OREGON ENERGY POLICY SIMULATOR INSIGHTS: RECENT DEVELOPMENTS, POLICIES TO MEET EMISSIONS GOALS

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EXECUTIVE SUMMARY

Leading on climate: Oregon has emerged as a climate leader for the United States, finalizing rules to slash consumption of natural gas and transportation fuels and ensure 100 percent clean electricity by 2040. However, state policymakers must take additional action to hit Oregon's greenhouse gas (GHG) emissions targets of at least 45 percent below 1990 emissions by 2035 and at least 80 percent below by 2050, set in Executive Order (EO) 20-04; and to reduce emissions in line with what the International Panel on Climate Change reports is necessary for a safe climate future.

Local and immediate co-benefits of decarbonization: Oregon Energy Policy Simulator (EPS) modeling shows that increased ambition is not only possible, but that it creates dramatic economic, employment, and health benefits. We find that

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deep decarbonization scenario, consistent with the U.S. Nationally Determined Contribution under the Paris Climate Agreement (NDC Scenario), would reduce Oregon's GHG emissions by 74 percent compared to 1990 levels and save nearly $11 billion annually by 2050. This is not surprising—clean technologies are often the cheapest sources of energy today.

Transportation electrification: For example, electric vehicle (EV) prices continue to fall and are expected to reach upfront cost parity with internal combustion engines within a few years, meaning lifetime costs are typically already lower when accounting for fuel savings. These favorable economics make EV support one of the most cost-effective policies in the modeled scenarios, generating significant consumer benefits while also decarbonizing one of Oregon's largest sources of emissions.

Other cost-savings opportunities: Many other cost-saving policy opportunities are available such as adopting efficiency standards and policies to promote public and non-motorized transit, which deliver cost benefits due to large fuel savings. As this research demonstrates, the earlier these measures are adopted, the greater the savings. Therefore, swift action to take advantage of cost-saving decarbonization policies will be critical for Oregon.

Clean infrastructure: Achieving the state's climate targets will also require new, clean infrastructure. Our modeling finds fuel switching—for example adopting more transportation biofuels to comply with the state's Clean Fuels Program—is only a part of the solution. Deep decarbonization will require shifting nearly all of Oregon's purchases of new vehicles to EVs and supporting charging infrastructure buildout. In addition, replacing fossil fuel equipment in buildings and industry with electric and other zero-carbon alternatives will be critical.

Job creation: These investments offer major opportunities to boost statewide workforce and economic activity. We find the more ambitious scenarios generate greater benefits. For example, a scenario incorporating the Climate Protection Program (CPP Scenario) on top of Oregon's recent clean electricity and transportation policies delivers far more economic benefits than those recent policy developments alone. And the CPP Scenario adds 9,500 net jobs and boosts Gross Domestic Product (GDP) nearly $2.5 billion in 2050, while the more ambitious NDC Scenario generates 18,000 net jobs and boosts GDP nearly $4 billion in the same year.

Health benefits: Avoiding local sources of air pollution also generates significant public health benefits. The NDC Scenario avoids over 800 asthma attacks annually and delivers nearly $5 billion in monetized public health and climate benefits in 2050, compared to the CPP Scenario which avoids 600 asthma attacks annually and delivers more than $3 billion in monetized public health and climate benefits in 2050. We find that benefits are greater across the CPP and NDC scenarios for people identifying as Black, with the percentage change in avoided deaths for people identifying as Black averaging 1.6 times higher than avoided deaths for people identifying as white in 2050.

New policy options: Oregon's existing policies, notably House Bill 2021 which sets a timeline for 100 percent clean electricity, the Clean Fuels Program, the recent Clean Trucks Rule, and the CPP, create a solid foundation for additional climate action. We find key policies to further accelerate emissions reductions include stronger EV sales standards, standards and incentives to support fully-electric buildings and transition industrial equipment to a mix of electricity or hydrogen, and policies to promote further carbon sequestration through the state's forests. Even though the NDC Scenario

incorporates these ambitious policies, it does not fully meet Oregon's climate targets as defined in EO 20-04, highlighting the need for other policies not explored in this research, such as additional agricultural practices.

Opportunities: While clean energy clearly delivers numerous benefits, the state must adopt policy tools to encourage this growth and ensure new investment decisions lead to clean rather than polluting infrastructure. Early and sustained action will be key to delivering the scale of necessary emissions reductions and realizing the economic and health benefits of strong climate action.

INTRODUCTION

On March 10, 2020, Governor Kate Brown issued EO 20-04, directing Oregon state agencies to take actions to reduce and regulate the emissions of GHGs.[1] This EO updated the state's aspirational carbon reduction goals by setting targets of at least 45 percent below 1990 levels by 2035, and at least 80 percent by 2050. Notable inclusions are a stronger transportation sector clean fuels standard, new construction building efficiency goals, greater household appliance efficiency, expanded EV charging infrastructure, transitioning new vehicles from fossil fuel powered vehicles to zero-emission vehicles (ZEVs), and creating the CPP.[2]

Oregon has also made significant progress toward meeting its GHG targets by passing House Bill 2021 (HB2021) in June 2021, adopting the Clean Trucks Rule in November 2021, and approving the Oregon Department of Environmental Quality's (DEQ) new CPP in December 2021. The CPP will enforce declining limits on GHG emissions from natural gas and transportation fuel consumption. Each year the DEQ will set the overall GHG emissions limit from covered fossil fuel suppliers and stationary sources, reaching 50 percent by 2035 and 90 percent by 2050 below the baseline (equal to Oregon's average 2017 to 2019 emissions from covered fuels).[3]

The Oregon EPS, developed by Energy Innovation (EI)[iii] in collaboration with Power Oregon[iv] and the Green Energy Institute,[v] estimates the impact of climate policies on emissions of 12 different pollutants as well as on the economy and public health, thus providing policy guidance for how to substantially reduce harmful GHG and particulate emissions in Oregon, while maximizing economic and health benefits.

This research note outlines the results of five policy scenarios modeled with the Oregon EPS:

- The **Business as Usual (BAU) Scenario** shows Oregon's GHG emissions trajectory through 2050 as of 2020, absent additional policy actions at the state or federal levels.
- Two **Recent Policy Development scenarios** incorporate recent policy developments: an expanded Clean Fuels Program based on EO 20-04, the Clean Trucks Rule, and HB2021. These two scenarios differ in only one respect: One scenario assumes Oregon meets new clean electricity demand with in-state production only, while the the other assumes Oregon only

[iii] Energy Innovation: Policy and Technology LLC, https://energyinnovation.org.
[iv] Power Oregon, poweroregon.org.
[v] Green Energy Institute, law.lclark.edu/centers/green_energy_institute/.

imports clean electricity to meet the new demand; thus bracketing the range of new energy production in Oregon.

- The **Example CPP Scenario** charts one possible compliance pathway for the CPP program, as it does not identify specific policies to reach the legislated targets. This scenario stresses electrification and efficiency, which we find are the least-cost decarbonization pathways.
- Finally, the **NDC Scenario** outlines a policy package to align policies in Oregon with national policies intended to meet the U.S. commitment under the Paris Agreement and a global target of limiting warming to 1.5 degrees Celsius (i.e., the U.S. NDC). This scenario finds stronger policies across all sectors of the economy would reduce emissions 50 percent below the 1990 baseline annually by 2035 and 74 percent below annually by 2050, while boosting state GDP by nearly $4 billion. The Oregon EPS shows how additional, stronger climate policies that reduce emissions across all sectors would put the state on a path to achieving its climate goals, while growing the economy and enhancing public health.

The table below shows total emissions under each policy scenario, along with the percentage emissions reductions from 1990 levels in 2035 and 2050 for each scenario. More tables summarizing all impacts can be found in Appendix A.

Policy Scenario	Emissions in 2035 (MMT CO_2e)	Percentage Below 1990 Emissions in 2035 (%)	Emissions in 2050 (MMT CO_2e)	Percentage Below 1990 Emissions in 2050 (%)
BAU	56	3	57	1
Recent – No Added Imports	43	25	41	30
Recent – Added Wind and Solar Imports	43	25	41	30
CPP	36	38	26*	55*
NDC	29	50	15	74

Table 1. *EPS policy scenario results in 2035 and 2050 relative to EO 20-04 emissions goals of 45 percent reductions below 1990 levels by 2035 and 80 percent by 2050. Emissions in this table exclude the land use and land use change sector. *The modeled CPP Scenario does not explicitly include the ~2.5 MMT of assumed Community Climate Investments (explained in the CPP section of this note). Including Community Climate Investments, 2050 emissions would be 24 MMT, or a 60 percent reduction relative to 1990 emissions.*

THE OREGON ENERGY POLICY SIMULATOR

The Oregon EPS is a free, open-source model that allows users to estimate climate and energy policy impacts on statewide emissions, the economy, and public health using publicly available data. Elements of the model have been peer reviewed by a diverse set of national laboratories, universities, think tanks, and regional partners. The model estimates these impacts through 2050 and accounts for

how selected policies interact with each other, helping policymakers and the public rapidly vet policies and recognize remaining emissions gaps. EPS models now cover 56 percent of global GHG emissions, and models have been developed for more than a dozen countries and several U.S. states, including California, Colorado, Louisiana, Minnesota, Nevada, and Virginia.

As with any modeling tool, the EPS carries uncertainties including the precise impacts of a given policy. The EPS also does not make any determinations about the likelihood of policy implementation. Additionally, some policies in the EPS rely on new and developing technologies, particularly those in the industry sector such as green hydrogen and carbon capture utilization and storage, which have yet to be deployed at scale. Regional uncertainty and variation are accommodated through the model's flexible, thoroughly documented, and data-driven design. While the Oregon EPS does not replace more detailed analyses of specific sectors and processes, the model complements such granular approaches while calculating large-scale impacts in seconds in an accessible web-based interface. A companion document that explains key data sources, assumptions, and methodologies used in the EPS, along with EPS model documentation is available.

The EPS also calculates social and health benefits using regional emissions factors by fuel and end use[4] provided by the U.S. Environmental Protection Agency.[5] The benefit per ton pollutant values are then multiplied by the reduction in nitrogen oxides, particulate matter (PM 2.5), and sulfur dioxide emissions to report avoided health incidents.[6]

OREGON'S BAU EMISSIONS OUTLOOK

The BAU Scenario estimates Oregon's emissions trajectory prior to 2021 policy developments. It includes other existing policies, scheduled power plant retirements, some building and transportation efficiency improvements, and economic adoption of EVs. Without additional policy action, the BAU Scenario projects the state's emissions will decrease just 1 percent in 2050 compared to the EO 1990 baseline.

With electricity as its own sector, Oregon's two largest-emitting sectors in 2019 were transportation and electricity, at 35 percent and 29 percent of 2019 GHG emissions, respectively. The third-largest emitting sector was buildings at 13 percent, followed by industry at 11 percent, and agriculture at 10 percent.[7]

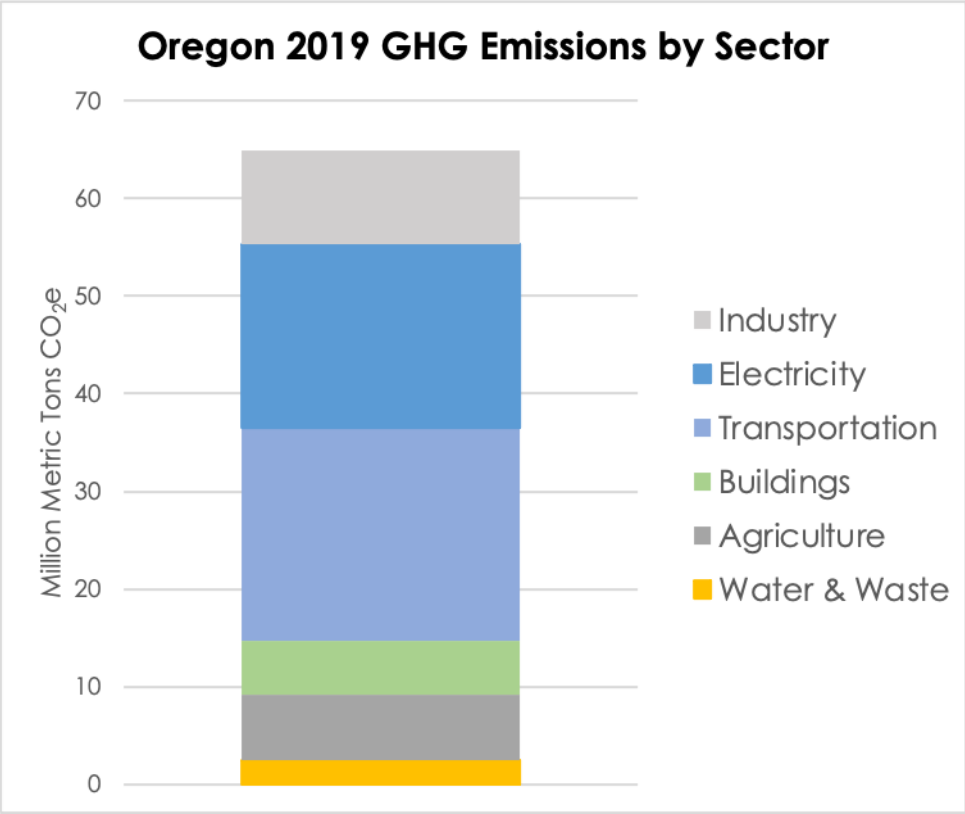

Figure 1. *Oregon's 2019 GHG emissions from Oregon DEQ's GHG Sector-Based Inventory. Elements of the Inventory have been recategorized in line with the classification system used by the EPS.*

However, with emissions from electricity generation reallocated to the demand sectors, the state's two largest-emitting sectors are transportation and buildings, with the GHG emissions breakdown by sector as follows: 35 percent for transportation, 34 percent for buildings, 19 percent for industry, and 10 percent for agriculture.

In 2019, 28 percent of Oregon's electricity was fueled by coal, mostly through imported electricity from out-of-state coal-fired power plants (the state includes imported electricity emissions in its GHG inventory).[8] But while Oregon still relies heavily on coal, electricity sector emissions are declining and will continue to do so in the coming decades. PacifiCorp,[vi] currently the largest grid operator in the Western U.S., plans to retire 16 of the 24 coal units in its current portfolio by 2030, and 20 units will be retired by the end of the 2038 planning period.[9] The Oregon EPS accounts for these trends, projecting electricity sector emissions will decrease 36 percent by 2050 in the BAU Scenario, as clean electricty prices continue to fall in comparison to fossil generation.

[vi] PacifiCorp, https://www.pacificorp.com/about.html.

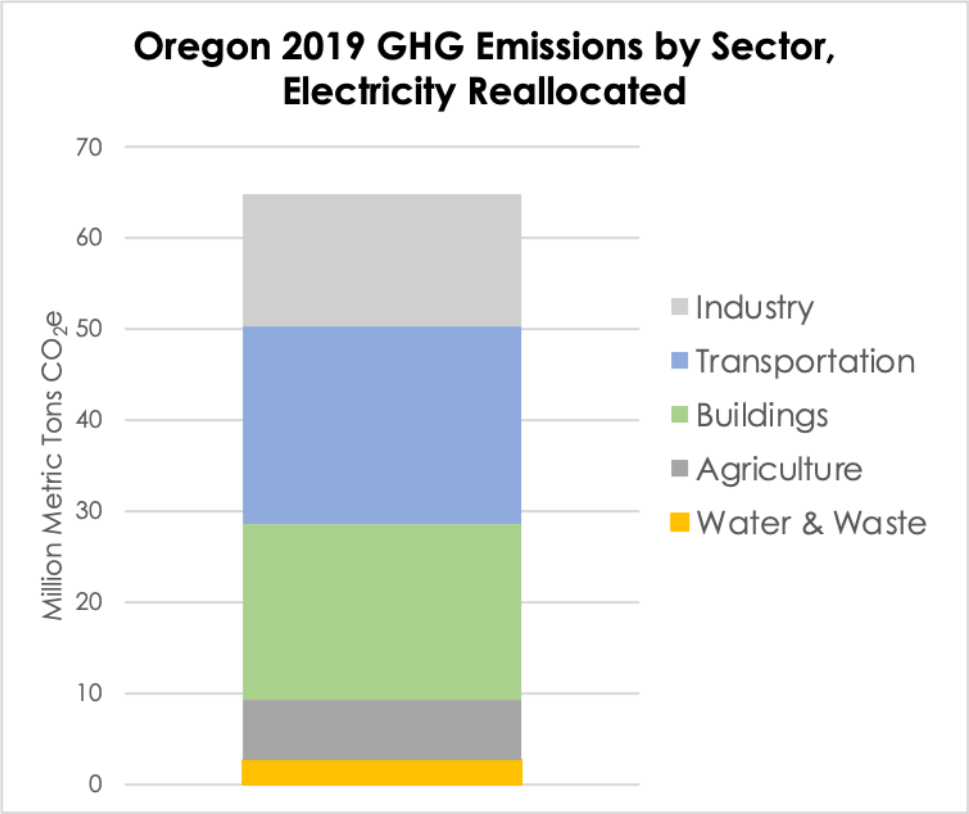

Figure 2. *Oregon's 2019 GHG emissions from Oregon DEQ's GHG Sector-Based Inventory, with electricity emissions reallocated to respective demand sectors. Elements of the Inventory have been recategorized in line with the classification system used by the EPS.*

Within the electricity sector, buildings create the largest electricity demand by a significant margin at almost 70 percent. Following buildings is the industry sector with 24 percent of the state's electricity demand, while all remaining sectors tracked by the Oregon EPS encompass the remaining 6 percent. Decarbonizing electricity, especially within the buildings and industry sectors, will be crucial to achieving Oregon's GHG emissions reductions goals.

Compared to many other states, industry is a relatively small portion of Oregon's GHG emissions, due to the absence of heavy industry and fuel production.

Finally, though not shown in Figures 1 and 2, Oregon has a vast land use sink in its forests, sequestering 59 million metric tons of carbon dioxide equivalent (MMT CO_2e),[10] nearly equal to the state's total GHG emissions. However, it is important to note that estimates of the land use sink vary, and annual variations are expected due to wildfires. Because the land use and land use change sector is not included in Oregon's GHG Inventory nor its EO targets, Table 1 reports changes in CO_2e excluding land use. The Oregon Global Warming Commission has laid out a separate goal to sequester an additional 5 MMT CO_2 per year in Oregon's natural and working lands and waters by 2030, and 9.5 MMT per year by 2050, which is addressed in the NDC scenario.[11]

Figure 3 shows the BAU scenario through 2050. Note that while direct combustion of petroleum products made transportation the largest emitting sector in Oregon's 2019 GHG Inventory, the EPS

shows transportation emissions slightly lower than electricity sector emissions in 2020 due to the effects of COVID-19.

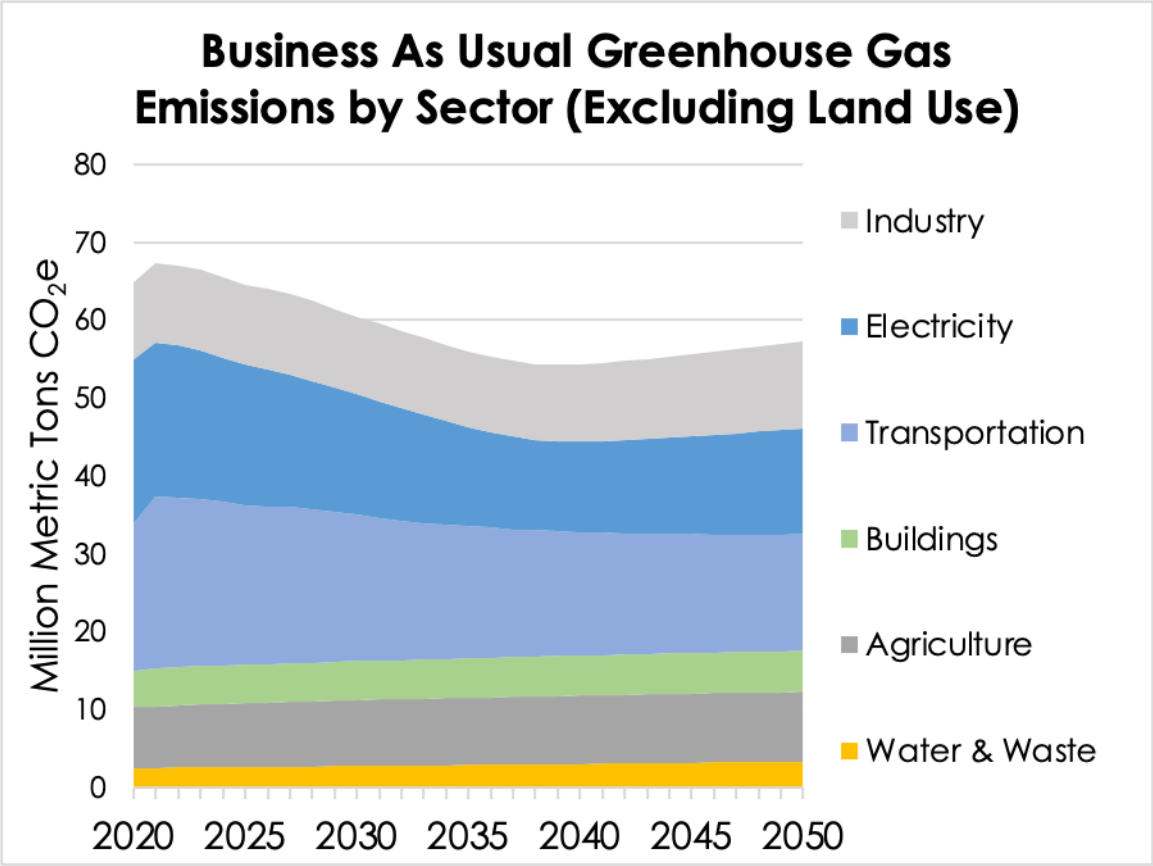

Figure 3. *Projected GHG emissions by sector in the Oregon EPS, excluding the land use and land use change sector.*

RECENT POLICY SCENARIOS

In 2021, Oregon made progress on several new policies to reduce GHG emissions, including initiating rulemaking for the recently expanded Oregon Clean Fuels Program targets, HB2021, and the Clean Trucks Rule. The Oregon EPS features scenarios that incorporate these developments: the "Recent Policy Developments – No Added Imports Scenario" (No Added Imports Scenario) and the "Recent Policy Developments – Added Wind and Solar Imports Scenario" (Added Wind and Solar Imports Scenario). These two scenarios bookend the range of expected electricity sector emissions due to uncertainty around the state's reliance on imported electricity.

The Oregon Clean Fuels Program encourages consumption of fuels with lower carbon emissions compared to gasoline and diesel through incentives and requirements that create greater demand for cleaner fuels.[12] For example, fuel providers can sell credits they have earned by going beyond that year's reduction goals for fuel carbon intensity. The program began in 2016, with 2015 serving as a baseline, and Governor Brown's EO recently directed the Oregon DEQ to adopt rules increasing the program's 2035 target from a 10 percent to a 25 percent reduction in carbon intensity.

The Clean Trucks Rule requires 30 to 50 percent of new medium- and heavy-duty trucks, vans, and buses sold in the state to be zero-emission by 2030, reaching 40 to 75 percent by 2035 (varying by vehicle class). Oregon was the second state to adopt zero-emission truck rules, and now belongs to a cohort with five other clean truck states as of December 2021: California, Massachusetts, New Jersey, New York, and Washington.[13]

Finally, Oregon's HB2021, effective in September 2021, established one of the country's fastest power sector decarbonization timelines. This bill requires retail electricity providers to reduce GHG emissions of electricity sold to consumers 80 percent below baseline emissions (the state's emissions average from 2010 to 2012) by 2030, 90 percent below baseline emissions by 2035, and 100 percent below baseline emissions by 2040.[14] This bill also prohibits the expansion or new construction of power plants that burn fossil fuels.[15]

The 'Recent Policy Development' scenarios demonstrate two alternative pathways for replacing Oregon's coal-fired electricity imports—either entirely with new clean resources built in-state or with zero-carbon imports from other Western states. The No Added Imports Scenario replaces coal-fired electricity imports with new clean energy power plants within the state, while the Added Wind and Solar Imports Scenario replaces coal-fired electricity imports with imports of onshore wind and solar power. The eventual outcome will likely fall somewhere between these two scenarios. While the two scenarios result in the same level of electricity sector emissions reductions, they vary in terms of economic impacts.

EMISSIONS, ECONOMIC, AND HEALTH BENEFITS OF 'RECENT POLICY SCENARIOS'

These two policy packages show recent climate policies could slash electricity and transportation emissions, while delivering significant economic and health benefits. HB2021 drives steady, annual electricity sector reductions reaching more than 90 percent below BAU in 2035 and approximately 100 percent below BAU in 2040. Transportation sector emissions decrease 3 percent in 2035 and 15 percent in 2050 compared to the BAU Scenario in both scenarios. Together, the included policies make progress towards reaching Governor Brown's GHG emissions reductions goals, reaching 25 percent below the 1990 baseline in 2035 and nearly 30 percent below in 2050.

While there is some year-to-year variation based on when projects are built, the scenarios also add jobs, increase GDP, and generate human health and social benefits. Both scenarios add jobs to Oregon's economy, with the No Added Imports Scenario creating 400 jobs in 2050, compared to 570 jobs resulting from the Added Wind and Solar Imports Scenario. Both scenarios also show an increase in GDP compared to the BAU Scenario, with the No Added Imports Scenario forecasting $40 million and the Added Wind and Solar Imports Scenario forecasting $140 million in added GDP in 2050.

Both scenarios also find public health benefits due to reductions in air pollution from burning fossil fuels, with approximately 195 avoided asthma attacks annually by 2050.

The resulting emissions reductions and avoided health impacts are estimated to avoid $1.5 billion in damages annually by 2050.[vii]

These results confirm Oregon's recent climate policies could generate immense economic and health benefits as they decarbonize the economy. The CPP, discussed below, delivers additional reductions in the transportation, buildings, and industry sectors.

OREGON'S CLIMATE PROTECTION PROGRAM

The CPP mandates an emissions cap for covered fuels rather than specific policy actions. Therefore, emissions reductions pathways and associated co-benefits from the program are not as clear as for other policies. However, we include an example CPP Scenario, which models one possible pathway by adding or strengthening current policies on top of what is already included in the No Added Imports Scenario. The scenario uses a combination of policy levers to meet the annual emissions caps specified by the CPP for covered natural gas and transportation fuels. The caps are calculated relative to average emissions of covered fuels between 2017 and 2019, and reach 50 percent below baseline by 2035 and 90 percent below baseline by 2050.

Of note, we assume roughly 2.5 MMT emissions reductions will come from 'Community Climate Investments' (CCIs), along with emissions banking and trading[viii] by the year 2050, as allowed under the program. The CCI mechanism allows natural gas and transportation fuel suppliers to purchase emissions reduction credits from non-governmental organizations that invest in Oregon-based projects that reduce GHG emissions and benefit local communities. In the absence of more recent analysis of expected CCIs and banked instruments, we rely on an estimate from ICF International's 2021 modeling study[16] on CPP options, which was commissioned by the Oregon DEQ. Given uncertainty about how CCIs will be implemented, CCIs are not explicitly modeled in the EPS (meaning 2050 emissions from covered fuels are 2.5 MMT higher than the target in the CPP Scenario). Therefore, they are not reflected in the economic or health benefits below.

To comply with the CPP, we focus on electrification in transportation, buildings, and industry, adopting California's 100 percent light-duty EV sales by 2035 and 100 percent electric building equipment sales by 2040. We also include ambitious efficiency improvements in vehicles, building components, and industrial equipment. Finally, we model increased biofuel penetration in the transportation sector, primarily biodiesel for remaining heavy-duty vehicles with internal combustion engines.

[vii] Monetized co-benefits are calculated using the value of a statistical life as defined by the U.S. Environmental Protection Agency and the social cost of carbon as defined by the U.S. Interagency Working Group on Social Cost of Greenhouse Gases. "Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990" (Interagency Working Group on Social Cost of Greenhouse Gases, United States Government, February 2021), https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf?source=email. "Mortality Risk Valuation," United States Environmental Protection Agency, n.d., https://www.epa.gov/environmental-economics/mortality-risk-valuation#whatvalue.

[viii] One compliance instrument permits 1 MMT CO_2e of allowable GHG emissions

This scenario shows adding policies to implement the CPP would generate greater co-benefits for Oregon, creating nearly 9,600 jobs and generating $2.5 billion in GDP in 2050, while also avoiding 600 asthma attacks and 40 premature deaths in that year. On a percent change basis, we find avoided deaths are greater for people of color. The percentage reduction in premature deaths is 40 to 90 percent greater for people identifying as Black, Asian, or 'other race,' compared to people identifying as white. Additionally, monetized health and climate benefits reach almost $3.1 billion in 2050. Because of its broader scope, the CPP Scenario leads to much greater emissions reductions than the Recent Policy Developments scenarios, reaching 38 percent below 1990 emissions in 2035 and 55 percent below in 2050 (or 60 percent below if including CCIs).

The NDC Scenario highlights additional policies Oregon can implement to meet GHG emissions reduction goals aligned with international efforts to limit climate change to warming of 1.5°C.

POLICY OPTIONS FOR DEEP DECARBONIATION

While Oregon's recently passed policies will deliver significant emissions reductions, the state can achieve even greater reductions while delivering climate, health, and economic benefits. The NDC Scenario is adapted from a nationwide policy scenario developed by EI to meet the U.S. NDC of 50 to 52 percent below 2010 emissions by 2030.[17] When layered on top of current state policies, this scenario reduces economy-wide emissions 50 percent in 2035 and 74 percent in 2050 compared to 1990 levels.

Although the NDC Scenario in the Oregon EPS does not meet the state's EO targets for the year 2050, the policies outlined below achieve deeper economy-wide reductions following Oregon's recent policy developments. Because the largest remaining source of 2050 emissions in the NDC scenario is agriculture, additional agricultural policies, in particular, will likely be important to closing the gap to the EO target. Additional abatement opportunities may also exist in the transportation sector—for example, sustainable aviation fuels or biodiesel in remaining heavy-duty trucks.

Figure 4 shows the emissions reductions by policy. The major policies are discussed by sector below.

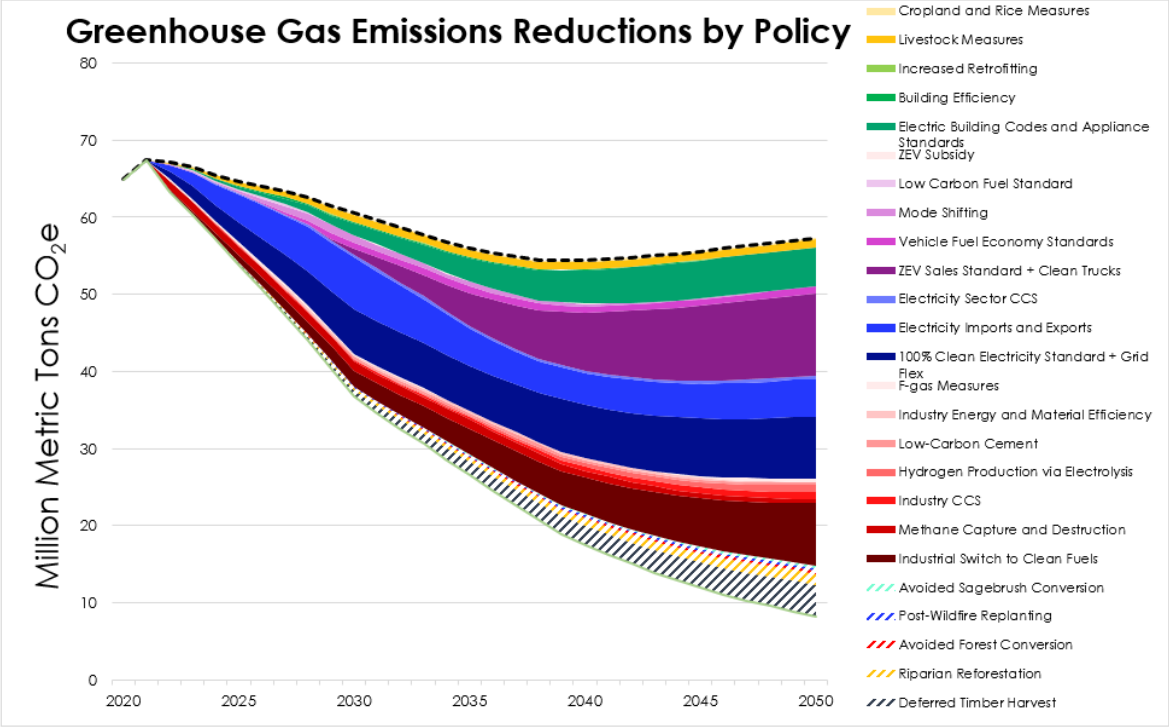

***Figure 4**. "Wedge" chart for the NDC Scenario. This graph shows GHG emissions excluding Oregon's land use and land use change sector, consistent with the fact Oregon's EO targets do not include land use. However, land use policies are included in the NDC Scenario showing additional carbon sequestration opportunities in the bottom striped wedges. Note this wedge chart aggregates some policy levers to improve figure readability; a full interactive wedge graph is available on the Oregon EPS.*

TRANSPORTATION

Implementing clean vehicle standards is extremely important to decarbonizing the transportation sector and meeting the state's climate goals. Considering that 56 percent of Oregon's transportation sector emissions originate from passenger cars and trucks, deploying ZEVs for light-duty vehicle use is critical. The state's recent measures encourage the use of lower carbon intensity fuels and require up to 50 percent of new medium- and heavy-duty trucks, vans, and buses sold in-state to be emissions-free by 2030, and up to 75 percent emissions-free by 2035. But additional policies could accelerate transportation decarbonization.

In this scenario, an EV sales standard equivalent to California's EV sales standard is implemented, which requires all new passenger vehicles sold in Oregon to be fully electric by 2035; this is paired with an EV subsidy lasting through 2030, which encourages consumer uptake by lowering the purchase price of qualifying EVs. Additional transportation sector policies include EV charger deployment, fuel efficiency standards, and promoting mode shifting (personal light-duty travel demand either shifted to public transport or non-motorized forms of transit, such as walking and biking).

ELECTRICITY

Replacing electricity produced by fossil fuels with clean power is vital to deep decarbonization and subsequent emissions reductions across all sectors. HB2021 requires Oregon's retail electricity providers to reduce electricity emissions 80 percent below baseline by 2030, 90 percent below baseline by 2035, and 100 percent below baseline by 2040. The NDC Scenario includes additional measures to maximize the benefits of this policy, including increasing Oregon's grid-scale electricity storage potential and adding transmission capacity. Such policies will increase grid flexibility (allowing for better wind and solar integration) and will make the system more resilient.[18]

INDUSTRY, AGRICULTURE, AND LAND

Industry policies in the NDC Scenario include cement clinker substitution to significantly lower cement process emissions and standards that require the use of clean fuels, among other policies. Deep industrial decarbonization will require capital investment and is unlikely to be pursued without a mix of standards and incentives, which is why these policies are vital for decarbonizing industry.[19]

Agriculture accounts for a sizable portion of the state's remaining GHG emissions in 2050, requiring smart practices to decarbonize this sector. Policies in this scenario include livestock-related measures to reduce methane, and cropland management practices such as reduced soil tillage and improved fertilizer composition and application. Livestock-related measures, such as targeting methane formation and release, could reduce livestock GHG emissions 10 percent in 2050. Though not modeled here, additional policies may unlock greater agricultural emissions reductions.

Although the land use sector is not included in Oregon's EO targets, the NDC Scenario also finds ample opportunity for additional carbon sequestration through natural lands, based on potential identified by the Oregon Global Warming Commission;[20] the impact of these land use policies included in the NDC Scenario can be seen in Figure 4 at the bottom of the wedge chart.

BUILDINGS

Improving energy efficiency and transitioning buildings away from burning fossil fuels to clean electricity for space and water heating are critical to meeting Oregon's emissions goals. The NDC Scenario includes standards for electrifying building components, energy efficiency standards, and retrofitting existing buildings. The majority of emissions reductions are attributed to strong building electrification policies leading to 100 percent sales of electric building components by 2030, which also offer consumer fuel savings and health benefits. Electric heat pumps have been shown to be more efficient than their fossil fuel burning, water heating counterparts,[21] and induction stovetops are more efficient and improve indoor air quality by reducing polluting gas fumes.[22] Additionally, the scenario includes retrofits for 15 percent of the existing building stock to deliver important consumer benefits and accelerate building sector decarbonization.

EMISSIONS, ECONOMIC, AND HEALTH BENEFITS OF THE NDC SCENARIO

The NDC Scenario finds expanding grid-scale electricity storage, increased transmission, EV charger installation, carbon capture and sequestration for natural gas peaker plants, and new hydrogen equipment installation would be an economic boon. In total, NDC scenario investments would increase the state's GDP by almost $4 billion annually in 2050 and create more than 18,000 jobs in the same year.

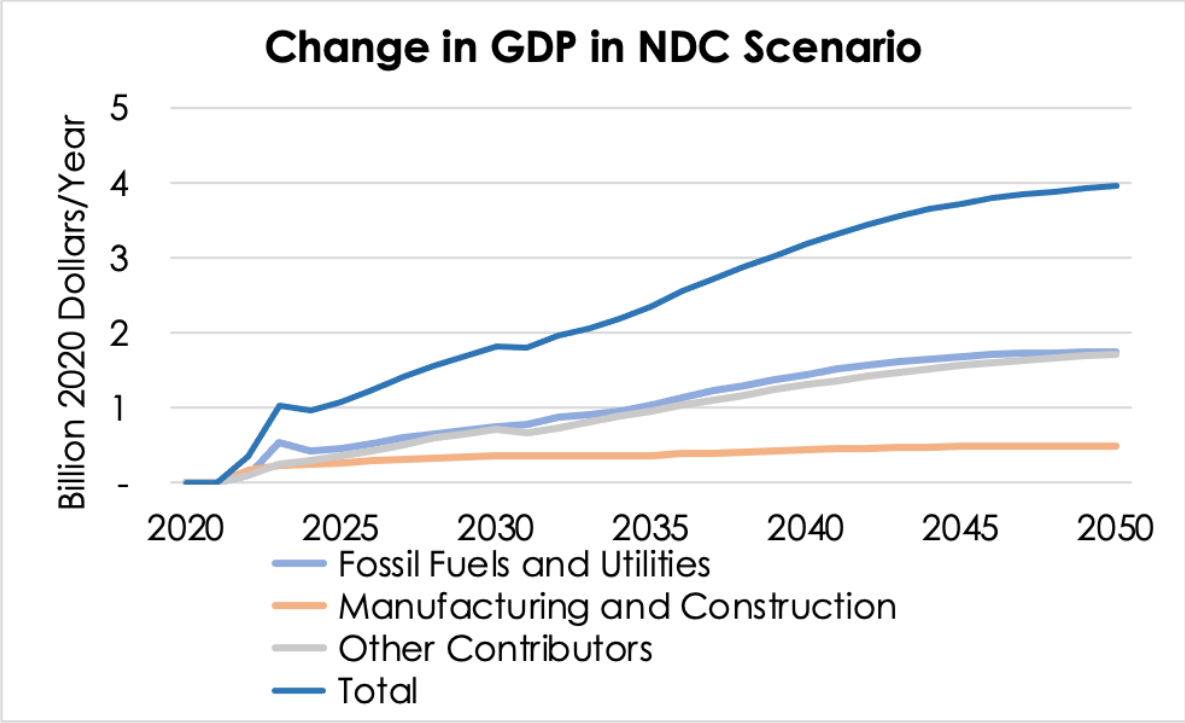

Figure 5. Projected changes in GDP relative to BAU in the NDC Scenario

This broader set of climate policies would also improve public health due to reductions in harmful air pollution from burning fossil fuels. The Oregon EPS estimates the NDC Scenario policies would avoid 27 premature deaths and 409 asthma attacks in 2035; these numbers increase to 59 avoided premature deaths and 879 asthma attacks in 2050. Like in the CPP scenario, we find that the percentage reduction in premature deaths are 50 to 90 percent greater for people identifying as Black, Asian, or 'other race,' compared to people identifying as white.

The NDC Scenario achieves the deepest GHG emissions reductions among all modeled scenarios, achieving 50 percent in 2035 and 74 percent in 2050 relative to 1990 levels. The NDC Scenario achieves Oregon's 45 percent reduction goal below 1990 levels of GHG emissions; however, this policy package falls short of the 2050 goal by a little over 3 MMT CO_2e, primarily due to remaining agricultural emissions.

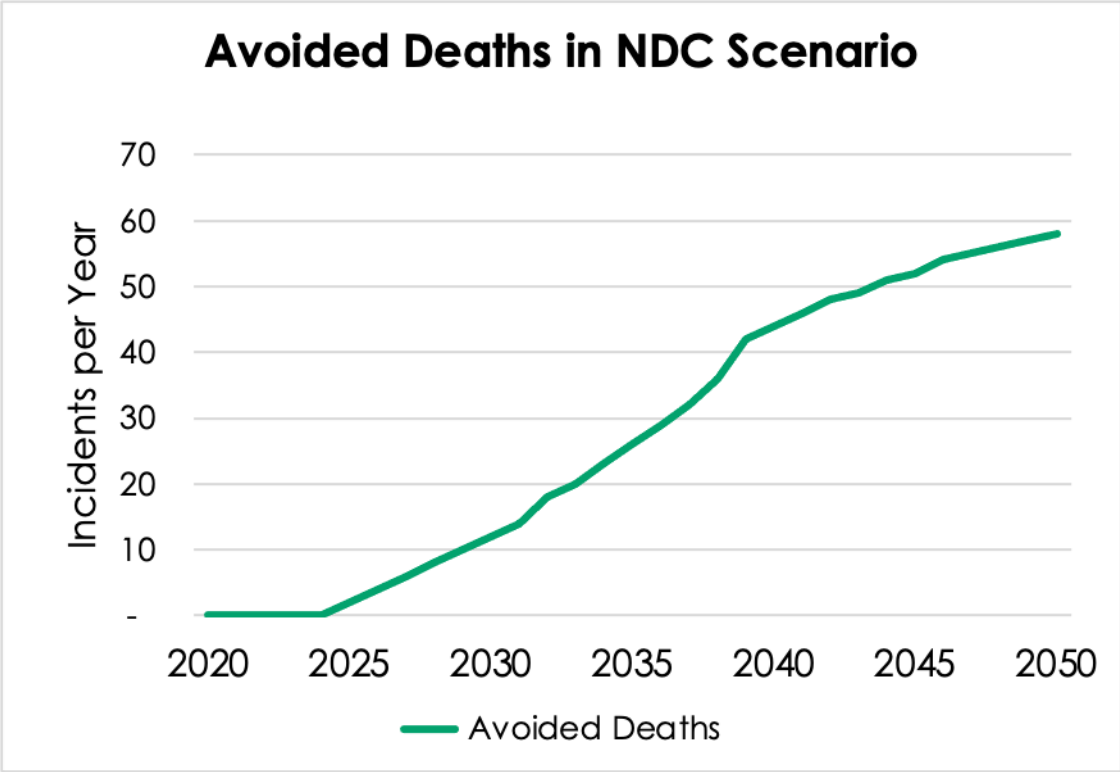

Figure 6. Projected changes in avoided deaths relative to BAU in the NDC Scenario

CONCLUSION

Oregon is quickly becoming a U.S. climate leader. The state has set one of the fastest timelines in the nation for achieving clean power and has adopted ambitious policies for decarbonizing transportation, buildings, and industry. Additional policies, particularly focused on electrification of transport and buildings, can leverage this transition to achieve deeper decarbonization. The NDC Scenario provides one possible policy pathway to cut emissions and achieve climate goals, while successfully growing the economy and creating new jobs. The Oregon EPS can help state policymakers measure progress and design effective emissions reductions policies in the buildings, transportation, land use, and industry sectors.

[1] "Carbon Policy Executive Order," oregon.gov, n.d., https://www.oregon.gov/gov/Pages/carbonpolicy_climatechange.aspx.
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[5] "Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors" (U.S. Environmental Protection Agency, n.d.), https://www.epa.gov/sites/default/files/2018-02/documents/sourceapportionmentbpttsd_2018.pdf.
[6] "Public Health and Additional Outputs," Energy Policy Solutions, n.d., https://us.energypolicy.solutions/docs/additional-outputs.html.
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APPENDIX A

Policy Scenario	Change in CapEx and OpEx – 2035 (Billion 2020 $)	Change in CapEx and OpEx – 2050 (Billion 2020 $)
Recent – No Added Imports	0.7	2.4
Recent – Added Wind and Solar Imports	0.4	2
CPP	3.6	7.0
NDC	3.7	10.8

Policy Scenario	Jobs – 2035 (Total)	Jobs – 2050 (Total)	GDP – 2035 (Billion 2020 $)	GDP – 2050 (Billion 2020 $)	MC & HB – 2035 (Billion 2020 $)	MC & HB – 2050 (Billion 2020 $)
Recent – No Added Imports	230	404	(0.01)	0.04	0.90	1.57
Recent – Added Wind and Solar Imports	312	571	0.06	0.14	0.92	1.57
CPP	6,113	9,585	1.23	2.46	1.54	3.09
NDC	11,869	18,027	2.35	3.95	2.28	4.80

Annual results of EPS policy scenarios relative to BAU: Job Creation (Jobs), Gross Domestic Product (GDP), and Monetized Climate and Health Benefits (MC & HB)

Policy Scenario	APD – 2035 (Incidents)	APD – 2050 (Incidents)	AAA – 2035 (Incidents)	AAA – 2050 (Incidents)
Recent – No Added Imports	3	14	55	197
Recent – Added Wind and Solar Imports	4	14	56	196
CPP	15	40	230	604
NDC	27	59	409	879

Annual results of EPS policy scenarios relative to BAU: Avoided Premature Deaths (APD) and Avoided Asthma Attacks (AAA)