Oregon Clean Energy Pathways Analysis

Executive Summary

July 2, 2021

Introduction

In late December 2020, as Washington State was finalizing its 2021 State Energy Strategy based on technical analysis by the Clean Energy Transition Institute and decarbonization pathways modeling by Evolved Energy Research, Oregon advocates were considering the value of a similar study to look at various pathways to decarbonization for their state.

A coalition that included Renewable Northwest, GridLab, and the Clean Energy Transition Institute was formed to raise funds for an Oregon clean energy pathways study that would mirror successful studies conducted in other Western states, including Washington, Nevada, New Mexico, and Colorado. Evolved Energy Research was engaged to analyze several decarbonization scenarios aimed at answering the following questions:

- What if Oregon had an economy-wide, net-zero emissions target?
- What if Oregon and the rest of the West were restricted from building new gas plants?
- What if Oregon had to meet its emissions and clean electricity targets with only in-state resources?
- What if Oregon moved more slowly on transitioning to clean alternatives through electrification?

A Technical Review Committee (TRC) composed of key stakeholders (see Appendix A) was created and met first on January 12, 2021 to kick off the modeling project and discuss the study methodology. The TRC met midway through the study on March 2, 2021 to review the preliminary results, and on May 20, 2021 for a presentation of the final results.

The Project Team (see Appendix B) altered the scope of the modeling and modified assumptions based on input from the TRC. The final report, which also incorporated TRC feedback study results, was completed on June 15, 2021. This Executive Summary presents the summary conclusions of the study.

Summary of Key Results and Recommendations

- Oregon can meet its 2035 emission reduction targets by removing coal from electricity and replacing it with new clean resources while reducing energy consumption through electrification; the state's 80% emissions reduction below 1990 emissions by 2050 target can be reached with deep electrification of transportation and buildings, and 100% clean electricity.

- Oregon contributes to regional energy solutions with offshore wind investment by 2050, exporting large amounts of clean electricity out of state; gas generators remain a capacity resource in 2045.
- Significant expansion of Oregon transmission connections to other states by 2050 will facilitate imports and exports of clean energy, taking advantage of geographic and resource diversity.
- Approximately 0.2% additional GDP per year would be required to achieve deep decarbonization in Oregon, delivering net benefits by 2040.

Study Design

Evolved's study evaluated 100% clean energy pathways for Oregon by taking a wholistic, economy-wide modeling approach that determines the demand for different types of energy over the next 30 years and how best to supply it across the 11 Western states.[1] It considered the transition needed to decarbonize all sectors of the economy, including the investments in energy-producing and consuming technologies and their operations, constrained by electricity and emissions policy across the West.

The Oregon Clean Energy Pathways Study models six scenarios for decarbonizing Oregon's economy, ranging from 80% to 100% reductions in economy-wide greenhouse gas emissions below 1990 levels by 2050. Table 1 describes the seven modeled scenarios and the key questions that each scenario aimed to answer.

Table 1. Scenario Summaries and Key Questions Posed

Scenario	Summary	Key Question
Reference	Business as usual	Assumes current CES policy is implemented and no emissions targets anywhere in the West.
80x50	Investigates the challenge of achieving an 80x50 emissions target and 100% CES	What investments are needed and how much would it cost to meet the 80x50 target if the demand side aggressively electrifies and energy supply options are relatively unconstrained?
80x50 No New Gas (West-wide scenario)	Investigates what the West would do differently if new gas build was not permitted (allows extension of existing gas)	What is the cost and investment impact of preventing new gas build? What alternative investments would be needed in place of gas?
80x50 Electricity Proposal	Investigates the impact of Oregon's electricity proposal	How does the Oregon electricity proposal impact the results versus the CETA-like policy assumed in the other scenarios?
100x50	Investigates the challenge of achieving an 100x50 emissions target and 100% CES	What investments are needed and how much would it cost to reach a more stringent 100x50 target?
100x50 In-State Only	Investigates the impact of restricting Oregon to serving future energy needs with in-state only resources	What alternative investments in in-state resources would Oregon make if energy has to come from in the state? Scenario includes resources located physically within Oregon as in-state.
100x50 Low Transformation	Investigates how slower electrification and efficiency gains impact investments	How does reduced electrification and efficiency impact total costs and investment strategy?

Source: Oregon Clean Energy Pathways Final Report, page 30.

[1] Washington, Oregon, California, Idaho, Nevada, New Mexico, Arizona, Montana, Utah, Wyoming, Colorado

(See Oregon Clean Energy Pathways Final Report pages 5-20 for a description of how Evolved's modeling is structured.)

Study Results

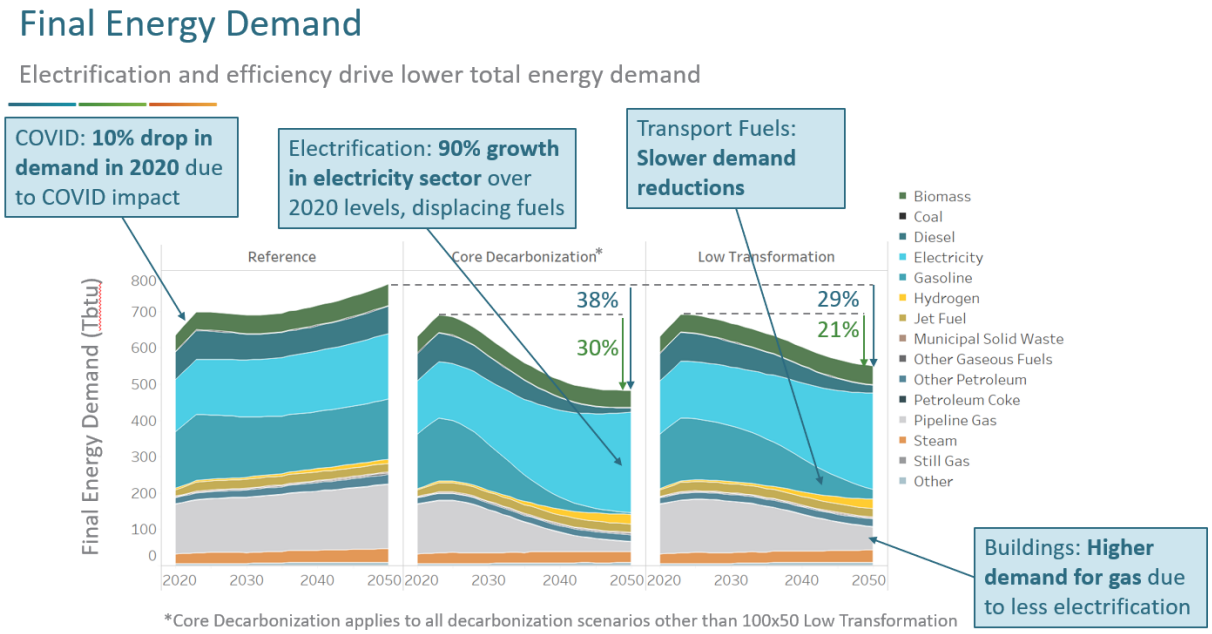
Meeting the Targets

Oregon can meet its current economy-wide target of 80% emissions reductions below 1990 by 2050 with rapid demand-side electrification and 100% clean electricity. The interim 2035 target can be met by replacing coal generation with new clean resources and imported renewables combined with early action on electrifying energy demand. Oregon's last coal plant was retired in 2020, but electric utilities in Oregon continue to hold an ownership stake in coal plants located in other states and supply coal power to Oregon customers.

The pace of action required to meet Oregon's 2035 emissions target is lower than in neighboring states because of both the longer timeline (Washington for example has the same emissions target but to be met by 2030), and how much coal supplies Oregon electricity generation. Unlike Washington, Oregon can stay on track to meet its target of 80% emissions reductions below 1990 levels by 2050 without decarbonizing significant quantities of liquid fuels by 2050.

For Oregon to meet a 100% emission reduction target by 2050, all liquid fuels and the majority of gas usage remaining in the economy would need to be decarbonized by 2050, which would require investment in electrolysis and biofuels.

Figure 1. Final Energy Demand



Source: Oregon Clean Energy Pathways Final Report, page 33.

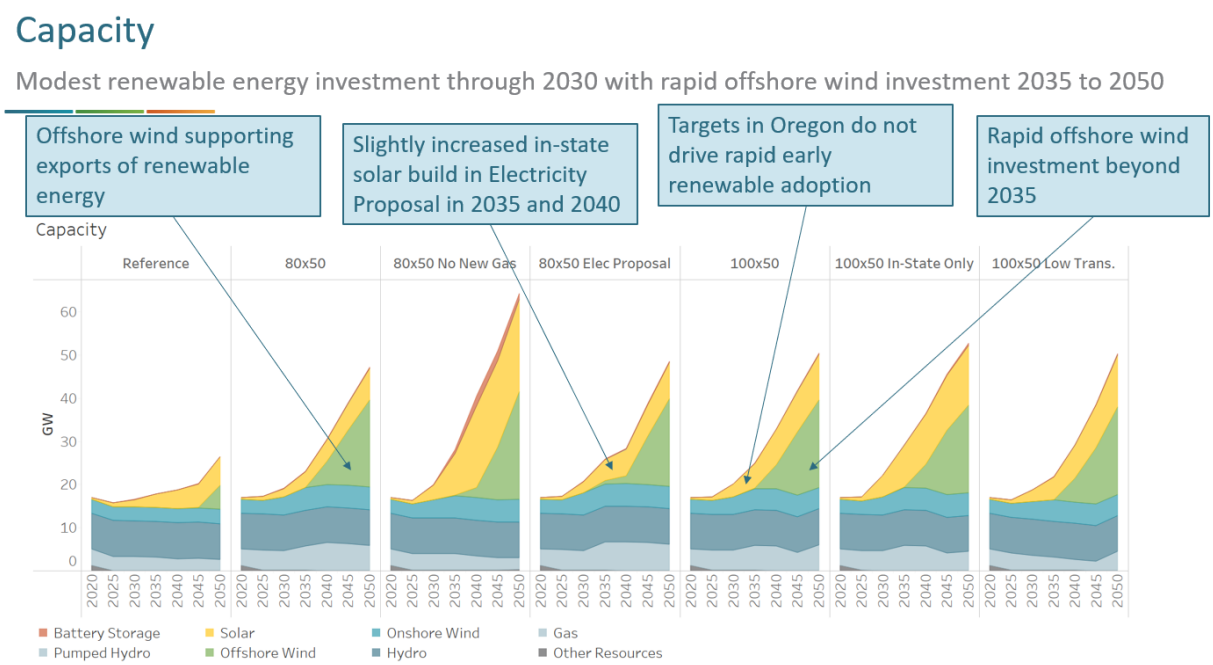
Resource Investment

Oregon's location within the Western Interconnection and between California and Washington, which have significantly greater electricity loads, impact the state's resource decisions. Gas generation, exported to other states to provide regional reliability, is a component of Oregon generation through 2045 in the *80x50* scenario and through 2040 in the *100x50* scenarios. Gas remains a capacity resource in 2045.

If gas generation is limited to extensions of existing plants, as explored in the *80x50 No New Gas* scenario, regionally-driven investment in gas is replaced with investment in renewables and other balancing solutions.

A substantial portion of the investment in Oregon offshore wind is made to enable exports of low-cost, high capacity-factor clean electricity to other states across the West. The 20 GW of offshore wind projected to be built over 15 years would require a rapid scale-up of new supply chains and production capacity.

Figure 2. Capacity Requirements 2020-2050



Source: Oregon Clean Energy Pathways Final Report, page 39.

Transmission

A large expansion of transmission connections between Oregon and surrounding states are required to achieve 100% clean energy by 2050, specifically 3.4 GW of new transmission capacity to Idaho built from 2030 to 2050 and 6 GW of new transmission capacity to California between 2040 to 2050.

Expanded transmission facilitates imports and exports of clean energy, taking advantage of geographic and resource diversity across the West to balance the grid more easily. Oregon uses north-south transmission capacity to export electricity from offshore wind to California and import electricity from solar resources in California and across the rest of the Southwest. East-west transmission capacity allows Oregon to import electricity from onshore wind resources in Wyoming and Montana.

The modeling assumes that the Western grid operates as a single balancing area, which is not the case today. Hence, regional grid integration is a critical requirement.

Costs

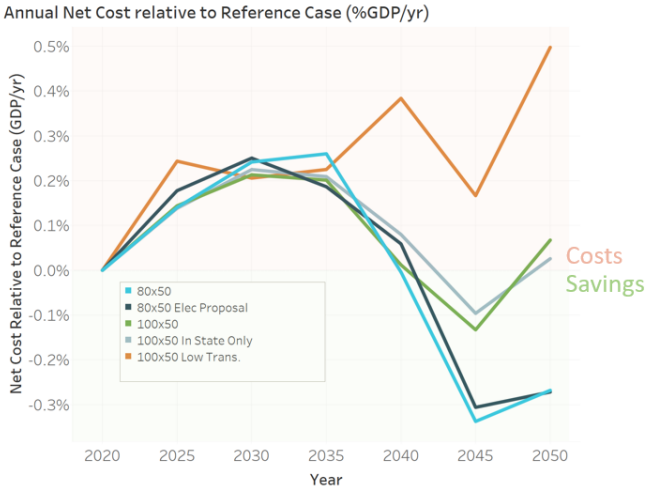
While some additional spending will be needed through 2035, modeled costs remain relatively low—approximately 0.2% of Oregon GDP per year—for achieving the target of 45% emissions reductions below 1990 levels by 2035 modeled for all scenarios. The cost of deep decarbonization is notably lower in Oregon than in other surrounding states. Retiring coal power plants in Oregon and replacing them with low-cost renewables can move the state relatively far along its path to carbon neutrality without incurring substantial costs.

Deep decarbonization provides Oregon net economic benefits after 2040 in both the *80x50* and *100x50* scenarios, except when demand-side electrification is slow. These net economic benefits are realized when the demand side becomes majority electrified and is powered by renewable electricity that is forecasted to see significant price declines beyond 2040.

Figure 3. Cost Comparison Across the Scenarios

Scenario Cost Comparison GDP

- Additional investment in GDP terms is approximately 0.2% per year through 2035 across scenarios
- Spending decreases as technologies get cheaper in the future
- Lower cost transition compared to Washington
  - Meeting targets is easier with Oregon coal retirements
  - Valuable offshore wind resource

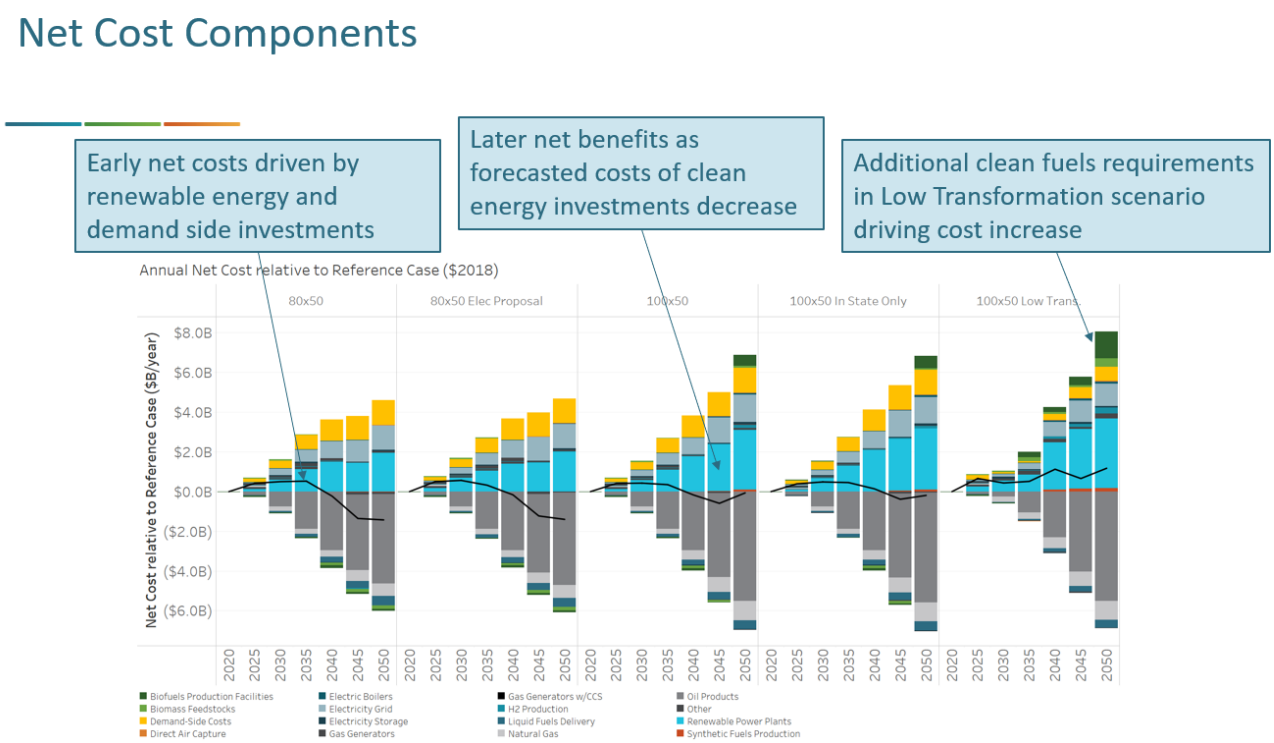


Source: Oregon Clean Energy Pathways Final Report, page 50.

Because Oregon is a large exporter of clean energy in the *100x50* scenarios, requiring all electricity generation to occur in state does not significantly increase costs. Energy produced in both the *100x50* and *100x50 In-State Only* scenarios is directed locally, requiring little increase in investment.

In contrast, slow demand-side electrification, illustrated in the *100x50 Low Transformation* scenario results in a significant increase in costs (the scenario costs about 0.4% of GDP more each year than the reference scenario between 2040 and 2050). Higher costs are driven by increased investment in the electricity system and fuel conversion technologies needed to supply greater overall energy demands than in a largely electrified energy system in the form of decarbonized fuels.

Figure 4. Net Cost Components Across Scenarios 2020-2050



Source: Oregon Clean Energy Pathways Final Report, page 52.

Grid Operations and Contracted Power

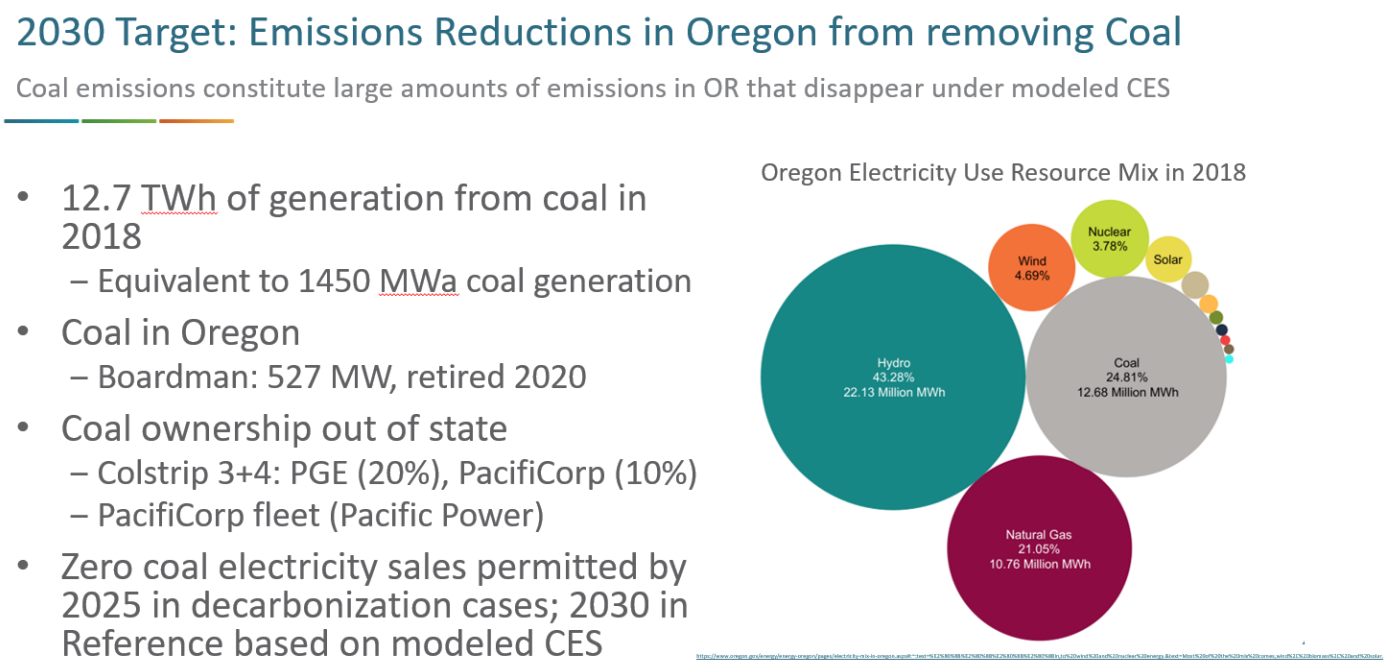
The modeling in this study does not account for contractual arrangements of power plants that may constrain how electricity is bought and sold. Instead, the modeling examines how the electricity grid could be decarbonized at lowest cost if existing resources were dispatched and new resources were built optimally within a single balancing area across the Western United States.

Because a single balancing authority in the West does not exist today, achieving the lowest cost regional decarbonization portfolio will require greater regional coordination of energy system planning and operations.

In practice, contractual arrangements of power plants could be an important determinant of the cost of a policy requiring the use of in-state generation. Existing resources within Oregon that are currently under contracts to sell power out of state (~3,000 MW) are counted as in-state resources in the *100x50 In-State Only* scenario. If Oregon instead were required to replace these megawatts with additional in-state generation, the costs of an in-state only solution would be driven higher.

The modeling finds that emissions reductions from replacing coal generation are the primary means of meeting near-term Oregon emissions targets. The study policy assumptions included retiring coal in electricity delivered to Oregon loads by 2025. Removing coal from the resource mix costs less than alternative means of reducing emissions and the state should look at the options and timeline for achieving coal-free electricity.

Figure 5. Coal Removal Hits 2030 Emissions Reduction



Source: Oregon Clean Energy Pathways Final Report, page 61.

Key Actions in the 2020s

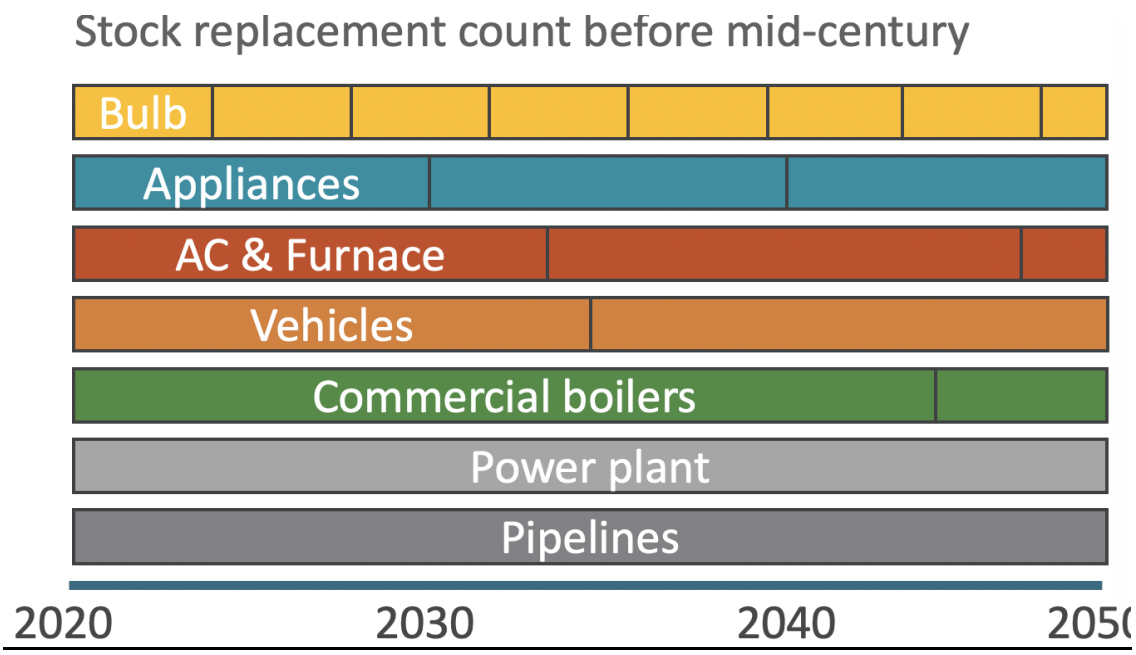
<u>Electrify Transport and Buildings</u>

Rapid adoption of electric vehicles, electric appliances, and electric space/water heating enable lower cost economy-wide decarbonization by 2050. Most vehicles, appliances, and space/water heating systems will need to be replaced no more than a few times before 2050 (see figure 6).

Because it is generally most cost-effective to replace equipment at the end of its useful life, there will be limited opportunities to electrify and avoid the technological lock-in that is inconsistent with the most

affordable decarbonization pathways. Therefore, early action is needed to achieve stock rollover of demand side technologies.

Figure 6. Stock Replacement Schedule by 2050



Source: Oregon Clean Energy Pathways Final Report, page 12.

Key policy question: What is the best approach to promoting end use electrification, while minimizing adverse impacts of the shift?

<u>Phase Out of Coal Power Procurement</u>

Eliminating coal power from Oregon's electricity supply is the most impactful and cost-effective near-term path to achieving significant emissions reductions. By achieving emissions reductions through coal retirement, Oregon avoids investing in expensive clean fuels strategies and can take advantage of the expected drop in renewable energy costs after 2040.

Key policy question: What steps are needed to eliminate coal from Oregon's electricity mix?

<u>Enhance Regional Grid Operation and Planning</u>

A regionally integrated power grid is critical to enabling Oregon to take advantage of out-of-state clean energy resources, export power to other states, and efficiently plan for grid reliability. Regional grid integration will also be key to efficient decarbonization throughout the West. Early action is needed to identify how regional coordination can facilitate increasing clean energy transmission and construction of new transmission lines.

Key policy question: What are the next steps to promote greater regional coordination?

Key Actions in the 2030s and 2040s

- Significant investment in new renewable generation in Oregon should begin in the 2030s. Build out of onshore wind and solar should come first, followed by large and rapid investment in offshore wind between 2035 and 2050 if current price forecasts are realized.

- Early electrification is key to avoiding large decarbonization costs in the future. Oregon should strive to reach 100% electrification sales of light-duty vehicles and building appliances by 2035.

- Transmission upgrades and expansion between Oregon and surrounding states, if feasible, are part of a least cost pathway in the 2030s. Planning for these transmission lines needs to begin in the 2020s.

- Greater regional market coordination needs to be explored starting in the 2020s and in place by the 2030s to facilitate clean energy transfers across the West/United States.

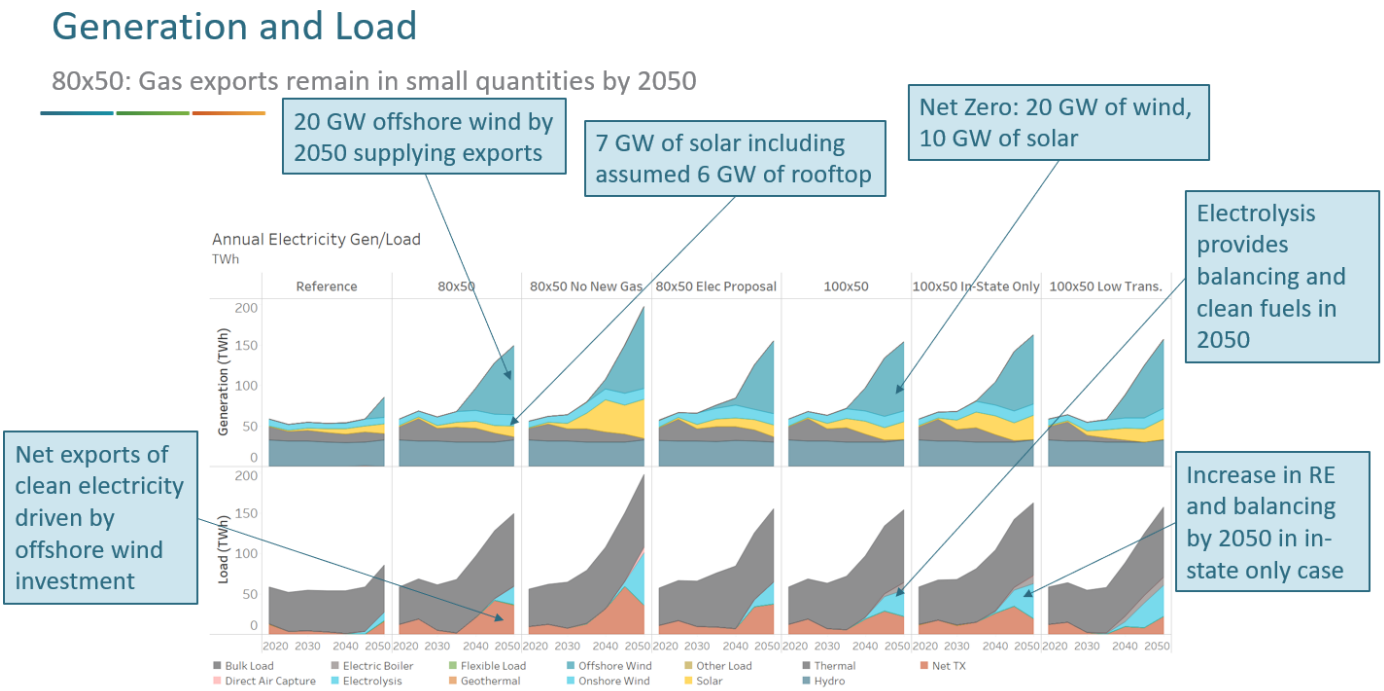
- Starting in the 2040s, investment in electrolysis for clean fuels and grid balancing ramps up. While other states must develop these technologies earlier to reach emission targets, Oregon will require lower volumes of clean fuel, using it for the final push to net-zero emissions by 2050 after significant electrification in the earlier decades.

- Electrified end uses reach nearly 100% penetration in many sectors of the economy in the 2040s.

- In the 2040s, offshore wind development ramps up significantly, reaching 20 GW by the end of the decade.

- By 2050 Oregon has the mix of renewables and storage detailed in Figure 7, some of which is exported to the regional market):

Figure 7. Generation and Load Across Scenarios, 2020-2050



Source: Oregon Clean Energy Pathways Final Report, page 38.

Conclusion

As the Oregon Clean Energy Pathways study was concluded, the Oregon State Legislature passed HB2021, a clean energy standard requiring Oregon utilities to achieve full decarbonization by 2040 and meet two interim goals along the way: 80% reduction by 2030 and 90% reduction by 2035.

This study demonstrates that Oregon can meet the near-term goals established by HB2021 by eliminating coal from its resource mix. The 2040 goal will be met with a mix of new renewable resources, including offshore wind, investment in electrification and demand side resources, as well as regional cooperation to ensure the geographic diversity benefit of renewable generators can be fully realized.

Nearby states in the region will rely on Oregon's rich and diverse resource mix to help meet their clean energy standards and carbon emission reduction targets which, in turn, will result in additional economic benefits for Oregon as an energy exporter.

Transmission capacity was identified as a clear challenge the state will face in the near future. Oregon is not unique in this regard and will need to work cooperatively with neighboring states to plan for regional transmission solutions.

The clean energy pathways analyzed in this study can guide policy makers and state agencies as they implement HB2021 and will also inform the economy-wide goals and mandates established in the Governor's Executive Order on Climate Change (EO-20).

Appendix A. Technical Review Committee

GridLab facilitated a Technical Review Committee (TRC) made up of stakeholders from a variety of organizations to provide feedback on scenario development and study results. The member organizations that participated in the TRC are listed in Table 2.

Table 2. Technical Advisory Committee Members

Organization	**Representative**
BlueGreen Alliance	Ranfis Villatoro
Bonneville Power Administration	Alisa Kaseweter
Climate Solutions	Meredith Connolly
Community Renewables Energy Association	Mike Mcarthur
Lewis and Clark Green Energy Institute	Melissa Powers
Moment Energy Insights LLC	Elaine Hart
Northwest Energy Coalition	Fred Heutte
Northwest Intermountain Power Producers Coalition	Spencer Gray
Northwest Power and Conservation Council	Leann Bleakney; Ben Kujala
NRDC	Angus Duncan
OCEAN	Shannon Souza
Oregon Citizens' Utility Board	Michael Goetz; Bob Jenks
Oregon Department of Energy	John Cornwell; Kaci Radcliffe; Ruchi Sadir
Oregon Environmental Council	Jana Gastellum
Oregon Municipal Electric Utilities Association	Jennifer Joly
Oregon Public Utility Commission	JP Batamale; Robin Freeman; Caroline Moore
Oregon Rural Electric Co-Op Association	Ted Case
Oregon Solar Energy Industries Association	Angela Crowley-Koch
PacifiCorp	Mary Weinke
PNGC Power	Roger Gray
Portland General Electric	Seth Wiggins; Nora Xu
Public Generating Pool	Therese Hampton
Renewable Northwest	Max Greene; Nicole Hughes
Verde	Oriana Magnera

Appendix B. Project Team

Renewable Northwest's mission is to decarbonize the region by accelerating the transition to renewable electricity.

GridLab provides technical grid expertise to enhance policy decision making and to ensure a rapid transition to a reliable, cost effective, and low-carbon future.

Evolved Energy Research was founded to address key energy sector questions accelerated by policy goals and new technology development.

Clean Energy Transition Institute is an independent, nonpartisan Northwest research and analysis nonprofit organization dedicated to accelerating the clean energy transition in the Northwest.

Contact: Max Greene, Regulatory Director, Renewable Northwest: max@renewablenw.org