Oregon Cap-and-Trade

An Analysis of the Economic Impacts of SB 1574 (2016)

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Executive Summary

Overview

- AOI retained FTI to estimate the economic impacts of SB 1574 (2016), a proposed cap-and-trade bill that would require Oregon to reduce a subset of its total GHG emissions to 75% below 1990 levels by 2050.
- SB 1574 (2016) would cap emissions for entities that produce more than 25,000 metric tons of carbon dioxide annually, which in aggregate represent approximately 80% of the state's total GHG emissions.
  - Agriculture, waste water and waste incineration, and non-combustible emissions are not covered.
  - Industrial processes, HGWP, and MSW landfills are partially covered.
- FTI closely followed the proposed SB 1574 (2016) with the exception of offsets, where zero offsets were assumed in FTI's Baseline Scenario.
- FTI's Baseline Scenario and DEQ's Reference Policy case have similar underlying assumptions, but FTI's emissions without the cap are significantly lower.
- FTI uses models to force GHG reductions while DEQ assumes a carbon price informed by forecasts of the California price floor and reserve price in 2035.
- FTI applied three long-term, dynamic models in its analysis:
  - PLEXOS: provides power sector supply, demand, and price forecasts
  - CTAM: provides non-electric sector emissions response to GHG prices
  - REMI: provides responses to macroeconomic outcomes due to policy
- The FTI modeling approach and structure are different than DEQ:

Modeling Approach	DEQ	FTI
Years modeled	1 year: 2035	34 years: 2017-2050
Oregon regions modeled	State level	State and 8 regions in OR
Electricity market modeling area	Unknown	Western Interconnect
Price effects	No	Yes
Macroeconomic model	Static	Dynamic
CO_2 price	Fixed input	Solved by the models

Findings

Cap-and-Trade Allowance Prices

- GHG allowance prices ($/MT CO_2e) start at $13 in 2021, rise to $84 in 2035, and continue to $464 by 2050. If offsets of up to 8 percent of baseline were to be included, we estimate GHG prices to be about 44 percent lower, on average.
- Complementary policies (Boardman, CFP, no coal imports after 2030, RPS) reduce capped baseline GHG emissions to 21 percent below 1990 levels by 2030. These policies have costs but help mitigate GHG prices under the C&T.

Macroeconomic Impacts

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

- GHG prices would result in the following in 2050:
  - $7.60 (with taxes) per gallon of gasoline (in 2016$'s), higher than prices in Europe.
  - A 65%, 108%, and 118% increase in average retail electricity rates (above the baseline forecast) for PGE, Idaho Power, and PacifiCorp customers, respectively.*
  - A 179% increase in retail natural gas rates (above the baseline forecast) for Oregon.

Policy Design

- Allocating allowances to EITE industries is key to retaining jobs in high-income industries and minimizing emissions leakage resulting from production moving to more fossil fuel-intensive states or countries.
- Giving auction revenues to state infrastructure funds or climate investments results in some out-of-state wealth transfers; allocating more allowances to impacted parties would perhaps improve the forecasted economic impacts.
- Offsets could be important for reducing the economic costs of the policy.

* Average percent increase based on simple average for residential, commercial, and industrial rate increases.

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Contents

Background

- Both the Oregon Senate and House have made proposals to reduce greenhouse gas (GHG) emissions 75 percent below 1990 levels by 2050, for example:
  - HB 3543 (2007)
  - SB 80 (2009)
  - SB 1574 (2016)
  - HB 2135 (2017)
- The Associated Oregon Industries (AOI) engaged FTI Consulting to forecast the state-wide and regional impacts to Oregon's residential, commercial, and manufacturing sectors if a policy like SB 1574 (2016) were implemented.
- GHG reduction policies already exist in Oregon that would "complement" SB 1574 (2016):
  - **Clean Fuels Program:** 10 percent reduction in emissions-intensity in the transportation sector by 2025 (SB 324, 2015)
  - **Renewable Portfolio Standard:** major utilities must procure 50 percent renewable power by 2040 (SB 1547, 2016)
  - **Closure of Boardman:** by the end of 2020, the Boardman facility will be retired (2010 DEQ approval)
  - **Ban on Coal-fired Generation Imports:** starting in 2031, coal-fired power generation is banned from being imported into Oregon (SB 1547, 2016)
- Complementary policies have costs, but these costs are not included in our analysis:
  - The policies are imbedded in FTI's baseline outlook
  - We show the "incremental" costs of achieving SB 1574 (2016) and not the full costs of all GHG policies
- Our analysis does not account for the possibility of emissions "leakage," which are new emissions generated outside of Oregon resulting from Oregon industries shifting production to more fossil-intensive areas.

FTI Consulting at a glance

FTI Consulting is a global business advisory firm that provides multidisciplinary solutions to complex challenges and opportunities.

United by a culture of urgency, our professionals are organized around the globe to provide critical assistance wherever and whenever needed.

GLOBAL REACH

With over 3,600 employees and offices in 29 countries on six continents, our breadth and depth extends across every major social, political, and economic hub across the globe.

EXPERIENCED PROFESSIONALS

We are trusted advisors with diverse expertise and exceptional credentials serving clients globally.

DEEP INDUSTRY EXPERTISE

We combine unparalleled expertise and industry knowledge to address critical challenges for clients. Key expert areas include:

- Aerospace and Defense
- Chemicals
- Construction
- Energy & Utilities
- Financial Institutions & Insurance
- Manufacturing & Industrials
- Retail & Consumer Products
- Transportation

FCN Publicly traded – NYSE	**$1.84 BLN** Equity market capitalization
1982 Year founded	**80** Different disciplines
3,600 Consultants and professionals	**700+** Industry specialists
440+ Senior Managing Directors	**81** Offices in 29 countries
2 Nobel Laureates	**48** 48 of Global 100 corporations are clients
10 of 10 Advisor to the world's top 10 bank holding companies	**92** Advisor to 92 of the world's top 100 law firms

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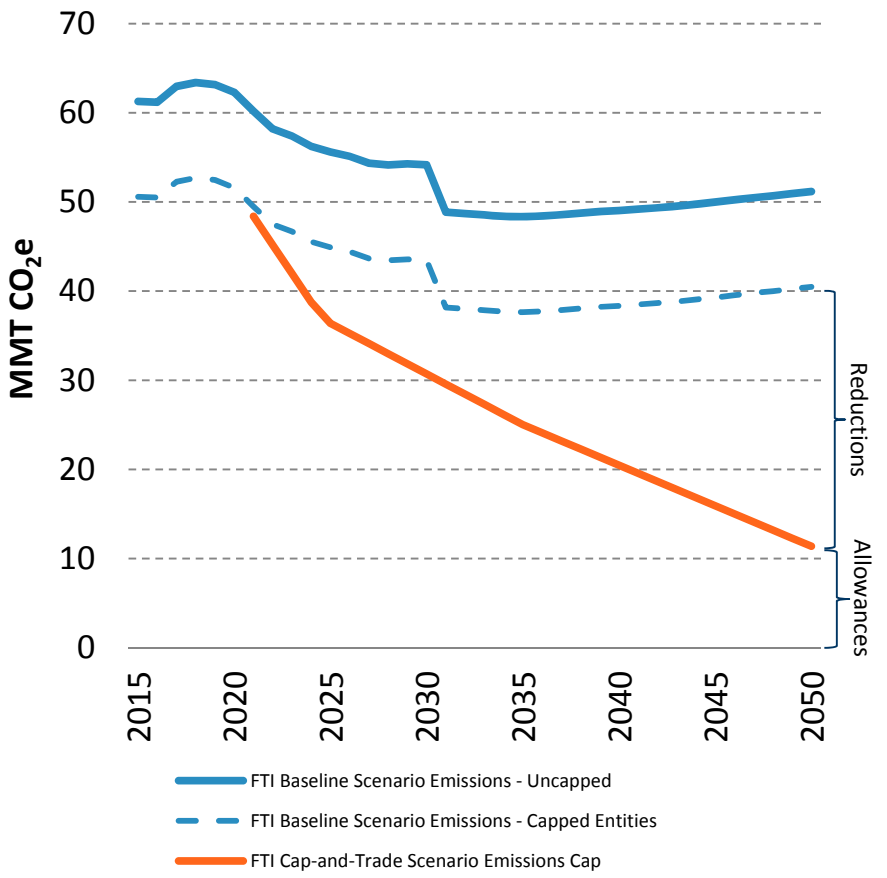
SB 1574 (2016) would reduce covered GHG emissions to 75 percent below 1990 levels by 2050.

SB 1574 Overview

- A majority (80 percent) of the state's total emissions would be covered by SB 1574 (2016)
  - Entities that produce more than 25,000 metric tonnes of carbon dioxide (or equivalents) annually
  - Agriculture, waste water and waste incineration, and non-combustible emissions are not covered
  - Industrial processes, HGWP, and MSW landfills are partially covered
- Program would start in 2021 and continue through 2050
- Covered entities could purchase allowances at auctions, bilaterally, or in secondary markets to comply. We assumed 100 percent auction for initial distribution of allowances.
- FTI closely followed SB 1574 (2016) as proposed except for the provision allowing up to 50 percent offsets; we instead assumed zero offsets in our Baseline Scenario.
  - We did run a sensitivity of up to 8 percent offsets, which California allows

Baseline Scenario Emissions and Cap



SB 1574 (2016) other major provisions

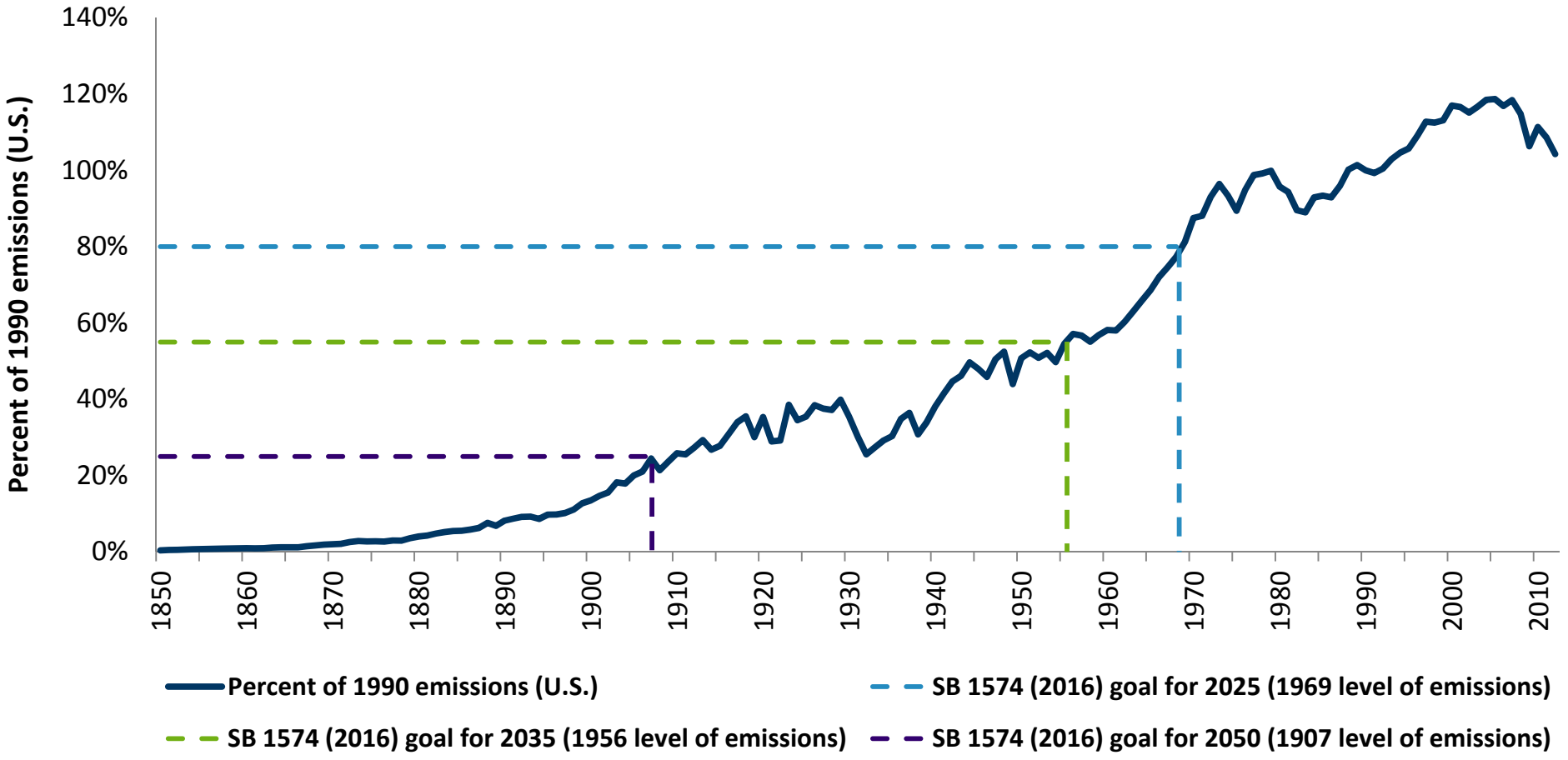
- **Direct allocation of allowances**
  - Emissions-intensive, trade-exposed ("EITE") industries could receive free allowances
    - The quantity of allowances and industries affected is at the discretion of the Environmental Quality Commission
    - Likely candidates include covered manufacturers in subsectors such as computers, food, pulp, and paper

- **Consignment of allowances to utilities**
  - Allowances would be consigned to utilities to help them compensate low-income customers for higher energy costs
  - Electric and natural gas utilities would receive free allowances that would have to be consigned to the auction
    - Proceeds from the sale of these allowances would benefit these customers (at the PUC's discretion)
  - Utilities would have to participate in auctions or a secondary market to obtain allowances for compliance

- **Disbursement of auction revenues**
  - 85 percent to the Oregon Climate Investment Account in the State Highway Fund
    - Used to fund state infrastructure and energy efficiency programs
  - 15 percent in the Just Transitions Fund, a new account separate from the General Fund
    - Appropriated to the Oregon Business Development Department

Climate goals under SB 1574 (2016) are lofty, because they intend to reduce emissions to levels last seen during the postwar boom of the 1950s and 1960s by 2025 or 2035 and to those of over a century ago by 2050 – 33 years from now.

SB 1574 (2016) Reduction Levels and Corresponding Historical Year



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Contents

FTI and DEQ used similar underlying modeling assumptions for the electricity market.

Assumption Type	FTI Assumption	DEQ Assumption
Natural Gas Prices	Used EIA's 2017 AEO Reference case	Used EIA's 2016 AEO Reference case
Oregon Load Forecast	Applied the NW Power & Conservation Council assumptions (including conservation) for load growth; Load growth is essentially flat.	Uses "utility-projected load growth," which would be the same if including the utility forecasts that factor in energy efficiency.
Renewable Portfolio Standard	Based on SB 1547 passed in 2016 (50% by 2040)	**Same**
Imports of Coal-Fired Power	After 2030, no purchases of out-of-state coal-fired generation	Either 2030 or 2035 per statements in E3 slides.
Closure of Boardman	Plant closure by December 31, 2020	**Same**
Other Coal Plant Closures	Centralia 1 closure on December 31, 2020 Colstrip 1 & 2 closure on July 31, 2022. Centralia 2 closure in 2025.	N/A
CO_2 Emissions Standard for New Gas-Fired Combined Cycle Plants	CO_2 emissions standard set to 675 lb/MWh. The difference between the standard and the current technology must come from offsets, with the cheapest offset option being the $1.27 per short ton owners must pay.	N/A – little to no impact if not assumed.
Clean Power Plan	Oregon's in-state existing and new electric generators must reduce their CO_2 emissions to 8.1 million tonnes by 2030.	N/A

N/A: not available

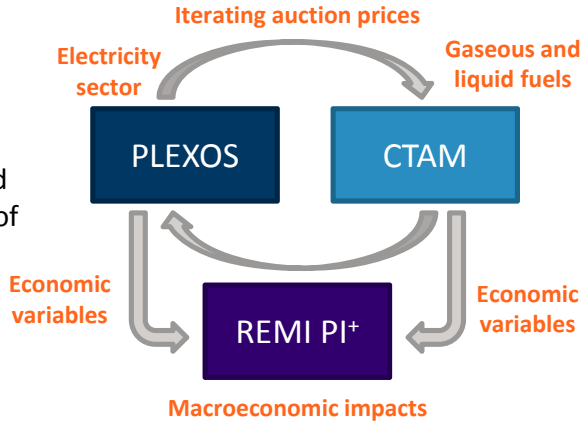
Comparison of Other Major Assumptions

Assumption Type	FTI Assumption	DEQ Assumption
Clean Fuels Program	Carbon-intensity (emissions/gallon) of transportation motor fuels declines 10 percent by 2025	Emissions (aggregate sum) from transportation motor fuels declines 10 percent by 2025
Oregon fuel consumption	Based on share of Pacific Region in the AEO 2017 forecast, which has lower long-term emissions	Based on share of Pacific Region in AEO 2016 forecast, which has higher long-term emissions
GDP growth	Based on Oregon OEA employment forecast to 2026, REMI control forecast thereafter	IMPLAN for the early 2010s with adjustment to the scale of the Oregon economy in 2035
Population growth	REMI control forecast demographics, averaged 0.6 percent per year from 2021 to 2050	IMPLAN model has no demographics
PHEV, EV, etc. market penetration	No explicit numbers, but carbon-intensity of vehicular fleet is reduced via price-elasticity of demand	Between 80,000 and 120,000 PHEVs by 2025, numbers derived from an ICF study
Loss factor	Used a 15 percent loss factor to represent allowance revenue lost to overhead and out-of-state entities.	Examined 15 and 30 percent loss factor scenarios.

FTI's modeling approach was dynamic and long-term; while DEQ's approach was static and one-year.

FTI Modeling Approach

- **PLEXOS** – represents individual electric generating units and regional transmission constraints in the Western Interconnect. It provides power sector supply, demand, and electricity price forecasts.
- **CTAM** – represents demand, emissions, and prices for gaseous and liquid fuels and solves allowance prices under cap-and-trade. CTAM generated the first estimates of GHG allowance prices before iterating with PLEXOS.
- **REMI PI+** – a computable general equilibrium model of a regional economy, including demand and supply, the labor market, demographics, commodity markets, and regional competitiveness.



DEQ Modeling Approach

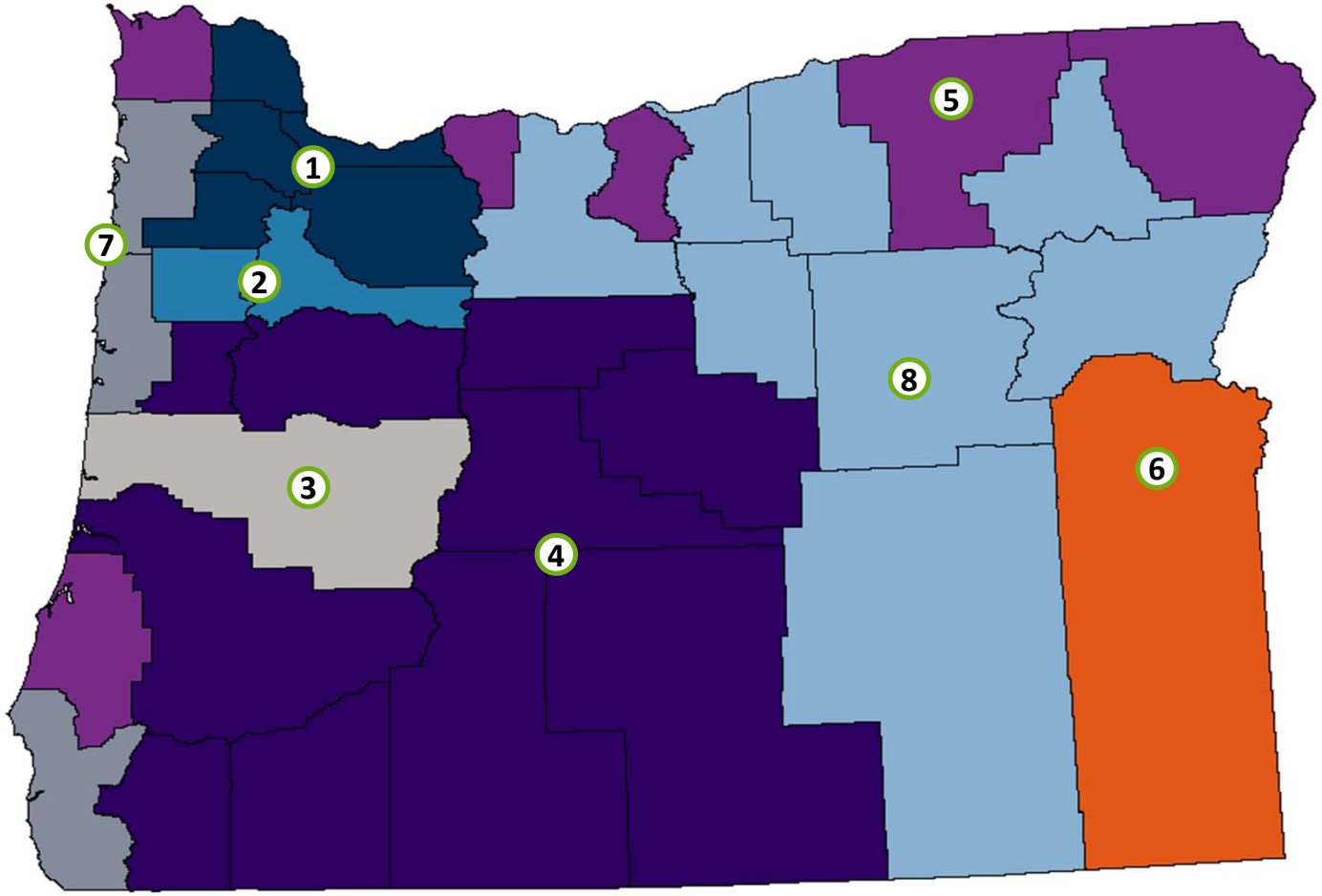
- **LEAP** – an integrated, scenario-based modeling tool that can be used to track energy consumption, production, and resource extraction.
- **IMPLAN** – an input-output (IO) model that tracks transactions between industries, households, and governments throughout the economy.

LEAP ⟷ IMPLAN

Key Differences

Modeling Approach	FTI	DEQ
Years modeled	34 years: 2017-2050	1 year: 2035
Oregon regions modeled	State and 8 regions in OR	State level
Electricity market modeling area	Western Interconnect	Unknown
Price effects	Yes	No
Macroeconomic model	Dynamic	Static
CO_2 price	Solved by the models	Fixed input

For the macroeconomic impact analysis, we divided Oregon into 8-regions based on economic regions (as defined by MSAs) and different utility service territories.



1. Portland MSA
- Clackamas, Columbia, Multnomah, Washington, and Yamhill Counties

2. Salem MSA
- Marion and Polk Counties

3. Eugene-Springfield MSA
- Lane County

4. Corvallis, Medford, and Bend
- Benton, Crook, Deschutes, Douglas, Jackson, Jefferson Josephine, Klamath, Lake, and Linn Counties

5. PacifiCorp Areas
- Clatsop, Coos, Hood River, Sherman, Umatilla, and Wallowa Counties

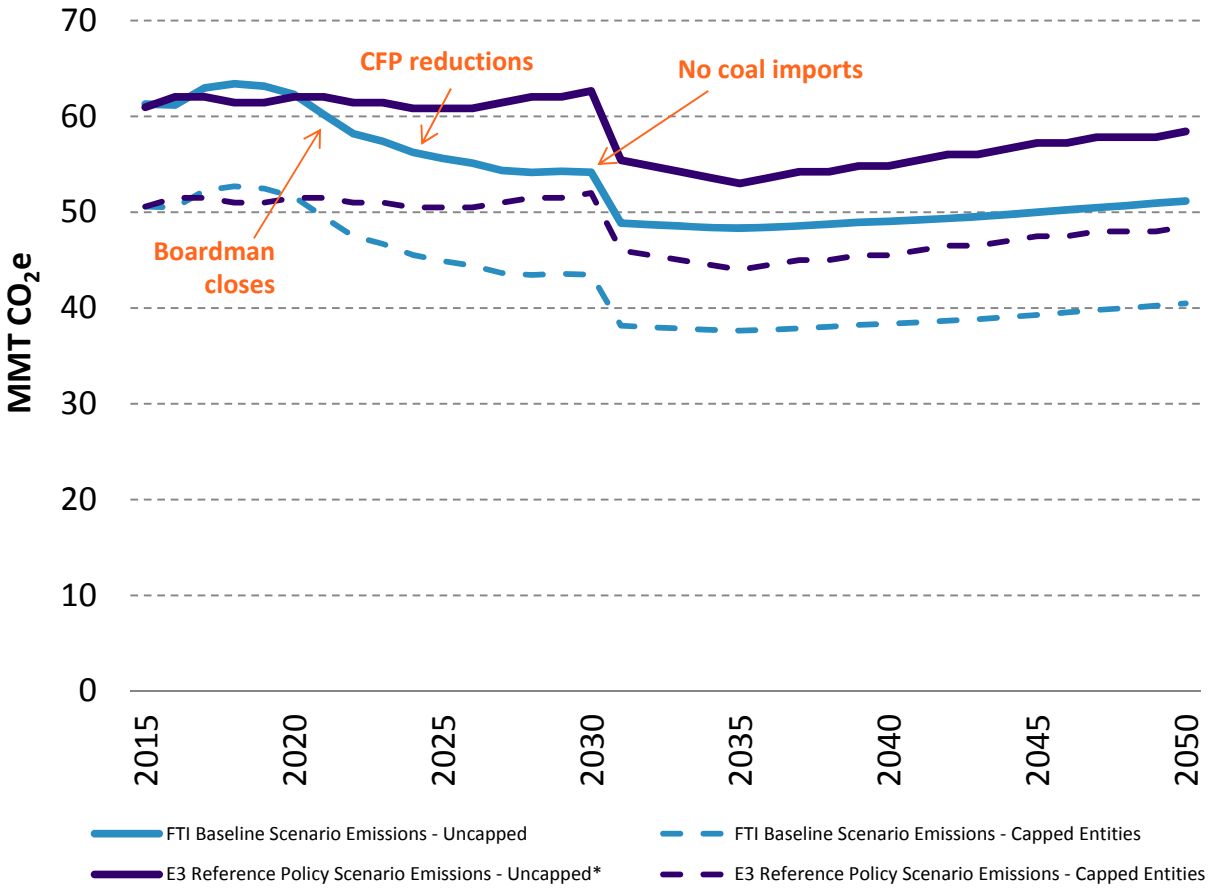
6. Malheur County

7. Co-op Costal Oregon
- Curry, Lincoln, and Tillamook Counties

8. Co-op Eastern Oregon
- Baker, Gillian, Grant, Harney, Morrow, Union, Wasco, and Wheeler Counties

The FTI "Baseline Scenario" uncapped emissions are forecasted to be below DEQ's capped emissions in its Reference Policy case.

GHG Emissions – Baseline Scenario



* Implied uncapped emissions based on ~83% coverage on pg. 23 of DEQ presentation on January 25, 2017.

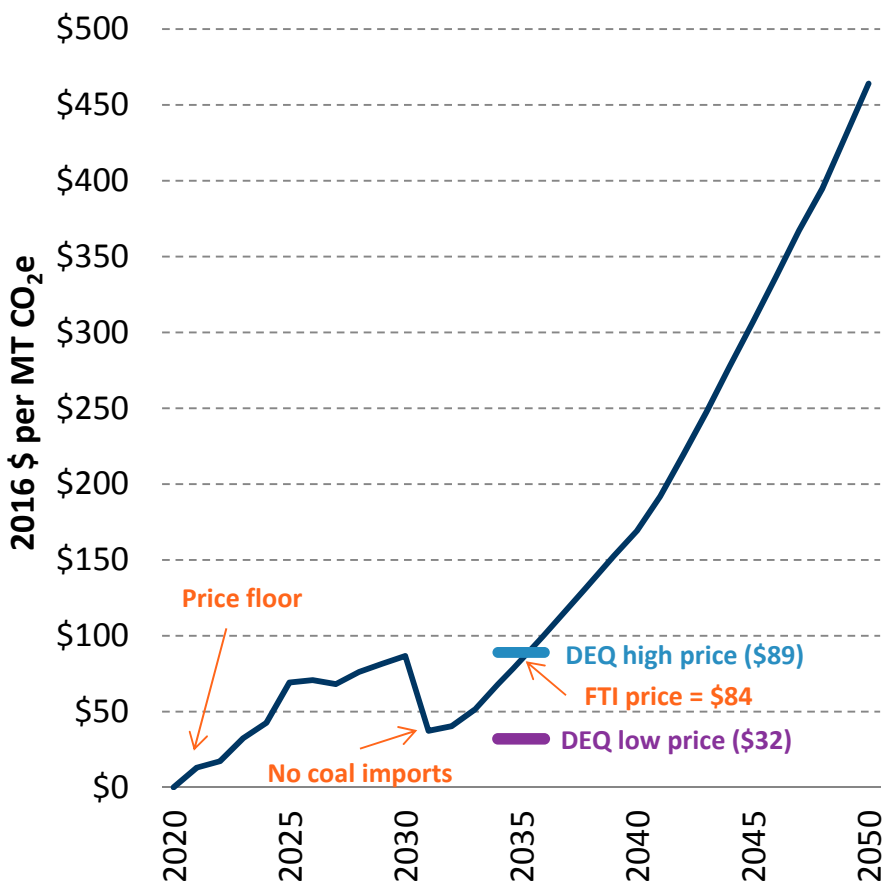
Commentary

- The underlying assumptions for FTI and DEQ's cases are rather similar, but the emissions forecasts are much different.
  - The FTI forecast shows sizable emissions reductions from the Boardman closure, CFP, RPS, and the coal import ban.
  - DEQ forecasts flat emissions through 2030, a decline from 2031-2035 that is likely due to the coal import ban, and then a slight rise in emissions through 2050.
- FTI used the AEO 2017 forecast as an input to its modeling while DEQ applied the AEO 2016 forecast. AEO 2017 forecasts lower fuel consumption and thus lower fossil emissions for the Pacific Region.
- If FTI were to apply DEQ's Reference Policy case emissions as its baseline, the result would be higher GHG allowance prices as complying with the cap would be even more challenging.

Contents

Using the cap limits defined in SB 1574 (2016), we solved for GHG allowance prices, which are within DEQ's 2035 price range but then reach over $450/MTCO$_2$e by 2050.

Forecasted GHG Allowance Prices

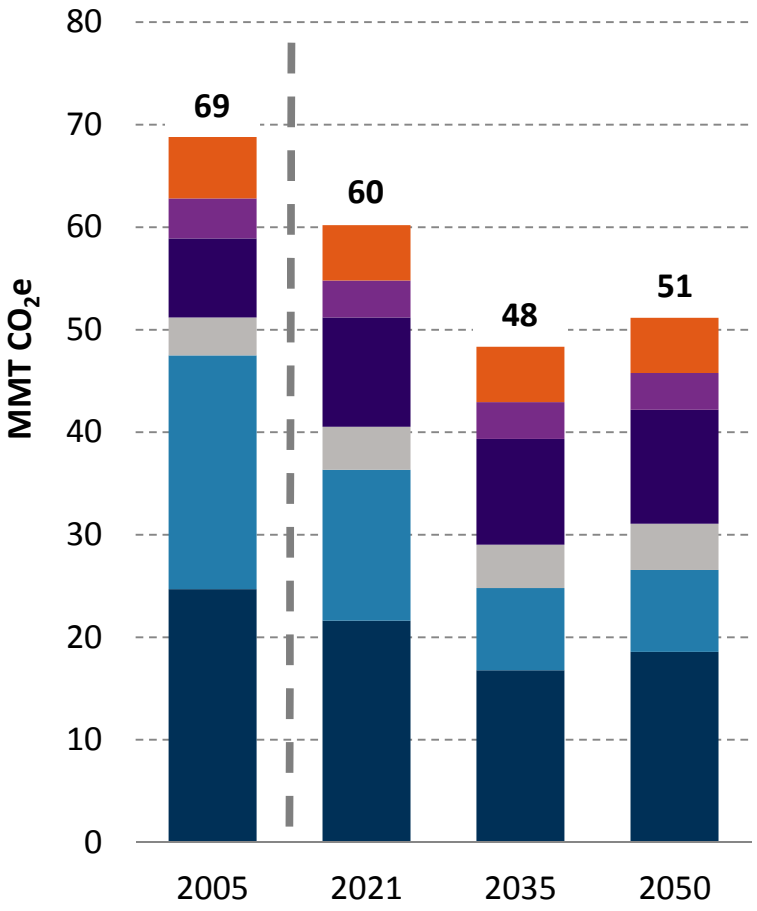


Commentary

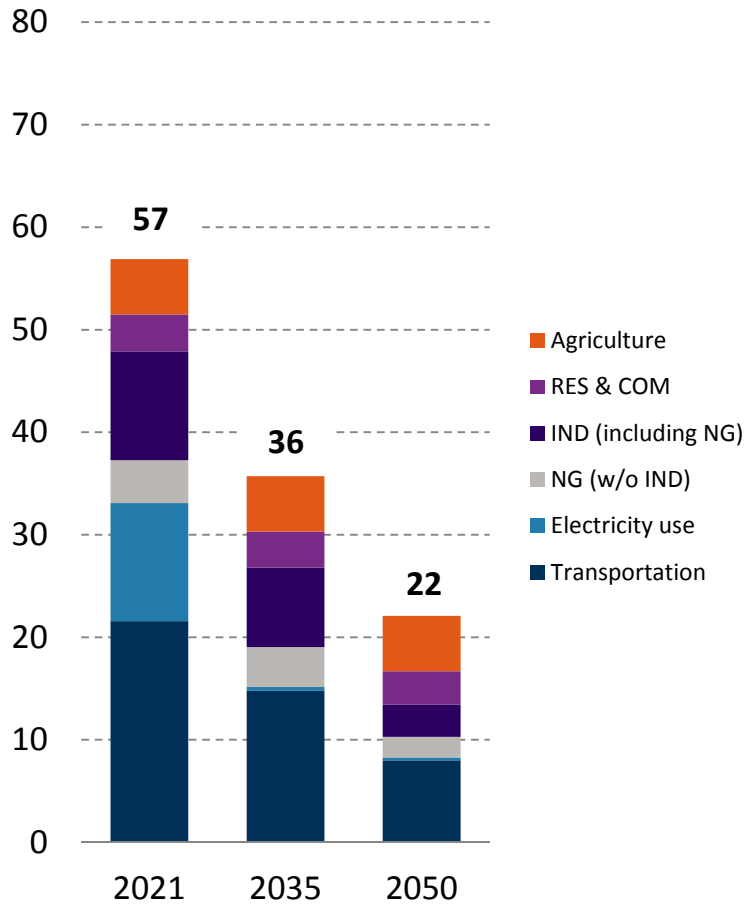
- SB 1574 (2016) calls for Oregon's per capita emissions to "Europeanize" – or more
  - 2025 goals (11.5 MT per capita) are similar to (world) middle-income, industrialized nations in East Asia such as Singapore, Japan, and South Korea
  - 2035 goals (7.5 MT per capita) similar to Western Europe
  - 2050 goals (3.0 MT per capita) similar to Caribbean nations
    - *$500 per tonne is $4.50 per gallon of gasoline and adding $4.50 to a baseline gasoline price of $3 to $4 per gallon yields $7.50 to $8.50, which are higher than gasoline prices currently paid in Western Europe*
- Waxman-Markey projections to 2050 by SAIC in the NEMS model were $400 to $500/tonne
- NAM study examined attainment of Waxman-Markey goals (20% of 2005 emissions, very similar to 25% of 1990) with a tax mechanism and found $1,000 per tonne in 2050 to achieve this goal – twice the finding here
- **Oregon lacks many large, singular emissions sources – such as coal-fired power plants – to target for reductions**

Early emissions reductions are in the power sector, while later reductions are in inelastic space heating and transportation.

Baseline Scenario Emissions by Sector



C&T Scenario Emissions by Sector

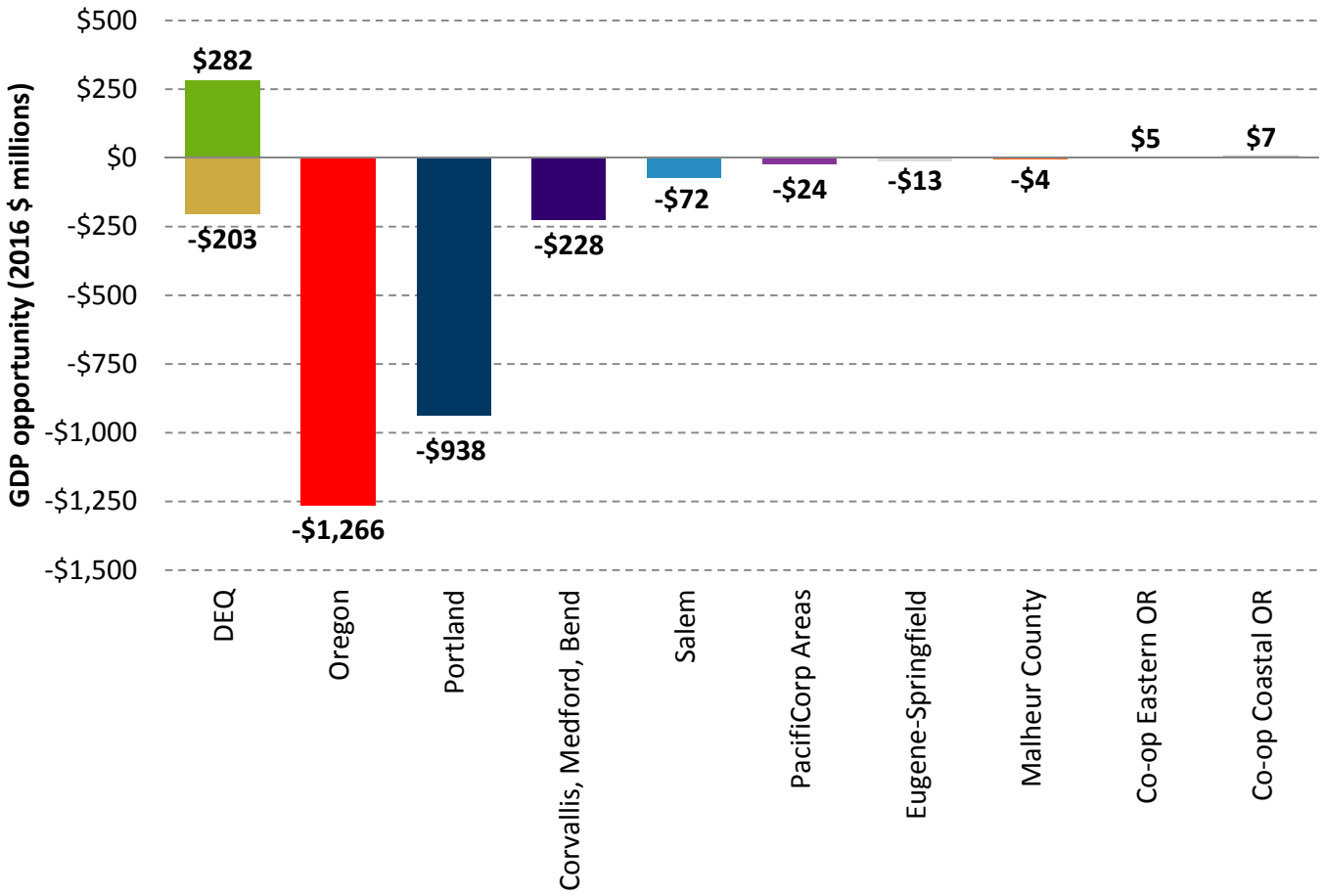


Commentary

- Assumed agricultural emissions and non-fuel emissions from R&C (mostly landfills) remain at most recent historical year.
- These figures include all emissions, including the approximately 20% of aggregate not under the cap.
- Most of the reductions in emissions are from the electricity sector from 2021 through 2031 due to coal plant closures and the ban on imported coal electricity.
- Thereafter, reductions come from the inelastic space heating and transportation sectors.
- Hence, allowance prices escalate rapidly after the last "windfall" from electrical power generation fades after the end of coal imports.

FTI's and DEQ's results differ by an order of magnitude; the FTI results show a wide spread in potential impacts to GDP when including price effects, with Portland driving the results.

GDP Impact in 2035 – DEQ vs. FTI



Commentary

- DEQ's results show impacts range from +$282 to -$203 million in GDP impacts in 2035.
- Using longer-range, more dynamic models (which include price effects for businesses and consumers' real incomes), FTI finds that the Baseline Scenario results in almost $1.3 billion in lost GDP opportunity for Oregon in 2035.
- FTI estimates that Oregon's GDP growth in the long-term from 2016 to 2035 is positive with C&T, though diminished from the baseline.
  - A reduction in GDP of 0.4% from the baseline in 2035.

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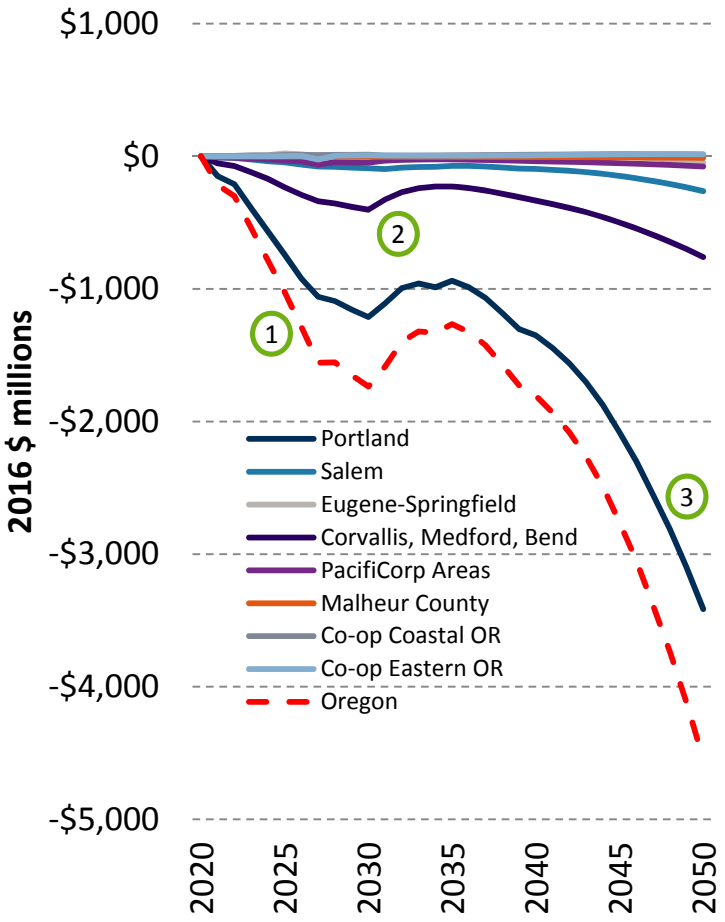
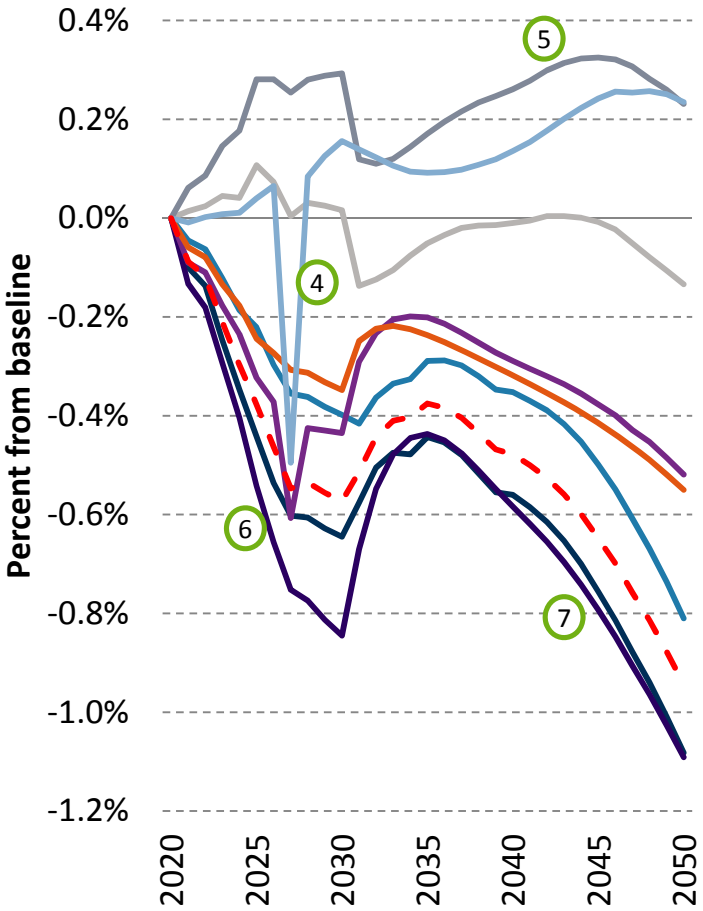
The impact to GDP fluctuates over time with the cap, and the regions experience the policy's impact differently.

Absolute Change in GDP by Region



Percent Change in GDP by Region



Commentary

1. Higher energy prices are a drag on the Oregon economy in the 2020s, driven by the impact in the Portland MSA.
2. Some "snap back" occurs when auction prices drop with the end of coal imports after 2030.
3. Against the baseline, long-term GDP is lower as auction prices rapidly escalate versus the inelastic transportation and space heating fuel sectors.
4. SB 1574 (2016) reduces the size and number of power generation investments, reducing construction activities
5. Long-term, these regions have a generally lower impact to electricity prices and more free allowances to their trade-exposed industries
6. Urban areas find their industry is less competitive and their households have less real income from higher prices
7. Urban areas find their industry is less competitive and their households have less real income from higher prices

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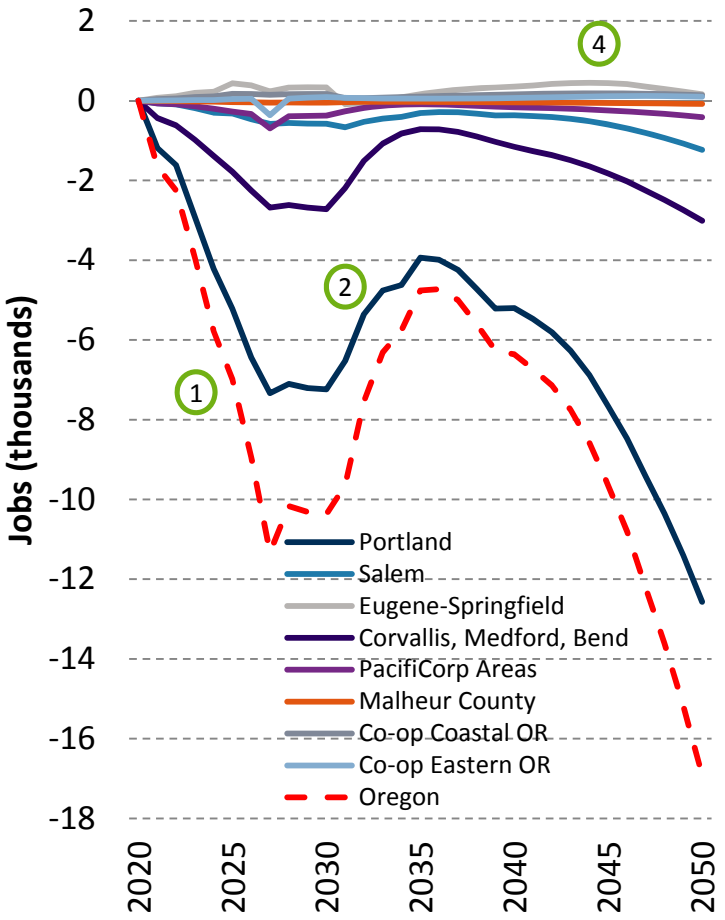
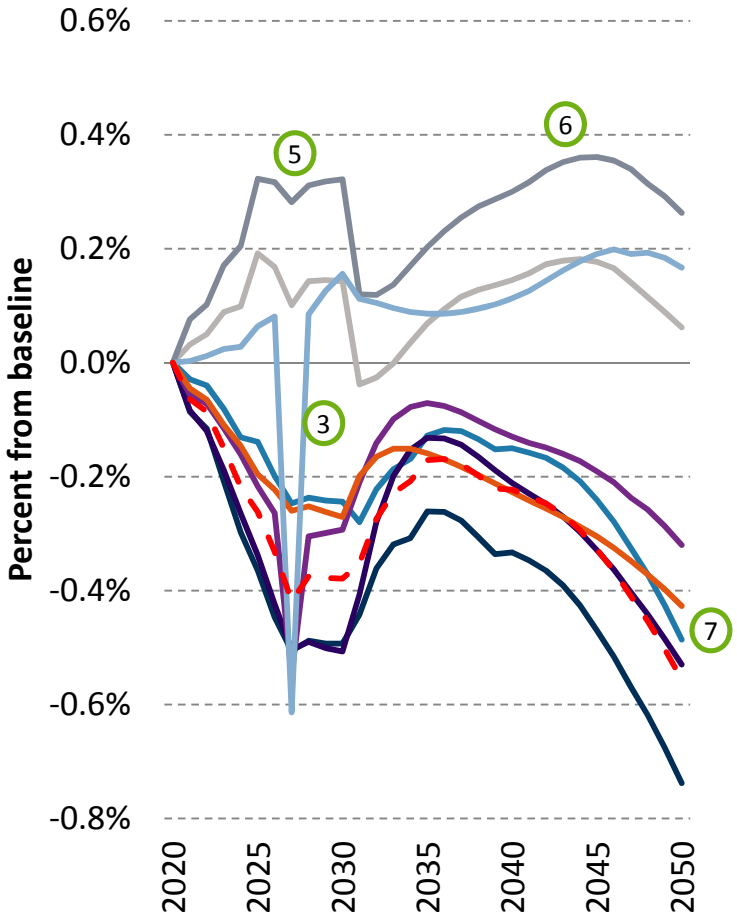
Statewide and regional employment follows similar trends to GDP, with different impacts over time and by the region.

Absolute Change in Jobs by Region



Percent Change in Jobs by Region



Commentary

1. Similar to GDP, the tightening cap and rising auction prices in the 2020s reduces the size of the Oregon economy and the number of jobs relative to the preexisting baseline.
2. "Snap back" with lower auction prices after coal imports ban.
3. Reduced construction jobs
4. The more rural regions outside of the service territories of PGE and PacifiCorp have numerous advantages, including…
5.
6.
   - Lower electricity rate impacts outside of PacifiCorp and PGE
   - Smaller population bases, so less lost real income from higher energy prices
   - Their free allowances for industry are larger compared to their economies
7. …though these are not enough to overcome the long-term impact in Oregon's cities.

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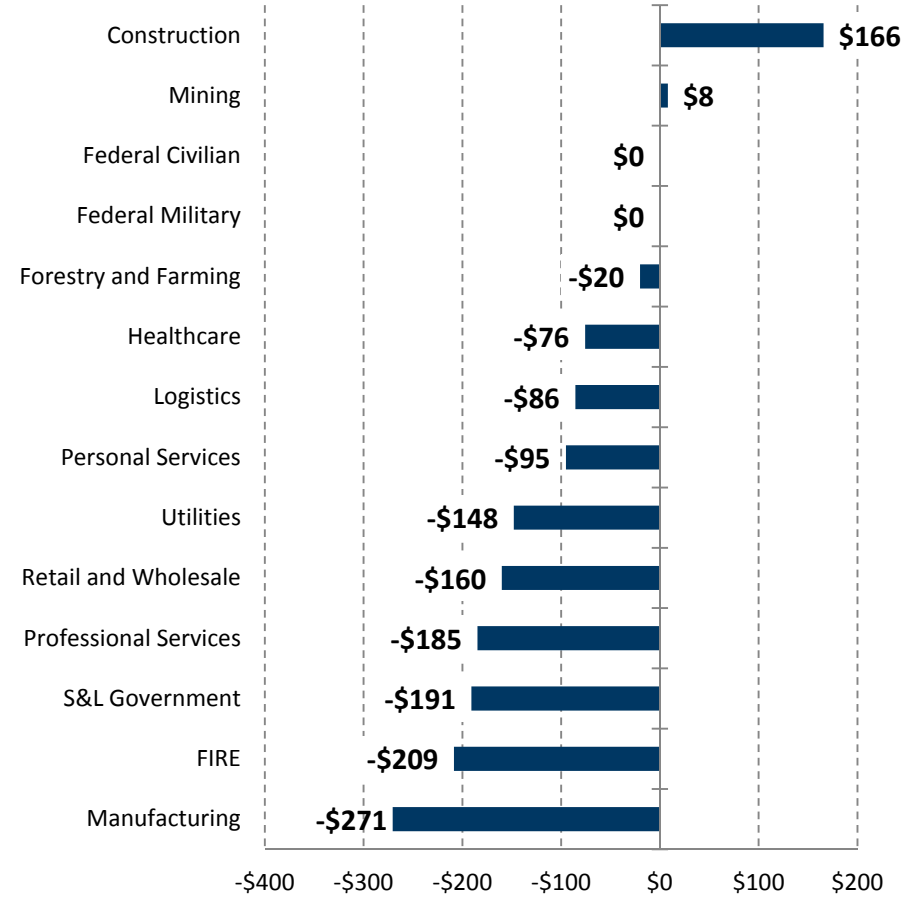
Expenditure of the auction revenues has economic benefits, particularly in the construction sector, yet higher operating costs, lower real incomes for households, and a diminished tax base combine to produce a net negative impact.

Change in GDP by Sector (2035)

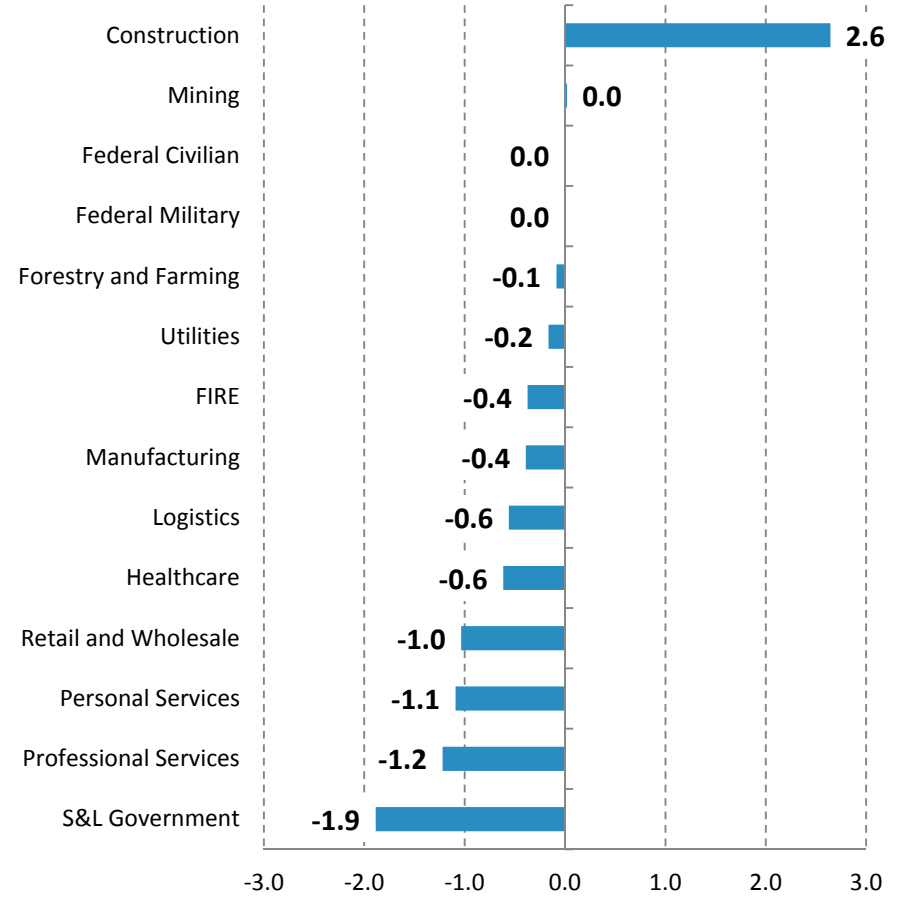
2016 $ millions



Net = -$1,266 million

Change in Employment by Sector (2035)

Thousands



Net = -4.8 thousand

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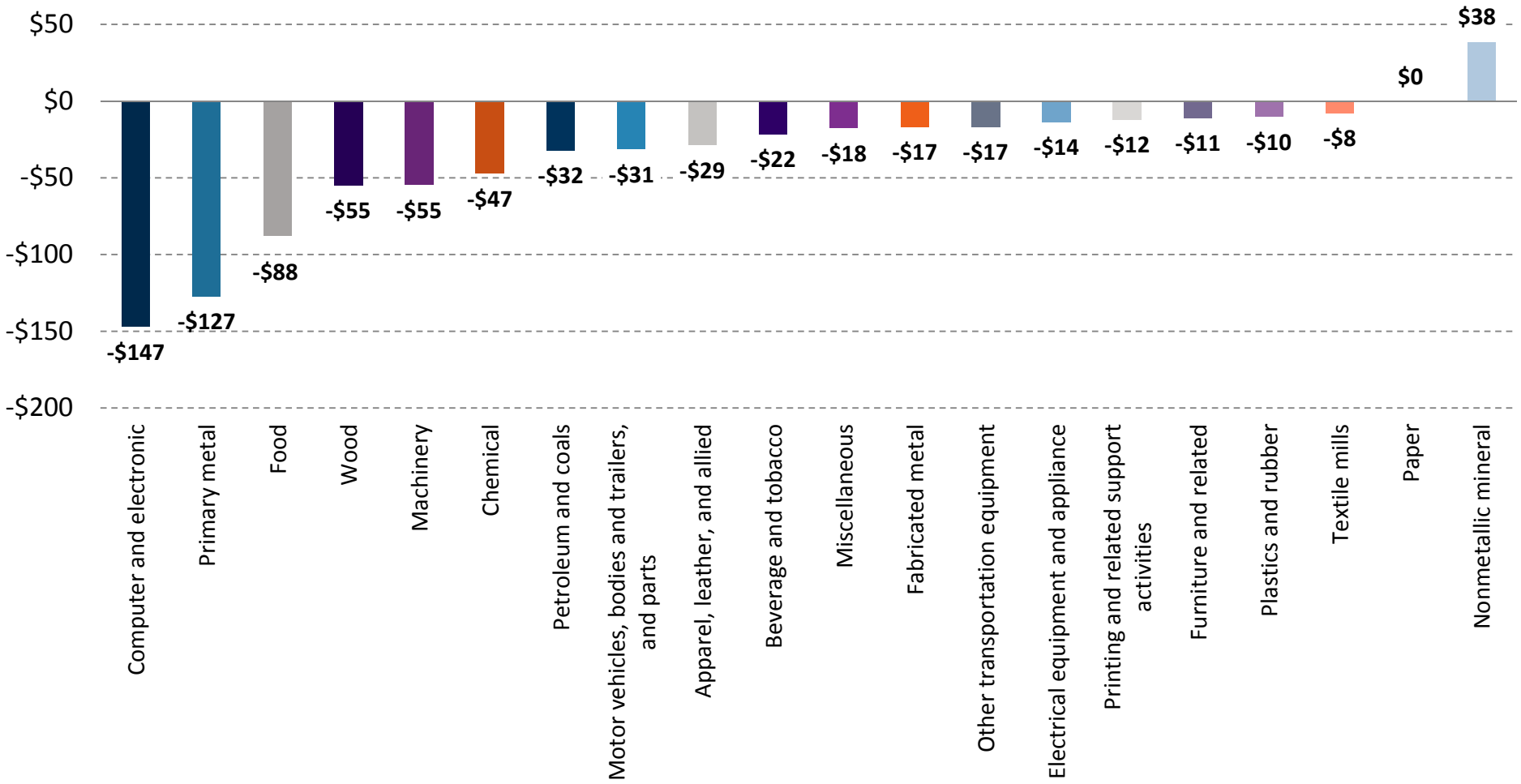
Most manufacturing subsectors see their output decrease, with the exception of nonmetallic mineral products, which concrete and materials subindustries have a close relationship with infrastructure construction activities.

Change in Manufacturing Subsector Output in 2035 (2016 $ millions)



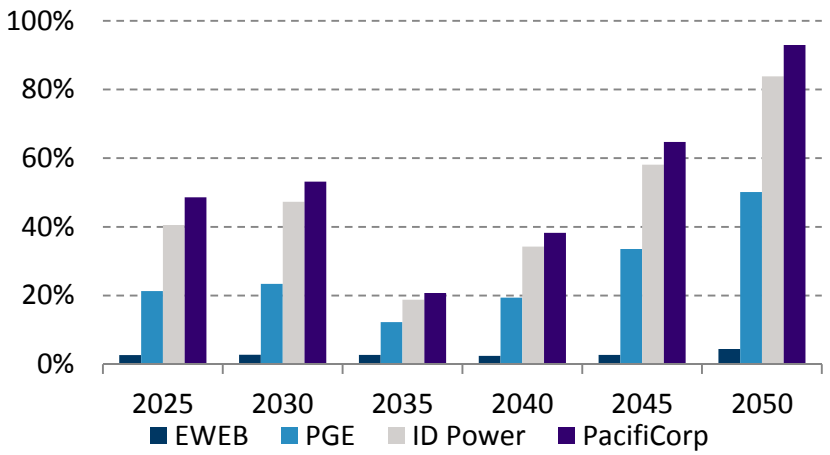
Contents

Idaho Power and PacifiCorp fleets' have more exposure to coal power plants, creating more onerous impacts for their customers.

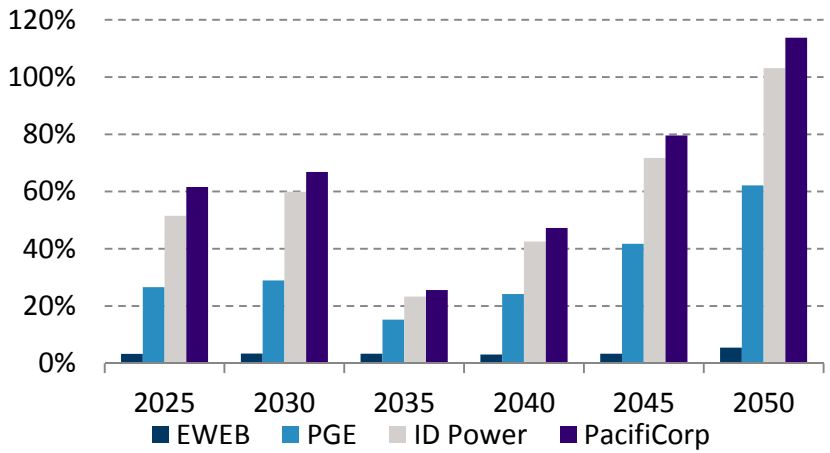
Commentary

- For PGE, the rate increases follow the trend in GHG allowance prices under the cap-and-trade. *For market purchases, we used the average WECC-wide annual market emissions rate from PLEXOS.*
- For PacifiCorp, coal units outside Oregon are tagged with Oregon GHG allowance prices based on PacifiCorp's Oregon load relative to its to total load across the Western Interconnect.
  - PacifiCorp's rate impact is highly pronounced through 2030 due to out-of-state coal production and then becomes more muted as coal imports are banned after 2030.
- Idaho Power follows a similar pattern as PacifiCorp as the majority of its generation is outside of Oregon and the largest portion of its electricity generation capacity is fossil-based.
- EWEB experiences almost no rate impact.
  - EWEB has an almost 100 percent zero-carbon portfolio.

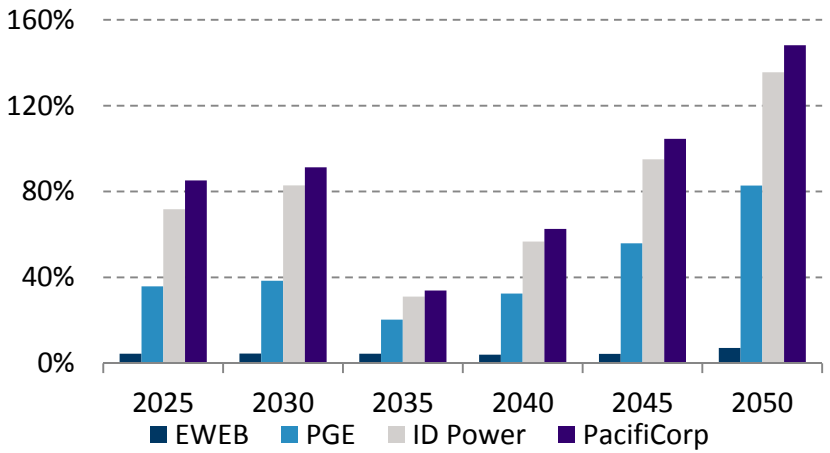
Residential Price Change from Baseline



Commercial Price Change from Baseline

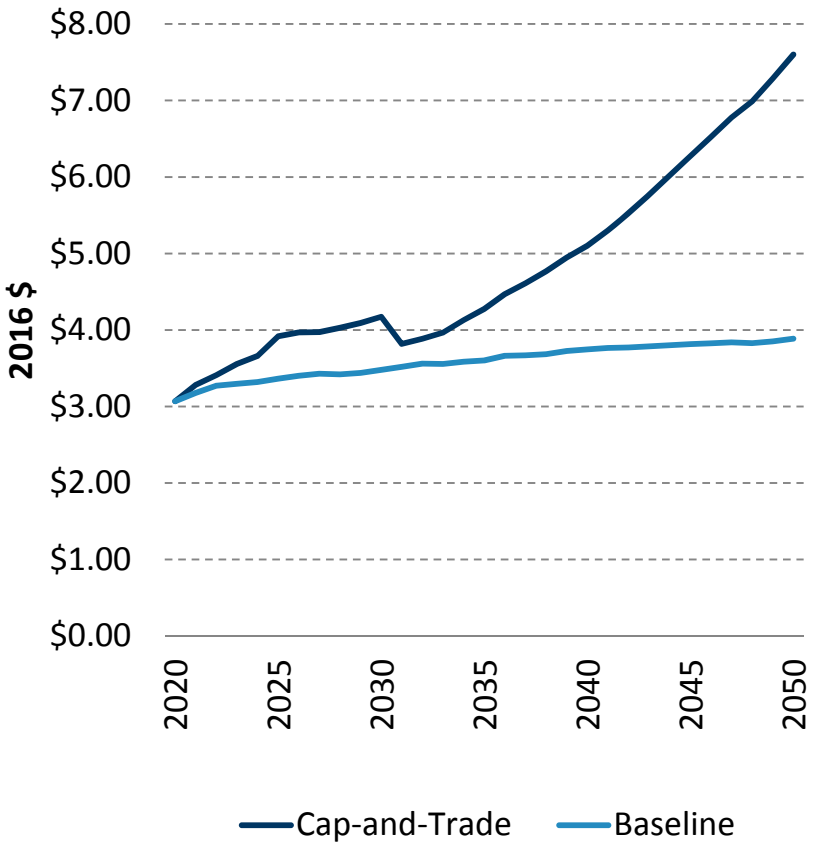


Industrial Price Change from Baseline

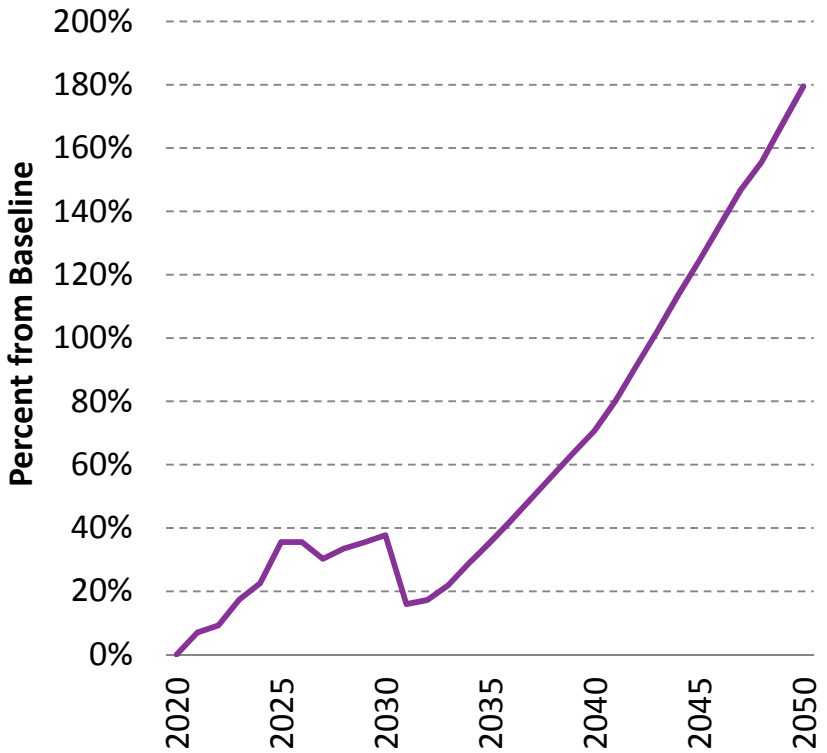


By 2050, the cost of allowances leads to retail gasoline prices over $7.50 per gallon and natural gas prices that are 180% higher.

Change in Retail Gasoline Prices



Change in Residential Natural Gas Prices



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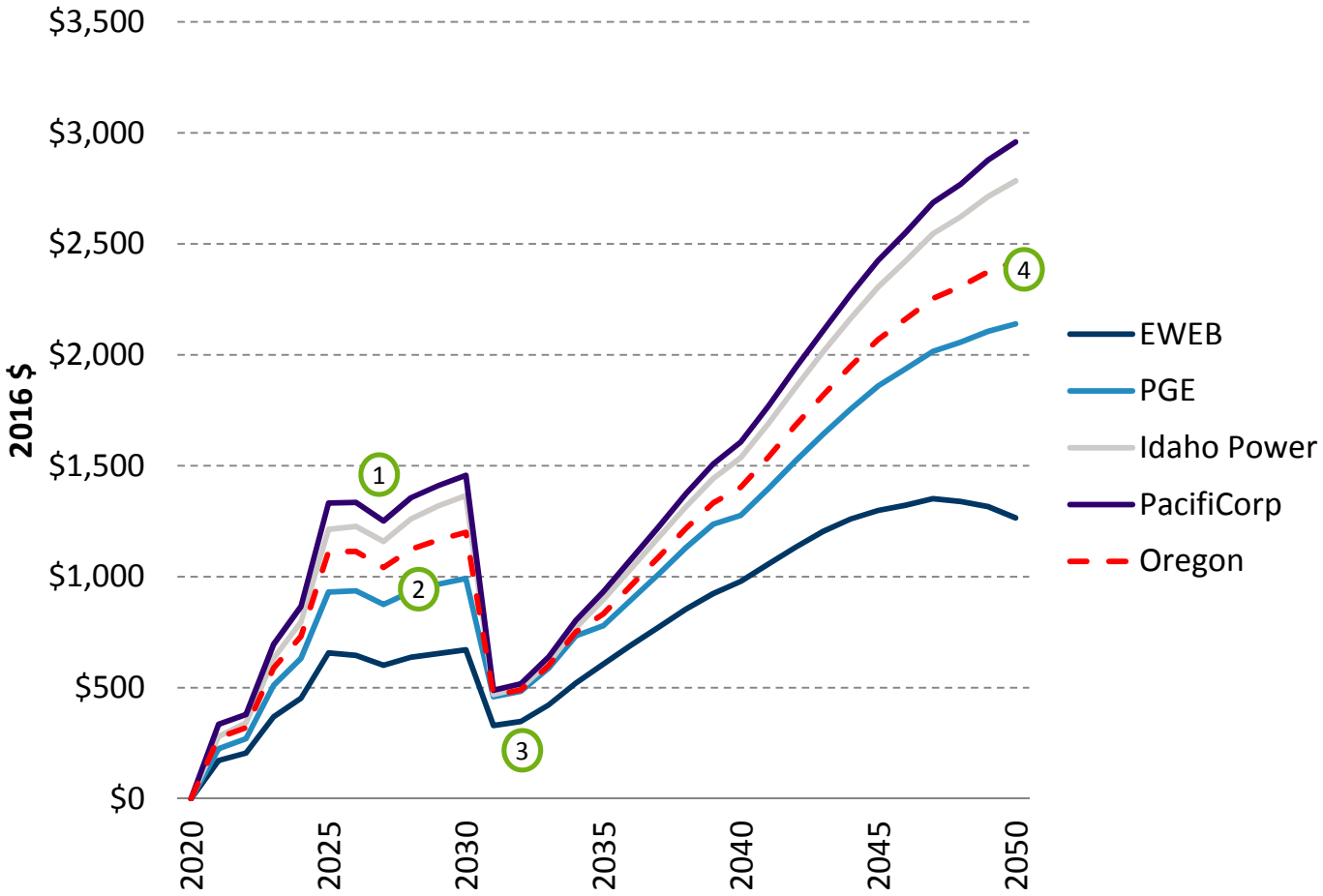
SB 1574 (2016) would have significant impacts on the utility bills and fuel prices "at the pump" paid by the average family-of-four

Average annual direct cost-of-living impact per family-of-four



Commentary

- This analysis covers only "direct" costs to customers' energy bills – utility bills for electricity and gas and higher prices for petroleum products
- Real income losses from commercial firms passing their higher costs of operations to local customers is not included
- Any impact of changes in the labor market are not included
- If these were to be included, then the results could be 1.5 to 2.0 times higher than now

1. Direct cost per family-of-four varies between $500 and $1,500 per year in the 2020s
2. Idaho Power and PacifiCorp customers tend to have higher costs while PGE and EWEB customers tend to have lower
3. Direct costs drop with the drop in allowance prices in 2031
4. Oregon costs are close to the cost for the IOUs' customers, which serve most of the state's total population

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Appendix

Acronyms

- AOI – Associated Oregon Industries
- BAU – business-as-usual
- C&T – cap-and-trade
- CFP – Clean Fuels Program
- CGE – computable general equilibrium model
- CO_2e – metric tonnes of carbon dioxide and equivalents
- CTAM – Carbon Tax Assessment Model
- EITE – emissions intensive, trade-exposed
- EWEB – Eugene Water and Electric Board
- FIRE – finance, insurance, and real estate
- FTI – FTI Consulting
- GDP – gross domestic product
- GHG – greenhouse gases
- HGWP – high global warming potential gases
- I/O – input-output model
- MSA – metropolitan statistical area
- MSW – municipal solid waste
- MT – metric tonne
- MMT – million metric tonnes
- OEA – Office of Economic Analysis
- PGE – Portland General Electric
- R&C – residential and commercial
- RDPI – real disposable personal income
- RPS – renewable portfolio standard
- S&L – state and local government
- SB 1547 (2016) – Oregon Senate Bill enacted in 2016
- SB 1574 (2016) – Oregon Senate Bill 1574 proposed in 2016

Overview and Findings

Overview

- AOI retained FTI to estimate the economic impacts of SB 1574 (2016), a proposed cap-and-trade bill that would require Oregon to reduce a subset of its total GHG emissions to 75% below 1990 levels by 2050.
- SB 1574 (2016) would cap emissions for entities that produce more than 25,000 metric tonnes of carbon dioxide annually, which in aggregate represent approximately 80% of the state's total GHG emissions.
  - Agriculture, waste water and waste incineration, and non-combustible emissions are not covered.
  - Industrial processes, HGWP, and MSW landfills are partially covered.
- FTI closely followed the proposed SB 1574 (2016) with the exception of offsets, where zero offsets were assumed in FTI's Baseline Scenario.
- FTI's Baseline Scenario and DEQ's Reference Policy case have similar underlying assumptions, but FTI's emissions without the cap are significantly lower.
- FTI uses models to force GHG reductions while DEQ assumes a carbon price informed by forecasts of the California price floor and reserve price in 2035.
- FTI applied three long-term, dynamic models in its analysis:
  - PLEXOS: provides power sector supply, demand, and price forecasts
  - CTAM: provides non-electric sector emissions response to GHG prices
  - REMI: provides responses to macroeconomic outcomes due to policy
- The FTI modeling approach and structure are different than DEQ:

Modeling Approach	DEQ	FTI
Years modeled	1 year: 2035	34 years: 2017-2050
Oregon regions modeled	State level	State and 8 regions in OR
Electricity market modeling area	Unknown	Western Interconnect
Price effects	No	Yes
Macroeconomic model	Static	Dynamic
CO_2 price	Fixed input	Solved by the models

Findings

Cap-and-Trade Allowance Prices

- GHG allowance prices ($/MT CO_2e) start at $13 in 2021, rise to $84 in 2035, and continue to $464 by 2050. If offsets of up to 8 percent of baseline were to be included, we estimate GHG prices to be about 44 percent lower, on average.
- Complementary policies (Boardman, CFP, no coal imports after 2030, RPS) reduce capped baseline GHG emissions to 21 percent below 1990 levels by 2030. These policies have costs but help mitigate GHG prices under the C&T.

Macroeconomic Impacts

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

- GHG prices would result in the following in 2050:
  - $7.60 (with taxes) per gallon of gasoline (in 2016$'s), higher than prices in Europe.
  - A 65%, 108%, and 118% increase in average retail electricity rates (above the baseline forecast) for PGE, Idaho Power, and PacifiCorp customers, respectively.*
  - A 179% increase in retail natural gas rates (above the baseline forecast) for Oregon.

Policy Design

- Allocating allowances to EITE industries is key to retaining jobs in high-income industries and minimizing emissions leakage resulting from production moving to more fossil fuel-intensive states or countries.
- Giving auction revenues to state infrastructure funds or climate investments results in some out-of-state wealth transfers; allocating more allowances to impacted parties would perhaps improve the forecasted economic impacts.
- Offsets could be important for reducing the economic costs of the policy.

* Average percent increase based on simple average for residential, commercial, and industrial rate increases.

Carbon Cap-and-Trade Modeling Approach and Methodology

STEPS

1. **Apply cap in ORCTAM to 80% of the emissions that are considered "feasible" to reduce by DEQ**
   - Fossil fuel combustion is under the cap
   - The cap excludes agriculture and non-CO_2 global warming pollutants (GWP)
2. **Produced CO_2 prices from ORCTAM**
   - PLEXOS BAU emissions are an exogenous input into the scenario analysis
   - ORCTAM solves for price on remaining non-electric emissions under the cap
3. **Apply CO_2 prices in PLEXOS**
   - Post-2030 imports of coal from NWPP and neighboring regions (Rocky Mountain and Basin) are blocked through changes to the "pipe and bubble" transmission structure
   - Imports of gas into OR are taxed at the CO_2 price in each year
   - Gas generators in OR are subject to the full CO_2 price; Hermiston is the sole plant subject to 25% of the CO_2 price; 25% is chosen because it represents the OR portion of PAC's total WECC load
   - PAC generators outside Oregon are not subjected to the CO_2 price for dispatch purposes (but are subjected to the CO_2 price for rate purposes)
4. **Iterate on Steps 2 and 3**

Carbon Cap-and-Trade Modeling Approach and Methodology (cont'd)

STEPS

5. Run REMI model

- Inputs from PLEXOS and ORCTAM
  - ORCTAM inputs include residential, commercial, and industrial costs of natural gas and petroleum products and auction revenues for distribution back into the Oregon economy
  - PLEXOS inputs include electrical power generation totals, capacity by type, emissions, and electricity prices

6. SB 1574 (2016) spells out which priorities might receive free allowances or auction proceeds, but leaves some of the exact definition of terms, administration, and split of the funds to DEQ's Environmental Quality Commission

- We attempted to follow the letter of SB 1574 (2016) where possible and the spirit with sound assumptions elsewhere
  - Assumed 15% of potential auction revenues lost to "inefficiencies" – same as DEQ's lower-bound
    - Likely money lost either to administrative expenses or payments to out-of-state entities
  - Defined "emissions-intensive, trade-exposed" (EITE) as large manufacturing emitters in the DEQ inventory
    - Highlights include computers and electronics, metals, food processing, and pulp and paper
    - Gave them a share of allowances roughly equal to their share of total emissions (~7%)
  - 12.5% of allowances to low-income households to offset energy costs – 12.5% being a middle estimate in other literature on the share necessary to make the poorest quintile "whole" again with carbon pricing
  - Of the remainder, 85% to the Climate Investments Account (mixed construction expenditures)
  - Of the remainder, 15% to the Just Transition Fund (transfers to households)

7. Complete simulation

- Economic impacts (such as jobs and GDP) on residential sector, 39 commercial sectors, 8 resource extraction and processing sectors, 20 manufacturing sectors, and 3 government sectors

The emissions-intensity of Oregon's economy is already declining rapidly, and SB 1574 (2016) would reduce it even further.