34.53	$ 34.97	$ 70.43	$ 130.55
2037	$ 36.49	$ 36.72	$ 73.95	$ 137.08
2038	$ 38.72	$ 38.55	$ 77.65	$ 143.94
2039	$ 41.27	$ 40.48	$ 81.53	$ 151.13
2040	$ 44.21	$ 42.50	$ 85.61	$ 158.69
2041	$ 47.61	$ 44.63	$ 89.89	$ 166.63
2042	$ 51.58	$ 46.86	$ 94.39	$ 174.96
2043	$ 56.24	$ 49.20	$ 99.10	$ 183.71
2044	$ 62.21	$ 51.66	$ 104.05	$ 192.89
2045	$ 68.94	$ 54.25	$ 109.26	$ 202.54
2046	$ 77.11	$ 56.96	$ 114.72	$ 212.66
2047	$ 87.17	$ 59.81	$ 120.46	$ 223.30
2048	$ 99.76	$ 62.80	$ 126.48	$ 234.46
2049	$ 115.82	$ 65.94	$ 132.80	$ 246.18
2050	$ 136.78	$ 69.24	$ 139.44	$ 258.49

Source: Author estimates from the BEAR model.