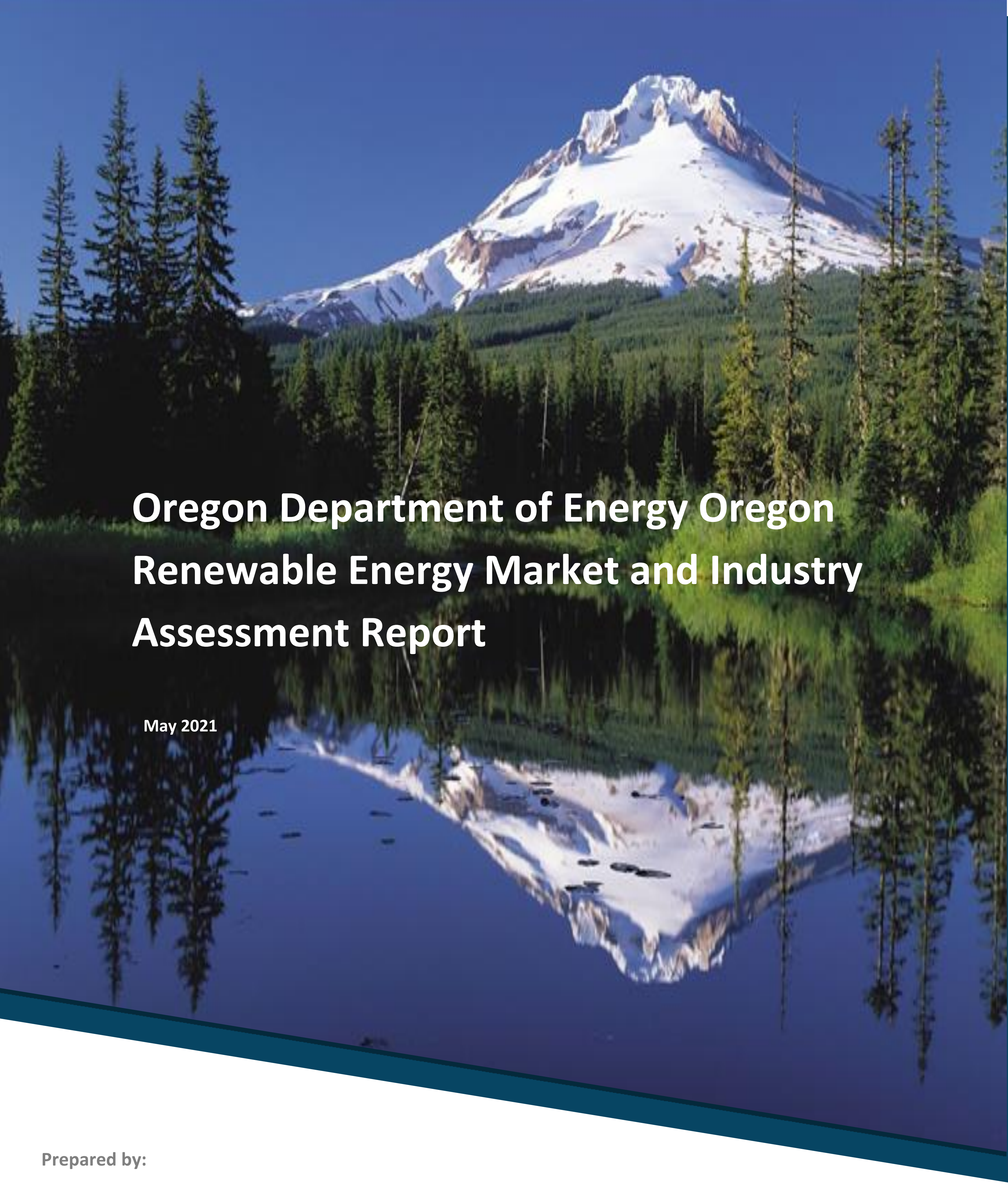
The following information is part of the Oregon Renewable Energy Siting Assessment (ORESA). The ORESA project is funded through a $1.1 million U.S. Department of Defense Office of Local Defense Community Cooperation grant awarded to the Oregon Department of Energy, working with the Department of Land Conservation & Development and Oregon State University's Institute for Natural Resources.
More information is available at https://www.oregon.gov/energy/energy-oregon/Pages/ORESA.aspx

Oregon Renewable Energy Siting Assessment (ORESA)

Supporting Materials

Please refer to the ORESA Final Report and ORESA Mapping and Reporting Tool for more information and context



Oregon Department of Energy Oregon Renewable Energy Market and Industry Assessment Report

May 2021

Prepared by:

Energy+Environmental Economics

Project Team

This report was produced by Energy and Environmental Economics, Inc. (E3) and Energy Reflections

Energy and Environmental Economics, Inc. (E3) is a leading economic consultancy focused on the clean energy transition. E3's analysis is utilized by the utilities, regulators, developers, and advocates that are writing the script for the emerging clean energy transition in leading-edge jurisdictions such as California, New York, Hawaii and elsewhere. E3 has offices in San Francisco, Boston, New York, Calgary, and Raleigh.

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Abbreviations

ATC	Available Transfer Capability
BTM PV	Behind-the-Meter Solar Photovoltaic
CFI	Conditional Firm Inventory
COU	Consumer-Owned Utility
DLCD	Department of Land Conservation & Development
DOD	Department of Defense
DSM	Demand-Side Management
EIA	U.S. Energy Information Administration
EFSC	Energy Facilities Siting Council
ELCC	Effective Load Carrying Capability
EPA	U.S. Environmental Protection Agency
EV	Electric Vehicle
FAA	Federal Aviation Administration
FOF	Forced Outage Factor
GHG	Greenhouse Gas
ILR	Inverter loading ratio
INR	Institute for Natural Resources
IOU	Investor-Owned Utility
ISO	Independent System Operator
LSE	Load Serving Entity

NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
ODOE	Oregon Department of Energy
OLDCC	Office of Local Defense Community Cooperation (DOD)
ORESA	Oregon Renewable Energy Siting Assessment
PRM	Planning Reserve Margin
PUD	Public Utility District
RECS	Renewable Energy Certificates
RPS	Renewable Portfolio Standard
RTO	Regional Transmission Operator
SAM	NREL's System Advisor Model

Executive Summary

Introduction

The Oregon Renewable Energy Siting Assessment (ORESA) project is funded through a $1.1 million U.S. Department of Defense Office of Local Defense Community Cooperation (DOD-OLDCC) – formerly the Office of Economic Adjustment (OEA) – grant awarded to the Oregon Department of Energy (ODOE), working with the Department of Land Conservation & Development (DLCD) and Oregon State University's Institute for Natural Resources (INR).

Development of renewable energy resources in Oregon – particularly solar, wind, and associated transmission infrastructure – is expected to continue in the coming decades as the state and region progress towards aggressive clean energy and renewable goals. Developing these energy resources requires careful consideration of issues related to natural resources, land use, environmental impacts, noise concerns, and cultural and archaeological artifacts (among others) through processes at all levels of government – federal, state, and local.

Additionally, future renewable energy and transmission projects may have effects on current and future military training and operations in Oregon and adjoining states. Early consultation between project proponents and the military is particularly important especially for the areas of the state that have substantial renewable energy resources and facility potential and military training and operating areas.

Through assessments and a mapping tool, this project is collecting data and information about locations for current and future renewable energy and transmission development and building an understanding of the opportunities and constraints that come with specific locations in Oregon. The state can use this information to continue to support renewable energy growth and economic development.

DOD-OLCDD's overarching goal is to support military compatibility through coordination with local, regional, and state agencies and raise awareness about the military through the ORESA project. Beyond this, the ORESA project's key goals are to create relevant educational tools for stakeholders, agencies, local governments, and policy makers about the following topics:

- Renewable energy development in Oregon;
- Military training and operating areas;
- Economic and community benefits;
- Land use considerations;
- Natural, cultural, and environmental resources; and
- Other regulatory requirements.

While facilitating renewable energy development to meet state and local objectives over the next ten to fifteen years is a worthy goal unto itself, it takes on an even greater significance in the context of Oregon's long-term climate goals, which include a target to reduce greenhouse gas emissions by 80 percent relative to 1990 levels by 2050. Achieving this long-term milestone will require a number of significant economy-wide transitions that will begin over the next decade but must accelerate through 2050, several of which directly implicate the need to scale the supply of renewable generation rapidly as well. While a portion of this need may be met by resources developed outside the state of Oregon, ensuring that the renewable energy industry is healthy and thriving – and that the processes that surround it are conducive to growth and expansion – will be crucial to the state's climate goals. This study is not a deep decarbonization analysis and is not making any prescriptions on the location or type of renewable energy development in Oregon based on least-cost optimizations. With this in mind, this study seeks to characterize the state of the renewable energy development landscape in Oregon, to identify the challenges and opportunities that exist for renewable energy development in Oregon, and to identify the gaps that can be addressed in the various processes and procedures needed to support achievement of Oregon's long-term goals.

The Policy Landscape for Renewable Development in Oregon

Looking forward, both policy and economics will continue to drive investment in renewable energy. Procurement of renewable resources by utilities, corporations, and other entities – driven by a combination of policy, customer preferences, and economics – is accelerating throughout the Western Interconnection. While Oregon's own renewable and clean energy goals may be the most direct driver of development within the state, interregional dynamics will also affect the development landscape in Oregon as utilities around the west seek out resource diversity and optimize their portfolios across multiple states.

A number of Oregon's existing policies and goals are expected to drive this continued resource development and are relevant to the question of how much development in the state may occur. These include:

- Oregon's Renewable Portfolio Standard (RPS), most recently amended by Senate Bill 1547, requires investor-owned utilities (IOUs) in the state to procure renewable resources equal to 50 percent of retail sales by 2040 and establishes a range of lower targets for the state's consumer-owned utilities (COUs) that vary by utility size;
- The Public Utility Regulatory Policies Act (PURPA) of 1978 serves as an avenue for renewable energy development – particularly small projects – allowing developers to sell, and requiring utilities to purchase, output from Qualifying Facilities (QFs) to utilities at an avoided cost rate under standard contracts;
- The state's net metering policy and community solar program currently address the distributed solar market segment and provide an opportunity for consumers to receive bill credits for solar production; and
- Governor Kate Brown's Executive Order 20-04 established a 2050 economy-wide greenhouse gas reduction goal of 80 percent below 1990 levels for the state, implicating the electric sector as enabling this transition through direct reductions in electric emissions and indirect reductions via electrification of transportation and buildings.

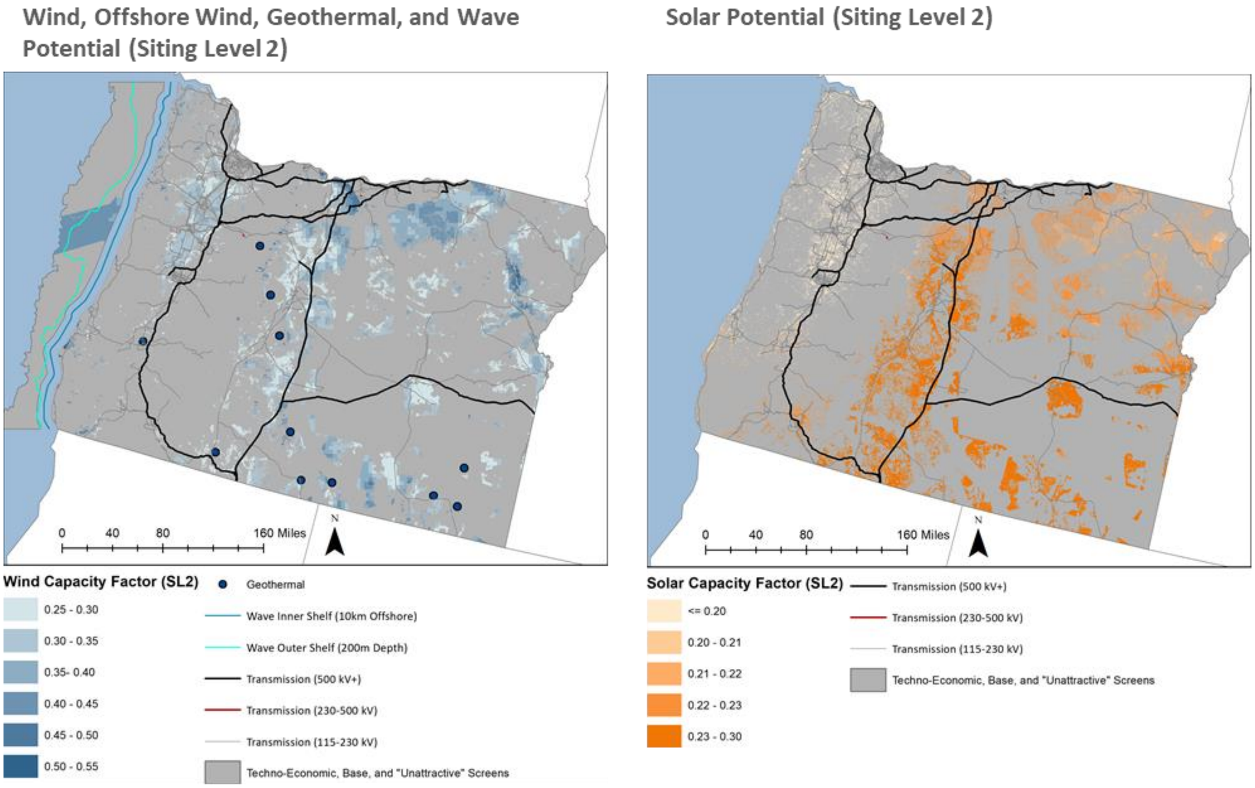
As multiple respondents contributing to the Renewable Energy Industry Assessment observe, Oregon has not yet defined a clear policy pathway for long-term carbon or renewable energy policy to support its greenhouse gas goals. However, ongoing conversations at the state legislature continue to explore increasingly aggressive clean energy and decarbonization goals (such as a 100 percent clean energy policy).

Renewable energy development in Oregon has historically also been driven by broader regional dynamics, as offtakers in other states have been responsible for a significant share of wind development in the state. As other Western states – Arizona, California, Nevada, New Mexico, and Washington – have set goals and mandates to achieve 100 percent carbon-free supplies, regional dynamics will also continue to influence development patterns in Oregon.

Oregon's Renewable Potential

To characterize the future potential for renewable energy development in the state of Oregon, this study relies on detailed geospatial analysis of the state's renewable energy potential alongside a broad collection of technoeconomic and land use datasets. The technical potential for renewable energy developed in this study is quantified under several land use screens: (1) Siting Level 1, which excludes areas where development would be prohibitively challenging for technical reasons (e.g. terrain, population density) and areas where development would be legally prohibited; and (2) Siting Level 2, which adds several additional exclusionary screens representing military areas in the state and several additional areas where current rules in the state could make development less likely due to potential additional costs, approval, and time involved (e.g. prime farmland, and special status species habitats). The exclusion of certain land use types in Siting Level 2 is not intended to suggest an outright prohibition of renewable energy development. On the contrary, there are existing avenues for developers to obtain siting and permitting approval on some of those lands. Nor are these screens intended to prejudge the siting and permitting process, rather they are meant to reflect the project development decisions renewable energy developers make to avoid certain areas due to potential increase in project lead time, cost, and risk. The resulting geographic regions contributing to renewable energy potential quantified in this study under Siting Level 2 are shown in Figure ES. Despite the exclusion of significant areas of the state by these screens, the technical potential for renewable energy development numbers in the thousands of megawatts.

Figure ES-0-1. Oregon wind (onshore and offshore), geothermal, and solar resource potential under Siting Level 2.



Note: This map does not capture all offshore military training and operating areas

While the technical potential quantified in this study is large, additional barriers to development exist. These barriers, if not properly addressed, could limit Oregon taking advantage of the vast and diverse technical potential for renewable resources within the state to support its own clean energy goals and to participate in regional markets. These barriers are identified and discussed in the subsequent section.

Renewable Energy Industry Assessment

One of the goals of this study is to support future renewable energy development in Oregon over the next fifteen years by conveying the opportunities and challenges of future development that exist from the perspectives of different groups in the renewable energy development industry; including state, local, and federal agencies, utilities, and developers. By sharing these perspectives, the Industry Assessment strives to lay the groundwork necessary to allow regulators, policymakers, and industry participants to identify solutions to concerns.

E3 conducted outreach through written surveys and interviews, soliciting input from a wide range of industry participants, specifically: small and large renewable resource developers, transmission developers, utilities, independent power producers, and clean energy advocates.

Although the Industry Assessment represents a diverse set of perspectives, these groups do not represent the whole range of stakeholders with interests or views on renewable energy development. There are other groups whose perspectives will also be important for creating a total picture of the renewable energy development industry who were outside the scope of this assessment. These include ratepayer advocates, climate advocacy groups, environmental advocacy groups, and land use conservation advocacy groups. This is important to keep in mind: even when stakeholders consulted for this study are in agreement on certain topics, those views may not be shared by all groups or stakeholders with a stake in the outcome of a specific process. Where consensus is expressed in the responses below, it reflects a consensus among the specific subset of stakeholders consulted in this study.

The perspectives that are represented herein provide an intricate portrait of the current state of the industry. Many respondents point to the maturity and experience of electricity industry participants and Oregon's rich resource potential as signs of an industry ready and eager to scale, but most also make clear that multiple factors will serve as barriers to scalable development if not addressed. The most common themes articulated by stakeholders across survey responses are summarized below.

- **Respondents want more clarity on the state's long-term policy goals – and more cohesion and coordination among state agencies and processes to support those goals.** Oregon's existing RPS statute, enacted in 2016, has been exceeded by 100 percent targets in many neighboring states, and while the governor's executive order committed the state to deep carbon reductions, many respondents are hoping for additional clarity on the state's long-term energy policy. Several respondents also describe the inherent tension between the state's carbon reduction ambitions, which will require significant deployment of renewable energy; and its land use planning goals, which have precluded certain areas from development a priori. Citing this discrepancy, these respondents suggest the need for a comprehensive roadmap that considers Oregon's long-term goals for climate, land use, social justice, and the environment simultaneously.
- **The limits of the transmission system could present a challenge to renewable energy development at significant scale in the state.** There is broad consensus among stakeholders that limited availability and access to transmission capacity also limit renewable energy development. At the same time, respondents observed that new investments in transmission are slow, costly, and difficult to permit. Respondents suggest a range of potential solutions, including proactive transmission planning modeled after successful efforts in other jurisdictions (such as ERCOT's Competitive Renewable Energy Zones (CREZs), CAISO's Tehachapi trunkline project, and California's RETI 2.0), establishment of a regional transmission organization (RTO), and streamlining the state's transmission siting and permitting approval process. Additional solutions, which could potentially defer the need for entirely new transmission investments while addressing near-term challenges include improved optimization of the existing transmission system, reconductoring of existing transmission pathways, and the strategic deployment of utility scale battery resources.
- **Siting and permitting processes are currently perceived as cumbersome and costly by some electric industry stakeholders and could benefit from reform.** Many respondents, from the renewable energy developers and clean energy advocates groups, point to the Energy Facility Siting Council (EFSC) process as antiquated and cumbersome. According to these respondents, the length

of the process serves as a deterrent to development of renewables and the permitting cost for new renewables is sometimes prohibitive, especially to less-established renewable energy developers. While the impacts of permitting timelines are a concern of some respondents, an analysis of the impacts to date of these timelines on the expansion of renewable energy development in the state was not within the scope of this study. Some respondents call for a comprehensive reform; one respondent expressed the need to "reform the state's siting and permitting processes to create a 'smart from the start' structure that balances state and local jurisdiction and concerns, removes unnecessary bureaucracy, considers cumulative impact, and fully incorporates community engagement." These concerns intersect with a common refrain among respondents that Oregon's land use planning goals are outdated and do not adequately prioritize investment in renewable energy development that will be needed to meet the state's long-term climate goals.

+ **Coordination with neighboring states and jurisdictions will be needed to effectively integrate renewables.** In multiple areas of the survey, respondents emphasize the importance of Oregon's relationship to neighboring states. With respect to market design, multiple respondents describe today's wholesale bilateral market construct as obsolete and inadequate to facilitate renewable energy integration at scale. While some respondents consider the formation of a Western RTO as one solution, this has proven difficult in the past due primarily to governance-related challenges. The utilities' participation in the Western Energy Imbalance Market has alleviated some of these challenges; CAISO's proposed Enhanced Day Ahead Market (EDAM) could further support variable resource integration. Similarly, the challenges related to transmission – considering federal oversight of the regional transmission planning process and BPA's and PacifiCorp's presence across multiple states in the region – are more appropriately addressed at a regional level, as many of the transmission-related challenges observed in Oregon are not unique to that state. While regional transmission planning processes exist today, respondents call for more proactive and comprehensive assessment of the transmission needs associated with integrating more renewable resources to meet state clean energy mandates and goals.

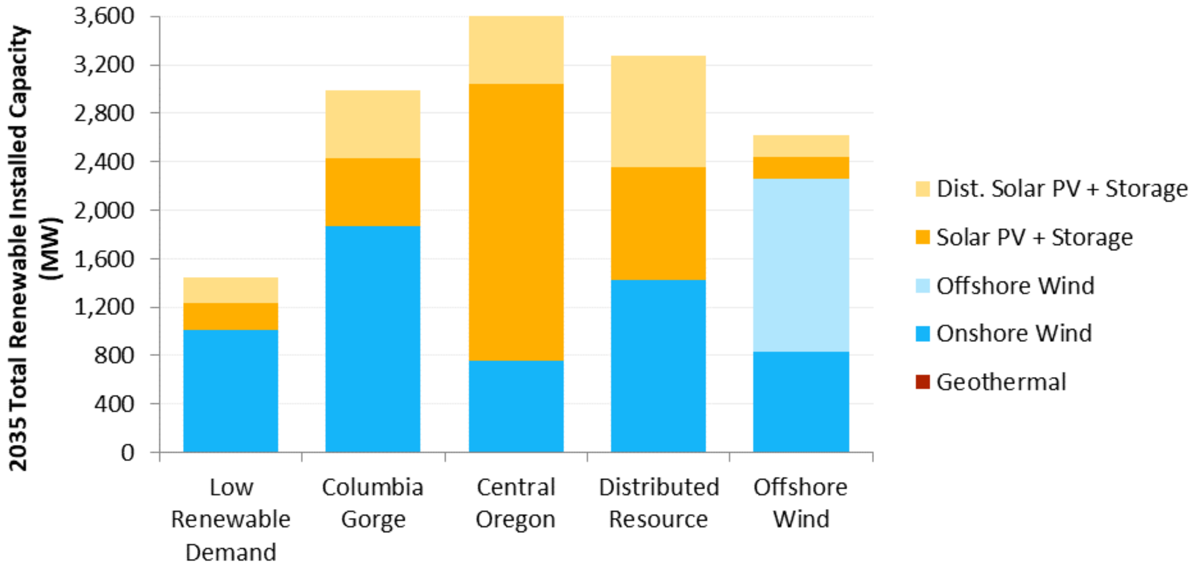
Renewable Energy Market Assessment

The purpose of the Market Assessment portion of this study is to provide plausible projections of how much renewable energy and transmission infrastructure might be built within Oregon over the next 15 years under the current RPS and GHG policy goals to serve Oregon in-state demand. This study evaluates plausible outcomes across five different scenarios, each reflecting a unique combination of different emphases on technology, geography, and scale of development. No single scenario considered in this study represents a forecast or prediction of the likely outcome; rather, the scenarios serve as tools to explore the implications and tradeoffs of various development futures in the state. The five scenarios, for which new investments in renewables by 2035 are summarized in Figure ES-0-2, include:

+ **Low Renewable Demand:** a scenario designed to reflect a future with limited interest in renewable energy development within the state (all the other scenarios reflect a higher renewable energy demand);

- **Columbia Gorge:** a scenario with higher demand, fulfilled largely by continued development of new wind resources in the Columbia River Gorge;
- **Central Oregon:** a scenario with higher levels of development that, consistent with current trends in commercial interest, results in extensive development of solar resources in Central Oregon;
- **Distributed Resources:** a scenario that prioritizes resources – particularly solar – that may be located close to load, mitigating the potential need for new transmission investments; and
- **Offshore Wind:** a scenario that incorporates a major set of offshore wind infrastructure projects – including 1.5 GW of generation and transmission to deliver it to loads.

Figure ES-0-2. New renewable resource additions by 2035 across all scenarios considered.



The key implications of each of these scenarios for the industry and related institutions are summarized in Table ES.

Table ES-0-1. Summary of results and implications across scenarios.

		Low Renewable Demand	Columbia Gorge	Central Oregon	Distributed	Offshore Wind
New Resources by 2035 (MW)	Geothermal	-	-	4 MW	-	-
	Solar	213 MW	563 MW	2,295 MW	926 MW	181 MW
	Solar (Dist.)	213 MW	563 MW	581 MW	926 MW	181 MW
	Wind (Onshore)	1,016 MW	1,866 MW	749 MW	1,426 MW	836 MW
	Wind (Offshore)	-	-	-	-	1,420 MW
	Total	1,442 MW	2,992 MW	3,629 MW	3,278 MW	2,618 MW
Consistency with Commercial Interest in new development		Limited development reflects low investment in the state compared to present commercial interest	Resource mix weighted towards wind reflects a shift – but may be driven by regional economics	Resource mix weighted towards solar is most consistent with current developer activity	Reflects an increase in commercial interest in DER, interconnection at subtransmission and distribution level voltages, and local resilience	Primary reliance on offshore wind reflects a pivot from today's commercial activity
Transmission		With limited development, impacts on transmission are limited	Further development in the Gorge will strain existing system, requiring either transmission expansion or optimization and more flexible use of existing system (e.g., energy-only projects)	Gathering infrastructure (e.g., collector substations); colocating solar & storage or standalone storage can help mitigate need for upgrades; regional transmission planning may support current lack of infrastructure in this area.	Proximity of resources to load centers may mitigate transmission impacts; further study of hosting capacity of local systems is needed to understand local impacts; will likely still strain the existing transmission system due to the significant development in the Gorge	Large-scale development of offshore wind will change transmission flows dramatically, and possibly alleviate the current transmission constraints; upgrades west of the Cascades may be required but further study is necessary
Land Use		With limited development, conflicts with land use are likely limited	Many of best sites are gone, and further development will likely require close coordination with the military	Significant development in central Oregon suggests close coordination with military will be needed. This level of development will also need to be conscious of potential environmental impacts (such as sage grouse habitat)	Increased deployment of DER like rooftop solar systems, co-located solar & storage, and standalone storage may reduce pressure on siting & permitting processes	Development of offshore wind will require close coordination with ocean users, coastal communities, and multiple state and federal agencies including the military
Cost		Limited costs associated with renewable development	Limited costs associated with renewable development, but	Limited costs associated with renewable development, but	Increased focus on distributed & rooftop resources likely to translate	Limited data on the costs of floating offshore wind generation and costs

		transmission costs could be significant	transmission costs could be significant	to higher resource costs, although these resources might offset some fraction of the costs of investment in bulk generation and transmission upgrades, and contribute toward increased local resilience and customer preferences	transmission upgrades that could be necessary to support interconnection to the onshore grid
Technology Risk	Development relies on today’s commercial technologies and presents limited risk	Development relies on today’s commercial technologies and presents limited risk	Development relies on today’s commercial technologies and presents limited risk	Development relies on today’s commercial technologies and presents limited risk	Floating offshore wind has not yet been widely deployed in the United States or across the world, and may encounter unexpected challenges in development and operations

Conclusions

Together, the Industry and Market Assessments provide a portrait of the potential for renewable energy development within the state and the challenges that must be addressed to realize this potential. Policy, economics, and customer preferences will continue to drive demand for renewable resource development in Oregon and throughout the broader Western Interconnection. To support those needs, this study identifies and characterizes the technical potential for renewable energy development as significant as well as technologically and geographically diverse; however, industry participants interviewed for this study also identify a number of significant factors that serve as impediments to development. The most significant of those barriers identified by stakeholders include conflicts between renewable energy development goals and Oregon's land use planning goals, limitations of the existing transmission network, and challenges related to the siting and permitting processes. Creating a healthy environment for renewable energy development in the state will require these and other challenges to be addressed by regulators, policymakers, and other industry participants, within the context of continuing to provide least-cost, reliable electricity to electricity customers.

Our goal with this report is to illuminate the opportunities and challenges of renewable energy development in Oregon and help build understanding for the military, ODOE, and other state, local, and federal agencies, of the issues that should be addressed and actions that need to be taken to support the renewable energy development industry over the next fifteen years. Ultimately, we hope that the conversations started with this process will help Oregon achieve its long-term energy goals.

1 Introduction

1.1 Study Motivation

1.1.1 Oregon Renewable Energy Siting Assessment (ORESA)

The Oregon Renewable Energy Siting Assessment (ORESA) project is funded through a $1.1 million U.S. Department of Defense Office of Local Defense Community Cooperation (DOD-OLDCC) – formerly the Office of Economic Adjustment (OEA) – grant awarded to the Oregon Department of Energy (ODOE), working with the Department of Land Conservation & Development (DLCD) and Oregon State University's Institute for Natural Resources (INR).

Development of renewable energy resources in Oregon – particularly solar, wind, and associated transmission and storage infrastructure – is expected to continue in the coming decades as the state and region progress towards aggressive clean and renewable energy goals. Developing these energy resources requires careful consideration of issues related to natural resources, land use, environmental impacts, noise concerns, and cultural and archaeological artifacts (among others) through processes at all levels of government – federal, state, and local.

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While facilitating renewable energy development to meet state and local objectives over the next ten to fifteen years is a worthy goal unto itself, it takes on an even greater significance in the context of Oregon's long-term climate goals, which include a target to reduce greenhouse gas emissions by 80 percent relative to 1990 levels by 2050. Achieving this long-term milestone will require a number of significant economy-wide transitions that will begin over the next decade but must accelerate through 2050, several of which directly implicate the need to scale the supply of renewable generation rapidly as well. While a portion of this need may be met by resources developed outside the state of Oregon, ensuring that the renewable energy industry in Oregon is healthy and thriving – and that the processes that surround it are conducive to growth and expansion – will be crucial to the state's climate goals.

With this in mind, this study seeks to characterize the state of the renewable energy development landscape in Oregon, to identify the challenges and opportunities that exist for renewable energy development in Oregon, and to identify the gaps that can be addressed in the various processes and procedures needed to support achievement of Oregon's long-term goals. The results of the ORESA project will provide valuable information that can help move the needle in greater renewable energy development in Oregon, such as potential areas of interest for renewable energy development that will require consultation with the military and other local, state, and federal government stakeholders.

To this end, the ORESA project is made up of five (5) components to ensure the topics listed above are explored properly:

1. Renewable energy market and industry assessments;
2. Military needs and interest assessment;
3. Natural resources, environment, and development: opportunities and constraints assessment;
4. Siting procedures review; and
5. Mapping and reporting tool.

E3 was engaged by ODOE to conduct independent analysis for the Renewable Energy Market and Industry Assessments. This report summarizes the Renewable Energy Market and Industry Assessments.

1.1.2 Renewable Energy Industry Assessment

The assessment utilized direct feedback from stakeholders to create a deeper understanding of the challenges and opportunities that exist in the renewable energy development industry, while also identifying gaps that need to be addressed for Oregon to achieve its medium and long-term energy goals.

1.1.3 Renewable Energy Market Assessment

The primary purpose of this assessment is to create a baseline for understanding Oregon's renewable energy development landscape over the next fifteen years. This assessment provides plausible projections of how much and where renewable energy infrastructure might be built in Oregon by 2035.

1.2 Study Overview

This study was conducted to achieve three objectives:

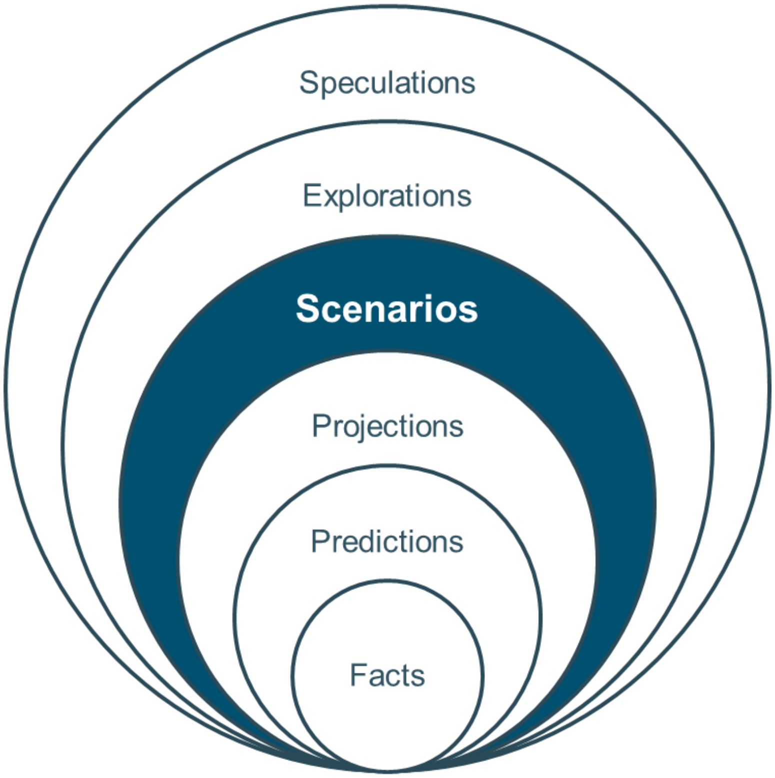
- Quantify the future opportunity for development of renewable energy generation and transmission infrastructure in Oregon;
- Develop an understanding of the constraints and opportunities that exist in the renewable energy development industry; and
- Develop renewable energy build-out scenarios for Oregon over the next fifteen years.

To succeed in these objectives, this study used scenario analysis to identify and analyze a range of different plausible outcomes for the renewable energy development industry within Oregon over the study period. The study used this scenario analysis approach because the results are not intended to predict or forecast any specific outcomes, neither is it intended to make recommendations on the path renewable energy development should take in Oregon over the study period. The study highlights key drivers and differences between the scenarios to inform future decision making. Figure 1-1 below highlights the role the scenario analysis approach plays relative to other analytical approaches that could have been employed in this study.

To carry out this analysis, the study utilized data generated by a renewable energy potential assessment that quantified the resource potential and performance characteristics of the renewable energy resource in Oregon. The study was also informed by direct input, data, and feedback from renewable energy industry developers and stakeholders on the historical, current, and potential future development landscape within Oregon over the study horizon. The study then utilized all this data in a custom-built spreadsheet model that selects different portfolios to meet certain renewable energy demand goals based on the different assumptions for each scenario. The rest of this report will go into more detail on each of these elements and present the results and conclusions of the analysis.

The renewable energy potential assessments do not directly consider the potential for development of energy storage resources. Although an increasing number of analyses of high renewable penetration in the Western Interconnection show the value of energy storage and more utilities are including them in their integrated resource plans, the question of their impact on land use and their interactions with military areas of interest is still uncertain. While certain energy storage technologies like pumped hydro storage are location dependent, the energy storage resources with the most commercial interest, battery storage, do not have those same challenges. Battery resources can be sited in areas with existing generation or close to load, and so the land use impacts were not considered within the scope of this assessment. Thus, in this study we have modeled storage resources as hybrid battery resources paired with solar PV resources, so that the value of energy storage to the electric system is captured even if they are not considered as stand-alone resources. Further analyses will be needed to investigate the impacts of short and long-duration storage resources.

Figure 1-1. The role of the scenario analysis method.



1.3 Report Contents

The remainder of this report is organized as follows:

- Section 2 provides the background, historical context, review of existing literature relevant to this study;
- Section 3 describes the methods and results of the renewable energy potential assessment portion of this study;
- Section 4 describes the methods and results of the industry assessment portion of this study;
- Section 5 describes the methods and results of the market assessment portion of this study;
- Section 6 describes the conclusions and discusses potential follow-up analyses; and
- Appendices 7 provide additional detail on study methods, and data inputs.

2 Background

2 Background

2.1 History of Renewable Energy in Oregon

Clean Energy in Oregon Before 1995

Oregon, located in the rainy and mountainous Pacific Northwest, has long enjoyed a natural abundance of resources for hydro-electricity generation. Since the late 19th century, dams along waterways of the Pacific Northwest – most notably along the powerful Columbia River — have enabled transportation, water supply for drinking and crop irrigation, flood control, and starting in the 1880s, electricity generation.[1] President Franklin D. Roosevelt's New Deal authorized the construction of several large dams and hydro-electric facilities along the Columbia River, including the Grand Coulee Dam in Washington (today, the largest electric generation facility in the U.S. with a nameplate capacity of 6,809 MW) and the Bonneville Dam in Oregon. Federal dam construction projects created jobs and provided economic relief to the Pacific Northwest during the Great Depression, while the electricity generated by federal dams became an important input to the region's growing aluminum industry.[1] In 1938, U.S. Congress passed the Bonneville Project Act, which established the Bonneville Power Administration (BPA) as a federal agency to market electricity from federal hydroelectric dams in the Northwest.[2] The construction of large hydroelectric dams in Oregon, Washington, and Idaho accelerated after the 1961 Columbia River Treaty was adopted by the United States and Canada, which established terms for both nations to develop dams in the Columbia River Basin for flood control and electricity generation.[3] The development of large hydroelectric dams in the Pacific Northwest was mostly complete by the 1980s.

Hydroelectric dam construction in the Pacific Northwest frequently resulted in the displacement of indigenous peoples from their ancestral lands, as well as the disruption of ecosystems – most notably wild salmonid populations – that have carried great economic and cultural significance to the indigenous peoples of the Pacific Northwest for thousands of years. The construction of the Grand Coulee Dam in Washington state partially flooded the ancestral lands of the Colville and Spokane tribes and prevented the migration of salmon upstream of the dam.[4] The construction of the Bonneville, The Dalles, and John Day dams in Oregon and Washington inundated the historic fishing grounds of several tribes. The controversy over their construction lives on to the present day: in 2019, the Yakama Nation and Lummi Nation called for the removal of these dams, arguing that their construction violated the Treaty of 1855, signed by western settlers and the Yakama, Warm Springs, Umatilla, and Nez Perce Indians, in which the tribes ceded 11.5 million acres of land to the United States but were promised indefinite access to their historic fishing

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[1] Oregon Department of Energy. (n.d.). Energy History Timeline. Retrieved February 11, 2021, from https://energyinfo.oregon.gov/energy-history-timeline

[2] About us - Bonneville Power Administration. (n.d.) Retrieved February 11, 2021, from https://www.bpa.gov/news/AboutUs/Pages/default.aspx

[3] Columbia River Treaty. (n.d.). Retrieved February 12, 2021, from https://www.nwcouncil.org/reports/columbia-river-history/columbiarivertreaty

[4] Bureau of Reclamation, Columbia-Pacific Northwest. (2021, March 1). Grand Coulee Dam Construction History. Retrieved April 06, 2021, from https://www.usbr.gov/pn/grandcoulee/history/cultural/index.html

grounds in return.[5,6] Tribal groups in Oregon and the Northwest have fought hard to reclaim access to the fishing grounds promised to them in the Treaty of 1855. Some progress has been made on this front in recent years, and the future of the tribes and waterways of the Pacific Northwest is still to be determined. However, it is important to acknowledge that environmental injustices against indigenous peoples of the Northwest are an unfortunate but real part of the history of energy in Oregon and the Pacific Northwest in general.

Today, more than 60 hydroelectric dams have been built along the Columbia River and its tributaries, whose combined hydro-electric generation capacity exceeds 36 gigawatts (GW). In 2019, hydropower comprised 49 percent of Oregon's electricity supply. Many of the Pacific Northwest's hydro-electric dams are owned and operated by the U.S. Army Corps of Engineers, while their electricity is marketed by BPA. Oregonians, in particular those served by Oregon's consumer-owned utilities (COUs), continue to enjoy the Northwest's abundance of clean, inexpensive hydropower, while the state's legislature recognizes the importance of hydropower in meeting Oregon's clean energy and environmental goals. However, because the legislative intent of the state's RPS policy was to promote new renewable energy development in Oregon, facilities that became operational before 1995 are not eligible; thus, excluding much of the existing hydropower in the region, even though the resource is considered a renewable resource.

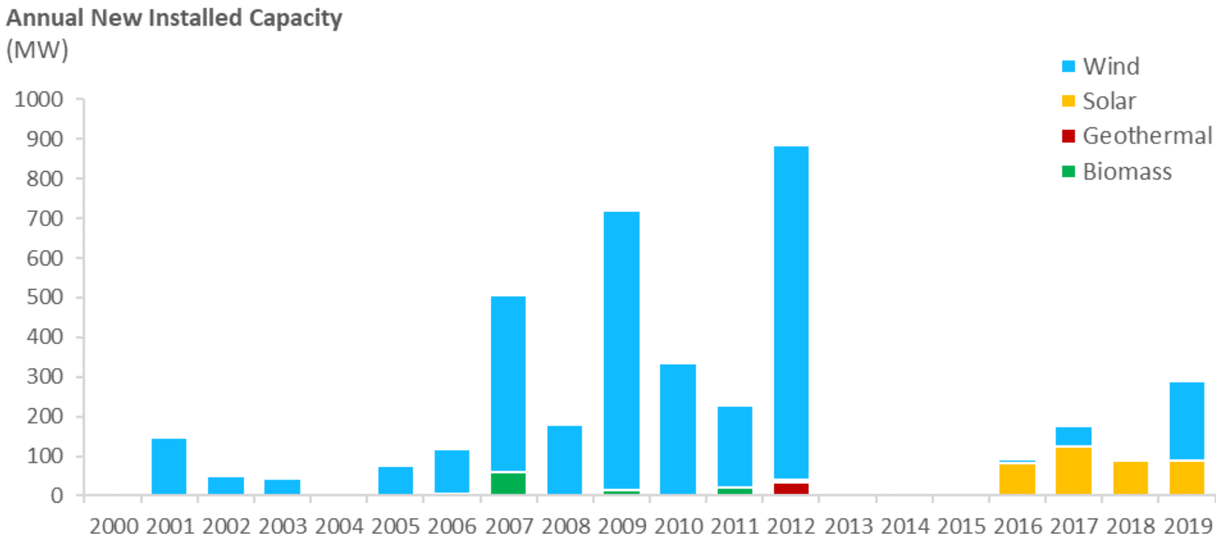
Renewable Energy Development in Oregon

Since 2000, a significant amount of renewable generation capacity has been developed in the state of Oregon. **Error! Reference source not found.** shows the historical additions of renewable resources in the state of Oregon since 2000.

[5] Yakama Nation. (n.d.). Treaty of 1855. Retrieved February 11, 2021, from https://www.yakama.com/about/treaty/

[6] VandenHeuvel, B. (2019, November 27). Yakama, Lummi Nations' Historic Call for Dam Removal on Lower Columbia. Retrieved February 11, 2021, from https://www.columbiariverkeeper.org/news/2019/11/yakama-lummi-nations-historic-call-dam-removal-lower-columbia

Figure 2-1. Annual additions of renewable resources in Oregon since 2000.



The modern history of renewable energy in Oregon begins in 2001, with the construction of Oregon's first wind energy project – the 222 megawatts (MW) Stateline Wind Project. At the time, non-hydro renewables in Oregon accounted for just 2.8 percent of the state's total electricity supply (capacity), while conventional hydropower accounted for 78 percent of the total. The total share of non-hydro renewables slowly grew to 8.6 percent by 2007[7], after which development of renewables in Oregon began to proceed rapidly. Over the next five years, several thousand megawatts of new capacity – predominantly wind resources in the Columbia River Gorge – were developed in Oregon.

Several factors contributed to the increased rate of development in renewables in Oregon. The passage of the state's first Renewable Portfolio Standard (RPS) bill in 2007 helped stimulate a surge of renewable energy development within the state. Under SB 838, the state's largest utilities would be required to source 25 percent of their retail electricity sales from renewable energy by 2025.[8] The bill also established intermediate RPS targets for large utilities, beginning with a 5 percent requirement in 2011.

At the same time, utilities in other states seeking to meet their own near-term RPS goals sought opportunities in Oregon. In particular, California utilities, who at the time were planning towards a 20 percent RPS goal in 2012, were directly responsible for construction of a number of wind projects in Oregon (and more broadly in the Northwest) through long-term power purchase agreements (PPAs) that still exist today.

After 2012, development in the state slowed dramatically, likely due to several factors:

[7] Energy Information Agency – State Renewable Electricity Profiles 2010. (n.d.) Retrieved June 1, 2021, from https://www.eia.gov/renewable/state/Oregon/pdf/oregon.pdf.

[8] Oregon Renewable Energy Act (S.B. 838), 74th Legislative Assembly, 2007 Reg. Sess. (Oregon 2007). https://olis.leg.state.or.us/liz/2007r1/Downloads/MeasureDocument/SB838/Enrolled

- The rapid buildout of wind in the Columbia River Gorge had resulted in transmission and congestion challenges, which came to a head in 2011 when BPA's curtailment of wind resources resulted in lawsuits; and
- California's implementation of a new RPS policy included more stringent restrictions on the use of resources outside of California to contribute to the goals, which diminished interest from out-of-state markets.

More recently, renewable energy developers have returned to Oregon, and over the past several years, a mix of wind and solar resources have been developed in the state. Significant drivers of this trend include Oregon's passage of a more aggressive RPS policy and the increasingly competitive economics of renewable energy projects, allowing them to compete with traditional resources in all-source RFPs and through PURPA standard contracts. These factors are discussed in the subsequent section.

While the majority of carbon-free energy produced in Oregon today is still sourced from hydroelectric facilities, the amount of renewable energy capacity in Oregon has more than doubled in the last decade,[9]. Currently more than 3,400 MW of wind turbines and 590 MW of photovoltaic solar panels are generating electricity in Oregon. Altogether, in-state non-hydro renewables (which included small amounts of biomass, wood, and geothermal energy as well as wind and solar) accounted for 13.4 percent of the state's total electricity generation in 2019. The state's largest utilities relied partially on out-of-state renewable resources to meet their 20 percent by 2020 RPS, as well as on qualifying hydroelectric facilities.

2.2 Drivers of Future Renewable Energy Development

Looking forward, both policy and economics will continue to drive investment in renewable energy. Utility and corporate procurement of renewables – driven by a combination of policy, preference, and economics – is accelerating throughout the Western Interconnection. While Oregon's own renewable and clean energy goals may be the most direct driver of development within the state, interregional dynamics may also affect the development landscape in Oregon as utilities around the west seek out resource diversity and optimize their portfolios across multiple states. This section explores the various factors that will contribute to the demand for future development of renewables within the state of Oregon.

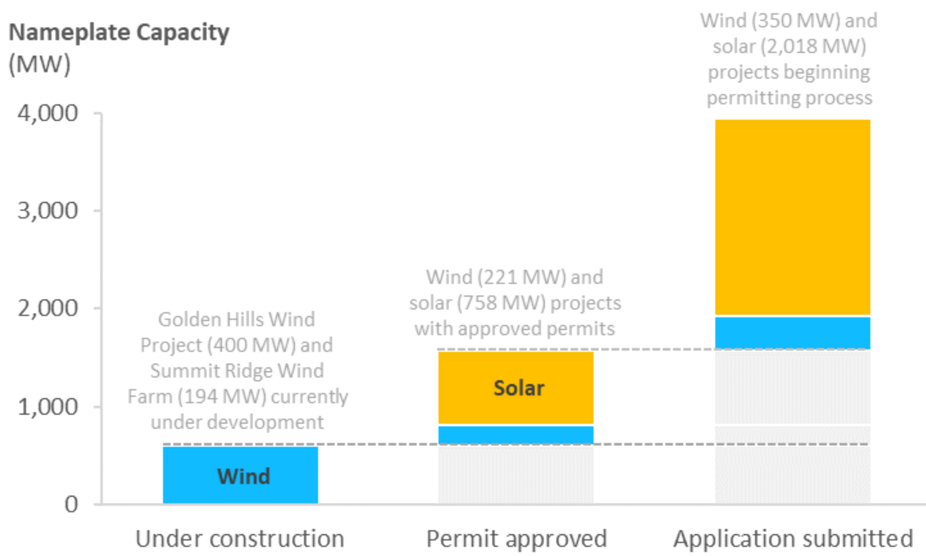
Current Development and Commercial Interest

At the time of this study, a number of projects are in various stages of development. These include projects under construction, projects currently seeking siting and permitting approval, and projects that have applied for interconnection within the state. While not all projects seeking approval or interconnection will come online, the projects in these categories nonetheless provide an indication as to the level of commercial interest in renewable energy development and the types of resources in consideration in the state of Oregon. Figure 2-2 summarizes commercial interest in renewable energy development within the state of Oregon as represented by projects in various phases of development. Aside from projects under

[9] Energy Information Agency – State Renewable Electricity Profiles 2010. (n.d.) Retrieved June 1, 2021, from https://www.eia.gov/renewable/state/Oregon/pdf/oregon.pdf.

construction, commercial interest is currently heavily weighted towards solar PV resources, whose recent cost declines and technology improvements (described in Section 3.2) have catalyzed significant development activity. This level of interest is corroborated by BPA and PacifiCorp's interconnection queues[10], to which a significant number of renewable energy projects – particularly solar PV – have been submitted for study. A final point worth noting is that the number of solar projects with approved permits, about 750 MW of capacity, is greater than the existing operational solar capacity. If all of these projects were to be brought online, it would more than double the state's operational solar capacity.

Figure 2-2. Status of projects in various phases of development in Oregon.



Data on project characteristics and status provided by ODOE staff. A significant number of proposed solar facilities also include colocated energy storage.

2.2.1 Clean Energy Policy in Oregon

2.2.1.1 Senate Bill 1547: Renewable Portfolio Standard

Most recently, Oregon's RPS goals were revised by the passage of Senate Bill 1547 (SB 1547) in 2016. SB 1547 established a 50 percent RPS target for investor-owned utilities (along with interim milestones) as well as smaller targets for the state's consumer-owned utilities. The specific statutory requirements established by SB 1547 are shown in Table 2-1.

Table 2-1. Statutory RPS requirements established by SB 1547.

	2020	2025	2030	2035	2040
IOUs	20%	27%	35%	45%	50%
Large COUs	-	25%	25%	25%	25%

[10] BPA Interconnection Queue Data is based on information as of February 25, 2021 at 10:02 am.

Medium COUs	-	10%	10%	10%	10%
Small COUs	-	5%	5%	5%	5%

Note: Electric Service Suppliers (ESS) must meet the RPS requirements applicable to the electric utilities that serve the territories in which the ESS sells electricity to retail electricity customers. In cases where ESS serve customers in multiple electric utility service territories the OPUC or COU boards may develop aggregate standards or other procedures for ESS.

The RPS statute allows exemptions from compliance with the targets under certain specific conditions, namely:

- If compliance would require a utility to procure electricity such that the incremental cost of compliance exceeds 4 percent of the utility's annual revenue requirement; or
- If compliance would result in conflicts with mandatory and enforceable reliability standards of the North American Electricity Reliability Corporation, or compromises to the integrity of the electric company's electrical system; or
- If compliance would require a utility to procure electricity in excess of its annual load or would result in displacement of a resource other than coal, natural gas, or petroleum; or
- If compliance would reduce a consumer-owned utility's ability to purchase Tier 1 energy from BPA.

Because some of these conditions exempt many of the state's COUs from requirements to comply with the RPS targets, this study focuses on the compliance requirements associated with the state's IOUs as one of the significant drivers for new renewable energy development to serve Oregon's needs. Electricity service suppliers (ESS) also have similar statutory requirements as the IOUs, but their share of the state's electricity load is much smaller than that of the IOUs.

The most recent integrated resource plans (IRPs) of Portland General Electric (PGE)[11] and PacifiCorp[12], the state's largest IOUs, provide some general insights into utilities' current plans to satisfy the requirements of Oregon's current RPS requirements. While the IRPs do not themselves determine a utility's portfolio – the specific resources procured by utilities will be determined through competitive solicitations and other procurement mechanisms and are likely to differ from those identified in an IRP for many reasons – the IRPs nonetheless provide an indicative picture of a utility's plans to meet future needs at one snapshot in time.

[11] Portland General Electric 2019 IRP, available at: https://downloads.ctfassets.net/416ywc1laqmd/6KTPcOKFlLvXpf18xKNseh/271b9b966c913703a5126b2e7bbbc37a/2019-Integrated-Resource-Plan.pdf

[12] PacifiCorp 2019 IRP, available at: https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/integrated-resource-plan/2019_IRP_Volume_I.pdf

2 Background

In the Preferred Portfolio of its 2019 IRP (shown in **Error! Reference source not found.**), PGE identified a portfolio comprising the following generic renewable resource additions through 2025:

- 100 MW of Gorge Wind (41 MWa with an assumed capacity factor of 41 percent);
- 179 MW of Washington Wind (77 MWa with an assumed capacity factor of 43 percent); and
- 253 MW of Montana Wind (109 MWa with an assumed capacity factor of 43 percent)

PGE's IRP also projects that renewable resource additions will grow to total of about 3,000 MW by 2040.

To meet its near-term needs, PGE's Action Plan identified the need to "Conduct a Renewables Request for Proposals (RFP), seeking up to approximately 150 MWa of RPS-eligible resources to enter PGE's portfolio by the end of 2023." 150 MWa is equivalent to about 517 MW of solar resources with 29 percent capacity factor, or about 350 MW of wind with 43 percent capacity factor. PGE now plans to launch this RFP in 2021.[13] In 2020, PGE received approval for the Wheatridge Renewable Energy Facility which will account for 400 MW of combined wind, solar and battery storage resources in Oregon.[14][15]

[13] PGE application to OPUC for approval of an Independent Evaluator for 2021 All-Source RFP. https://edocs.puc.state.or.us/efdocs/HAH/um2166hah15141.pdf

[14] Wheatridge Renewable Energy Facility East information. https://www.oregon.gov/energy/facilities-safety/facilities/Pages/WREFE.aspx

[15] Wheatridge Renewable Energy Facility III information. https://www.oregon.gov/energy/facilities-safety/facilities/Pages/WREFIII.aspx

Figure 2-3. Summary of resource additions in PGE's 2019 IRP Mixed Clean Portfolio.

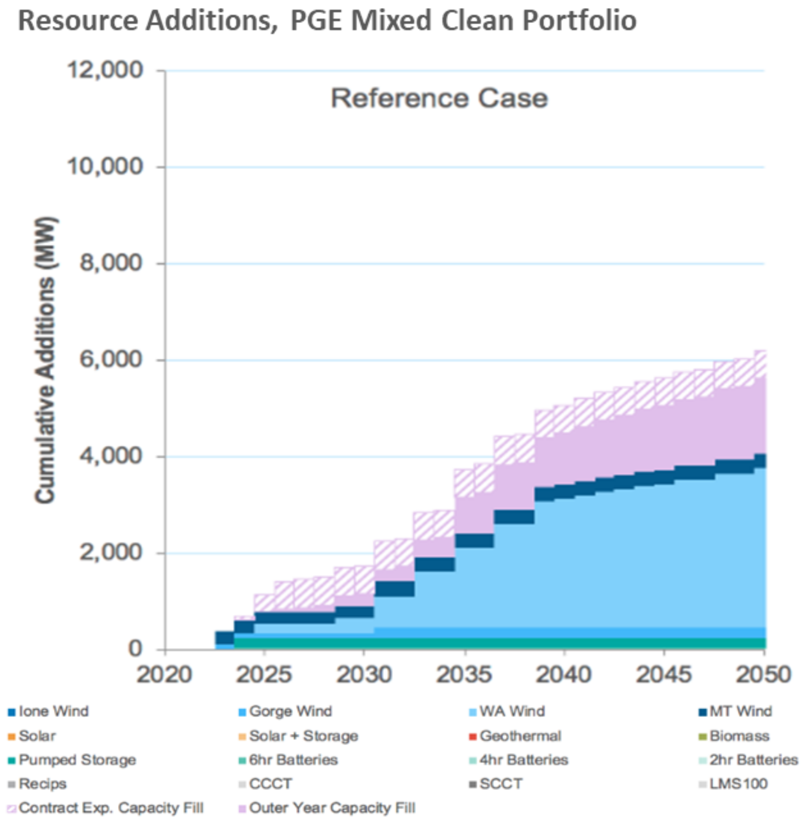


Image source: PGE 2019 IRP

PacifiCorp's 2019 IRP identified a Preferred Portfolio (shown in Figure 2-4) that included the following renewable resource additions:

- 20 MW of Washington wind;
- 815 MW of utility-scale Washington solar and storage;
- 1,100 MW of Idaho wind;
- 975 MW of utility-scale Oregon solar and storage (500 MW in 2024 and 475 MW in 2033); and
- 1,415 MW of utility-scale Wyoming solar and storage.

This plan also includes over 800 MW of co-located storage, 1,200 MW of standalone storage, and other resources across Oregon, Washington, Idaho, and Utah. PacifiCorp's plan does not explicitly specify which of these resources will be used to satisfy the requirements of Oregon's RPS and which will be used to meet needs in other states. Nonetheless, this plan provides a useful reference point on PacifiCorp's perspectives on the potential scale of renewable development in Oregon.

Figure 2-4. Summary of resource additions & retirements in PacifiCorp's 2019 IRP Preferred Plan.

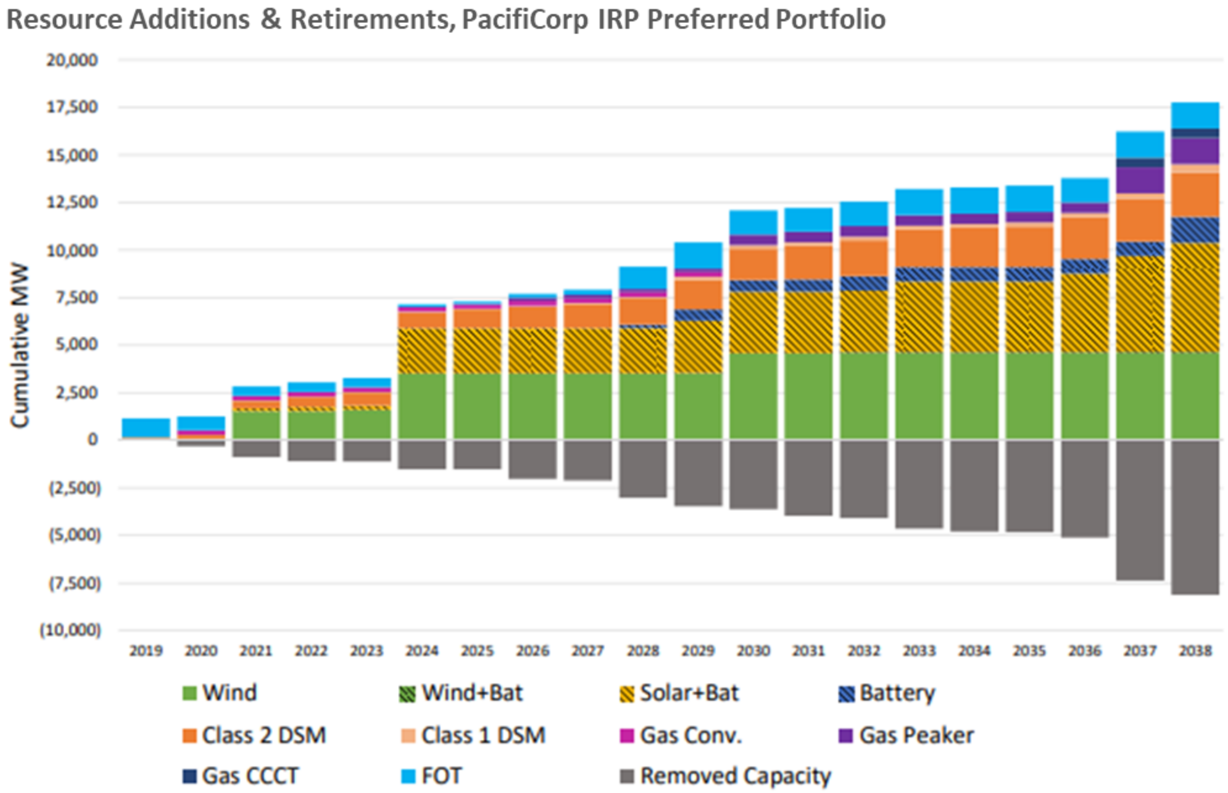


Image source: PacifiCorp 2019 IRP

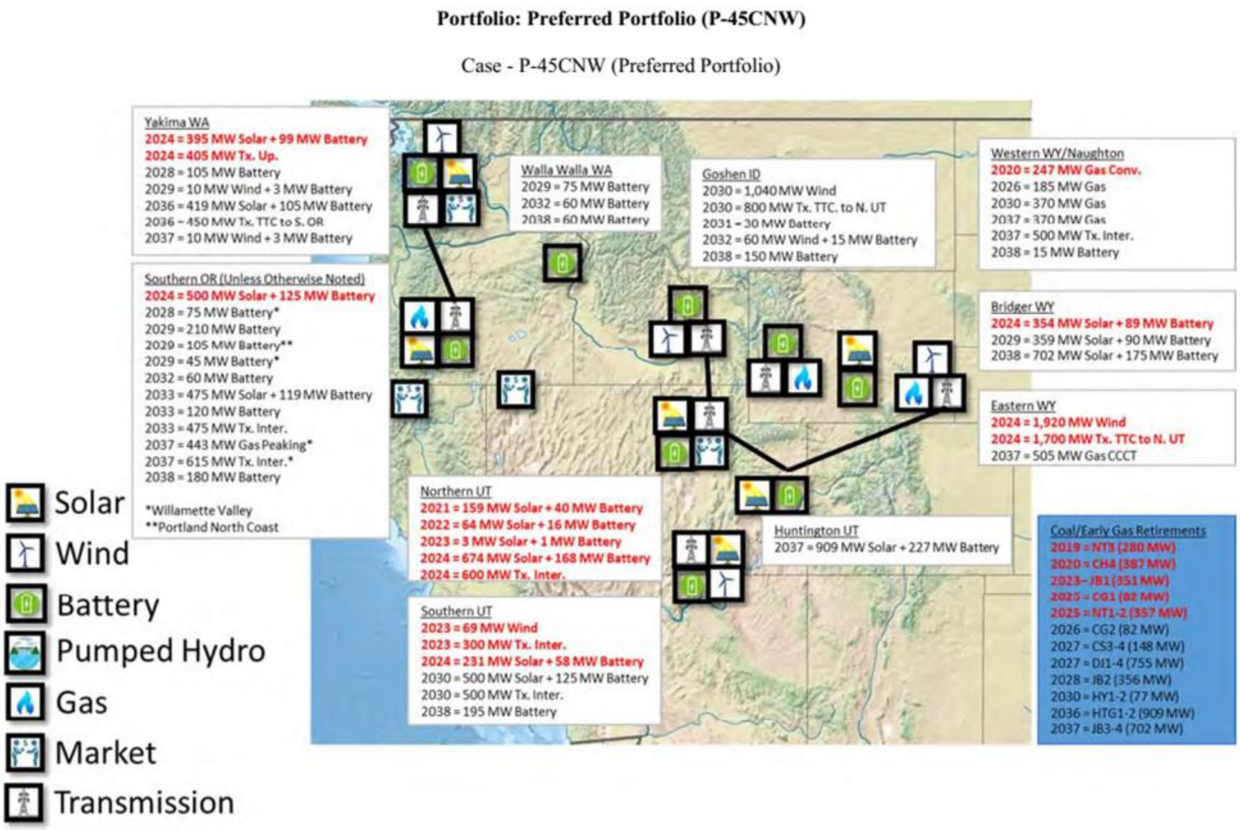


Image source: PacifiCorp 2019 IRP

2.2.1.2 Public Utility Regulatory Policies Act (PURPA) Implementation

The Public Utility Regulatory Policies Act (PURPA) was passed by Congress in 1978 to encourage fuel diversity through alternative energy sources, and to introduce competition in the electric sector. Primarily encouraging generation development by small, non-utility power producers called Qualifying Facilities (QFs), the generation covers energy sources like industrial waste-heat recovery, biomass, solar, and wind. Currently, PURPA gives QFs the right to interconnect with a utility-controlled grid and requires utilities to purchase the QFs energy generated under a mandatory purchase obligation – at "avoided cost"[16] rates. While PURPA is a federal law, states are responsible for implementing significant aspects of the law. In Oregon, OPUC is in charge of PURPA's implementation. Oregon's legislation ORS 758.505 governs the definitions associated with the implementation of PURPA within the state.[17]

This topic is discussed in more detail in Section 4.

2.2.1.3 Net Energy Metering & Oregon's Community Solar Program

PGE, PacifiCorp and many COUs currently offer net metering to customers who install solar PV on their rooftops. Under current net metering regulations, customers that export power to the grid receive a bill

[16] Avoided cost is the incremental cost to an electric utility of electric energy or energy and capacity that the utility would generate itself or purchase from another source but for the purchase from a qualifying facility. https://www.oregonlaws.org/ors/758.505

[17] Definitions for ORS 758.505 to 758.555. https://www.oregonlaws.org/ors/758.505

credit at their retail rate, which provides an economic incentive for solar PV. As of 2019, the estimated capacity of net metered solar across the state exceeded 150 MW, most of which is located in the IOU service territories. The continuation of net metering in the state will provide support for continued growth of this market segment.

In addition to net metering for rooftop solar, the Oregon Public Utilities Commission (OPUC) and IOUs recently implemented a Community Solar program that allows customers to subscribe to output from small-scale community solar projects, for which they receive a monthly bill credit based on the output of the facility. This program commenced offering in 2020 and is poised to contribute to continued growth of small-scale solar within the state.

2.2.1.4 Executive Order 20-04: Greenhouse Gas Reduction Goals

In 2020, Governor Kate Brown issued Executive Order 20-04, directing state agencies to take action to reduce greenhouse gases within the state. Augmenting previous greenhouse gas reduction goals implemented by the state legislature, this executive order established key future goals for the state:

> "Consistent with the minimum GHG reduction goals set forth in ORS 468A.205(1)(c), this Executive Order establishes science-based GHG emissions reduction goals, and calls for the State of Oregon to reduce its GHG emissions (1) at least 45 percent below 1990 emissions levels by 2035; and (2) at least 80 percent below 1990 emissions levels by 2050."[18]

The order sets forth directives to state agencies to evaluate and reform processes and procedures as needed in furtherance of this goal, to consider this goal in future decision making, and coordinate in their efforts to support the achievement of this goal. Further guidance is given to the OPUC, emphasizing the importance of its role in regulating the state's electric utilities, whose actions to mitigate their own greenhouse gas emissions while supporting electrification will figure prominently in the state's progress towards that goal.

One of the most significant implications of the state's economy-wide greenhouse gas goal is that electrification – of transportation and of buildings – will likely drive future load increases at a scale that could be significant. Most studies of economy-wide deep decarbonization conclude that electrification of these end uses is a foundational element of a comprehensive plan, implying widespread adoption of electric vehicles, heat pumps, and electric water heaters to reduce direct consumption of gasoline in cars and natural gas in buildings. Meeting the state's climate objectives will require most, if not all, of this additional load to be supplied with carbon-free electricity, and based on current trends and technology options, renewable resources are likely to play a prominent role in meeting those demands.

The ambition of this goal notwithstanding, many of the stakeholders consulted in the Renewable Energy Industry Assessment expressed a hope for improved alignment and coordination of agencies and processes within the state to support this goal. This point is particularly important because of language like this from Section 3(A) of the order:

[18] Executive Order 20-04, available at: https://www.oregon.gov/gov/Documents/executive_orders/eo_20-04.pdf

> "Agencies shall exercise any and all authority and discretion vested in them by law to help facilitate Oregon's achievement of the GHG emissions reduction goals set forth in paragraph 2 of this Executive Order."[19]

This topic is discussed in further depth in Section 4.

2.2.2 Clean Energy & Climate Policies in Neighboring States

Historically, development of renewable generation in the state of Oregon has also contributed to meeting the policy goals of neighboring states throughout the West. State policies – as well as voluntary commitments by utilities, corporate entities, local governments, and individual customers – have increasingly preferred renewable and carbon-free resources.

2.2.2.1 California: SB100 & Executive Order B-55-18

California passed Senate Bill 100 in 2018, and in doing so became the first state in the continental United States to formally adopt a portfolio standard requiring 100 percent carbon-free resources by 2045. Like Oregon, California has also established aggressive economy-wide decarbonization goals that are likely to result in significant new electrification loads, further increasing the need for investment in new renewable energy generation. California's most recent economy-wide goals were established by Governor Jerry Brown's Executive Order B-55-18, which established a pledge "…to achieve carbon neutrality as soon as possible, and no later than 2045."

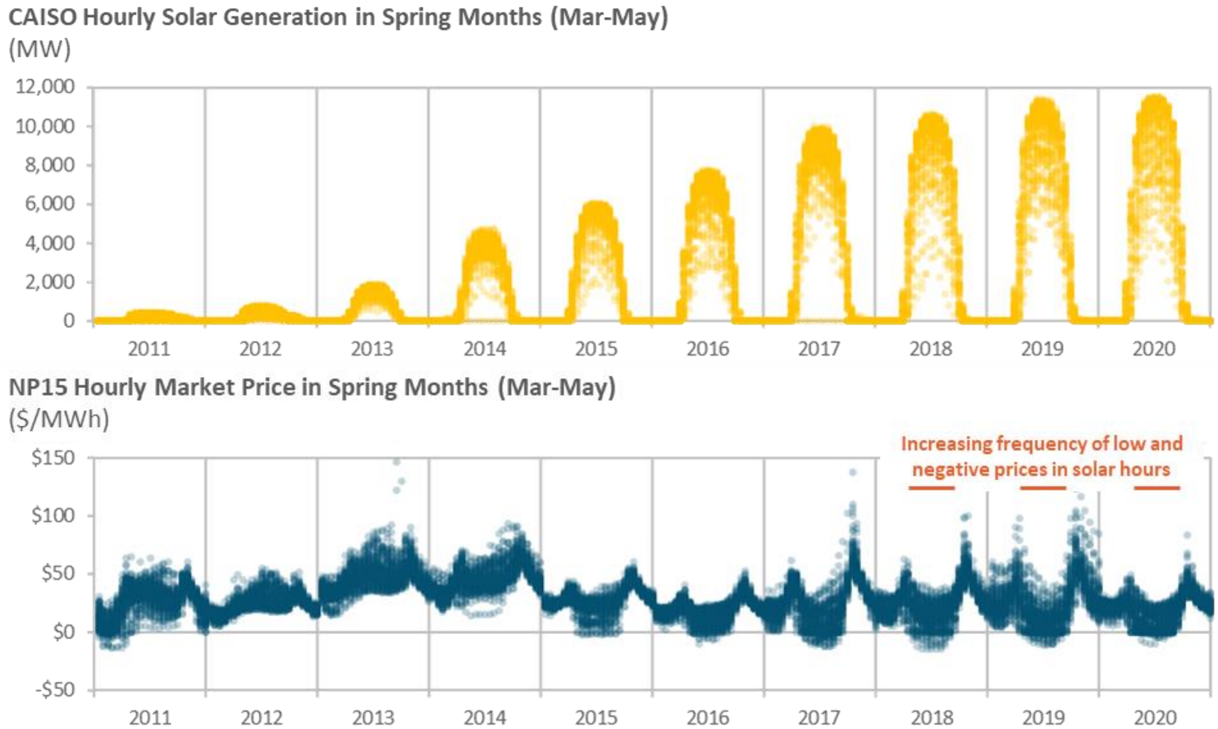
Multiple studies of these policies and prior decarbonization goals for the state of California identify both low-carbon electricity and electrification of transportation and buildings as pillars of the state's strategies to achieving these ambitious targets, which together set the stage for a renewable development effort that may require more than 100 GW of capacity by 2045.[20] While most studies so far suggest that in-state solar PV resources will play the most central role in meeting the state's targets, saturation of the grid will eventually lead utilities to seek more resource diversity, which may lead to pursuit of out-of-state resources across the Interconnection.

California's energy policy will likely also have indirect impacts on renewable energy development in Oregon due to its effects on regional wholesale energy markets. In the past ten years, California has added a total of roughly 17 GW of solar PV resources (11 GW utility scale and 6 GW behind-the-meter). These additions have had profound impacts on the dynamics of wholesale energy markets: during daytime, especially in the spring, wholesale markets are saturated with low marginal cost generation resources, which results in low wholesale energy prices that follow the pattern of California's eponymous "duck curve." The evolution of this dynamic is shown in Figure 2-5. Going forward, California's continued reliance on solar PV to meet a large share of its renewable energy needs – as well as development of solar PV resources in other Southwest states as discussed further below – will likely exacerbate this diurnal market dynamic.

[19] Ibid

[20] See, for example, the California Energy Commission's recent technical workshop on SB100-compliant scenarios for the state: https://www.energy.ca.gov/event/workshop/2020-09/senate-bill-100-draft-results-workshop

Figure 2-5. Evolving dynamics in CAISO day-ahead market due to increasing saturation of solar.



Due to California's size and its strong connections to neighboring states, these market dynamics impact the value of energy throughout the Western Interconnection. All else equal, the low daytime energy prices will encourage resource diversification, which will encourage further consideration of alternative renewable energy technologies (e.g., wind, geothermal) and storage (e.g., lithium-ion batteries, pumped storage).

2.2.2.2 Washington: Clean Energy Transformation Act

In 2019, Washington enacted the Clean Energy Transformation Act (CETA), which established several notable future targets for electric utilities within the state: (1) that all utilities would eliminate coal from their portfolios by 2025, (2) that all utilities would achieve carbon neutrality by 2030, including a minimum requirement that 80 percent of retail sales be met with clean energy sources, and (3) that all utilities would achieve a 100 percent clean energy portfolio by 2050.

2.2.2.3 Other Western States

While more distant Western states have not traditionally pursued development of renewable energy resources in the Pacific Northwest, the trend towards widespread aggressive renewable energy and greenhouse gas reduction policy goals is nonetheless notable due to its implications upon the need to develop renewable energy throughout the Western footprint. In addition to the states discussed above, the following states have established or are considering aggressive long-term renewable and carbon free energy policy goals:

- **Arizona:** In 2020, the Arizona Corporation Commission established draft energy rules for the state that would require a transition to 100 percent carbon-free resources by 2050. Those rules have not yet been finalized, but in the absence of formal guidance from the ACC, the state's major electric utilities have established their own goals: Arizona Public Service (45 percent renewables by 2030, 100 percent carbon-free by 2050), Tucson Electric Power (70 percent renewables by 2035, 80 percent carbon reduction by 2035 relative to 2005 levels), and Salt River Project (90 percent carbon reduction by 2050 relative to 2005 levels).

+ **Colorado:** Colorado has recently enacted a number of policies directly and indirectly encouraging increased deployment of renewable energy, including Senate Bill 19-236 (100 percent carbon-free electricity by 2050), House Bill 19-1261 (economy-wide carbon emissions reductions of 90 percent relative to 2005 by 2050), and a number of bills providing support for transportation electrification. These policies follow the prior commitment of Xcel Energy, the state's largest electric utility, to decarbonize its electricity portfolio by 2050.

+ **Idaho:** While Idaho does not have a legislated RPS standard, the state's major electric utility, Idaho Power Company (IPC), has established a goal of achieving 100 percent clean energy by 2045. IPC's existing portfolio includes a significant share of hydroelectric generation (45 percent), but the displacing the remaining fossil generation will likely require significant investments in renewables.

+ **New Mexico:** in 2019, the New Mexico legislature passed the Energy Transition Act (ETA), establishing goals for the state's utilities of 80 percent renewables by 2040 and 100 percent carbon-free resources by 2045. These targets are supported by interim milestones that will require utilities to meet a 40 percent RPS by 2025 and a 50 percent RPS by 2030.

+ **Nevada:** Nevada's legislature passed Senate Bill 358 in 2019, increasing the state's RPS target to 50 percent by 2030 and establishing a 2050 goal to supply loads with 100 percent carbon-free electricity by 2050.

While many of the utilities in these more distant states may not look as far as Oregon to meet their renewable energy development needs, their policies are nonetheless notable due to their implications for the scale of renewable energy development that can be expected throughout the West, as well as their impacts on regional markets and the corresponding value of different types of investments.

2.3 Oregon's Siting and Permitting Process

One of the processes that is discussed at length in many of the Industry Assessment survey responses is the Oregon state siting and permitting process. The Energy Facility Siting Council (EFSC or "the Council") is an independent government body that oversees siting of energy facilities that fall under state jurisdiction, including both generating facilities and transmission facilities. Although ODOE's Energy Facility Siting Division serves as staff to the Council, EFSC is a separate entity from ODOE. [21] Energy facilities under EFSC jurisdiction require a site certificate from the Council before they can be constructed and operated. In the instances where facilities fall under both federal and state jurisdiction, those facilities will require both federal approval and an EFSC site certificate. In these cases, ODOE and the Council coordinate with the federal agencies to reduce duplication of effort. Sometimes projects fall under the jurisdiction of federal,

[21] A Public Guide to Energy Facility Siting in Oregon. Oregon Department of Energy. July 2020. https://www.oregon.gov/energy/facilities-safety/facilities/Documents/Fact-Sheets/EFSC-Public-Guide.pdf

state, and local governments. Any project proposed on or crossing Tribal reservation lands would require approval from the associate Tribal Government.[22]

In conducting the Energy Facility Siting review, the Council seeks input from state agencies, local governments, and Tribal governments. EFSC's application review process is designed to integrate all applicable state and local standards, requirements, and permits necessary to receive a site certificate. These elements are considered in a single process with seven major steps, shown in Figure 2-6 below. This consolidated review process is meant to eliminate duplication, different decision timelines, and different appeal paths while simplifying opportunities for public engagement. For instance, once a site certificate has been issued by the Council, any state and local permits that are included in and governed by the site certificate must also be issued by the state or local governments without any additional hearings, conditions, or proceedings. [23]

Figure 2-6. The Oregon Energy Facility Siting review process.

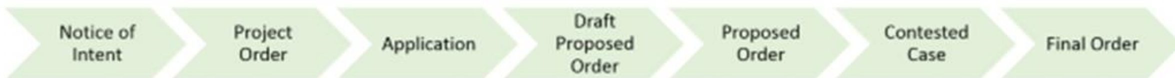


Image source: ODOE

Each stage of the process is summarized below:

+ Notice of Intent: This contains the conceptual plan and preliminary information on the proposed facility. This step is the public's first opportunity to submit formal comments on a proposed facility. This document is valid for two years.
+ Project Order: This is a blueprint for the project application. This tells the applicants which standards and requirements apply to their project and provides the basis for EFSC's evaluation and decision. Can be amended at any time and must be issued within 140 days after the NOI is received.
+ Application: This typically contains the preliminary and full applications. This stage provides detailed descriptions of the proposed facility and includes technical assessment of compliance with the standards identified in the Project Order.
+ Draft Proposed Order: This is based on an evaluation of the application against all applicable standards and rules. It incorporates reviewing agency, special advisory group (SAG) comments, and Tribal Government comments received during the application review phase. The outputs are detailed findings of facts and conclusions of law. Also sets forth recommended conditions of approval and any monitoring plans or reasons why the application should be denied. This phase includes a public comment timeframe and a public hearing in the vicinity of the project location.

[22] Oregon Department of Energy. (2020). "Energy 101: Energy Facility Siting and Permitting" in *2020 Biennial Energy Report*. https://www.oregon.gov/energy/Data-and-Reports/Documents/2020-BER-Energy-101.pdf#page=52

[23] A Public Guide to Energy Facility Siting in Oregon. Oregon Department of Energy. July 2020. https://www.oregon.gov/energy/facilities-safety/facilities/Documents/Fact-Sheets/EFSC-Public-Guide.pdf

- **Contested Case**: This is an administrative judicial process governed by Oregon law. This step is built into the EFSC process to ensure Oregonians have a clear chance to raise issues about a proposed energy facility. This step also allows additional evidence and evaluation of issues that are not resolved through the Proposed Order phase.
- **Final Order**: Here EFSC evaluates the proposed order and the contested case order then outlines the final order on what the Council's decision will be. If the facility is approved, a site certificate is issued with a final order and contains the conditions for construction, operation, and retirement of the facility.

2.4 Transmission

2.4.1 Transmission in Oregon Today

The Pacific Northwest Transmission system consists of a significant 500 kV, 230 kV, and lower voltage network in four major paths: (1) a north-south transmission line generally following the Interstate-5 (I-5) corridor from Seattle (and British Columbia, Canada) down to Eugene, (2) a second north-south dual-flow DC transmission line from The Dalles down to near Los Angeles, (3) transmission following the Columbia River and connecting hydropower projects from Grand Coulee in Washington south to the OR-WA border, and then westward to Portland, and (4) high voltage lines that cross the Cascades in Washington east of Puget sound and connect with hydropower in the Upper Columbia River area, and then connect over to Northern Idaho hydro projects and transmission further reaching on to Colstrip, Montana. An additional regional intertie connects the Northwest to California through the AC California - Oregon Intertie (from the Captain Jack and Malin substation).

The majority of this transmission infrastructure is managed by BPA. Additional transmission infrastructure is owned and operated by PacifiCorp across six states, including a significant amount in Southern Oregon; Idaho Power within Idaho and into Oregon; and Portland General Electric. PacifiCorp and Idaho Power also co-own a 500 kV line that connects Summerlake in southeastern Oregon to Midpoint substation in Idaho.

For interconnecting new renewable resources, there is an extensive transmission network west of the Cascades for new resources, though available land for resource development is more limited. East of the Cascades, transmission along the Columbia river is extensive, but available transmission capacity can be limited, and further south into Oregon, transmission is sparser with the exception of lines connecting to California and in the Klamath Falls area.

Given the concentration of loads to the west of the Cascades and its more limited land availability, a consideration that is potentially limiting to large scale renewable energy development East of the Cascades is the availability of East-West transmission capacity on BPA's and PGE's lines on the West of Cascades South transmission path. Some transmission capacity may be available here, but not as much as might be needed to import very large amounts of renewable energy into Western Oregon from Eastern Oregon, or from beyond in Idaho, Montana, Utah, and Wyoming.

Figure 2-7. Map of the Northwest transmission system.

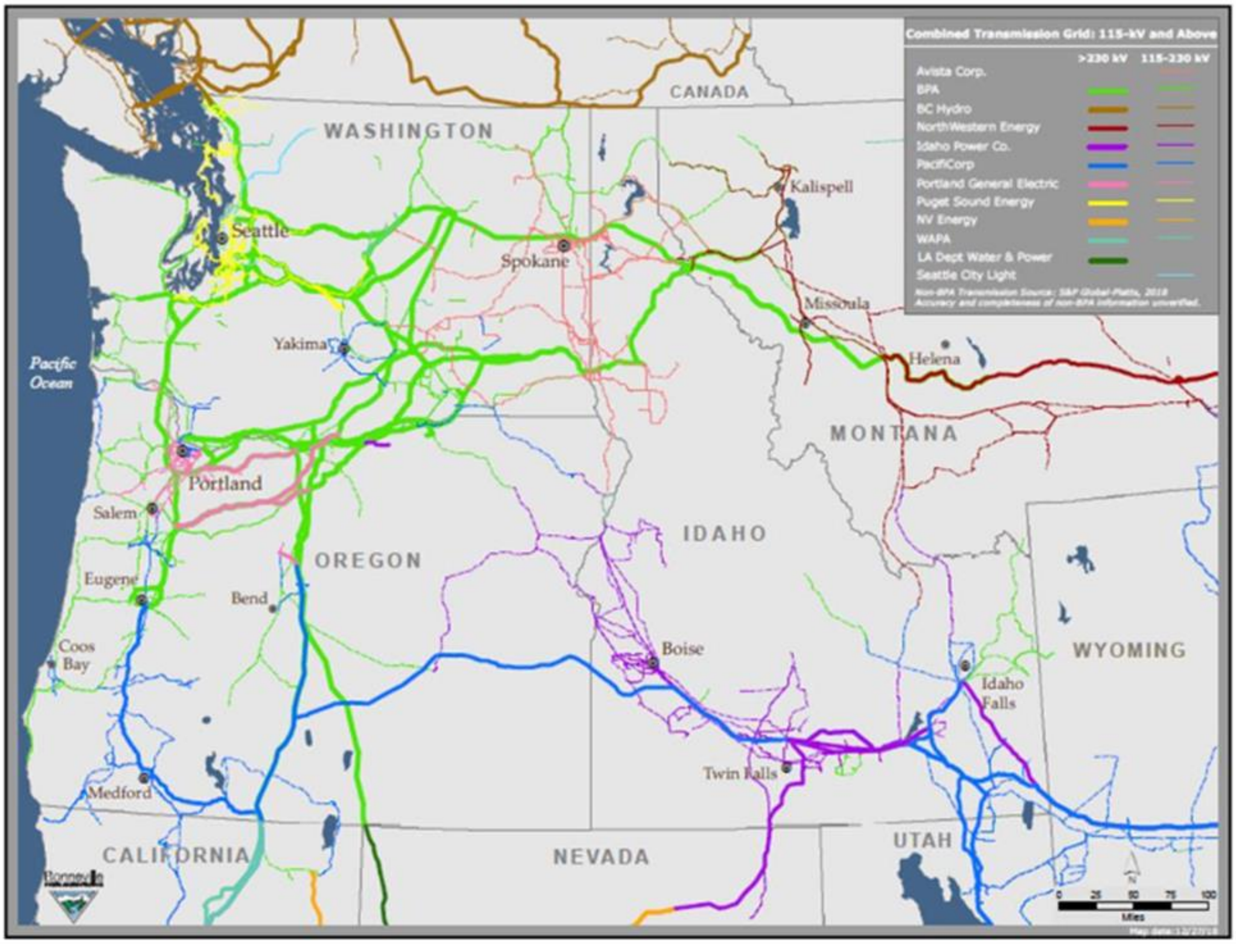


Image source: Bonneville Power Administration

Figure 2-8. Map of BPA transmission system & key flowgates.

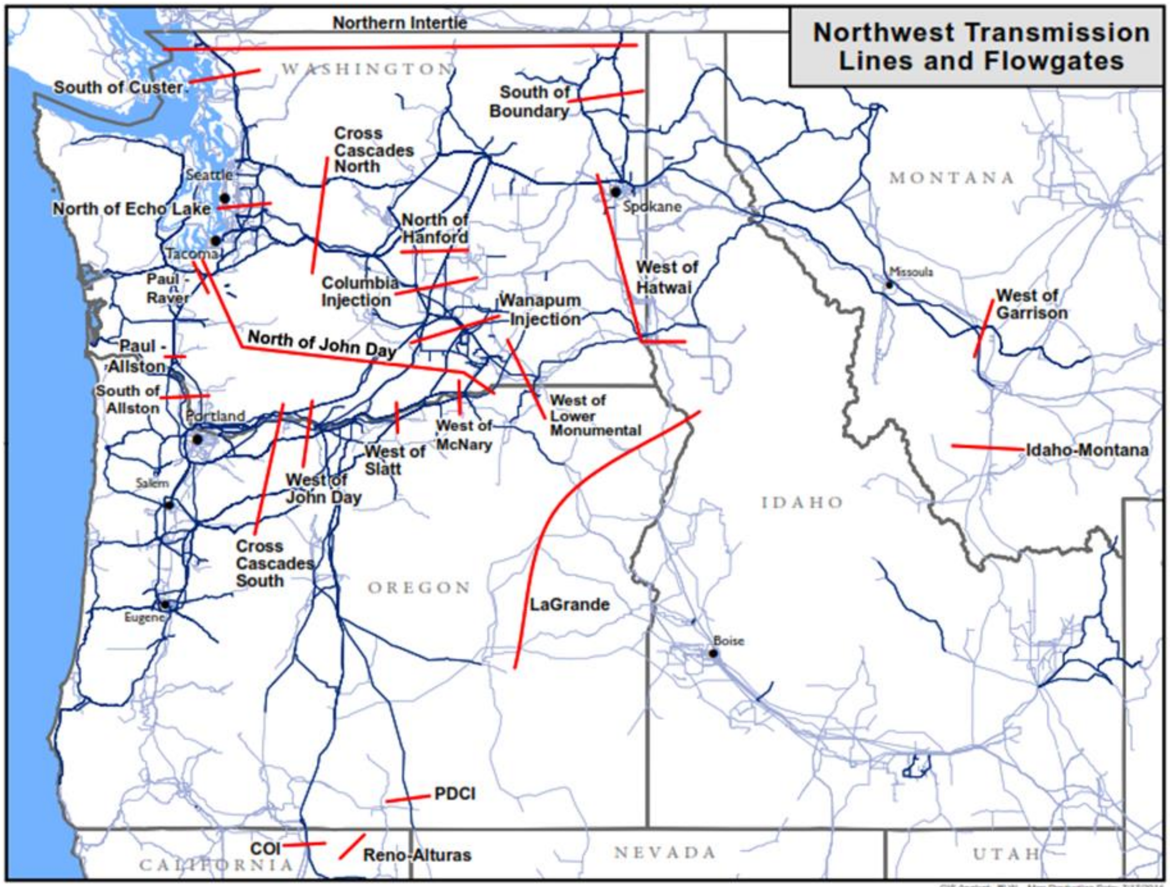


Image source: Bonneville Power Administration

In the Pacific Northwest, individual transmission owners control transmission planning across the footprint of their transmission systems. Transmission planning, governed by requirements set by the Federal Energy Regulatory Commission (FERC), considers needs for new transmission over various time horizons such as 5-, 10-, and 20-year outlooks. In January 2020, BPA and the region's investor-owned utilities and community-owned utilities formally launched the NorthernGrid regional transmission planning association. The purpose of NorthernGrid is to facilitate regional transmission planning across the Pacific Northwest and Intermountain West. Going forward, individual utilities will share their transmission plans with NorthernGrid. NorthernGrid will then coordinate a regional planning process that studies impact to regional power flows, identifies costs and beneficiaries, and integrates the transmission plans of individual transmission systems into a regional transmission plan.

This is in contrast to other regions of the country where transmission planning is controlled by a centralized regional entity such as a regional transmission organization (RTO). RTOs have enhanced energy markets like those discussed in the following section, but also have the additional feature of centralized regional transmission planning for new transmission lines. Centralized regional transmission planning considers and addresses the aggregated transmission needs across an entire regional footprint.

There are several points related to the transmission system discussed in this study on which stakeholders had different, and sometimes conflicting, viewpoints on, including the state of the existing transmission system, transmission planning, siting, permitting, and development process. But one thing that all parties can agree upon is that the renewable energy industry in Oregon, and the West more broadly, would benefit from more available transmission capacity on existing lines and new transmission development in areas with substantial technical renewable potential. More transmission capacity can come from optimizing the use of existing transmission or building new transmission lines in new corridors.

2.4.2 Optimizing the Existing Transmission System in Oregon

Building new transmission in new corridors can be a challenging and long-term effort with tradeoffs in land use and uncertainty in the likelihood of project approval over a number of years. This uncertainty about future transmission development can cause hesitation in generation development, creating a "chicken-or-egg" problem in which generation development does not manifest in an area due to lack of available transmission, but transmission development is not prioritized due to lack of generation projects in advanced stages of development. While these considerations are necessary in certain circumstances, they also highlight the merit of exploring all opportunities to make more optimal use of existing transmission infrastructure for enabling renewable energy development. This section discusses these options.

2.4.2.1 Enhanced Regional Markets

Regional market operations can, at times, make more optimal use of transmission networks by enabling generation at different locations to "redispatch" around transmission constraints. An individual example of this market approach to transmission use is BPA's use of a redispatch pilot project to reduce peak flows on the I-5 Corridor north of Portland, enabling the deferral of need to upgrade the line, while still meeting the needs of transmission customers to serve large north-to-south flows in the area.

More broadly, the Western Energy Imbalance Market (EIM), operated by California Independent System Operator (CAISO), which includes current Oregon participants of PacifiCorp, PGE, and Idaho Power, as well as BPA in 2022, optimizes transmission use in real time by creating a nodal real time dispatch of generation at each point in the EIM footprint. If a section of transmission becomes constrained in real-time, the EIM will reflect that as congestion, adjusting nodal prices for generation to incent units downstream of the constraint to increase dispatch and reducing the price incentives for production upstream of the constrain. The EIM also create transparency in identifying which sections of transmission are the constraining elements, which is useful information for transmission operations and planning, as well as for generation siting and development.

Going forward, regional participants are also discussing development of an Extended Day Ahead Market (EDAM) of the CAISO, which would function similarly to the EIM, but in a day ahead time frame. Day ahead markets enable more certainty in the scheduling of resource operations relative to real-time markets. This greater amount of certainty could potentially enable lower cost renewable generation to dispatch energy if optimal to do so from a cost perspective. It would also create a mechanism to compensate higher cost generators to relinquish transmission rights held but not used during certain hours, if those transmission rights would have prevented lower cost generators from operating in the same hours. Both the EIM and

EDAM could also help facilitate more close coordination of wind and solar generation with hydropower dispatch on the system to make use of existing transmission availability.

2.4.2.2 Reconductoring Existing Lines

Certain transmission paths can be upgraded by reconductoring existing lines in the path, which avoids the need to create new rights-of-way for transmission facilities. Some of these upgrades can require updates to the existing structures and poles, while other upgrades involve only a change to the line itself, utilizing the same poles and structures. Additionally, some upgrades involve increasing the voltage of particular transmission lines (which requires changes to transformer configurations at adjacent substations), while other reconductoring opportunities, such as using Aluminum Conductor Composite Core (ACCC) conductors, can increase the line's maximum thermal rating at the same voltage level.

Transmission system reconductoring needs to be planned in a coordinated approach with existing transmission as it can affect flows between different lines and have different implications for reliability under contingencies or system stability, but when use appropriately, it can sometimes relieve a bottleneck in a particular portion of a transmissions system while avoiding the need for an additional corridor.

2.4.2.3 Dynamic Line Ratings

Additionally, existing transmission lines can often carry different maximum amounts of load during different conditions. For example, during a hot day with low wind, transmission lines will reach higher levels of heating sooner with a given level of high loading than they will on a colder day with moderate wind. If weather and other conditions can be reflected to dynamically update the rating of the line, rather than always using the lower limit to be conservative, existing lines can be used to transfer a larger aggregated amount of power over the course of a year. BPA currently applies operating transfer capabilities (OTC) to its major internal paths to reflect this dynamic. Potential regional use of dynamic limits, or more advanced metrics, for evaluating line capability in real time could further increase transmission's ability to bring energy to loads.

Additionally, transmission line limits are typically set to have the network maintain reliability under contingency conditions – after a line or a generator has unexpectedly gone out of service. Transmission operators often use Remedial Action Schemes (RAS) to address some types of contingencies by immediately triggering a reduction of generation upstream of a constraint in the event of an outage, and potential reduction to interruptible loads downstream of the constraint. Using this approach, more power is allowed to flow during normal system conditions, when all lines are in service, because the transmission operator has a plan in place to reduce the remaining flow on a path if a critical line in the path goes down.

Incorporating renewable resources and storage, which can often respond very quickly to system signals to change output levels, into updated RAS designs may enable additional transmission usage for delivering renewables.

2.4.2.4 Strategic Deployment of Utility-scale Storage Resources

Finally, strategic placement of storage resources can be helpful for delivering additional renewable resources to loads over existing transmission systems. For example, if a line has 200 MW of transfer capability available, typically it would be assumed that only 200 MW of renewable resources can be developed upstream of the transmission and delivered to loads over the line. If, however, 100 MW of energy storage is utilized at the renewable generation site (or another location upstream of a transmission constraint, the storage can shift 100 MW of the renewable generation output (when it is near max output) to other hours when the generation is less than 200 MW, enabling a higher utilization of the transmission line over all hours and reducing or avoiding the need to curtail renewable generation when output exceeds the line's rating. Determining the optimal combinations of wind, solar, and storage at various points of a transmission-constrained system will depend on the relative costs and other considerations of each resource, but this approach can be a useful tool if seeking to increase renewable energy development in an area while maintaining existing transmission system limits.

Utility-scale storage resources such as batteries could also be located on the distribution system, where they could be charged during times outside of when transmission constraints may prevent bulk generation from being delivered to loads. Charging during non-constrained times would allow energy to be where it needs to be when it needs to be there to serve load, and mitigate the need for new transmission upgrades or new transmission lines.

2.4.3 New Transmission Proposals in Oregon

There are currently two proposed transmission projects to build new lines that are linked to the state of Oregon and are in different stages of development that have the potential to be beneficial for renewable energy development in Oregon and the Northwest as a whole. They are discussed in more detail below.

2.4.3.1 Boardman to Hemingway

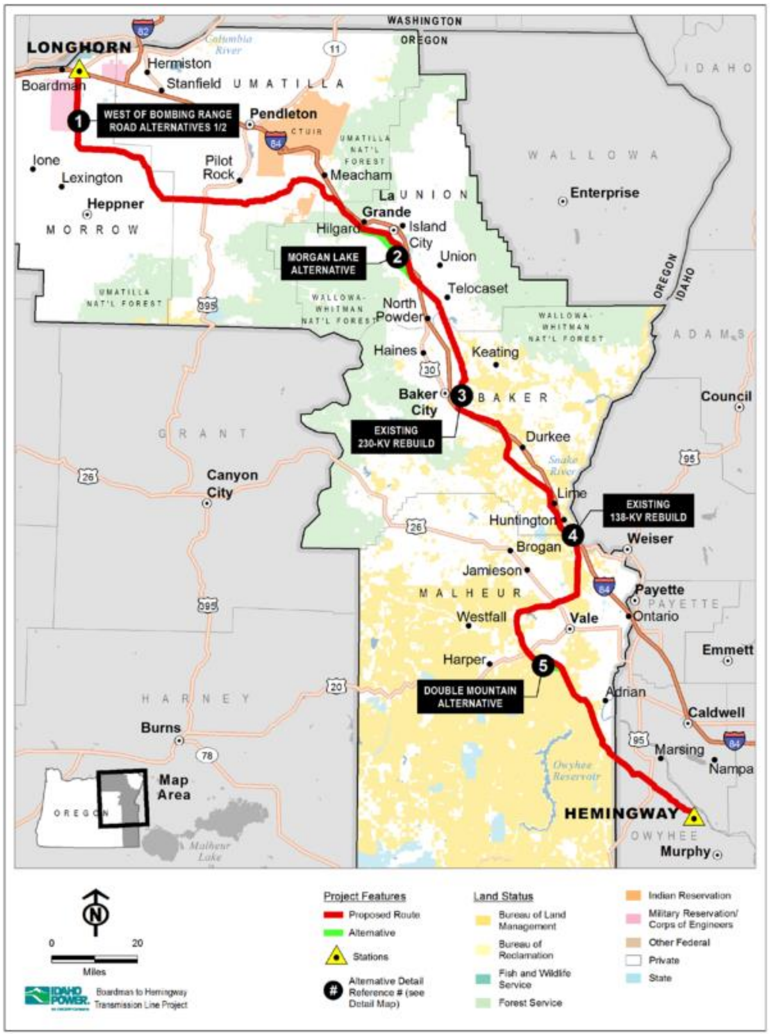
The Boardman to Hemingway (B2H) Transmission Line is a proposed 290-mile 500 kV line that is expected to add roughly 1,000 MW of transmission capacity between the proposed Longhorn Substation along the Columbia River near Boardman, Oregon to the existing Hemingway Substation near Melba in southwestern Idaho. The proposed B2H route is shown in Figure 2-9 below. Idaho Power, a public utility that operates in Oregon and Idaho is leading the federal, state and local permitting efforts. Idaho Power has selected B2H as a lowest cost, least-risk option for meeting projected customer demand.[24] B2H has had preliminary co-ownership interest from BPA (24 percent), PacifiCorp (55 percent), and Idaho Power (21 percent).[25] To date, these percentages of co-ownership correspond with each entities capacity needs, however, based on information under review by the Oregon Public Utility Commission (OPUC) these B2H co-participants are exploring several alternative asset, service, and ownership arrangements.[26]

[24] Boardman to Hemingway Transmission Line Project. About the Project. Available at: https://www.boardmantohemingway.com/purpose-and-need

[25] Ibid.

[26] Docket No. LC 74. Update regarding Boardman to Hemingway Transmission Project. Available at: https://edocs.puc.state.or.us/efdocs/HAO/lc74hao112918.pdf.

Figure 2-9. Map of the proposed Boardman to Hemingway Transmission Line project.



The B2H website[27] indicates in its timeline that Idaho Power submitted a Notice of Intent (NOI) to submit an Application for a Site Certificate (ASC) to ODOE Siting Division staff to EFSC in August 2008, but this application was withdrawn based on negative feedback on the original proposed location being on active farmland. Following the withdrawal, Idaho Power went through a Community Advisory Process to seek input on relocating the line. This eventually led to a resubmittal of the NOI in July 2010.[28] Initially, Idaho Power proposed to go through the NEPA process and the EFSC process simultaneously. However, in 2013 it put the EFSC application process on hold and resumed in 2017 after completing the NEPA process, which determined final route on federally owned lands. As a result, Idaho Power finally submitted its completed ASC to EFSC on September 28, 2018.[29] The B2H project is a reflection of how complicated and time-consuming it can be for transmission developers to plan and complete a permitting application for a new

[27] Boardman to Hemingway Transmission Line Project. Project History. Available at: https://www.boardmantohemingway.com/project-history

[28] Boardman to Hemingway Transmission Line. Oregon Department of Energy. Available at: https://www.oregon.gov/energy/facilities-safety/facilities/Pages/B2H.aspx

[29] Ibid.

transmission line in a new corridor across privately owned and federally managed lands. The proposed and alternative routes submitted to EFSC reflect transmission line siting constraints and opportunities. For instance, the B2H transmission line is proposed to be co-located within some existing utility corridors, and avoids, minimizes, and mitigates impacts to Sage Grouse habitat, agricultural lands, and protected areas.[30] The current status of the project is "Proposed", as it is in the "contested case" phase of the EFSC process. The Proposed Order, under review in the contested case, continues to recommend the EFSC approve the ASC and grant a Site Certificate.[31]

Idaho Power's schedule expects permitting to be finalized in 2022 and with the planned in-service date of 2026 or later. If Idaho Power receives the EFSC Site Certificate, it must then file for a Certificate of Public Convenience and Necessity (CPCN) in both Oregon and Idaho, if landowner agreements cannot be met. If Idaho Power receives the final state approvals and meets federal and state preconstruction requirements, the B2H transmission line would enhance the northwest regional transmission capacity. B2H would support renewable energy development in northeastern Oregon and in southwestern Idaho and could open up the delivery of renewable energy generation between these two regions and the areas between them.

2.4.3.2 Cascades Renewable Transmission Project

The Cascade Renewable Transmission System (Cascade Project) is a conceptual transmission project. It is designed as a 90-mile 1,100 MW high-voltage DC line that is expected to connect between The Dalles and the greater Portland area: shown in Figure 2-10.

Figure 2-10. Map of the proposed Cascade Renewable Transmission Project.

[30] B2H Proposed Order on ASC, Sections IV.E. Land Use, IV.F. Protected Areas, and IV.H. Fish and Wildlife Habitat; https://www.oregon.gov/energy/facilities-safety/facilities/Facilities%20library/2020-07-02-B2H-PO-ASC.pdf

[31] Boardman to Hemingway Transmission Line. Oregon Department of Energy. Available at: https://www.oregon.gov/energy/facilities-safety/facilities/Pages/B2H.aspx.

PowerBridge is the proposed developer of the Cascade Project. PowerBridge is a non-utility transmission developer and operator. An interesting feature of the project is that it will be installed almost entirely under the Columbia River and the developers believe that it “will have no visual impact on or disturbance to the natural habitat or populated areas.”[32] Because the environmental impact assessment portion of the approval process for new transmission lines is significant, it seems prudent for transmission planners and developers to consider transmission lines that could have less environmental impacts. Additionally, with the growing risk of wildfire events and winter storms, evaluating a path with less risk of being exposed to these types of events also seems prudent. However, it is uncertain whether this approach will actually result in less negative environmental impacts than terrestrial projects, because the area of the Columbia River the line is expected to run through includes federally listed fish species and, potentially, culturally sensitive fishing areas of some of the Pacific Northwest’s Indigenous Tribes.

Though PowerBridge has not submitted any listed NEPA or EFSC applications, it has initiated its Phase 1 Path Rating and Project Coordination with the Western Electricity Coordinating Council (WECC) and is working with NorthernGrid to be included in the first NorthernGrid Regional Transmission Plan. With an expected commercial operation start date in early 2026, it seems the project owners believe that this project will go through the approval process a lot faster than is typical for transmission projects in the West. Only time will tell if this may happen as envisioned.

With the potential benefits of delivering generation from east to west across the Cascades this project would likely provide significant support for Oregon’s and Washington’s long-term energy goals, especially given the limited available transmission capacity across BPA’s West of Cascades South path.

[32] Cascade Renewable Transmission Project. Overview. Available at https://www.cascaderenewable.com/project/overview

3 Renewable Potential Assessment

3.1 Purpose

The first objective this study sought to achieve was to quantify the potential of renewable energy resources that could be developed in Oregon. To achieve this objective required answering a few key questions:

- What renewable energy technologies can be considered as viable for development in Oregon over the next fifteen years?
- What are the quantities of the resources that fall under these technological classifications?
- What are the performance characteristics of these resources?
- Are there constraints on the development of the full potential of these resources?
- Are these constraints explicit or are they more nuanced?

The renewable energy potential assessment was performed to answer all these questions. The results of this analysis are used in the Market Assessment, and also served as inputs for some of the other broader ORESA project assessments, particularly the ORESA mapping and reporting tool.

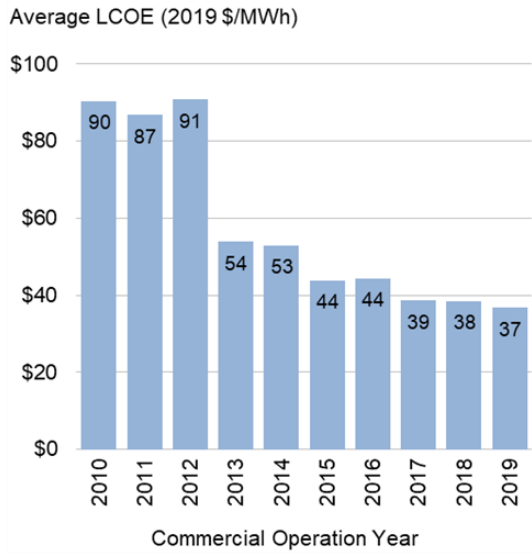
3.2 Options for Renewable Energy Development in Oregon

This study focuses on characterizing a range technology types as options for renewable energy development in Oregon over the next fifteen years. The study examines a combination of currently commercially available renewable energy technologies and some pre-commercial technologies.

3.2.1.1 Onshore Wind

A significant amount of onshore wind development has occurred in Oregon since the 2001 construction of the state's first facility. Onshore wind is currently the second-largest zero-carbon generating resource in the state (behind hydropower), accounting for 11.6 percent of Oregon's electricity generation in 2018 and totaling about 3,400 MW of operating generation capacity today.[33] As is shown in Figure 3-1, between 2010 and 2019, in the non-CAISO regions of the Western Interconnection, the levelized cost of wind energy reduced by 59 percent in real terms from $90 per MWh to $37 per MWh (in 2019 dollars).[34] This has likely been driven primarily by the reduction in installed costs (43 percent in real terms) over the period. Federal tax incentives like the production tax credit (PTC) have also been key in reducing the installation costs. In addition to the downward trajectory of the capital costs, a few technology design trends are also likely responsible for this significant reduction in the levelized energy costs and are significant markers of future innovation, shown in Figure 3-2:

Figure 3-1. Historical trends in onshore wind levelized cost of energy.



Data based on LBNL's Wind Energy Technology Data 2020 Update. Statistics represent installations in the Western Interconnection outside of the CAISO jurisdiction

+ **Increase in average hub height:** developers have continued to improve on the average hub-heights of installed facilities. The hub is the mount which connects the turbine blades to the nacelle (which contains the generator). Typically, the higher you go off the ground surface, the stronger the wind blows. So, the higher the hub, the more access the turbines have to faster windspeeds. Thus, with increased average hub heights, has also come increased performance.

+ **Increase in average rotor diameter:** another technology component that has seen an upward trend is the rotor diameter, increasing at a pace that has surpassed the hub height increase. The rotor diameter is diameter of the circle formed by the turbine blades and determines the swept area of the turbine. The greater the rotor diameter, the more wind the turbines are able to catch. This higher the hub is, the longer the individual blades can be. So, when you combine the higher hub heights with the increase in average rotor diameter, it translates to even better overall performance.

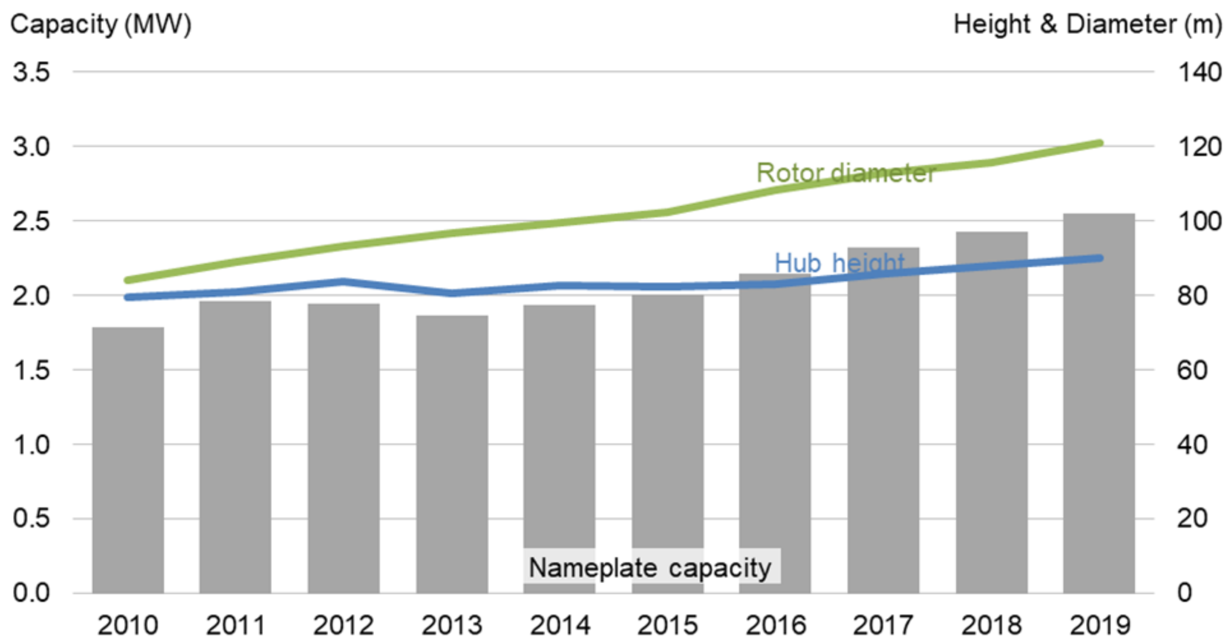
+ **Increase in average nameplate capacity:** the nameplate capacity represents the maximum output a turbine can generate. As turbines have gotten bigger, so have their outputs. One of the benefits of larger average turbines include better land use intensity, because the same land area is being

[33] 2020 Biennial Energy Report Technology Reviews. Oregon Department of Energy. November 2020, Available at: https://www.oregon.gov/energy/Data-and-Reports/Documents/2020-BER-Technology-Resource-Reviews.pdf

[34] Lawrence Berkeley National Laboratory, Wind Energy Technology Data Update: 2020 Edition. August 2020. Available at: https://emp.lbl.gov/wind-technologies-market-report

used to generate more energy. It also translates to needing fewer turbines on wind farms, leading to cheaper total costs.

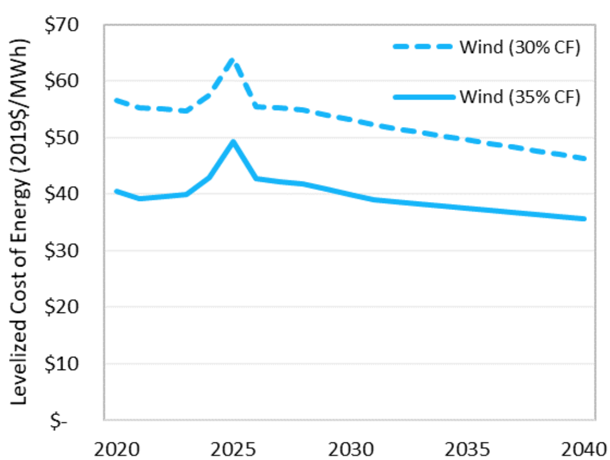
Figure 3-2. Key historical onshore wind technology trends.



Data based on LBNL's Wind Energy Technology Data 2020 Update. Statistics represent all installations across continental United States.

These technological innovations, and their resultant improvements in cost and performance, are projected to continue into the future. Figure 3-3 shows projections for the levelized cost of energy for generic wind resources at different levels of performance, based on data from the National Renewable Energy Laboratory's (NREL) 2020 Annual Technology Baseline (ATB)[35]. With Oregon's vast resource potential, particularly East of the Cascades, it is important to understand what other areas of the state onshore wind might be developed, beyond the Columbia River Gorge area where considerable deployment is already occurring.

Figure 3-3. Projected levelized cost of energy for new onshore wind resources.

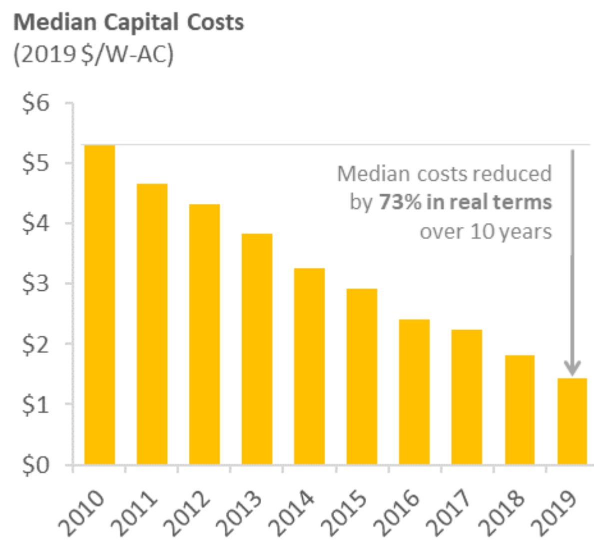


[35] 2020 Annual Technology Baseline, National Renewable Energy Laboratory (NREL). https://atb.nrel.gov/

3.2.1.2 Solar PV (Utility Scale)

Historically, renewable energy development in Oregon has not seen significant deployment of solar PV technologies. Over the past decade, the cost of developing solar PV at a utility scale has declined precipitously. Similar to wind, the role of federal tax incentives, in this case the investment tax credit (ITC), have been instrumental in reducing installation costs. As shown in Figure 3-4, between 2010 and 2019, the median cost of new projects in the United States declined by 73 percent in real terms, from $5.32 to $1.44/W-AC (in 2019 dollars). With this cost decline, deployment of solar PV has accelerated, and the lower costs have opened up new geographies where lower insolation would not previously have allowed economic development. Such is the case in Oregon and the broader Northwest, where interest in solar PV has grown considerably among utilities and planners. There are currently about 590 MW of solar PV generators (utility-scale, commercial, and residential) operating in Oregon today, but considerably larger amounts of capacity have applied for interconnection.

Figure 3-4. Historical trends in solar PV capital costs.



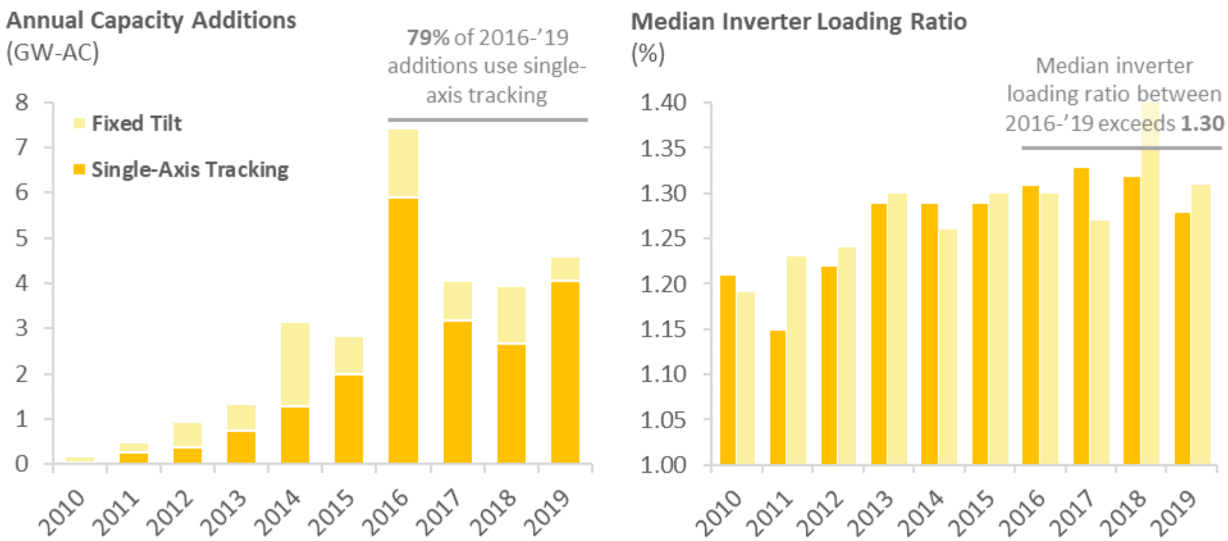
Data based on LBNL's Utility Scale Solar 2020 Data Update. Statistics represent all installations across continental United States.

In addition to the precipitous decline in capital costs, several other trends in plant design and configuration are notable (shown in Figure 3-5):

+ **Increasing use of single-axis tracking:** utilities and developers have increasingly opted for plant configurations using single-axis tracking technologies over fixed tilt configurations. Tracking configurations produce relatively higher capacity factors, which in most situations more than offsets the increased capital cost for the required mechanical systems.
+ **Higher inverter loading ratios (ILRs):** the ILR of a solar PV plant represents the ratio between the rated DC capacity of the solar PV modules and the AC capacity of the inverter that interconnects to the grid. As the cost of modules has declined significantly, oversizing of DC capacity relative to the rating of the inverter has become relatively common, allowing developers to maximize output for a specified interconnection capacity. Today, many plants are installed with ILRs of 1.30 or greater.
+ **More frequent hybridization with battery storage:** with the emergence of grid-scale lithium-ion batteries as a commercially available form of energy storage, many developers have begun to pair solar PV generators directly with on-site batteries. Storage that is collocated with solar PV is eligible for the federal Investment Tax Credit (ITC), which offsets some of its costs, but it also provides operational benefits, allowing storage of daytime solar production for dispatch in the evening or overnight (during net peak periods when the value of energy is often highest) and enabling more

efficient use of the transmission system and reduce the reliance of solar PV facilities on other generating resources to balance the variability of their generation.

Figure 3-5. Key trends in solar PV plant design over time.

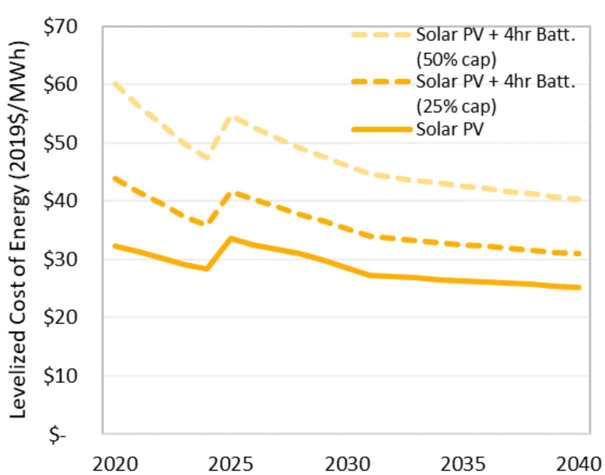


Data based on LBNL's Utility Scale Solar 2020 Data Update. Statistics represent all installations across continental United States.

Today, low resource costs, locational and transmission-related versatility (utility-scale connected to bulk transmission or distributed resources located close to load), significant resource potential, and the maturity of the technology make solar PV a prime candidate for consideration in analyses of renewable resources for development to meet long-term energy goals.

Going forward, costs of solar PV (including those paired with energy storage) resources are expected to continue to decline due to continued technology improvements and innovation. Figure 3-6 shows the projected levelized cost of energy produced by a representative new utility-scale solar PV installation based on public projections provided by NREL's 2020 ATB,[36] as well as levelized costs for that same plant with several configurations of hybridized energy storage costs from the Lazard Levelized Cost of Storage (LCOS) 5.0. [37] These levelized cost trajectories assume that the federal Investment Tax Credit (ITC) steps down according to the current tax

Figure 3-6. Projected levelized cost of energy for generic solar PV resources.



[36] 2020 Annual Technology Baseline, National Renewable Energy Laboratory (NREL). https://atb.nrel.gov/

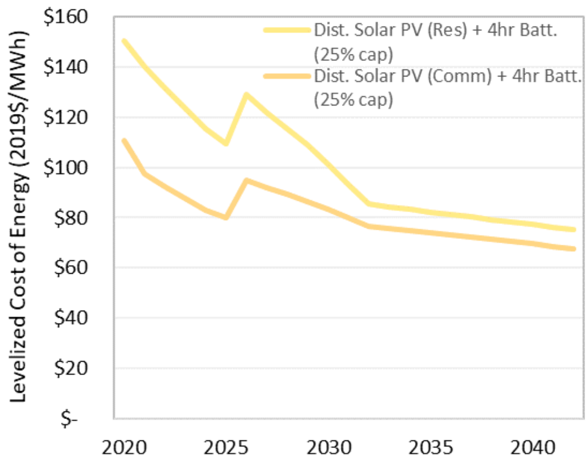
[37] Levelized Cost of Storage 5.0, 2019. Lazard. https://www.lazard.com/perspective/lcoe2019

code, which is the driver of the increase in levelized costs in the mid-2020s in spite of continued and sustained reductions in capital costs.

3.2.1.3 Solar PV (Distributed)

For areas with transmission constraints, particularly load centers with concentrated load pockets, distributed solar resources provide an option for development of resources closer to loads without the concern of bulk-transmission access. About a quarter of Oregon's solar capacity is from distributed solar resources. Because of their smaller sizes, these resources are more practical for siting in areas where the available land cannot accommodate utility-scale. However, there are trade-offs that come with this benefit: higher resource costs (especially for rooftop solar) because the smaller sized projects do not benefit from the same economies of scale of utility-scale resources; and lower performance (especially for rooftop solar) because they typically utilize fixed-tilt technologies and have lower ILRs. Figure 3-7 shows the projected levelized cost of energy for two kinds of generic distributed solar PV plants hybridized with 4-hour storage at 25 percent capacity sizing. The cost of the distributed solar are from the 2020 NREL ATB[38] while the storage costs are from the LCOS 5.0. [39]

Figure 3-7. Project levelized cost of energy for generic distributed solar PV resources.

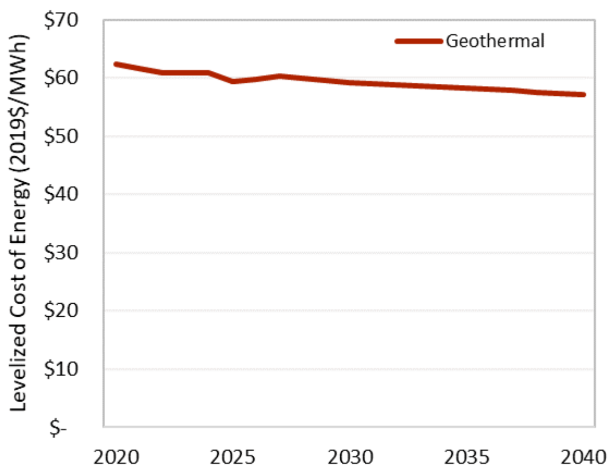


3.2.1.4 Geothermal

Geothermal generation utilizes naturally occurring heat, generated continuously within the earth, to create electricity (and provide heating and cooling for buildings and industrial processes). Because the heat that is used in the thermal process is from a continuous source, electricity generated from geothermal resources has the dual benefit of being renewable and providing firm generation.

There has not been major development of geothermal resources in Oregon. There are only 3 geothermal facilities in Oregon, and only 2 of them are currently operational, representing g a total nameplate capacity of 24 MW. This is partly due to

Figure 3-8. Projected levelized cost of energy for generic geothermal resources.



[38] 2020 Annual Technology Baseline, National Renewable Energy Laboratory (NREL). https://atb.nrel.gov/

[39] Levelized Cost of Storage 5.0, 2019. Lazard. https://www.lazard.com/perspective/lcoe2019

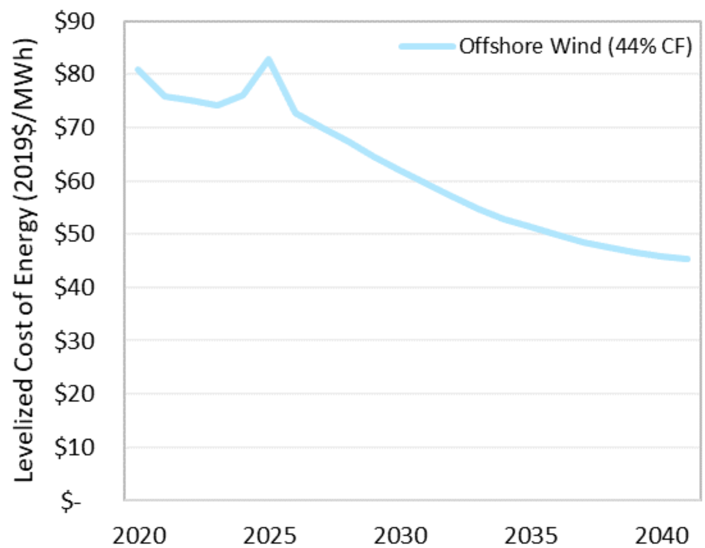
the fact that developing geothermal resources can be a lengthy and uncertain process with high capital and financing costs. As shown in Figure 3-8, the projections for the levelized cost of energy (also based on the NREL's 2020 ATB[40]) remains relatively high compared to onshore wind and solar PV. But, because of the clean and reliable attributes of the resource, it is important that any study analyzing the potential renewable energy development in Oregon in the next fifteen years considers the viability of geothermal generation.

3.2.1.5 Offshore wind

Development of offshore wind off the coast of Oregon presents another opportunity for renewable resource development. In the last 5 years, the offshore wind industry has experienced renewed interest due to breakthroughs in technological innovation on the global scene with turbine sizing, wind speed characterization and subsurface technologies. In the US, increased lease auctions activity on the East Coast, and call area characterization on the West Coast has created an interest among developers and resource planning experts.

Specific to Oregon, recent studies on the potential for jobs and economics,[41] the resource cost and potential,[42] and the benefits to the grid[43] have shown that there is interest from federal, state, and local agencies, research organizations, and developers in understanding the role offshore wind can play in Oregon's long-term energy goals. Due to the depths of the subsurface of the Pacific offshore continental shelf, only floating-bottom offshore wind technology is viable for deployment. This is different from the Atlantic coast where fixed-bottom technologies can also be deployed. Currently, there are no utility-scale floating-bottom offshore wind facilities operational in the United States.

Figure 3-9. Projected levelized cost of energy for Oregon offshore wind resources.



[40] 2020 Annual Technology Baseline, National Renewable Energy Laboratory (NREL). https://atb.nrel.gov/

[41] Jimenez et al, "Floating Offshore Wind in Oregon: Potential for Jobs and Economic Impacts in Oregon Coastal Counties from Two Future Scenarios" National Renewable Energy Laboratory and Bureau of Ocean Energy Management. July 2016. Available at:

https://www.nrel.gov/docs/fy16osti/65432.pdf

[42] Musial et al. "Oregon Offshore Wind Site Feasibility and Cost Study" National Renewable Energy Laboratory. October 2019. Available at:

https://www.nrel.gov/docs/fy20osti/74597.pdf

[43] Douville et al. "Exploring the Grid Value Potential of Offshore Wind Energy in Oregon" May 2020. Available at:

https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-29935.pdf

As it has not yet been deployed widely in the United States, offshore wind is still considered an emerging technology. As a result, its costs – both current and future – are subject to considerable uncertainty. However, experts nonetheless identify significant opportunities for future cost reductions; as shown in Figure 3-9, NREL's ATB projects significant declines in the going forward costs of floating offshore wind resources over the next 20 years.[44]

3.2.1.6 Other Technologies

The renewable energy potential assessment also examined the available potential for wave and tidal generation; however, the resource was not modeled in the renewable energy market assessment analysis.

3.3 Geospatial Resource Potential Analysis

3.3.1 Overview

This study utilizes publicly available LBNL MAPRE[45] tools and the ORB framework to quantify the renewable energy resource potential in the state of Oregon in a geospatially explicit manner. The analysis relies on several foundational datasets developed by NREL as the basis for identifying and characterizing renewable energy potential and resource quality within the state, including:

- NREL's Renewable Energy Potential Model[46] for wind resources;
- NREL's System Advisor Model (SAM)[47] for solar PV resources; and
- The Renewable Energy Transmission Initiative, Phase 1A report[48] for geothermal resources.[49]

These geospatial datasets, used in conjunction with a large number of additional layers representing various potential criteria that may prohibit or present challenges to renewable energy development, provide the basis for the quantification of technical potential for resource development in the state.

To identify potential resources, the state is divided into Candidate Project Areas (CPAs) using a 0.5 km by 0.5 km grid throughout the study area. For each Candidate Project Area, the following location-specific attributes are calculated: technology (solar, wind, offshore wind, geothermal, bioenergy, wave), nameplate capacity (MW), estimated annual generation (MWh), capital cost ($), distance to nearest existing

[44] Musial et al. "Oregon Offshore Wind Site Feasibility and Cost Study" National Renewable Energy Laboratory. October 2019. Available at:

https://www.nrel.gov/docs/fy20osti/74597.pdf

[45] Lawrence Berkeley National Lab Multi-criteria Analysis for Planning Renewable Energy (MAPRE) https://mapre.lbl.gov/

[46] Maclaurin, G., Lopez, A., Grue, N., Buster, G., Rossol, M., & Spencer, R. (2020). Open Source reV (The Renewable Energy Potential Model) (No. Open Source reV). National Renewable Energy Lab.(NREL), Golden, CO (United States).

[47] Blair et al. "System Advisor Model (SAM) General Description (Version 2017.9.5)." National Renewable Energy Lab (NREL), 2018.

[48] "Renewable Energy Transmission Initiative, Phase 1A" Black & Veatch Project: 149148. Prepared for RETI Coordinating Committee, RETI Stakeholder Steering Committee, University of California, Office of the President, California Institute for Energy and the Environment. 2009

[49]

transmission infrastructure (km), slope (deg), population density (person/km2), transmission zone, electric retail service territory (name), and distance to nearest load center (U.S. Census defined urban area) (km).

For the purposes of understanding the technical potential of renewable resource development in the state of Oregon, this study uses two land use screens, each of which combined a number of geospatial datasets:

1. "Siting Level 1," which excludes lands not suitable for development for techno-economic reasons as well as land where development is legally prohibited; and
2. "Siting Level 2," which, in addition to the screens included above, excludes military lands and a number of other sensitive areas.

"Siting Level 1" is best characterized as an estimate of raw technical potential for renewable energy development within the state, but because it includes only technoeconomic screens and legal prohibitions, it includes many areas where development of renewable resources may face significant challenges that would arise in the siting and permitting processes. In contrast, while the additional criteria included in Siting Level 2 present challenges to development, it is worth noting that many of them do not explicitly prohibit renewable energy development a priori.

The spatial analysis for developing these screens was completed through several iterations of engagement involving ODOE and its ORESA partners, the military, and other renewable energy industry stakeholders. The iterative process involved several revisions to calibrate the geographic screens in such a way that the inputs to be used in the modeling for the Market Assessment analysis would conform with industry practice. The decision to represent the additional exclusions in Siting Level 2 in a binary form for the purpose of the modeling was not intended to suggest these areas are not necessarily suitable for development; rather, it was a convention chosen in the modeling to narrow the study's focus to areas where development may face fewer challenges. Ultimately, representing them this way would still enable the analysis to answer one of the core questions of the Market Assessment portion of this study – what are the quantity of, type of, and location where renewable energy resources might be developed. Thus, the Siting Level 2 screens were used as a proxy for how renewable energy developers might make project development decisions to not develop renewable energy projects in certain areas in order to avoid the increased time, cost, and risk associated with those areas, even if development in those areas was not excluded.

For Siting Level 2, these less attractive areas for development due to social or environmental sensitivities are represented by a group of GIS datasets called "less attractive" geographic screens. A summary of assumptions used in the Siting Levels 1 and 2 supply curves is presented in Table 3-1. A more comprehensive list of site suitability input assumptions and data sources is provided in Appendix 7.2.

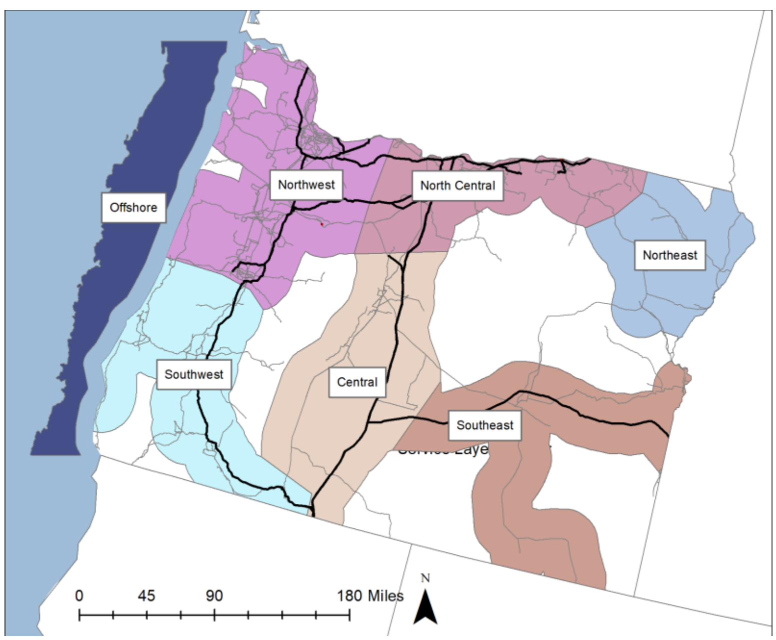
Table 3-1: Siting level assumptions used in resource potential assessment.

	Siting Level 1	Siting Level 2
Techno-economic screens	Remove urban areas, water bodies, highways, railroads, submarine cables, 100-yr floodplain, mines, airports, forested areas	
Slope	Remove >= 16 degrees	

Population Density	Solar: Remove >=112 person/km2 Wind: Remove >=58 person/km2	
Protected Areas	Exclude National Parks, National Wildlife Refuges, Wilderness Areas, State Parks, State Natural Areas, Natural Heritage Areas (registered & dedicated, OPRD), State Estuarine Research Reserves (South Slough, DSL), National Wild and Scenic Rivers, National Historic Landmarks, National Natural Landmarks, BLM ROW Exclusions, BLM Visual Resource Management I areas (VRM I)	
Sensitive habitats	Available for portfolio development	Remove
Indigenous people's lands	Available for portfolio development	Available for portfolio development
Prime Farmland	Available for portfolio development	Remove for solar
Military Areas	Available for portfolio development	Remove for both solar and wind

For the purposes of this study, the state is divided into seven transmission zones. The boundaries for these zones were developed in consultation with BPA to reflect the most significant existing transmission constraints within the state. Each resource is mapped to a transmission zone, allowing for a more detailed assessment of the transmission implications of different resource options in the Market Assessment. The transmission zones used in this study are summarized in Figure 3-10 and are discussed in more detail in subsequent sections.

Figure 3-10. Transmission zones used in this study.

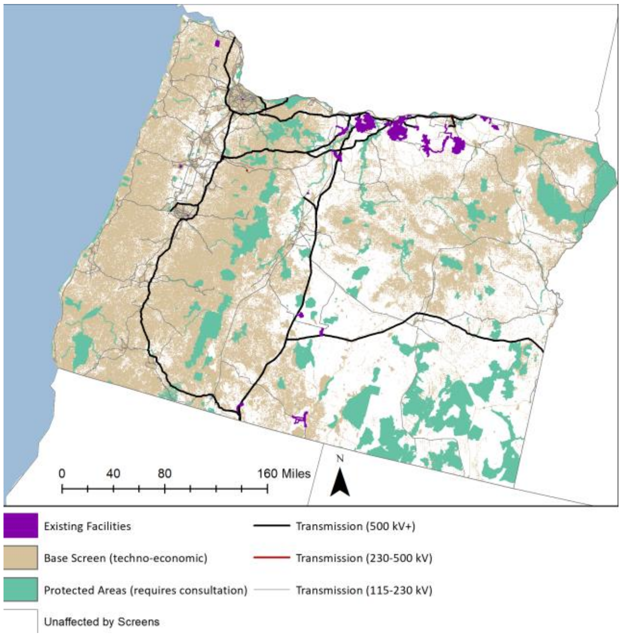


3.3.2 Siting Level 1

The first step in the identification of Candidate Project Areas is the elimination of areas unsuitable for utility-scale renewable energy facility development, based on a set of techno-economic and social criteria generally established in the literature.[50,51,52,53] These criteria are represented in the spatial analysis by GIS data layers called techno-economic screens. Protected areas are included in the group of GIS datasets called "base" geographic screens, along with techno-economic geographic screens.

Under Siting Level 1, all technically viable areas (outside of techno-economic screens and outside of protected areas) are included as part of the resource potential in the supply curve, regardless of the presence of social or environmental sensitivities which may require additional consultation.

Figure 3-11. Land use screens considered in development of Siting Level 1 potential.



As shown above, a significant amount of land within the state is unsuitable for renewable energy development on the basis of technoeconomic screens (shown in tan). In particular, most of the western half of the state is excluded from consideration in this study due to unsuitable terrain, proximity to urban areas, and forested land cover. The technoeconomic screens also eliminate a large amount of land in the northeastern portion of the state, where forests and steeply sloped areas are prevalent. The protected areas (shown in green) result in further exclusions – principally in the Cascades (state natural and heritage areas) and in the southeast (Wilderness Study Areas, BLM Right of Way Exclusions, Sage Grouse Priority Habitat Management Areas).

Despite the significance of the Siting Level 1 screens, the raw technical potential identified in Siting Level 1 is very large, including 4,000 GW of solar and 200 GW of onshore wind resources. These values are

50 Anthony Lopez, Billy Roberts, Donna Heimiller, and Nate Blair, and Gian Porro. "U.S. Renewable Energy Technical Potentials: A GIS-Based Analysis," 2012. https://www.nrel.gov/docs/fy12osti/51946.pdf.

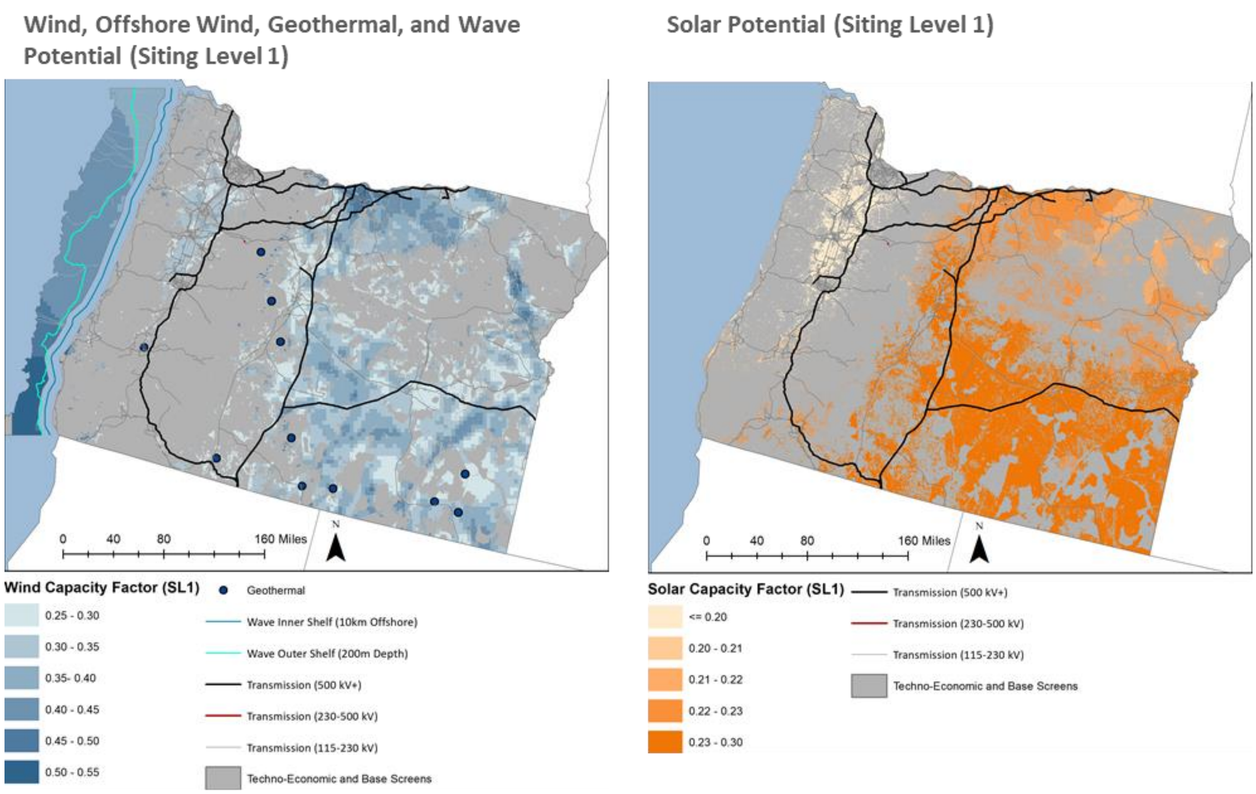
51 Western Electricity Coordinating Council and ICF. "WECC Environmental Data Viewer and Risk Mapping," n.d. https://ecosystems.azurewebsites.net/WECC/Environmental/.

52 RETI Coordinating Committee, RETI Stakeholder Steering Committee. "Renewable Energy Transmission Initiative Phase 1B Final Report." California Energy Commission, January 2009.

53 Pletka, Ryan, and Joshua Finn. "Western Renewable Energy Zones, Phase 1: QRA Identification Technical Report." Black & Veatch and National Renewable Energy Laboratory, 2009. https://www.nrel.gov/docs/fy10osti/46877.pdf.

consistent with other studies of renewable energy technical potential in the Pacific Northwest. The remaining areas of resource potential after Siting Level 1 screens are applied are shown in Figure 3-12.

Figure 3-12. Oregon wind (onshore and offshore), geothermal and solar technical potential under Siting Level



Note: This map does not capture all offshore military training and operating areas

3.3.3 Siting Level 2

The next step is to identify areas where additional state or federal consultation is likely to be required for the siting of utility-scale renewable energy facilities (such as additional protected areas, and areas less attractive for development due to social or environmental sensitivities).

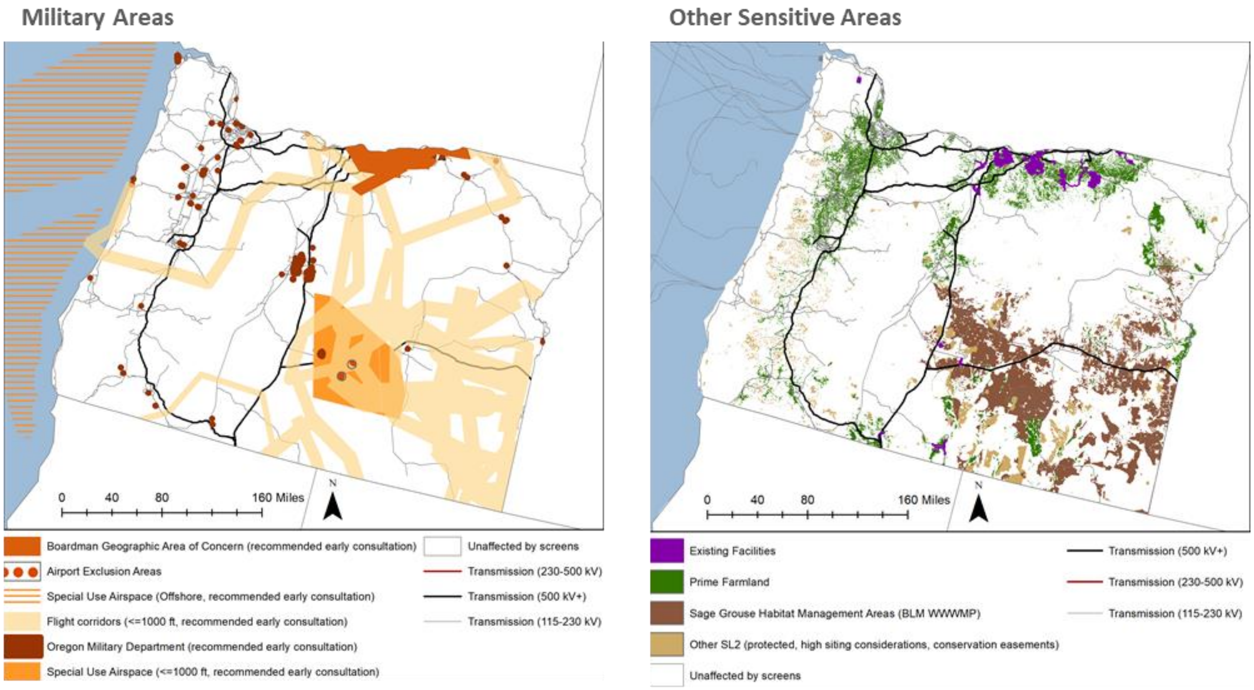
Under Siting Level 2, areas with known location-specific social and environmental sensitivities have been removed from the resource potential in the supply curve. One of the additional screens incorporated in Siting Level 2 was military areas. Although there is no outright rule preventing utility scale renewable energy development in these areas, early consultation is recommended, and thus it was deemed important to show these areas on the map. For military training and operating areas both onshore and offshore, early consultation by project developers is recommended for wind, solar and transmission proposals. Early coordination with the Northwest DoD Regional Coordination Team (NW DoD RCT) represents the first step in this ad hoc consultation process for renewable energy projects. The NW DoD RCT will provide guidance to stakeholders regarding subsequent coordination and consultations, including coordination with the Military Aviation and Installation Assurance Siting Clearinghouse and the FAA Obstruction

Evaluation/Airport Airspace Analysis process.[54] However, for the purpose of this study, specific military data layers and consultation with the DOD were used to inform the military-related geographic screens.

Figure 3-13 also highlights the other sensitive areas of the state affected by the criteria applied in Siting Level 2. Notable layers include prime farmland (green), where a 2019 LCDC ruling has restricted development of solar PV; sage grouse priority habitat management areas and general habitat management areas (dark brown), treated as a screen or "high-level siting considerations" (HLSC) in the BLM West-Wide Wind Mapping Project (BLM WWWMP); and a variety of other criteria (designated Threatened and Endangered Species Critical Habitat, BLM-designated Areas of Critical Environmental Concern, BLM Visual Resource Management Areas, to name a few). For military training, testing, and operating areas including those within the Boardman Geographic Area of Concern, and flight corridors with aircraft travel occurring at or below 1000 ft, early consultation is recommended to assess potential affects due to scenarios such as radar interference from wind facilities; low-level flight obstructions from tall structures such as wind turbines; electromagnetic interference from high-voltage transmission lines; and glint and glare from solar photovoltaic arrays. Much of the offshore wind study area, as well as some onshore areas, are potentially affected by low level training and operating airspace, where aircraft travel occurs at or below 1000 ft above ground level, reducing the available area considered in this analysis and the resource potential available for selection in the Market Analysis. The military screened areas do not capture all offshore military training and operating areas including surface and subsurface training and operating areas. For actual siting of projects within those screened areas, early consultation is recommended.

[54] 10 USC 183a: Military Aviation and Installation Assurance Clearinghouse for review of mission obstructions. Dec 2020. https://uscode.house.gov/view.xhtml?req=(title:10%20section:183a%20edition:prelim)%20OR%20(granuleid:USC-prelim-title10-section183a)&f=treesort&edition=prelim&num=0&jumpTo=true

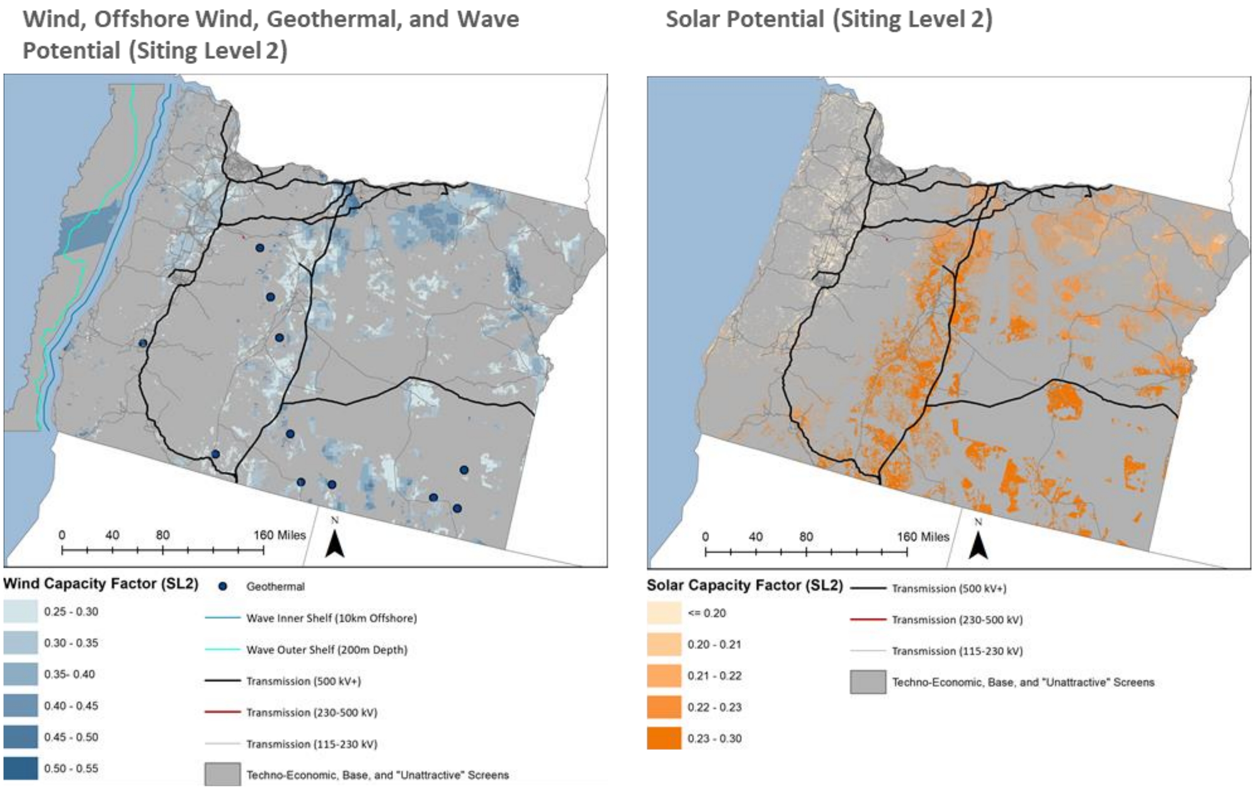
Figure 3-13. Other land use screens considered in development of Siting Level 2 potential.



Note: This map does not capture all offshore military training and operating areas

Figure 3-14 shows the remaining wind and solar potential in the state once the additional screens included in Siting Level 2 are applied. Despite the screening of significant land area, the technical resource potential still far exceeds the plausible needs of the state. This renewable energy potential does not take into account some of the challenges described by renewable developers in the Industry Assessment related to timelines, cost, and other development challenges which make it difficult to actually get renewable energy projects built in the state. What follows from this observation is that these factors are likely to play a significant role in determining where, when, and how renewables are developed within the state and the region as a whole.

Figure 3-14. Oregon wind (onshore and offshore), geothermal & solar resource potential under Siting Level 2.



Note: This map does not capture all offshore military training and operating areas

A final adjustment to the technical potential based on feedback from stakeholders: while some wind resource potential in the Northwest zone was not screened out by the GIS data layers, stakeholders pointed to the lack of commercial interest as a sign of the lack of viability. For the purpose of this study, wind resources in the Northwest zone are not considered. It is worth reiterating that the Siting Level 2 screens are not intended to disfavor or preclude these areas from renewable energy development, rather they are meant to reflect areas that require additional permitting requirements or consultation and so are potentially to be higher risk for developers or of lower interest.

Table 3-2 below summarizes key takeaways from the resource potential analysis.

Table 3-2. Results of resource potential assessment; supply curve inputs summary for Market Assessment.

	Solar	Wind	Offshore Wind
SL1 Resource Potential (GW)	4,000	200	175
SL2 Resource Potential (GW)	1,600	100	29

Transmission zone with majority of resource	Central and Southeast Oregon (highest quantity and solar irradiance)	North Central Oregon (highest wind speeds) Central and Southeast Oregon (highest quantity)	South Western Oregon (highest wind speeds) North Western Oregon (fewer siting considerations especially airspace)
Mean capacity factor (%)	22%	28%	43%
Mean distance to nearest existing substation > 161 kV (km)	21	18	47
Majority terrain type	Rolling Hills (2-8% Slope) Mean slope = 5%	Rolling Hills (2-8% Slope) Mean slope = 8%	Mean sea floor depth = 500 m (Range: 50-1300 m)

Distributed Solar

A detailed geospatial assessment of the potential for distributed solar PV resources is beyond the scope of this study; however, prior analyses of this topic have gone into significant depth to quantify the technical potential of this resource in a geospatially explicit manner. A 2016 study completed by NREL[55] identified 14.1 GW of technical potential in the state of Oregon, which would produce enough energy annually to satisfy approximately one third of Oregon's retail sales. This relative abundance suggests that for this resource, like utility-scale resources discussed above, limited technical potential will not be a barrier to development. And unlike utility-scale resources discussed above, transmission and siting and permitting considerations are not as likely to be barriers in determining where, when, and how distributed solar is developed within the state.

[55] Gagnon, P., et al. "Rooftop Solar Photovoltaic Technical Potential in the United States: A Detailed Assessment." NREL/TP-6A20-65298. Golden, CO. National Renewable Energy Laboratory. January 2016. Available at: https://www.nrel.gov/docs/fy16osti/65298.pdf

4 Industry Assessment

4.1 Purpose

As discussed in Section 1, one of the goals of this study is to support future renewable energy development in Oregon over the next fifteen years by conveying the opportunities and challenges of future development that exist from the perspectives of different groups in the renewable energy development industry; including state, local, and federal agencies, utilities, and developers. To achieve this purpose, the Industry Assessment solicits input from stakeholders most directly involved in the development of renewable energy resources, who present their perspectives on the state of the industry in Oregon and share their thoughts on any potential improvements that can be made. The approach and the findings of the analysis are presented in detail in the following sections.

4.2 Overview of the Renewable Energy Development Process

Before going into detail on the responses shared during the Industry Assessment, it is necessary to provide some background context on the typical renewable energy development process. The steps required for developing a new renewable energy project are complex and require coordination of many workstreams and processes. While each project's arc of development is unique, the types of activities that a developer engages in over the course of the development process can generally be described in a series of phases. The United States Department of Energy's Office of Indian Energy (US DOE OIE) offers one useful classification scheme for the stages of project development that divides the process into five phases.[56] These steps can sometimes be repetitive or sequential or both. The general steps in the process are shown in Figure 4-1 below.

Figure 4-1. Project development process for renewable energy projects.

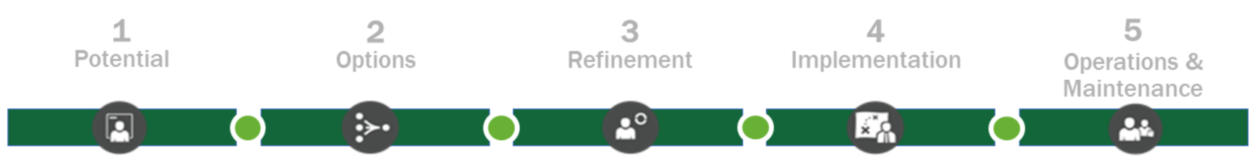


Image source: US DOE Office of Indian Energy

4.2.1.1 Project Potential

The first step in the project development lifecycle is to evaluate the potential of the project. The purpose of this phase is to assess whether a potential project may be viable. Much of the requirements in this phase entail information gathering: identification and characterization of potential sites, identification of market opportunities and potential off-takers, review of transmission interconnection processes, and assessment

[56] U.S. Department of Energy. (n.d.) "Renewable Energy Project Development and Finance Framework: The 5 Step Process." https://www.energy.gov/sites/prod/files/2015/04/f21/3b%20IE_0_B_Renewable%20Energy%20Project%20Development%20and%20Finance%20Framework.pptx

of potential risks that may be encountered later in the process. The ultimate question that a developer seeks to answer in this phase is whether a potential project is viable or not.

4.2.1.2 Project Options

In subsequent phase, a developer will begin to assess and narrow options for development. This may require due diligence on potential project sites to identify a final location, beginning to develop plans to secure the necessary permits, and initiating the interconnection process. In this phase, a developer will typically also begin the engineering, procurement, and construction (EPC) procurement process. The steps taken in this phase lay the foundation for the developer to begin finalizing the details of the project.

4.2.1.3 Project Refinement

In the Project Refinement phase, a developer will begin to make many of the final decisions that will be needed to bring a project into existence. In this phase, developers seek to finalize the project's ownership structure, project finance details, permitting, and interconnection. This will typically require developers to complete detailed economic modeling and environmental impact assessments for the project. In this phase, a developer will also typically finalize contracts with the offtaker and interconnection agreements. After completing all of these steps, a developer has completed the steps needed prior to beginning construction of the project.

4.2.1.4 Project Implementation

The Project Implementation phase represents the construction of the project itself and any required transmission infrastructure, culminating in full commercial operations. In this phase, the developer will coordinate among the various vendors involved in the construction and installation of the project.

4.2.1.5 Project Operations and Maintenance

The final step in the process is one that extends throughout the lifetime of the project. The purpose is to conduct or ensure ongoing operation and maintenance, including repair and replacement. Alternatively, the developer may often at this point choose to sell the project to another party who will take on the off-taker agreement and takes on responsibility for the operations of the project.

4.3 Approach

E3 conducted outreach to a broad group of stakeholders to provide their perspectives on the renewable energy development landscape in the state. This outreach process involved two components:

+ **Surveys:** E3 created and administered surveys to stakeholders across the spectrum of the renewable energy development industry; and
+ **Interviews:** E3 conducted one-on-one interviews with selected individuals representing organizations across the spectrum of the renewable energy development.

The respondents were from organizations representing different perspectives of the renewable energy development industry, specifically: small and large renewable resource developers, transmission developers, utilities, independent power producers, and clean energy advocates. Although they reflect a wide set of perspectives, these groups do not represent the whole range of stakeholders in the renewable energy development industry. There are other groups whose perspectives are also important for creating a total picture of the renewable energy development industry, who were outside the scope of this assessment. These include ratepayer advocates, climate advocacy groups, environmental advocacy groups, and land use conservation advocacy groups. To encourage candidness in responses, the individual responses to surveys and interviews are kept anonymous.

The survey included a total of 22 open-ended questions organized into seven themes that impact renewable energy development in Oregon: (1) general observations, (2) siting, permitting, and ease of development, (3) market design, (4) state policies and tax incentives, (5) transmission, (6) the regulatory approval process, and (7) procurement processes, contracting and offtaker agreements. Respondents were encouraged to respond to any of the questions they felt comfortable answering depending on their areas of expertise, interests, or topics they felt were most impactful or urgent. At a high level, in each thematic area, the survey sought input from stakeholders on what is working well, what is not, and what improvements are needed.

After the survey responses were received, E3 conducted individual interviews with several respondents. The interviews gave these stakeholders the opportunity to elaborate upon viewpoints expressed in their survey responses.

Altogether, E3 received 18 survey responses and conducted 10 interviews. E3 synthesized the contents of these responses and follow-up interviews to provide a comprehensive portrait of the state of the renewable energy development landscape in the state of Oregon with the intent of providing ODOE, the military, and other local, state, and federal agencies with information to deepen their understanding of the needs of Oregon’s renewable energy industry. The findings were also used to inform inputs and assumptions used in the Market Assessment.

Table 4-1. Types of stakeholders consulted in the Industry Assessment

Respondent Category	Number of Responses
Small renewable developer	2
Large renewable developer	4
Transmission developer	1
Utility - IOU	3
Utility - COU	3
Power producer	2
Clean energy advocacy	2
Research organizations	1

While the responses gathered in this study reflect a diverse range of perspectives within the electricity industry, it is worth noting that other stakeholders involved in various processes were not included within the scope of the survey. This is important to keep in mind: even when stakeholders consulted for this study are in agreement on certain topics, those views may not be shared by all groups or stakeholders with a stake in the outcome of a specific process. Where consensus is expressed in the responses below, it reflects a consensus among the specific stakeholders consulted in this study.

4.4 Key Findings

Several key themes emerged from the perspectives shared by respondents with implications for future renewable energy development within the state:

+ **Respondents want more clarity on the state's long-term policy goals – and more cohesion and coordination among state agencies and processes to support those goals.** Oregon's existing RPS statute, enacted in 2016, has been exceeded by 100 percent targets in many neighboring states, and while the governor's executive order committed the state to deep carbon reductions, many stakeholders are hoping for additional clarity on the state's long-term energy policy. Several respondents also describe the inherent tension between the state's carbon reduction ambitions, which will require significant deployment of renewable energy; and its land use planning goals, which have precluded certain areas from development a priori. Citing this discrepancy, these respondents suggest the need for a comprehensive roadmap that considers Oregon's long-term goals for climate, land use, social justice, and the environment simultaneously.
+ **The limits of the transmission system could present a challenge to renewable energy development at significant scale in the state.** There is broad consensus among respondents that limited availability and access to transmission capacity also limits renewable development. At the same time, some respondents observed that new investments in transmission are slow, costly, and difficult to permit. Respondents suggest a range of potential solutions, including proactive transmission planning modeled after successful efforts in other jurisdictions, establishment of an RTO, and streamlining the state's transmission siting and permitting approval process. Additional solutions, which could potentially delay the need for entirely new transmission investments while addressing near-term challenges include improved optimization of the existing transmission system, reconductoring of existing transmission pathways, and the strategic deployment of utility scale battery resources.
+ **Siting and permitting processes are currently perceived as cumbersome and costly by some electric industry stakeholders and could benefit from reform.** Many respondents from the renewable energy developer and clean energy communities perceive the EFSC process as antiquated and cumbersome. According to these respondents, the length of the process serves as a deterrent to development of renewables and the permitting cost for new renewables is sometimes prohibitive, especially to less-established renewable energy developers. Some respondents call for a comprehensive reform; one respondent expressed the need to "reform the state's siting and permitting processes to create a 'smart from the start' structure that balances state and local jurisdiction and concerns, removes unnecessary bureaucracy, considers cumulative impact, and fully incorporates community engagement." These concerns intersect with the common refrain among respondents that Oregon's land use planning goals are outdated and do

not adequately prioritize investment in renewable energy development that will be needed to meet the state's long-term climate goals.

+ **Coordination with neighboring states and jurisdictions will be needed to effectively integrate renewables.** In multiple areas of the survey, respondents emphasize the importance of Oregon's relationship to neighboring states. With respect to market design, multiple respondents describe today's wholesale bilateral market construct as obsolete and inadequate to facilitate renewable energy integration at scale. While some respondents consider the formation of a Western RTO as one solution, it has been proven in the past to be difficult due primarily to governance-related challenges. The utilities' participation in the Western EIM has alleviated some of these challenges; CAISO's proposed EDAM could further support variable resource integration. Similarly, the challenges related to transmission – with BPA's and PacifiCorp's presence across multiple states in the region – are more appropriately addressed at a regional level, as many of the transmission-related challenges observed in Oregon are not unique to that state. While regional transmission planning processes exist today, respondents call for more proactive and comprehensive assessment of the transmission needs associated with the need to integrate more renewable resources to meet state clean energy mandates and goals.

4.5 Detailed Findings

4.5.1 General

The purpose of this section was to collect perspectives on the overall climate for renewable energy development in Oregon. The three questions included in this section asked stakeholders to provide general feedback on the state of the renewable energy industry in Oregon:

1. Is the renewable industry in the state of Oregon well-positioned to scale development at the level needed to meet Oregon's long-term renewable goals?

2. What are the most valuable steps that can be taken by regulators and state agencies to support the development of renewables in the state of Oregon?

3. What are the most significant barriers you foresee to achieving high levels of renewable deployment in the State of Oregon?

Highlights and key themes from stakeholder responses are summarized in the box below, which is followed by a more detailed discussion of the issues raised by stakeholders.

Section Highlights

- Developers responding to the survey point to the maturity and experience of the industry players, the number of participants, and Oregon's rich resource potential as a sign of an industry with the capability to scale, but most also make clear that multiple factors would serve as barriers to scalable development if not addressed.
- The most significant barriers to development identified by stakeholder responses were generally (1) lack of access to transmission due to constraints on the existing network and difficulty permitting & constructing new lines, (2) the length and cost of the siting and permitting processes, which particularly inhibits participation

from smaller developers, and (3) the lack of a cohesive and unified policy framework that balances the tradeoffs between the state's carbon, land use, social justice, and economic goals.

Responses to these questions cut across most of the specific themes covered in the survey and interviews. Many of the comments in response to these general prompts set the tone for the more detailed comments in the other discussion sections of this Industry Assessment.

Stakeholders' views of the industry's readiness to scale renewable energy development over the next 15 years and beyond reflect a complex landscape. Many responses from developers indicate an eagerness to proceed with development in the state – as described by one respondent, "Oregon has deep industry experience and developers that stand eager to undertake further development" – but they also worry that a number of factors will serve as barriers to scalable development if not addressed. While multiple barriers were identified, respondents tend to highlight two recurring themes as the most significant factors: (1) lack of access to transmission, and (2) challenges related to siting & permitting, especially as it pertains to the state's land use restrictions.

+ Many responses express a belief that a lack of transmission capacity availability is one of the biggest barriers to renewable energy development. Respondents believe that this barrier is exacerbated by approval processes for interconnection and bulk-transmission infrastructure development projects.
+ Closely related to the transmission challenge is the issue of land use restrictions for the development of the renewable resources and for interconnecting the renewable resources to the transmission system. Some respondents highlighted a current disconnect between the state's clean energy and decarbonization goals and its land use conservation goals. The respondents also feel there is a lack of a cohesive and comprehensive state pathway to achieving its clean energy and decarbonization goals.

Respondents offer a range of potential recommendations to address these and other barriers to prepare the state's institutions to support increased renewable energy development over the next decade and into the future. Some of these steps can be taken entirely within the state; others will require coordination with the other jurisdictions in the region and at the federal level.

+ A few responses call for the need to more clearly define these long-term energy goals before answering whether the industry was prepared enough to meet said goals. Building on this point, several responses implied Oregon's existing RPS statute is not a sufficiently aggressive long-term clean energy goal.
+ Almost all the responses mentioned the need for improvements and reforms in the siting and permitting approval process for renewable energy projects, interconnection projects, and bulk-transmission projects; particularly improvements that manage the cost, increase simplicity, and reduce the duration of these approval processes.
+ A lot of responses also acknowledged that the presence of an RTO could bring reforms the existing market structures that would better enable renewable energy integration and increase the

efficiency of the transmission system utilization, likely leading to more renewable energy development.

+ Finally, some responses raised suggestions that were more technology-specific. For instance, there were suggestions for overhauling the land use/permitting regime that some respondents believe is effectively inhibiting solar PV development and also consider the compatibility of solar development on agricultural land. Another set of respondents wanted a removal of the existing barriers surrounding development of distributed energy resources due to a perceived lack of proper quantification of non-utility owned renewable resources and perceived biases of utility planning policies and procurement protocol.

Ultimately, although there are key elements that favor the scalability of renewable energy development in the State, some respondents believe that significant reform is needed to overcome the existing barriers to renewable energy development.

Another theme that appeared in responses to these questions and resurfaced throughout the survey was the need for better coordination between the state agencies in their supervision of processes and creation of rules; and for cross-agency collaboration in creating a clearer and more comprehensive roadmap for achieving the state's existing clean-energy goals and potentially higher decarbonization goals.

4.5.2 Siting, Permitting, and Ease of Development

Siting and permitting are the foundations of the renewable energy development process. As has been discussed previously, projects in Oregon must either receive a site certificate through the EFSC approval process (for large projects[57]) or a land use permit from a local government. Through the EFSC approval process, projects are evaluated on the basis of a number of standards, which include impacts on land use and the environment, noise concerns, and cultural and archaeological artifacts, among others, through a process that includes public participation. The purpose of this section was to create a better understanding of how the processes related to siting and permitting of renewable energy projects affect the industry as a whole, and specific types of renewable energy technologies in particular. The questions asked of stakeholders in this section include:

4. **How do the siting and permitting processes in Oregon support or inhibit renewable energy development in the state?**
5. **How do the siting and permitting processes in Oregon compare with similar processes in other states?**
6. **What changes could be made to the siting and permitting processes changes to better support future renewable development within the state?**

Highlights and general themes from respondents' feedback are summarized in the box below; additional detail on stakeholder responses to specific questions follows.

[57] The criteria used to identify projects under EFSC jurisdiction differ by technology. Wind and geothermal projects exceeding 50 MW must receive EFSC approval. The threshold for solar projects is based on the project's acreage and varies according to the type of land use.

Respondents Feedback Highlights: Siting, Permitting, and Ease of Development

- In spite of the fact that most projects proposed through the EFSC process have ultimately received approval, multiple respondents feel this process is cumbersome, presenting a barrier to development because of its length and expense; this concern is especially salient among less-established renewable developers in the state.
- Stakeholders from the renewable energy developer and clean energy advocacy communities also point to some portions of the EFSC process as antiquated and inconsistent in its application to different types of resources and suggest that a comprehensive reform of siting procedures would benefit the industry.
- Almost all the responses encouraged the state to review and update its land use goals and the underlying data used in the land use classifications; there was a general consensus that the state's efforts to protect and/or preclude certain land use types from development as standing in conflict with the scale of renewable development needed to meet its long-term climate goals

Projects developed in Oregon are either permitted by the state through the EFSC process, which is required of large projects defined in Oregon Revised Statute 469.300, or by county and local government approval processes. Respondents largely focus on the EFSC process, but also share some perspectives on local processes by contrast.

While some respondents note appreciation of the centralized structure of the EFSC process as a one-stop shop for state approval of projects, others characterize the process as frequently serving as a barrier to renewable energy development. One respondent describes the process as "lengthy, expensive, and unduly burdensome"; this general sentiment is shared by a number of respondents and is of particular concern for less-established renewable energy developers, who remark that the length and expense of the process can be a deterrent to establishing a project development footprint in Oregon. With increasing development on the horizon due to increased demand for renewable resources, the perceived issues of the cost and time of the approval process could present barriers to development if not addressed.

Respondents identify several specific components of the process as challenges:

+ Most respondents that identify siting and permitting as a challenge also describe the inherent conflict between efforts to permit renewables and the state's land use planning goals, which they characterize as antiquated in the context of the state's shift towards long-term greenhouse gas reduction objectives. Several respondents describe protections for prime farmland and wildlife habitat as overly restrictive to solar development and transmission interconnection.
+ Several respondents suggest the need for the Oregon Department of Fish and Wildlife (ODFW) to be less restrictive in its consideration of wildlife mitigation.

In their responses, developers appear to believe that the local and county permitting processes that are required of smaller projects are favorable for their comparative speed and simplicity. Generally, the local processes were considered more efficient and less expensive compared to the EFSC process by these respondents. Still, these processes are not without their own challenges: some respondents remarked that these processes must also consider the same land use planning goals and policies that the EFSC process does, and can also be susceptible to delay, especially if appealed beyond the local level, which would require resolution through the Oregon Land Use Board of Appeals and Oregon courts.

Permitting for offshore resources – wind in particular – is administered by the federal Bureau of Ocean Energy Management (BOEM). One respondent noted that the BOEM siting process, too, could be improved upon: "BOEM's federal approach and site control continue to be the biggest hurdle to open inquiry and input from local communities. We would welcome more efficient and predictable regulatory processes to enable the deployment of wind power in federal waters. "

Respondents offer a wide range of suggestions, both specific and general, of potential improvements to the existing permitting and siting processes, as well as to the rules and regulations that directly affect siting and permitting of projects:

- Most responses emphasized the importance of an effort to review and update the state's land use goals and the underlying data used in the land use classifications – in particular, with an eye towards aligning those goals with the state's long-term climate objectives. Several respondents suggested expanding Goal 13, which states that "land and uses developed on the land shall be managed and controlled so as to maximize the conservation of all forms of energy, based upon sound economic principles" [58] to recognize the state's policy priorities for carbon-free and renewable energy. There was a general consensus that there is a need to change the view of renewable energy development as inherently in conflict with other land uses, even before studying of the compatibility of the development with those land uses.
- Several respondents point to the comparative flexibility of renewable energy siting and permitting in Washington, where renewable energy developers have the choice to opt into the state-administered Energy Facility Site Evaluation Council (EFSEC) process or to pursue permitting in through a local agency. The latter often offers a streamlined pathway to permitting. Multiple stakeholders suggest that Oregon consider a similar flexible approach – going beyond the measures proposed in House Bill 2329 (2019)[59] – would benefit developers in contrast to Oregon's process, where all projects that exceed a specified size threshold must receive EFSC approval.
- Several respondents suggest that improving access to GIS and other data needed to support permitting and siting – including improved land use datasets, information on transmission infrastructure, and information on renewable resource potential – could support or enable an expedited permitting process.
- A few respondents think Oregon should adopt an alternatives-based analysis approach similar to the federal National Environmental Policy Act (NEPA) permitting process and point to similar models in California, Washington, and Montana. This approach involves evaluating alternatives to any project or project location that can achieve most of the basic objectives of that project.

[58] https://www.oregon.gov/lcd/OP/Documents/goalssummary.pdf

[59] House Bill 2329 (2019) changes the definition of energy facilities subject to Energy Facility Siting Council (EFSC) site certificate requirements. It exempts certain renewable energy facilities from EFSC review and establishes guidelines for counties to authorize siting. It authorizes a developer of a facility exempted from EFSC review to elect to obtain a site certificate through EFSC instead of siting through a county process. Finally, it allows smaller facilities not currently subject to EFSC review, net metering facilities, and community solar projects to be authorized by counties without additional guidelines established in this Act. More details located here https://olis.leg.state.or.us/liz/2019R1/Downloads/MeasureAnalysisDocument/49067.

- Finally, respondents were in general agreement that increased collaboration and coordination between the different state agencies is needed. This observation was often paired with the recommendation to revisit the state's land use planning goals to align with the state's carbon objectives. Some respondents suggested an agency take the leadership on coordinating and streamlining the actions of the various state agencies' in achieving the state's clean energy and decarbonization goals.

There was overwhelming recognition that resolution of these challenges will require public engagement and collaboration. Unfortunately, some respondents find the current EFSC public involvement process to be complicated and costly and believe this portion of the approval process would benefit from administrative changes. These respondents believe the current public comment period is too open-ended, and they believe this causes delays because comments can be made throughout the entire approval process rather than in specific windows.

4.5.3 Market Design

The design of the electricity market in Oregon and regionally is another key factor in encouraging or inhibiting the development of renewable energy projects. The questions in this section allowed respondents to comment on the impact of market design and structure on renewable energy development within the state. Due to Oregon's unique position in the Pacific Northwest, respondents were asked to consider a few factors outside of just the state's internal practices. These factors included:

- Pacific Northwest's current bilateral wholesale energy market;
- Existing Energy Imbalance Market (EIM);
- Possible Extended Day-Ahead Market (EDAM);
- Existing utility resource adequacy practices; and
- Possible regional resource adequacy program – as proposed by the Northwest Power Pool.

Three questions were asked of stakeholders in this section:

7. **What is working in Oregon's current electric sector market design for renewable energy development?**
8. **What is not working in Oregon's current electric sector market design for renewable energy development?**
9. **What potential improvements can be made to Oregon's current electric sector market design for renewable energy development?**

Highlights are included in the box below, and responses are discussed in detail below.

Respondents Feedback Highlights: Market Design
• Many respondents agree that the characteristics of the current regional bilateral energy market, where standard products are "heavy-load hour" and "light load hour" fixed blocks, inhibit efficient integration of variable renewable energy and discourages investments in energy storage; these same respondents point to

the efficiencies gained by PGE, PacifiCorp, and Idaho Power's participation in the EIM as evidence that a broader RTO could bring additional renewable energy integration benefits.

- A number of respondents also point to the emerging proposals for a centralized resource adequacy program administered through the Northwest Power Pool as a step that would improve utilities' ability to support the region's reliability needs while continuing to increase reliance on variable resources; by standardizing capacity accreditation rules for variable resources, a centralized program could help ensure utilities and ESS are appropriately valuing the capacity contributions of renewables and provide a more clear, transparent signal to the market as to how resources like wind, solar, and storage are valued.

4.5.3.1 Wholesale Electricity Markets

The existing bilateral structure of wholesale markets in the Pacific Northwest is identified by several respondents as an impediment to effective renewable energy integration – increasingly so in the future as the penetration of renewables grows. The Mid-Columbia (Mid-C) wholesale trading hub, where the standard products exchanged are flat blocks of power across Heavy Load Hours (HLH) and Light Load Hours (LLH), reflects what one respondent describes as an "obsolete paradigm" that is not conducive to a system that includes increasing penetrations of variable resources and energy storage. Further, these respondents believe the existence of a single centralized bilateral trading hub at Mid-C and the lack of a market signal for congestion obscures potential differences in the locational value of energy that could provide a signal to developers.

Those respondents that point to the bilateral market as an impediment to renewable energy integration suggest that a centralized wholesale market administered by a Regional Transmission Operator (RTO) or other entity is needed to facilitate renewable energy integration. At the same time, respondents recognize the political challenges presented by such an effort. As described by one respondent:

> "There is no coherent 'market design' in Oregon. But at the same time, an immediate jump to the currently prevalent ISO/RTO model is not politically feasible nor optimal. The path to a full western market should take incremental steps that make consistent progress toward achieving reliability, optimized economic dispatch and acceleration of clean energy resources including renewable supply, storage and customer resources (also including renewables). The full western market should be built to purpose to meet the diverse needs of the western states and provinces in the Western Interconnection, rely on the underlying precepts of cooperative federalism, and not simply adopt an already out of date monolithic model."

Respondents do credit the three IOUs' participation in the Western Energy Imbalance Market (Western EIM) as having provided modest renewable energy integration benefits through improved efficiency in operations, more cost-effective management of the variability of renewable generation, and the diversity benefits that have come with access to a regional real-time market. Currently, the PGE, PacifiCorp, and Idaho Power Balancing Area Authorities (BAAs) are EIM members, but BPA has announced intentions to join the market by 2022; its entry may allow many of Oregon's COUs to benefit from participation in the market.

4.5.3.2 Resource Adequacy and Capacity Accreditation

Some stakeholders believe that current conventions in utilities' approaches to resource adequacy presents a barrier to developers designing projects to maximize value. Each utility uses different methods and assumptions to ensure its portfolio of resources meets its resource adequacy needs and to value the contributions of variable resources and storage towards those needs. The lack of standardization and a perceived lack of transparency are cited as challenges to developers who do not have a clear understanding of how projects are valued by utilities.

The regional resource adequacy program currently in early stages of development by the Northwest Power Pool is cited by some stakeholders as a remedy to this current challenge. Standardizing conventions around capacity accreditation across the region – and providing increased transparency and access to those determinations – would better allow developers to identify the projects that maximize value to the utility.

4.5.4 State Policies and Tax Incentives

A number of federal, state, and local policies will influence renewable energy development. Oregon has a renewable portfolio standard (RPS) that has varying levels of requirements for the different utilities within the state; the biggest portion is a 50 percent by 2040 target for the IOUs. The purpose of this section is to understand the roles the various current policies have played in enabling (or inhibiting) renewable energy development in Oregon and what kind of policies might further support the development of renewable energy within Oregon. Respondents were asked to consider the following factors in their responses:

+ State and/or local tax incentives offered to renewable energy developers;
+ Technology carve-outs and mandates;
+ Cap and trade and/or carbon pricing; and
+ Any additional policy mechanisms that could affect or encourage renewable energy development.

Four questions were asked of stakeholders in this section:

10. **How significant a role do state and local policies play in the development process for new renewable resources?**

11. **What state and/or local policies in Oregon are particularly effective at encouraging renewable development? Which policies are ineffective or discourage development?**

12. **How do state and local policies in Oregon related to renewable development compare to those in other states and localities?**

13. **What types of policies do you think could effectively support Oregon's pursuit of its renewable goals?**

Highlights are included in the box below, and responses are discussed in detail below.

Respondents Feedback: State Policies and Tax Incentives
• The state's RPS program is widely credited by respondents as a major driver of historical renewable development trends in the state; now, many respondents observe Oregon's current statute lagging behind neighboring states and express a belief that Oregon should increase its own long-term RPS and/or carbon goals.
• Respondents provide various suggestions for future policy consideration, including a recommendation not to substantially amend goals through 2030 lest the change destabilize the current development landscape, as well

as a recommendation by several to consider more comprehensive goals that expand policy support to include all resources that contribute to carbon reductions.

- A number of respondents mention the Oregon Land Conservation and Development Commission's (LCDC) 2019 ruling prohibiting solar on high value farmland as detrimental to the solar industry, observing that neighboring states seem to have been able to balance land use concerns with less prohibitive restrictions on development.
- Respondents agree that incentives and tax credits can play a role in effectively encouraging development, stimulating emerging segments of the industry and encouraging siting in specific areas, but also point to the challenges in designing and implementing these programs appropriately.

Respondents unanimously agree that state and local policies play a significant role in shaping the landscape for renewable energy development. Almost all respondents recognize the central role of Oregon's RPS policy and coal phase-out policy as drivers of renewable energy development in the state to date. At the same time, respondents clearly desire more clarity from the state on the future of long-term clean energy policy. Many respondents observe Oregon's RPS as lagging aggressive clean energy policy goals in neighboring states: Washington (100 percent requirement by 2045), California (100 percent requirement by 2045), Nevada (100 percent goal by 2050), Colorado (100 percent requirement by 2050), and New Mexico (100 percent requirement by 2045 for IOUs). These observations echo the request for greater clarity on the policies that will be needed to support the state's long-term climate goals. One respondent describes the benefits provided by increased policy certainty:

> "Market certainty, as expressed through aggressive RPS's, roadmaps for development, and technology specific carve outs result in increased competition, expanded supply chain development and lower costs of capital necessary for development – all of which lower delivered costs to rate payers without sacrificing investor interests."

In their discussion of this topic, multiple respondents emphasize their belief in the importance of moving beyond an RPS-style policy to a more technology agnostic one that recognizes the value of all carbon-free resources. Some argue that the focus of current RPS policy on the generation of Renewable Energy Certificates (RECs) has exacerbated oversupply dynamics characteristically observed in the spring runoff, particularly during high hydro years—and that this, in turn, has created an increasingly challenging economic environment for the region's hydroelectric generators. Multiple respondents suggest that a more comprehensive clean energy policy could provide policy support for existing carbon-free resources while also encouraging development of renewables in the future. They suggest options for comprehensive policy such as one similar to Washington's CETA or a program directly regulating carbon, such as direct carbon pricing or a cap & trade program like the one considered but ultimately not passed by the Oregon legislature in 2019 and 2020.

In addition to recognizing the guiding significance of the state's RPS and carbon objectives, respondents provide observations on a range of additional policies and their impacts on renewable energy development within the state:

- Land use policies: In response to these questions, several respondents contrast Oregon's land use planning goals and the attendant requirements for siting and permitting with the less stringent requirements in most of the other Western states, echoing a number of the barriers to development discussed in Section 4.5.2. This is underscored by the observation that even in California, where the siting and permitting process is described by some respondents as being the most challenging in the West, renewable energy development can occur on agricultural land; for example, solar on farmland with restricted water use.

+ Carve-outs and mandates for market transformation: Multiple respondents recognize the benefits of technology-specific carve-outs and mandates as mechanisms to drive market transformation of new resources and provide some certainty to developers evaluating the risks attendant to developing emerging technologies. Several respondents discuss how carve-outs for new technologies can help to jump-start an emerging industry. Some point to examples of solar carve-outs in the Southwest, while others discuss several east coast states with goals and mandates for offshore wind – the most prominent of which is New York's 9 GW goal by 2035.
+ Tax incentives: There was also general agreement that tax incentives, like tax credits and tax abatement programs, have also been very helpful, particularly at smaller scale. The federal and state incentives have helped improve the overall cost of Oregon renewable energy projects and made them cost competitive against non-renewable resources. Several respondents attribute decisions to locate new plants – particular solar PV – to local property tax exemptions.
+ PURPA: Several respondents comment on the role of PURPA, cited as an important policy driver of renewables. For additional detail on stakeholder perspectives on PURPA, see Sections 4.5.6 and 4.5.7.

Finally, several respondents recall the now defunct Business Energy Tax Credit (BETC) as a cautionary tale for the implementation of tax credits on a large scale. Some posited that rather than doing away with tax credits, the lesson is to design programs that work from test-scale to the intended scale, with appropriate safeguards built in. Some comments recognized that Oregon has experienced challenges in the past when it has sought to expand tax credit programs to a larger scale make it unlikely that state incentive programs will be reintroduced soon.

A number of other policies were mentioned by one or more respondents as effective mechanisms to encourage renewable energy development in Oregon, including property tax exemptions, the strategic investment program (SIP), and the enterprise zones program.

4.5.5 Transmission

Transmission access and the ability to expand existing transmission and develop new transmission infrastructure play a significant role in renewable energy development. The importance of understanding the challenges related to the development of transmission infrastructure cannot be overstated if we are to truly present a robust outlook on the possibilities of renewable energy development in Oregon over the next 15 years. However, because bulk-transmission planning largely falls under FERC jurisdiction, there are constraints on the changes that can be made at the state level. The purpose of this section was to understand how the transmission system will affect the renewable energy development in Oregon. Respondents were to consider the following factors while answering the questions in this section:

+ Transmission system interconnection processes;
+ Consideration of transmission in utility integrated resource plans (IRP);
+ The role of the newly formed NorthernGrid transmission planning association; and
+ The role of BPA as the state's major high-voltage transmission provider.

The questions in this section were centered around three key themes: support or inhibition, comparison to other jurisdictions, and modifications.

14. How do the interconnection process and bulk transmission development process in Oregon support or inhibit renewable development in the state?

15. How does the interconnection process and bulk transmission development process in Oregon compare to other states?

16. What changes could be made to better support future renewable development within the state?

Key themes and highlights from stakeholder responses are summarized in the box below, followed by more detailed discussion of stakeholder perspectives.

Respondents Feedback Highlights: Transmission

- The limits of the existing transmission system, coupled with perceived siting, permitting, construction, and economic challenges of new projects, make access to transmission appear to be a major potential barrier to renewable energy development.
- Most respondents believe that the perceived long lead time for development of new bulk transmission (many mention 10-15 years) presents a challenge to development in areas where new investment may be needed; some indicate that the state's approval processes, including the EFSC site certification process, could be streamlined to reduce the amount of time needed.
- Some respondents envision a more proactive transmission planning process to identify policy-driven transmission projects as a means of supporting future renewable energy development at scale, citing examples such as ERCOT's Competitive Renewable Energy Zones (CREZs), CAISO's Tehachapi trunkline project, and California's RETI 2.0 as potential models for the state to consider.
- While they are quick to recognize the political challenges of RTO development, several respondents suggest that its formation could provide relief from a number of the transmission-related challenges.

4.5.5.1 Bulk System Transmission

Most respondents generally agree that, between the limited available capacity remaining on the existing transmission system and the challenges presented by expansion through new transmission investments, access to transmission is one of the most significant barriers to development of renewables at significant scale. One respondent describes the lack of access to transmission as "the single biggest barrier at this time" to renewable energy development. Another respondent elaborates further:

> "The incredibly long and uncertain lead times to develop new transmission, development largely out of the hands of renewables developers (driven instead by investor-owned utilities, BPA, or occasionally merchant developers), is a significant and fundamental hurdle in accessing the full suite of high-quality renewables in each northwestern state, not just Oregon."

Multiple challenges in developing new transmission are claimed by some respondents from the renewable energy developers and clean-energy advocacy groups:

- Delays in the approval process lead to excessively long timelines (many mentioning 10 – 15-year lead times). These are sometimes caused by elements unique to Oregon. Echoing concerns raised in response to questions related to permitting, multiple stakeholders point to the lengthy EFSC site certification process, which can add two to three years to a project's timeline, as a major contributing factor.
- They characterized the problem of BPA not being big enough or neutral enough to truly play the role of a regional transmission operator. They highlighted the difficulty in BPA taking on transmission projects that do not benefit its power customers causing bottlenecks in the transmission planning conversation.

On the other hand, some respondents expressed opinions that are in contrast to these. Some remarked that while it is true that transmission is developed to meet the needs of the transmission provider, transmission developers are also obligated under federal law to meet the needs of an economic-driven transmission services request from a transmission customer. Further, they observe that according to the principles of open access, at any time a transmission customer could submit a binding transmission request to a transmission provider that could force them to provide service.

The perceived long lead time for new transmission investment could present a challenge considering that some of the highest quality potential renewable resources in the state exist in areas where limited transmission infrastructure exists altogether. Several respondents point to solar resources in the southeast portion of the state and offshore wind as resources for which the lack of existing transmission infrastructure and likely long-lead time for new investments would pose challenges to development in the near term.

Multiple respondents call for more proactive transmission planning as essential to encouraging renewable energy development, often noting the importance of a regional approach. One respondent expresses the importance of a paradigm shift:

> "Our transmission planning process is lagging behind trajectories toward existing Oregon RPS. Transmission planning should be proactively visioning and accommodating a state road map to meeting existing and emerging RPS goals…"

Respondents cite ERCOT CREZ, MISO MVP, SPP Highway-Byway, the CAISO Tehachapi trunkline policy, and California's RETI 2.0 process as examples of proactive transmission planning and broad cost allocation that might serve as appropriate models for consideration in Oregon. The newly formed NorthernGrid transmission organization was cited as a step in the right direction for achieving this goal of an independent regional transmission authority. Respondents suggested allowing greater input from outside parties into NorthernGrid's transmission planning process would be valuable to the renewable energy development industry and the Northwest region as a whole.

Here, as in responses to questions on market design, multiple stakeholders point to the formation of an RTO as a means to address some of the challenges identified – while also recognizing the political challenges presented by such a transition:

> "Making the leap into a true regional market operator of transmission would address many of the concerns above, and encompass the incremental solutions suggested already in this answer. Doing so would be a politically fraught discussion to the extent it affected BPA's power division."

4.5.5.2 Interconnection Processes

Respondents' views of interconnection processes within the state are mixed. For instance, typical responses from utility and transmission developers describe the interconnection process as relatively simple, yet responses from renewable energy developers and power producers described the interconnection process being difficult. Lack of consistency among the interconnection processes used by the IOUs and BPA is seen by some developers as contributing to this challenge. In spite of the differences in perceived challenges, many respondents were united in their belief that the interconnection process suffers from a lengthy approval timeline that presents a timing challenge to project development.

One utility attributes the slow pace of the interconnection process to the large number of projects that enter into the queue – many of which are never destined to achieve commercial operations. Nonetheless, utilities are obligated to study the interconnection requirements for each project, a process of study that has historically taken place serially according to pro forma tariffs. PacifiCorp recently implemented a "cluster-based" interconnection study process; this type of queue reform has the potential to improve efficiency of the interconnection process.

4.5.5.3 COUs & Transmission Development

A final issue raised by several respondents relates to the roles of COUs and PUDs. In some instances, these entities have the jurisdiction of securing easements for transmission infrastructure. For them, there is the constant tension between exercising their "condemnation power" or respecting the wishes of their members (whose lands are being condemned) who are partial owners of the COU. While these situations could benefit from state agencies as mediators, the COUs are wary of any form of state regulation. So, although the COUs and their customers want an easier path to renewable energy development, they also do not want any form of encroachment from the state on their local governance authority. However, any transmission line in which private property will be condemned must go through the PUC in a CPCN proceeding, which COUs and IOUs alike must apply for. The CPCN is then used as evidence of public need in a condemnation proceeding.

4.5.6 Regulatory Approval Process

Like the siting and permitting process, the regulatory approval process plays a key role in determining the certainty of any renewable energy project. The purpose of this section was to understand how Oregon's regulatory approval processes encourage or inhibit renewable energy development. Respondents were asked to consider the complexity of the steps involved in the approval process and non-financial regulatory support in their responses. Stakeholders were invited to share their perspectives in three questions:

17. What steps in Oregon's regulatory approval process support the growth of renewable energy development?

18. What steps in Oregon's regulatory approval process inhibit the growth of renewable energy development?

19. What potential improvements do you suggest could be made to the regulatory approval process in Oregon to support renewable energy development?

The responses are discussed in detail below.

Respondents Feedback Highlights: Regulatory Approval Process
• Respondents offer numerous suggestions to improve OPUC's operations and administration.
• A number of respondents believe that augmented funding and staffing are necessary for OPUC to effectively fulfill its role in the regulatory process, especially during a period of significant transition in the grid.

Responses to these questions tend to focus on three areas: (1) general comments on OPUC's operations and administration; (2) feedback on OPUC's implementation of PURPA rules, and (3) discussion of how cost recovery structures incent renewable energy development.

Most of the suggestions for improvement relate to the OPUC's operations and administration. Some responses call for OPUC to provide better and more transparent access to data for stakeholders involved in the regulatory approval process, citing processes in neighboring states where access to information in active dockets is fully public and not limited to intervenors. These respondents also called for OPUC to encourage more stakeholder involvement and explore discovery protections and increased intervenor funding for smaller companies; they argued that if utilities could use ratepayer funds to participate in these proceedings, it would be helpful for OPUC to level the playing field for smaller entities. But other respondents remarked that OPUC is actively taking up these issues currently, and that it is the legislature, not OPUC, who determines the parameters of what type of entities are allowed to receive intervenor funding.

Many respondents are sympathetic to the fact that many of OPUC's challenges result from their limited resources and are therefore beyond their control, and so call for increased funding for OPUC, hiring more staff for OPUC, and clearly defining OPUC's role to be focused on their areas of strength; for instance, OPUC should not handle contract disputes, rather it should be given more enforcement authority. As described by one respondent:

> "Staff do not appear to be equipped with sufficient time and resources (including access to consultants or other outside resource as necessary) to give each docket the attention it needs relative to the comparable complexity of the dockets they are tasked to provide recommendations on."

Several respondents discuss cost recovery mechanisms through OPUC processes. Their responses point to both positives and negatives:

- The renewable adjustment clause is described as a useful mechanism that allows for incorporation of renewable generation and related transmission to be incorporated into rates outside of a general rate case.
- Current power cost recovery mechanisms are seen as not adequately allowing utilities to recover costs due to the natural variability of renewable resources. Because power costs for renewables included in rates are based on annual forecast and there currently are no mechanism to true up variances, utilities face a risk of under-recovery of costs. Some respondents' comments go so far as to suggest that this mechanism inhibits renewable energy development by exposing utilities to the risk of under-recovery of power costs due to natural variability of renewable generation.
- Multiple respondents suggest consideration of a mechanism that allows utilities to earn a return on PPAs to provide further incentive to utilities to support the state's carbon goals and mitigate perceptions of bias; this suggestion is further discussed in Section 4.5.7.

The final suggestion was for an improvement to the regulatory process to align with Governor Kate Brown's statewide decarbonization action goal, EO 20-04. In December 2020, after the surveys and interviews were conducted, OPUC released a Work Plan on how it will "identify and manage the numerous activities the agency plans to undertake to help reduce GHG emissions in accordance with the goals set forth in EO 20-04."[60]

4.5.7 Procurement Processes, Contracting Mechanisms, and Offtaker Agreements

The final key driver that was analyzed in this Industry Assessment is the procurement of renewable energy. The purpose of this section is to understand the roles of utilities and other load-serving and energy-using entities as offtakers of renewable energy in Oregon. Respondents provided their perspectives on the impact of the procurement processes, contracting mechanisms, and offtaker agreements in Oregon's renewable energy development currently and in the future. Respondents were asked to consider the following factors in their answers:

- The role of long-term PPAs;
- The role of the Public Utility Regulatory Policies Act (PURPA); and
- The structure and design of competitive solicitations.

The questions in this section were centered around three key themes: conducive contracting mechanisms, utility competitive solicitations, and non-utility offtakers. The responses are discussed in detail below.

20. **What types of contracting mechanisms do you see as most conducive to a healthy renewable industry in Oregon and why?**

21. **Are utilities' competitive solicitation processes designed to encourage renewable development? If not, how so?**

[60] Oregon Public Utility Commission Executive Order 20-04 Work Plans. https://www.oregon.gov/puc/utilities/Documents/EO-20-04-WorkPlans-Final.pdf

22. How significant a role do you envision corporate entities and other non-utility offtakers playing in the development of renewable resources in Oregon in the next decade?

Key themes and highlights from stakeholder feedback are summarized in the box below, followed by a more detailed discussion of stakeholder perspectives.

Respondents Feedback Highlights: Procurement Processes, Contracting Mechanisms, and Offtaker Agreements

- Views of the role of the large utilities are mixed among respondents; some credit the IOUs for significant advances in offering competitive solicitations and creating opportunities for developers, whereas others view the utilities with suspicion and criticize a perceived bias and lack of transparency in their processes.
- Several steps are suggested as improvements in the competitive solicitation process to improve transparency, including enhancements to independent evaluations, increased participation from other state agencies in OPUC proceedings as neutral parties.
- Multiple respondents – mostly non-utilities – suggest exploring performance-based ratemaking constructs that would allow utilities to earn a return on PPAs as a means to align the IOUs' incentives with the state's policy goals and mitigate any bias – real or perceived – towards self-build projects. Respondents point to Washington's CETA as an example of this approach.
- While several respondents argue the merits of PURPA's standard contracts for renewable energy development, a larger number express unfavorable views of its effectiveness at stimulating renewable energy development; utilities express concerns that it imposes additional costs on customers and creates challenging uncertainties in planning processes.
- Many stakeholders expect non-utility procurement – by entities and direct access customers seeking to meet voluntary goals – to feature in an increasingly prominent role in the development landscape.

4.5.7.1 IOUs and the Competitive Solicitation Process

Several respondents applaud the IOUs for their roles in driving forward renewable energy within the state, recognizing the utilities' increasingly competitive RFPs that have created opportunities. All-source RFPs are cited as an example of a procurement mechanism that creates an opportunity for renewables to compete with non-renewable resources. One stakeholder credits utilities for driving significant activity in the state:

> "Oregon's major utilities are making strides toward bringing significantly new renewables onto their systems: PGE's and PacifiCorp's most recent IRPs led to a potential renewable RFP (PGE) and an All-Source RFP in which all preferred portfolio resources (and the vast majority of bids) are renewables or renewable & storage hybrids, while Idaho Power has adopted a 100% clean energy goal. Some elements of their individual procurements can pose barriers—in particular, requirements related to interconnection and transmission. But overall Oregon utilities are interested in investing in significant new renewable resources."

The prominence of the IOUs' roles in the procurement and solicitation process is viewed by other respondents as problematic. These respondents express concerns that the role and influence of the large utilities in supporting the state towards its policy goals through renewable energy procurement is outsized, offering several criticisms:

+ That the utilities' solicitation processes inherently favor self-build projects over PPAs, despite the incorporation of independent evaluation into the process;

- That utility solicitations are often structured with criteria that exclude otherwise viable bidders from participation (minimum credit requirements and requirements that developers secure firm transmission prior to consideration are cited as examples);
- That a lack of transparency in solicitation processes prevents developers from identifying the highest value projects (one example cited the lack of a clear signal as to how utilities value the capacity contributions of wind, solar, and storage towards resource adequacy needs); and
- That utilities are able to dedicate significantly more resources towards regulatory processes than OPUC or stakeholders, creating an asymmetric power balance in the regulatory landscape.

Several stakeholders suggest steps to address these perceived issues, including:

- Encouraging ODOE to participate in hearings at the OPUC with the aim of provide neutral third-party input into regulatory decisions;
- Allowing independent evaluations of solicitations to be conducted by an independent entity, rather than an entity under the employ of the utility; and
- Exploring performance-based ratemaking constructs that would allow utilities to earn a return on PPAs to discourage any bias towards utility ownership in competitive solicitations (notably, this suggestion is offered by a number of non-utility stakeholders) and to "compensate achieving policy goals and improvements to infrastructure."

It is worth mentioning at this juncture, that the competitive bidding rules adopted by OPUC in 2018 as part of docket AR 600 and codified in OPUC rules 860-089-0010[61] do establish rules for transparent competitive bidding processes, including requiring an independent evaluator to oversee the competitive bidding process.

4.5.7.2 The Public Utilities Regulatory Policies Act (PURPA)

Stakeholders consulted in this process express a range of viewpoints on the role of PURPA as a driver of renewable energy development in the state. Multiple developers point to PURPA as an effective and important alternative to the central solicitations of the large utilities for renewable energy developers, describing the opportunities it has created for developers – especially at a small scale. Others believe PURPA is "a symptom of an inefficient market" and point out that development of a regional wholesale market that relies upon locational marginal pricing will be a more effective market-based mechanism to encourage medium and small size projects built than relying on administratively determined avoided costs.

The state's IOUs provide a different set of perspectives on the role of PURPA, expressing concerns that the state's framework for PURPA implementation creates numerous challenges for utilities:

- Utilities worry that the standard offer contracts lead to higher retail electricity prices for their customers. The availability of a standard contract rate negates competition between developers and avoided cost rates locked in years in advance of a project's online date may be higher than the

[61] Oregon Public Utility Commission Chapter 860 Division 89, Resource Procurement for Electric Companies. 2018. https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=249817

true value of those resources to utilities. The utilities contrast PURPA's standard offer contracts with the result of competitive solicitations, which they describe as a more effective means of driving competition and ensuring least cost solutions for customers.

- Utilities also point to PURPA contracts as introducing more uncertainty in their planning processes. Because of the "must-take" obligation for the output of qualifying facilities, which means that utilities must plan their system to accommodate these resources. If planned QFs fail to achieve commercial operations, this can create an acute challenge for utilities left with an immediate resource need to fill. Due to the fact that securing a QF contract requires a low financial commitment by developers, utilities view QF projects as more likely to fail prior to achieving commercial operations.

Despite these challenges, the IOUs acknowledge OPUC's recent efforts to address some the tensions and concerns, pointing to multiple open dockets at the Commission as important venues for PURPA:

Table 4-2. Open OPUC dockets related to PURPA implementation.

Docket	Description
AR 629	Dispute Resolution for PURPA Contracts
AR 631	Procedures, Terms, & Conditions Associated with QF Standard Contracts
UM 1987	PGE Request to Update Schedule 201 and Standard Power Purchase Agreements
UM 2032	Staff Investigation into Treatment of Network Upgrade Costs for QFs
UM 2011	General Capacity Investigation
UM 2000	Staff Investigation into Broad Investigation of PURPA *(avoided cost methodology)*
UM 2038	Investigation into Treatment of QFs in Utility IRP Process
UM 2001	Staff Investigation into Interim PURPA Action *(interconnection umbrella docket)*

4.5.7.3 Procurement by Corporations and Other Non-Utility Entities

Most respondents agreed that procurement by corporate and other non-utility entities plays a significant role. Over the next decade it is likely non-utility offtakers will increase their direct purchase of renewables, but this will be dependent on a few factors: enabling from regulatory entities like OPUC giving them direct contracting options; proximity of the contracting generation resources to corporate load hubs (like data centers); and finally, the delivered cost of the electricity itself. Other comments emphasized the need for improving contracting options for non-utility entities in Oregon's current market design. They remarked that the mechanisms for contracting directly with commercial and industrial customers are different between service territories and utilities, and this creates inefficiencies in the relationship between direct-access commercial and industrial customers and independent power producers.

Other examples contained in the responses include community energy programs for small scale renewable energy development; an increase in the ability for developers to contract directly with commercial and industrial customers; and finally, an option for utilities to expand the voluntary commitment programs.

5 Market Assessment

5.1 Purpose

In Section 1.2 we described developing renewable energy build-out scenarios for Oregon over the next 15 years as the third objective of this study. The purpose of the Market Assessment is to provide plausible projections of how much renewable energy and transmission infrastructure might be built within Oregon over the next 15 years under the current State RPS and GHG policy goals to serve Oregon in-state demand. This study does not make any prescriptions or recommendations on where renewable energy development should happen in Oregon; rather, it analyzes the possible implications of a few different paths which the renewable energy development in Oregon could take within the study period.

Even though the analysis is forward-looking, it is important that this Market Assessment is grounded in the reality of Oregon's renewable energy development industry. Therefore, this analysis leverages the insights from both the renewable potential assessment and the Industry Assessment in its inputs and assumptions. The following sections below discuss the methods, inputs and assumptions, and results.

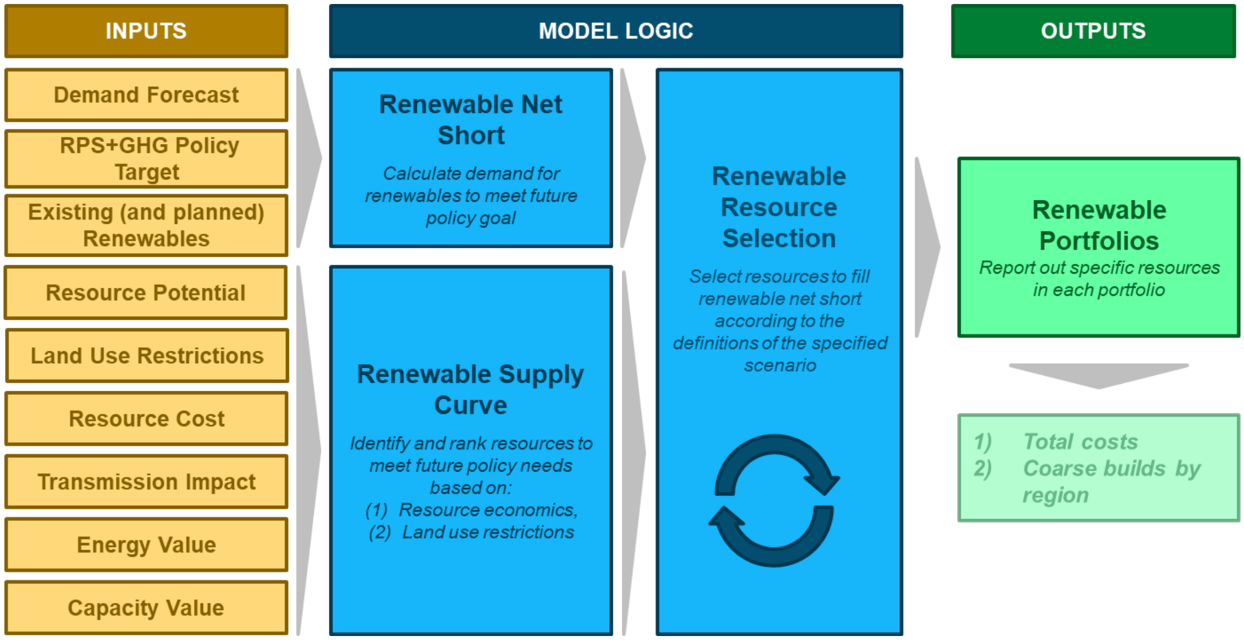
5.2 Methods and Assumptions

5.2.1 Modeling Approach

The model used in this study is a spreadsheet stack-model tool that aims to extract portfolios that meet Oregon's renewable energy demand over the next 15 years. The model is not meant to be a power-flow tool that analyzes the operational reliability of the resultant portfolios. It also does not explicitly consider such factors as ratepayer cost impacts, resource adequacy and reliability needs, and impacts of resource saturation. The focus is, rather, on defining multiple scenarios, determining portfolios that meet the renewable energy demand requirements across those scenarios, and understanding the land, transmission, and policy implications of such portfolios.

The goals of the modeling approach are: 1) to identify the need for renewables to meet future policy goals driven by the state's current RPS policy (referred to as the Renewable Net Short (RNS) in this study); 2) to curate a set of candidate renewable resources to fill the identified need (the "Renewable Supply Curve"); and 3) to select the least-cost portfolio from the renewable supply curve to fill the identified need. This approach is illustrated in the 'Model Logic' portion of the model schematic shown in Figure 5-1. A variety of inputs are needed to develop both the RNS and the Renewable Supply Curves. Key inputs are shown in the 'Inputs' section of the schematic. In particular, a demand forecast, an RPS target, and existing renewables all go into establishing the RNS.

Figure 5-1. Overview of modeling methodology used to design plausible development scenarios.



The model calculates the "net cost" for each candidate resource, taking the following factors into account:

- Cost of the resource;
- An estimate of the transmission upgrades (if any) needed to interconnect and deliver the resource;
- Integration costs for variable resources consistent with BPA tariffs;
- Energy value of the resource; and
- Capacity value of the resource.

Once the net cost has been calculated for each resource, the model fills in the RNS with a portfolio of resources that, together, have the lowest total cost to the system while meeting the RPS policy goals and scenario parameters. More details of the assumptions of the model are given in Section 5.2.4.

5.2.2 Scenarios

The analysis studied five scenarios. The scenarios chosen examined a range of potential outcomes that highlight a few key challenges and implications of achieving renewable energy development at scale within Oregon. The key themes explored in the scenario design are geography, technology, and transmission access.

Scenarios	
1. Low Renewable Demand	Analyzes a future with modest levels of renewable energy demand
2. Columbia Gorge Focus	Analyzes an emphasis on the continued development of new renewables within the Columbia River Gorge area

3. Central/Eastern Oregon Focus	Analyzes an emphasis on the development of the remote resources in the central and southeast portions of Oregon
4. Distributed Resource Focus	Analyzes an emphasis on the development of distributed resources near loads and limited availability of new bulk-transmission
5. Offshore Wind Focus	Analyzes the assumption of an addition of up to 1.5 GW of offshore wind by 2035 to meet Oregon's renewable energy demand

These scenarios were selected because they represent a wide range of plausible futures for renewable energy development in Oregon, considering various degrees of bulk-transmission availability and access, and various levels of geographic and technology readiness. Except for the Offshore Wind Focus scenario, all the scenarios have same assumptions on technology types and resource costs.

5.2.2.1 Low Renewable Demand

One of the major factors that will influence the level of renewable energy development that occurs within the state of Oregon is the extent to which utilities procure resources located outside the state to contribute to their RPS needs in Oregon. In their most recent IRPs, the preferred portfolios of both PGE and PacifiCorp include some out-of-state renewable resources. This scenario explores a future in which utilities rely to a significant extent on resources located outside the state, effectively limiting the amount of development that occurs within Oregon.

5.2.2.2 Columbia Gorge Focus

The overwhelming majority of the renewable energy projects currently operating in Oregon are within the Columbia River Gorge area. This scenario represents a future where this development paradigm is maintained. This scenario focuses access to the available transmission capacity, connected to the load centers in the Willamette Valley, on resources within the Columbia River Gorge area. This scenario explores a future in which the Gorge area remains the major hub for renewable energy development within the state.

5.2.2.3 Central/Eastern Oregon Focus

Oregon's best performing and largest potential for Solar PV resources is concentrated in the Central and South Eastern parts of the state. While there is some available transmission capacity in the Central area, the South Eastern area (with the best quality solar resource in the state) is severely transmission constrained. Further complicating this, the South East also does not have any large load centers that can be served if these resources are developed as distributed resources. The purpose of this scenario is to understand the impact on the rest of the state's renewable energy development if there was better transmission access to these high-quality resources east of the Cascades.

5.2.2.4 Distributed Resource Focus

As has been discussed in detail already, the access to bulk-transmission capacity is a significant challenge for renewable energy development in Oregon. Although there is currently some availability on the existing BPA transmission system, the market for that capacity is highly competitive, and there are no guarantees that the transmission headroom will be available for serving Oregon's renewable energy demand. This scenario investigates a future where access to the bulk-transmission system is constrained and there is a greater need for development of renewable resources closer to load centers.

5.2.2.5 Offshore Wind Focus

Results of a 2020 study by the Pacific Northwest National Laboratory (PNNL) "*Exploring the Grid Value Potential of Offshore Wind Energy in Oregon"* indicate that it is possible for over 2,000 MW of offshore wind to be carried by the current transmission system with relatively minimal upgrades. The PNNL study highlights some important points in the potential benefit of offshore wind to the Oregon grid as an independent resource and in the context of complementarity with other resources and transmission system utilization. Although the purpose of this study is different, the insights from the PNNL study informed the development of this scenario. This scenario explores the impact on the renewable energy development in the rest of the state, if about 1.5 GW of offshore wind resource is injected into the grid by 2035. This scenario is created by making the offshore wind resource and 1.5 GW of transmission available at zero cost starting in 2030 and letting the model select the quantity of offshore wind resource it requires, while selecting the other resources based on the least net-cost approach used in the other scenarios.

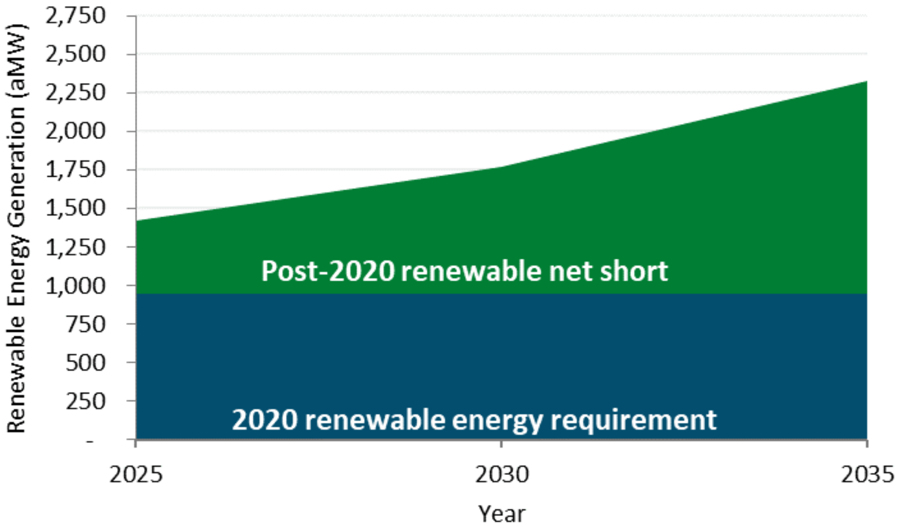
5.2.3 Renewable Demand

The answer to how much renewable energy development will happen in Oregon over the next fifteen years requires an understanding of some complicated regional dynamics. There are four key factors necessary for this answer: (1) what are Oregon's own renewable energy needs; (2) where will Oregon get its supply from; (3) what are the needs of the jurisdictions outside Oregon; and (4) where will these other jurisdictions get their supply from. A thorough analysis of these factors is beyond the scope of this study. But rather than being prescriptive in our determination of these factors, our analysis considers two bookend scenarios of different levels of renewable energy demand, which will cover a range of values for the four factors for Oregon and its regional neighbors.

- The **Low Renewable Demand** scenario reflects a future that is consistent with current utility plans for renewable energy procurement in Oregon.
- The **High Renewable Demand** scenarios represents additional renewable energy development in the state within the same timeframe.

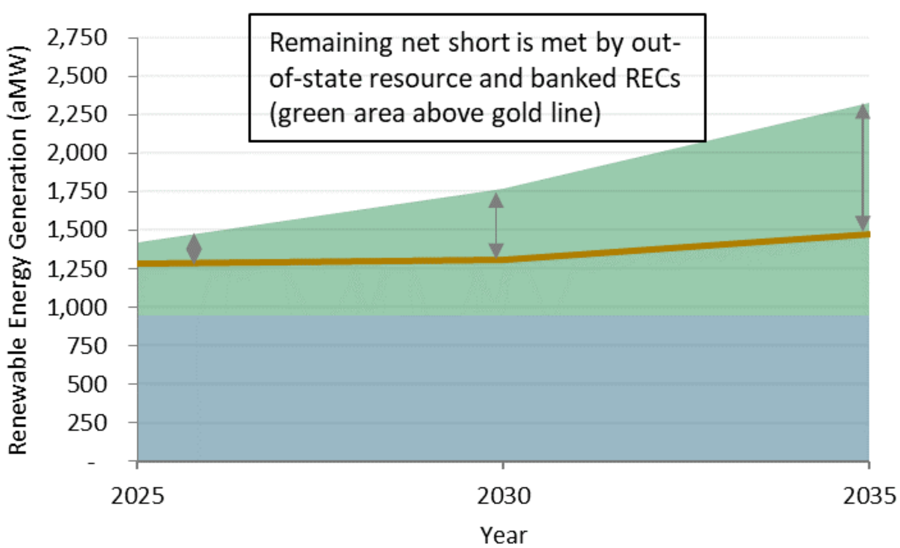
One of the most significant drivers of Oregon's renewable energy need will be its policy requirements. Oregon's current renewable energy policy is the RPS target set by SB 1547. Figure 5-2 shows our estimates of Oregon's renewable net short – the renewable energy requirements that need to be met by all the entities. These values are based on the Base trajectory of the retail sales forecast data used in the development of the Northwest Power and Conservation Council's (NWPCC) 2021 Northwest Power Plan.

Figure 5-2. Estimated Oregon RPS requirements for study period.



Based on the recent IRPs from the IOUs, a portion of the renewable energy needed to meet these goals currently may be provided by banked RECs and out-of-state (OOS) resources. Additionally, as discussed in Section 2.2.1, while there are statutory requirements for all of Oregon's utilities and electricity service suppliers, a number of utilities are exempt from these requirements due to their existing reliance on BPA hydro resources. Thus, based on current plans, the level of renewable energy development that occurs within the state of Oregon may be lower than the utilities' apparent renewable net short. Figure 5-3 shows how the potential reliance on out-of-state resources and banked RECs may affect the level of development of in-state renewable resources needed to meet Oregon's policy goals.

Figure 5-3. Estimate of renewable energy demand after accounting for RPS exemptions and current utility plans.

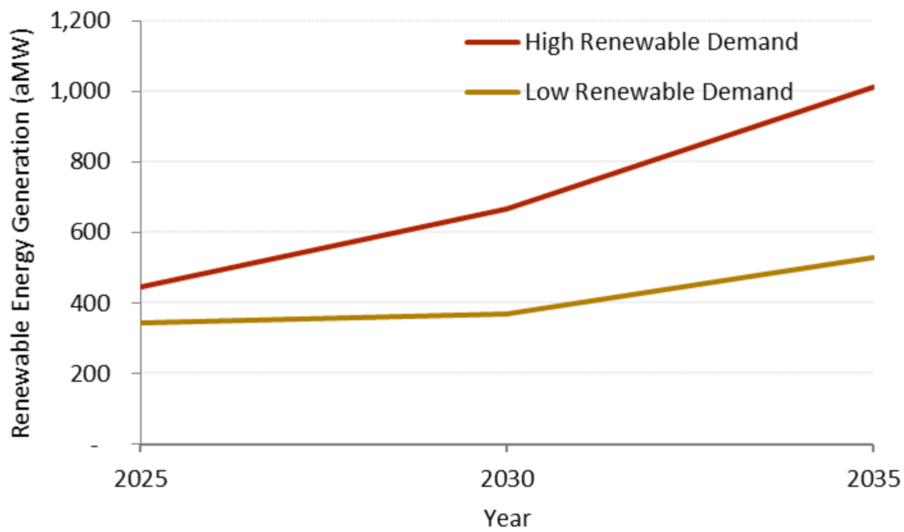


At the same time, many factors could drive higher renewable energy needs in Oregon, including increased in-state procurement by IOUs, more procurement of Oregon resources by regional entities, higher levels of voluntary and direct corporate procurement, increased loads with electrification, and changes to state clean energy policy. Thus, with a recognition of the scope of this analysis being limited to in-state Oregon renewable energy demand, we also designed a higher renewable energy demand scenario as well with certain assumptions:

+ Average in-state procurement of 70 percent between 2025 and 2035
+ High load forecast trajectory from the NWPCC draft data.

Figure 5-4 shows the final renewable energy demand scenarios used in this analysis.

Figure 5-4. Renewable energy demand scenarios used in this study.



5.2.4 Other Key Assumptions

5.2.4.1 Renewable Resource Options

Table 5-1 provides additional detail on the zonal breakdown of the potential identified in Siting Level 2.

Table 5-1. Siting level 2 resource potential (MW).

Zone	Geothermal	Onshore Wind	Offshore Wind	Solar PV (co-located with storage)
Central	212	21,316	-	416,754
North Central	-	23,206	-	217,134
Northeast	-	8,516	-	145,193

Northwest	45	-	-	169,616
Offshore	-	-	29,291	-
Southeast	24	14,199	-	187,222
Southwest	53	3,423	-	115,653
Total	334	70,660	29,291	1,251,572

Distributed generation resources are not modeled as independent candidate resources in this analysis. For the purpose of the modeling, we have assumed that 50 percent of all the solar and storage that is developed to meet demand within the zones ("local needs") are allocated to the distributed solar and storage resource. As is shown in Section 5.3 below, this results in an equal split between utility-scale solar + storage and distributed solar and storage resources in all but the Central Oregon Focus Scenario. Future analyses that incorporate least-cost optimizations and account for cost externalities will be better equipped to evaluate the likelihood of distinct distributed resources being selected in portfolios.

Additionally, because this study is focused on new renewable energy development, it does not consider the repowering of onshore wind resources to meet new renewable energy demand. The analysis assumes that all existing generation remain with their contract holders through the study period.

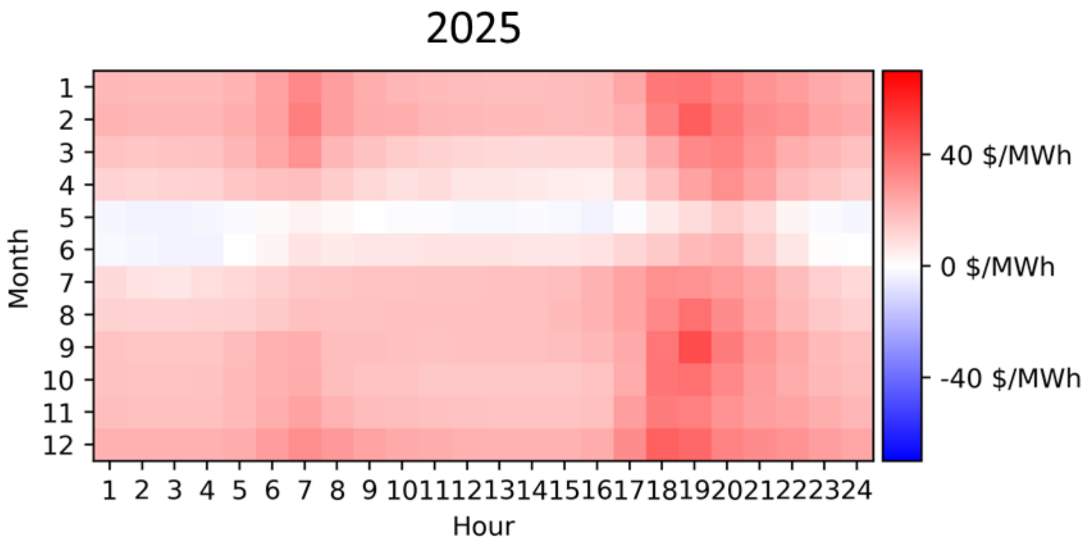
5.2.4.2 Resource Costs

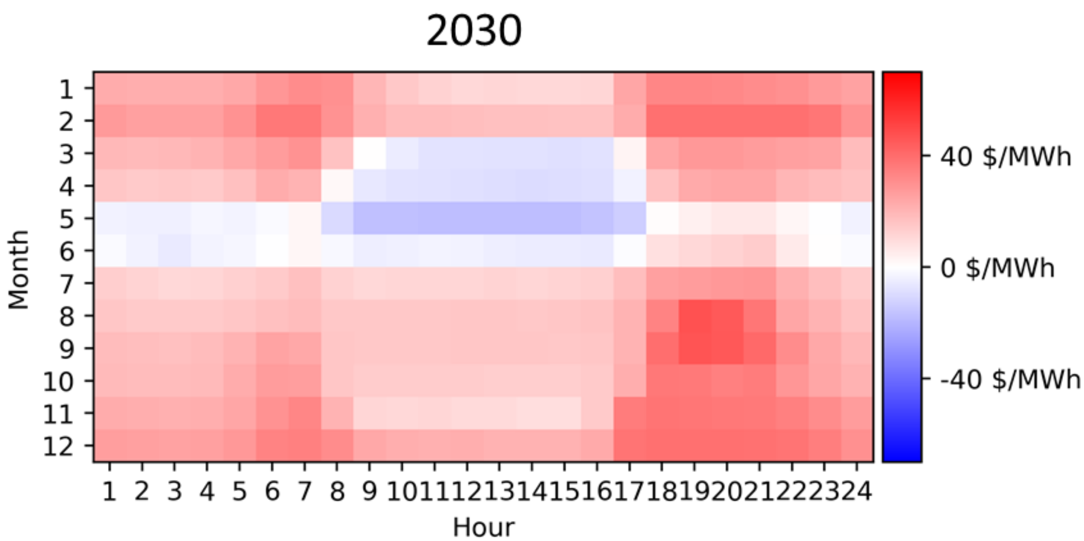
The costs of developing solar PV, onshore wind, and geothermal resources in Oregon were based on technology costs reported in the 2020 NREL Annual Technology Baseline. The costs of 4-hour battery storage resources paired with the solar PV resources was derived from the LCOS 5.0. Offshore wind technology costs were adopted from a 2019 NREL report that studied offshore wind grid potential in Oregon. The technology costs from these data sources were processed in a pro forma that computed long-term levelized cost trajectories for each resource class based on a number of financing assumptions.

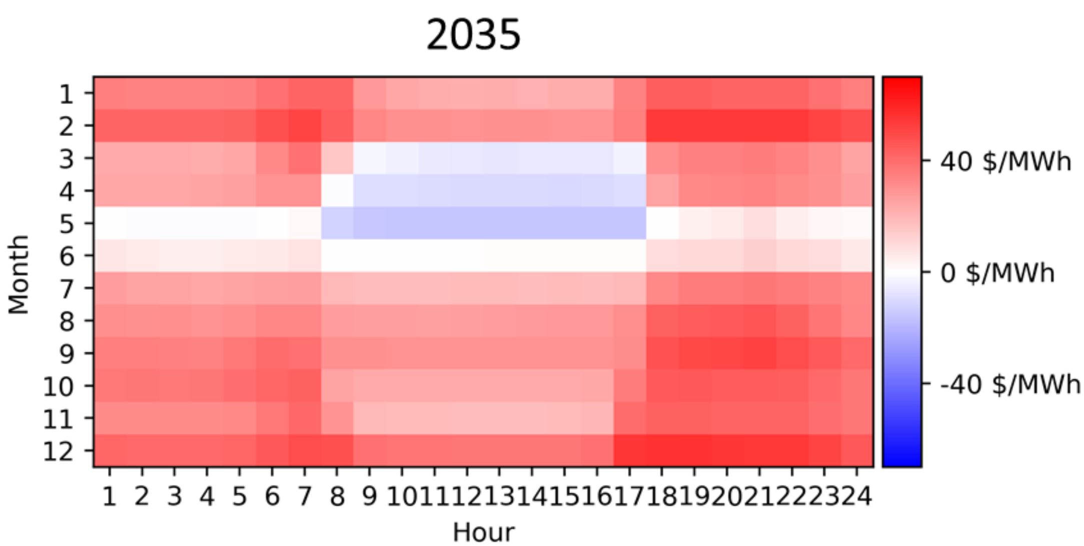
5.2.4.3 Energy Value

We estimated the energy value of resources included in the supply curve to compute their net cost. We used a long-term hourly energy price forecast in combination with expected hourly generation profiles for variable resources to compute the energy value of these resources. The energy price forecast was developed using AURORA, a long-term capacity expansion and energy production simulation tool. The price forecast reflects long-term energy price trends in the Pacific Northwest and encapsulates a number of predictions about future generation capacity development in the Pacific Northwest and the broader Western Interconnection driven by long-term trends in commodity prices, energy and climate policy, and demand growth driven by energy efficiency and electric vehicle adoption. Under the assumption that renewable resources developed in Oregon will be price-takers, the energy value computed by multiplying expected generation profiles with the long-term hourly price forecast reflects long-term trends in the energy value of renewable resources in the state.

Figure 5-5. Heat map of the assumed wholesale energy prices.


2025
Month
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
40 $/MWh
0 $/MWh
-40 $/MWh


2030
Month
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
40 $/MWh
0 $/MWh
-40 $/MWh


2035
Month
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24
Hour
40 $/MWh
0 $/MWh
-40 $/MWh

One of the most distinctive characteristics of the future wholesale price assumptions used in this study is the high frequency of low – occasionally negative – energy prices during the daytime. This dynamic is a result of the increasing penetration of solar throughout the Western grid, which leads to daytime periods – especially during the spring – that drive down the marginal cost of generation. This is apparent in the diurnal and seasonal trends shown in Figure 5-5 and has implications for renewable energy development in Oregon, where the diversity of potential resources – onshore and offshore wind, geothermal, storage – could serve as a natural hedge against increasingly low daytime prices.

5.2.4.4 Capacity Value

We estimated the capacity value of resources included in the supply curve to compute their net cost. Capacity value is the value attributed to a resource for its contribution to resource adequacy, and is typically expressed in units of $/kW-yr. We assumed a capacity price of 103 $/kW-yr, adopting this figure from the 2019 Integrated Resource Plan of Portland General Electric. The capacity price is based on the levelized fixed cost of new gas-fired combustion turbines as a proxy for the avoided cost of new capacity.

As variable energy resources like wind and solar do not provide firm capacity, it is necessary to discount their capacity value by a capacity contribution factor to accurately reflect these resources' contribution to resource adequacy. We adopted capacity contribution factors from publicly available data sources, including utility integrated resource plans, to estimate the capacity value of wind, solar, and hybrid solar + storage resources in the supply curve. For geothermal resources, the capacity contribution factor was approximated from geothermal forced outage rates and capacity factors that were adopted from utility integrated resource plans. Therefore, each renewable resource type was assigned a capacity value that was factored into the resource net cost.

We note that this method of assigning capacity value to variable resources does not account dynamically for "saturation effects," wherein the marginal capacity value of a resource diminishes as more of it is added to the grid. For example, as more solar is added to the grid, the marginal contribution of new solar resources to resource adequacy diminishes since existing solar resources have likely begun to shift peak net load hours away from daytime hours into early morning, late evening, or even nighttime hours, when solar is unavailable to generate electricity. Therefore, new solar resources become less likely to contribute to meeting peak net demand due to the saturation of solar resources on the grid.

5.2.4.5 Transmission

Our modeling simulated the development of renewable resources in tandem with bulk transmission system investments that would allow the delivery of renewable energy to load centers in Oregon, and transmission availability within local transmission and distribution systems for delivery of generation from distributed resources close to load. While our modeling did not explicitly simulate bulk system and distribution system power flows nor directly co-optimize investments in renewable generation and transmission, it did take into account the topology of the existing transmission system in Oregon to design seven "transmission zones" that were key to our modeling and analysis of geographic patterns of renewables development in Oregon.

In particular, we relied on flowgate data from BPA to identify important transmission corridors in Oregon. These transmission corridors and flowgates provided natural boundaries for the seven transmission zones used in our modeling. Additionally, the flowgate data provided information about available transmission capacity through these transmission corridors, which informed the design of the zonal transmission supply curves in our model.

For the available capacity on the local transmission and distribution system, we estimated the value assuming a percentage of the annual served load within each of the zones that could be met by local generation. The load information was derived from annual served load for all utilities and electricity service suppliers in Oregon.[62] These annual numbers were allocated using the transmission zones, and then the assumed percentage was applied. The capacity in MW needed to transmit this quantity of generation represents the available local transmission capacity that is independent of the bulk transmission system. For the Distributed Resource scenario we assumed a value of 10 percent while all other scenarios use an assumption of 5 percent. Table 5-2 below shows a summary of the transmission capacity assumptions used in all the scenarios.

Table 5-2. Available bulk and local transmission capacity for all scenarios.

	Low Renewable Demand	Columbia Gorge	Central Oregon	Distributed Energy	Offshore Wind
Zone	Transmission Capacity (MW)				
Central	104	104	1495	208	104
North Central	1872	1872	481	1894	1872
Northeast	65	65	65	130	65
Northwest	572	572	572	1144	572
Offshore	0	0	0	0	1500
Southeast	18	18	18	36	18
Southwest	122	122	122	244	122

Other inputs to the zonal transmission supply curve in our model included transmission project cost estimates, which were derived from data provided by the Northwest Power Pool. These costs were representative of the construction costs for new transmission development at various voltage levels and three different cost categories: (1) urban or high; (2) medium; and (3) rural or low. Table 5-3 shows the cost assumptions used in this study.

[62] Derived from the 2018 Oregon Department of Environmental Quality Reported Greenhouse Gas Emissions for Electricity Suppliers data. Available at: https://www.oregon.gov/deq/aq/programs/Pages/GHG-Emissions.aspx

Table 5-3. Cost assumptions for new transmission development for all scenarios

Zone	Cost Category	Cost ($Millions)	Cost ($/MW)
Central	Mid and High	$1,430	$953,306
North Central	Mid and High	$1,098	$731,973
Northeast	Mid and High	$1,534	$1,022,639
Northwest	High	$528	$351,837
Offshore	High	$1,267	$844,408
Southeast	Mid and High	$1,830	$1,219,973
Southwest	Mid	$880	$586,667

For the Distributed Resource Focus scenario, transmission costs for the Central North Central, Northeast, and Southeast zones were based entirely on the High cost category rather than the combination of Mid and High used in the other scenarios. For the Offshore Wind Focus scenario, the cost of transmission for the Offshore zone is assumed to be zero, because the purpose of that scenario is to understand the impact of a significant buildout of the offshore wind resource.

5.3 Results

The results of each of the scenarios analyzed are discussed below. Each set of scenario results presents the selected resource builds aggregated by technology and by zone, in five-year increments starting in 2025. As earlier stated, the results presented in this study are not meant to be prescriptive, rather they are illustrative of plausible outcomes for renewable energy development in Oregon over the next fifteen years.

Figure 5-6. New renewable resource additions by 2035, All Scenarios.

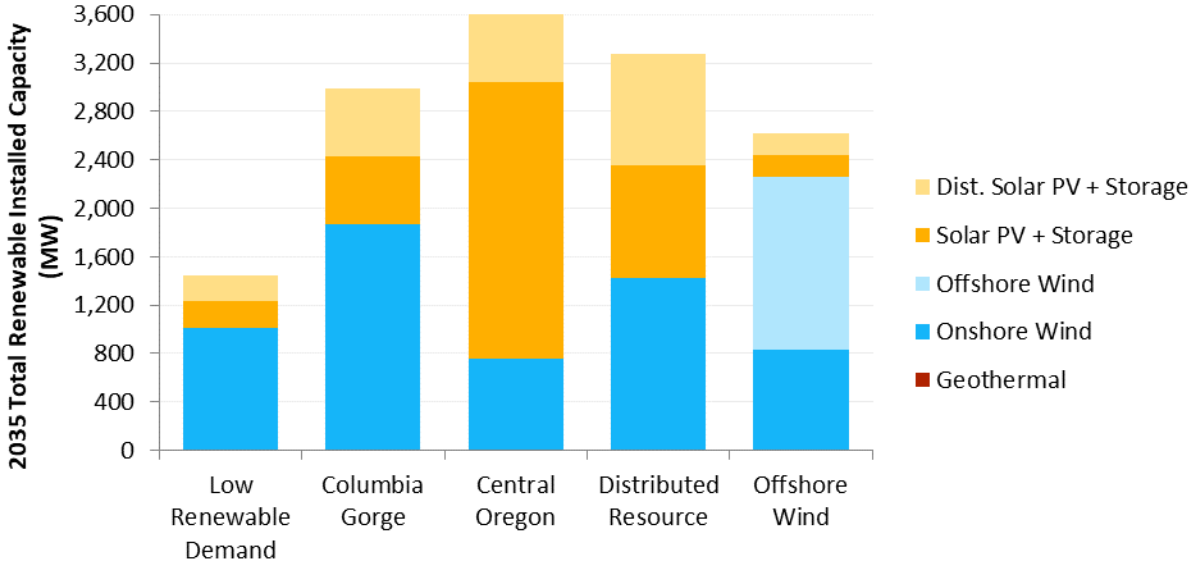


Table 5-4. Summary of results and implications across scenarios.

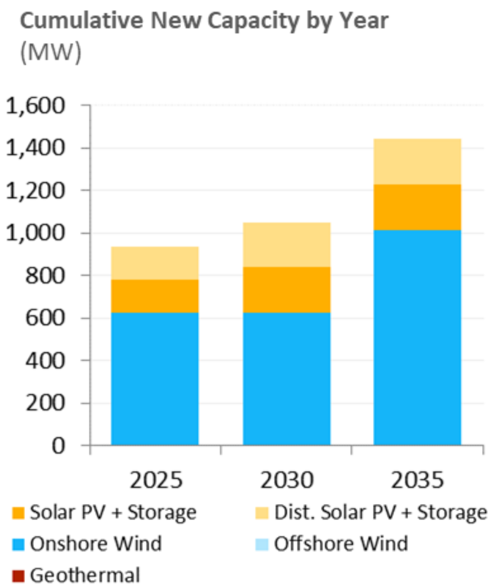
		Low Renewable Demand	Columbia Gorge	Central Oregon	Distributed	Offshore Wind
New Resources by 2035 (MW)	Geothermal	-	-	4 MW	-	-
	Solar	213 MW	563 MW	2,295 MW	926 MW	181 MW
	Solar (Dist.)	213 MW	563 MW	581 MW	926 MW	181 MW
	Wind (Onshore)	1,016 MW	1,866 MW	749 MW	1,426 MW	836 MW
	Wind (Offshore)	-	-	-	-	1,420 MW
	Total	1,442 MW	2,992 MW	3,629 MW	3,278 MW	2,618 MW
Consistency with Commercial Interest in new development		Limited development reflects low investment in the state compared to present commercial interest	Resource mix weighted towards wind reflects a shift – but may be driven by regional economics	Resource mix weighted towards solar is most consistent with current developer activity	Reflects an increase in commercial interest in DER, interconnection at subtransmission and distribution level voltages, and local resilience	Primary reliance on offshore wind reflects a pivot from today's commercial activity
Transmission		With limited development, impacts on transmission are limited	Further development in the Gorge will strain existing system, requiring either transmission expansion or optimization and more flexible use of existing system (e.g., energy-only projects)	Gathering infrastructure (e.g., collector substations); colocating solar & storage or standalone storage can help mitigate need for upgrades; regional transmission planning may support current lack of infrastructure in this area.	Proximity of resources to load centers may mitigate transmission impacts; further study of hosting capacity of local systems is needed to understand local impacts; will likely still strain the existing transmission system due to the significant development in the Gorge	Large-scale development of offshore wind will change transmission flows dramatically, and possibly alleviate the current transmission constraints; upgrades west of the Cascades may be required but further study is necessary
Land Use		With limited development, conflicts with land use are likely limited	Many of best sites are gone, and further development will likely require close coordination with the military	Significant development in central Oregon suggests close	Increased deployment of DER like rooftop solar systems, co-located solar & storage, and standalone storage may reduce pressure on siting & permitting processes	Development of offshore wind will require close coordination

				coordination with military will be needed. This level of development will also need to be conscious of potential environmental impacts (such as sage grouse habitat)		with ocean users, coastal communities, and multiple state and federal agencies including the military
Cost		Limited costs associated with renewable development	Limited costs associated with renewable development, but transmission costs could be significant	Limited costs associated with renewable development, but transmission costs could be significant	Increased focus on distributed & rooftop resources likely to translate to higher resource costs, although these resources might offset some fraction of the costs of investment in bulk generation and transmission upgrades, and contribute toward increased local resilience and customer preferences	Limited data on the costs of floating offshore wind generation and costs transmission upgrades that could be necessary to support interconnection to the onshore grid
Technology Risk		Development relies on today's commercial technologies and presents limited risk	Development relies on today's commercial technologies and presents limited risk	Development relies on today's commercial technologies and presents limited risk	Development relies on today's commercial technologies and presents limited risk	Floating offshore wind has not yet been widely deployed in the United States or across the world, and may encounter unexpected challenges in development and operations

5.3.1 Low Renewable Demand

This scenario examines a business-as-usual future where modest levels of renewable energy development occur within Oregon. Currently, a significant portion of the renewable energy demand within the state is met using out-of-state resources. Although this study is not explicit on the causes for low renewable energy demand within the state, this scenario explores certain assumptions for key drivers that could lead to such a future, including low load growth, continued availability of out-of-state resources to meet Oregon RPS policy and voluntary clean energy procurement needs, and low demand for Oregon resources from out-of-state utilities and load-serving entities.

Figure 5-7. New renewable resource additions through 2035, Low Renewable Demand Scenario.



2035 New Capacity by Zone
(MW)

Zone	Solar & Storage	Distr. Solar & Storage	Onshore Wind	Offshore Wind	Geothermal
Central	57	57	-	-	-
North Central	6	6	948	-	-
Northeast	13	13	68	-	-
Northwest	58	58	-	-	-
Offshore	-	-	-	-	-
Southeast	6	6	-	-	-
Southwest	73	73	-	-	-
Total	**213**	**213**	**1,016**	**-**	**-**

As shown in Figure 5-7, this scenario results in modest buildouts of two primary resource types: (1) new onshore wind resources, primarily located in the Columbia River Gorge, and (2) new solar PV resources located near load centers. This scenario accounts for about 394 MW of wind resources under construction in the Columbia River Gorge area scheduled to begin operation before 2025. Beyond these under-construction wind resources there is limited additional new wind development. Complementing the new wind resources are solar PV resources that are close to load centers, where we presume they can be injected into the system and avoid the need for significant transmission upgrades or development of new transmission infrastructure.

There are a few different factors that can make this outcome probable, a couple of them are discussed below:

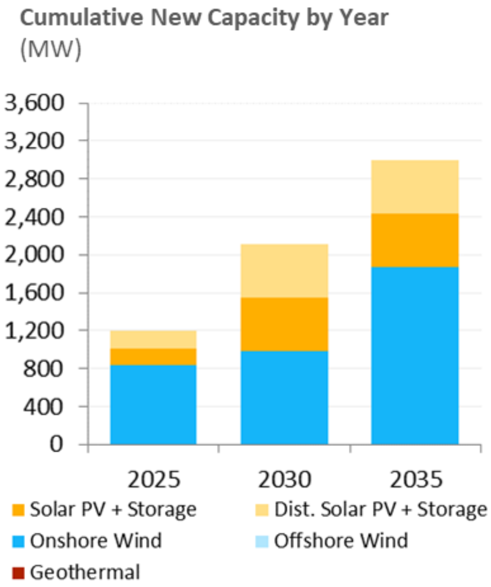
+ **Oregon's clean energy policy is not increased.** Compared to three of its closest neighbors – California, Washington, and Nevada – who all have clean energy standards or goals of 100 percent by 2045/2050, Oregon's RPS target of 50 percent by 2040 is a modest requirement. This result implies that over the next fifteen years Oregon will add about 70 percent more new solar PV resources to its current fleet, and about 30 percent more new resources to its wind generation portfolio. When viewed beside the renewable energy development over the last ten years, in which Oregon doubled the size of its wind assets and developed its entire solar portfolio, this scenario seems to reflect a trend toward tapering growth in renewable energy development in the state. This is a plausible outcome if the renewable energy requirements for its utilities remain modest and voluntary renewable energy programs are low.

+ **Reliance on out-of-state resources.** Implicit in this scenario's design is the assumption that about 65 percent of the incremental renewable energy requirements for IOUs will be supplied by out-of-state resources and/or RECs. For this outcome to be plausible it would require transmission access for out-of-state resources to remain available to deliver the generation to Oregon utilities. It would also mean that Oregon's access to these resources is unhindered by the more aggressive clean energy policies of its neighboring states, some of which will require the generation from the same out-of-state resources to meet their targets.

5.3.2 Columbia Gorge Focus

This scenario – as well as all subsequent scenarios analyzed – examines a future in which increased levels of renewable energy development occur within the state of Oregon. While the study remains agnostic to the specific drivers of the higher level of development relative to the Low Renewable Demand scenario, multiple factors could drive towards this outcome, including increased interest from Oregon utilities in contracting for in-state resources to meet RPS needs, interest from out-of-state utilities in search of resource diversity to meet their own increasing clean energy needs, or procurement to meet voluntary & corporate goals.

Figure 5-8. New renewable resource additions through 2035, Columbia Gorge scenario.



2035 New Capacity by Zone
(MW)

Zone	Solar & Storage	Distr. Solar & Storage	Onshore Wind	Offshore Wind	Geothermal
Central	57	57	-	-	-
North Central	6	6	1798	-	-
Northeast	13	13	68	-	-
Northwest	409	409	-	-	-
Offshore	-	-	-	-	-
Southeast	6	6	-	-	-
Southwest	73	73	-	-	-
Total	**563**	**563**	**1,866**	**-**	**-**

As shown above, this scenario results in notable buildouts of two primary resource types similar to the BAU scenario: (1) new onshore wind resources located in the Columbia River Gorge, and (2) new solar PV resources located near load centers, predominantly in the Northwest portion of the state. The new onshore wind resources add to an already significant base of capacity in the Columbia River Gorge (about 3,200 MW in Oregon today, and an additional 1,600 MW in Washington), reflecting the continuation of the region as a hotspot for renewable energy development. These new wind resources are paired with solar PV resources located closer to load centers, where they are presumed to be able to take advantage of the local transmission networks to help avoid the need for costly new major transmission upgrades.

Multiple factors could lead towards this outcome, one example is:

+ **Favorable economics for wind resources.** The relative economic competitiveness of solar and wind projects in Oregon is uncertain and depends on a range of factors. These include the relative costs of solar and wind resources themselves, the cost of energy storage (often paired with solar), and the level of solar saturation across broader Western markets. While these uncertainties make it difficult to predict today which resource will present a lower net cost option by 2035, the quality and potential of Oregon's Columbia Gorge wind resources are high enough that a large buildout of wind in the region is a plausible outcome to contribute to increasing policy goals of utilities in Oregon and neighboring states.

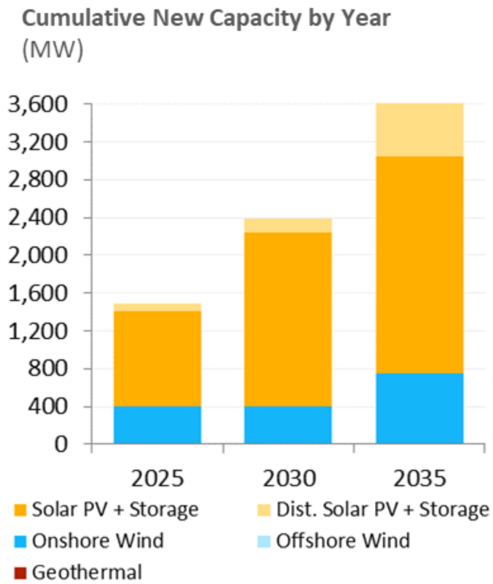
At the same time, achieving this buildout also presents several notable challenges specific to the resources considered herein:

+ **Transmission constraints & potential new investments.** The addition of 1,800 MW of new wind capacity will strain the capability of the existing transmission system to deliver energy from the Gorge area into the major load centers west of the Cascades. At the time of this study, BPA's Cross Cascades South flowgate has 743 MW of available transfer capability (ATC) and 1,849 MW of conditional firm inventory (CFI) available in 2030, suggesting that a buildout of this magnitude may be technically feasible but may also result in periods of congestion and curtailment if all energy is to be delivered to Oregon's major load centers. Additional analysis will be needed to understand and characterize the capability of the existing transmission system to accommodate large renewable energy buildouts given the potential for high quality wind (and possibly solar) resources within this area. To the extent that new transmission would be required to achieve a buildout of this magnitude, this would present a significant barrier to this outcome, as the cost and permitting challenges of expanding transmission across the Cascades are significant.
+ **Tradeoffs between high value urban/suburban land and higher cost rooftops.** This scenario includes 1,000 MW of new solar PV resources by 2035, most of which are located in or near the load centers of northwestern Oregon under the premise that local transmission and distribution infrastructure can be put to use to deliver smaller scale solar installations directly to loads. Capitalizing upon this potential is possible with both small-scale ground-mounted solar PV or rooftop PV; the former will generally have lower costs but may conflict with other high value options for land use; the latter mitigates the need for high-value land but is generally higher cost and lower quality. Additional study of local subtransmission and distribution networks may also be

needed to understand the extent to which solar PV resources can be installed locally without major requirements for new distribution infrastructure.

5.3.3 Central/Eastern Oregon Focus

Figure 5-9. New renewable resource additions through 2035, Central/Easter Oregon Scenario.



2035 New Capacity by Zone
(MW)

Zone	Solar & Storage	Distr. Solar & Storage	Onshore Wind	Offshore Wind	Geothermal
Central	1,789	75	-	-	4
North Central	6	6	681	-	-
Northeast	13	13	68	-	-
Northwest	409	409	-	-	-
Offshore	-	-	-	-	-
Southeast	6	6	-	-	-
Southwest	73	73	-	-	-
Total	**2, 295**	**581**	**749**	**-**	**4**

This scenario also results in buildouts of primarily solar PV and new onshore wind resources, shown in Figure 5-9 above. The scenario develops solar PV resources that are both close to load and utilize the available transmission that is made accessible. The solar PV development is complemented by onshore wind development, once again predominantly in the Columbia River Gorge area. The scenario also shows a small amount of geothermal build, but the quantity is not large enough to be indicative of any trends or implications that should be considered in detail.

This scenario presents the largest amount of total new renewable resource additions of all of the scenarios analyzed. This is in large part due to solar resources having lower capacity factors than onshore wind, thus needing more nameplate capacity to deliver the same amount of generation.

There are several factors that could make this outcome a reality, a key one is discussed below:

+ **Increased developer interest in solar.** This scenario reflects a future portfolio that is the most consistent with current commercial interest as represented in the EFSC list of project applications for new development. Many developers are looking to deploy hybrid solar PV + storage projects in regions east of the Cascades. Some developers and utilities have expressed concerns about the saturation of the Columbia River Gorge with wind development, and solar PV paired with storage can provide diversity to the portfolio.

- **Good quality solar resource in central and southeastern Oregon.** Although this scenario focuses on the central Oregon area because it is less transmission constrained, there is significant solar resource potential in the southeastern part of the state.

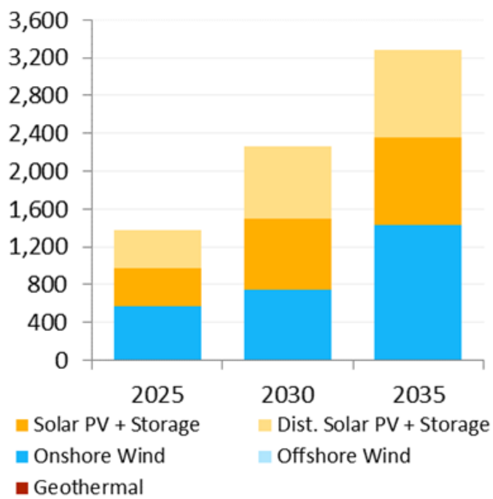
There are also a few challenges that need to be addressed if this outcome is to be considered in earnest:

- **Transmission interconnection can be costly.** The locations with the best solar resources in the central and southeastern parts of the state also happen to be significantly transmission constrained. This scenario adds about 1,800 MW of new utility scale solar which is assumed to be using available headroom on the Northwest AC Intertie line. Some stakeholders believe that this transmission line does not have enough available capacity. If the capacity was available, as is assumed in this scenario, a lot of the new resource additions will likely require lower voltage gathering systems before they can connect to the high voltage system. And a lot of these gathering systems will likely be within areas that fall under COU and PUD jurisdiction, meaning developers would first need to contract with the COUs and PUDs before contracting with the bulk grid transmission providers like BPA, PGE, and PacifiCorp. The implications here are increased costs for developers and the associated ratepayers and navigating lengthy approval processes. has All of which have an impact on the economics of renewable energy development.
- **Competition for transmission access.** The critical assumption in this scenario is that all 1,400 MW of ATC on the Northwest AC Intertie has access to the available headroom on the Cross Cascades South flowgate. In reality, there are several players competing for the access to that transmission headroom. Currently, on the EFSC application list, all 750 MW of EFSC approved solar projects are within Wasco, Gilliam, and Morrow counties in the north central area, and about 800 MW of 2,000 MW of EFSC proposed projects are located in the central area. As such, a lot of the solar PV development indicated in this portfolio could also come from the north central part of the state based on the inventory of approved and proposed renewable energy projects under EFSC jurisdiction.
- **Land use concerns in central and southeastern Oregon.** The central and southeastern parts of the state have the greatest concentration of special use airspace, military flight corridors, sage grouse habitat, and other sensitive areas. Although this scenario takes those land use factors into account in the analysis, it is important to recognize that these areas typically require additional consultation. This scenario includes 1,800 MW of utility scale solar in a region that currently has less than 100 MW of solar development. That level of ramp-up of development will need to be executed with caution to ensure conflicts are avoided or resolved early.

5.3.4 Distributed Resource Focus

Figure 5-10. New renewable resource additions through 2035, Distributed Resource Scenario.

Cumulative New Capacity by Year
(MW)



2035 New Capacity by Zone
(MW)

Zone	Solar & Storage	Distr. Solar & Storage	Onshore Wind	Offshore Wind	Geothermal
Central	135	135	-	-	-
North Central	28	28	1,359	-	-
Northeast	60	60	68	-	-
Northwest	527	527	-	-	-
Offshore	-	-	-	-	-
Southeast	6	6	-	-	-
Southwest	170	170	-	-	-
Total	**926**	**926**	**1,426**	**-**	**-**

As shown in Figure 5-10 above, this scenario reflects a portfolio that is almost evenly balanced between solar PV development and onshore wind development. The utilization of local transmission closer to load in developing solar PV resources minimizes reliance on bulk transmission that is often constrained and creates an opportunity for continued development of onshore wind on existing bulk transmission, primarily in the Columbia River Gorge. Increasing generation closer to load favors the development of solar PV resources, and this is more pronounced in the northwest which has the most concentrated load centers.

There are multiple factors and challenges associated with such an outcome that should be considered:

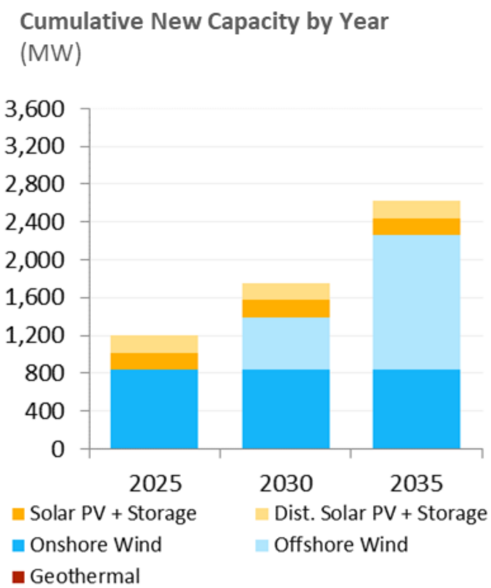
+ **Alternatives to some transmission upgrades.** The deployment of generation closer to loads can help avoid costly bulk-transmission system upgrades, or even costlier new transmission infrastructure. This is particularly relevant in Oregon where one of the more significant challenges is delivering generation across the Cascades to the urban centers in the Willamette Valley area. The opportunity to generate closer to load centers opens up more options for usage of the high voltage transmission lines that cut across the state.
+ **Land use restrictions on solar development.** This scenario reflects over 1,000 MW of total solar PV (utility-scale and distributed) development in the northwestern portion of the state. This is particularly notable because of the current limitations on development of solar on high-value prime farmland areas, a policy which mostly affects the Willamette Valley area. The development of the amounts of solar PV indicated in this scenario will require some amounts of ground-mounted solar, and with the current land use rules this could be challenging.
+ **Local transmission and distribution system impacts.** This scenario includes 900 MW of generation from distributed resources at the local transmission and distribution level close to large load

centers. In most of the zones, it is unclear if the magnitudes of additional renewable generation will have significant impact on the subtransmission system. With the 530 MW deployed in the northwest, additional study to see if there are any power flow challenges with local grids, and if new distribution infrastructure will be required, would likely be beneficial.

+ **Tradeoffs between high value urban/suburban land and higher cost rooftops.** As discussed in the Columbia River Gorge scenario deploying significant amounts of distributed resources will require tradeoffs between the higher property and permitting costs of developing projects on high-value land (especially the high-value farmland) and lower capacity factors and economies of scale of rooftop solar. This consideration is even more relevant in this scenario, because of the increased amounts of distributed resources selected in this scenario. Finding the right balance between the economies of scale with ground-mounted resources and less land-intensive rooftop solar resources will be crucial for the outcome presented in this scenario.

5.3.5 Offshore Wind Focus

Figure 5-11. New renewable resource additions through 2035, Offshore Wind Scenario.



2035 New Capacity by Zone
(MW)

Zone	Solar & Storage	Distr. Solar & Storage	Onshore Wind	Offshore Wind	Geothermal
Central	57	57	-	-	-
North Central	6	6	768	-	-
Northeast	13	13	68	-	-
Northwest	26	26	-	-	-
Offshore	-	-	-	1,420	-
Southeast	6	6	-	-	-
Southwest	73	73	-	-	-
Total	**181**	**181**	**836**	**1,420**	**-**

This scenario is designed such that offshore wind is available to be selected at zero cost for the resource and associated transmission starting in 2030. As such the portfolio is dominated by new offshore wind resources, as shown in Figure 5-11. The new offshore wind resources are paired with onshore wind, and solar PV resources located close to large load centers. This scenario has the lowest total of new renewable resource additions of all the four high renewable energy demand scenarios analyzed due to the large and consistent output of Oregon's offshore wind resource.

There are several considerations to be discussed for the outcome presented in this scenario.

+ **Offers resource-diversity and economic benefits.** Several analyses on the grid and economic benefits of offshore wind have shown it is a valuable resource for electric systems looking to achieve high levels of renewable energy penetration. The high capacity factor and the generation profile mean that offshore wind has great complementarity with solar PV resources, because it can provide power during the evening hours when there is no solar generation (and storing solar for evening and overnight dispatch can require longer duration storage that is more costly). Offshore wind also has job benefits because of the large supply chain for installation, operations, and maintenance. Oregon has significant resource potential and can be a hub for development that can meet Oregon's and regional renewable energy demand.

+ **Transmission flow benefits.** As has been discussed previously, one of the challenges of Oregon's current transmission system, is that the best performing renewable resources require transmission to deliver their generation to the load centers in the northwestern part of the state. This means the predominant utilization of the transmission system is in an east – to – west direction. One of the more significant findings related to the potential development of offshore wind is that the injection of 1.5 GW of offshore wind to serve the loads in the western parts of the state could relieve constrained transmission pathways east of the Cascades. Further study of the contractual implications of offshore wind development could clarify its impact on facilitating renewables development in the Columbia Gorge area and other areas where transmission is currently constrained.

+ **Uncertainty around available transmission headroom**. The 2020 PNNL study indicates that up to 2,000 MW of offshore wind resource can be injected into the grid before the system experiences minimal wind curtailment and that offshore wind could serve 1 GW of coastal loads. This scenario is designed based on a similar assumption of the amount of offshore wind injected into the grid, to see the impact on renewable energy development in the rest of the state. However, this scenario does not consider the contractual allocations on the coastal transmission system, or the transmission upgrade costs necessary to accommodate large scale offshore wind resources. The PNNL study acknowledges that transmission along the coastline is limited and requires significant maintenance investments. So, while the physical flow limits may be able to accommodate the injection of the quantities of offshore wind shown in this portfolio, additional analysis of the available transmission headroom on the coastal system, the length of the current contracts for transmission service rights on the existing transmission capacity, and the additional transmission upgrade costs needed to integrate up to 1.5 GW of offshore wind will be necessary for this outcome to be feasible.

+ **Uncertain policy and economic landscape.** At its current cost level, it is difficult for offshore wind to compete favorably with onshore wind and hybrid solar + storage resources. Further, with no floating offshore wind projects currently in operation in the US, the resource does not enjoy the same level of technology maturity and cost-competitiveness that these other technologies benefit from. States on the East Coast have instituted carve-outs and mandates for offshore wind (New York has the single largest commitment of 9,000 MW by 2035) that will help drive development of offshore wind because developers can leverage economies of scale, and this will eventually help mature the offshore wind industry and reduce costs – certainly for fixed-bottom offshore wind, and potentially floating offshore wind as well. The policy landscape in Oregon and the other Pacific coastal jurisdictions is less certain. In addition, the call area process led by the Bureau of Ocean Energy Management (BOEM) is less advanced than it is on the East Coast. Currently, California has three call areas, while Oregon and Washington have none, and no lease auctions have been scheduled to date – though BOEM is currently engaged in a public process that could lead to an Oregon call area in the future.[63] The implication is that, in order for offshore wind to economically serve the loads of Oregon utilities Oregon policy support may be needed in the near-term.

[63] Bureau of Ocean Energy Management, Oregon activities. https://www.boem.gov/Oregon

6 Conclusions

6.1 Key Takeaways

This study was undertaken because the state of Oregon is looking to create a deeper understanding of the challenges, opportunities, and potential conflicts that its renewable energy industry has today and will experience over the next fifteen years. As the deployment of renewable resources progresses from a primarily policy-dependent phase to a more established economic viability, the challenges that come with siting, development, administration, and operation of these renewable resources will need to be tackled proactively. This study is set up to start the conversations around some of the core topics associated with the renewable energy development landscape in Oregon and presents some insights that are based on scenario analysis and direct industry feedback.

The following conclusions are synthesized from all the analysis conducted in this study. Our goal is for them to help build understanding for the ODOE, and other state, local, and federal agencies, of the issues that should be addressed and actions that need to be taken to support the renewable energy development industry over the next fifteen years. Ultimately, we believe the conversations started by these results will help Oregon achieve its long-term energy goals.

+ **Solving the challenge of transmission access will be key to the future of renewable energy development in the state.** The challenges facing the bulk and local transmission systems are multifaceted, interrelated, and complicated. However, there are some possible solutions raised by respondents for some of the key issues identified in the different analyses in this study. To develop new transmission infrastructure, potential improvements suggested by respondents that could help the perceived challenges include: procedural reforms to the siting and permitting processes to reduce the perceived long-lead times and high expenses; increased consistency across utility interconnection protocol and actions, to improve efficiency of interconnection processes such as Pacificorp's "cluster based" approach; and, a more proactive planning process more cognizant of the differences in the transmission needs for electric systems with high renewable penetration, relative to the more traditional fossil-heavy systems. Because renewable energy technologies are typically more geographically dispersed than fossil-fuel technologies, the transmission considerations used for them will also require a different approach than for conventional fossil technologies. In the near term, options that can help mitigate or defer the need for new transmission will be valuable, including: siting generation and storage resources closer to load where possible; considering energy-only resources and other alternatives that can increase utilization of existing transmission lines; and co-locating storage resources where they can alleviate or mitigate congestion and other existing transmission system challenges. Eventually, a more transformative change like an RTO could help produce even more positive outcomes; but many respondents are cognizant of the political challenges surrounding this option.
+ **Siting and permitting processes are currently perceived as cumbersome and costly by some electric industry stakeholders and could benefit from reform.** Many respondents from the renewable energy developer and clean energy communities had several criticisms about the EFSC

process. They described it as outdated and cumbersome. These respondents feel the long lead times for the process are hindering development of renewables. Finally, for these same respondents, cost is also seen sometimes as prohibitive, especially to less-established renewable energy developers. Many respondents called for a comprehensive reform; a new system that approaches siting and permitting from a more holistic perspective and is able to strike a balance between state and local jurisdiction and concerns, is more administratively efficient, considers cumulative impact, and finally is more inclusive of community engagement.

+ **Clarity on the state's long-term policy goals, and greater cohesion and coordination among state agencies and processes to support those goals, are essential.** Some respondents expressed a need for more clarity on the state's long-term energy policy. Although many respondents acknowledge the value Oregon's existing RPS statute and coal phase-out have played in driving renewable energy development, some expressed concerns that Oregon has been left behind by its closest neighbors, who have more aggressive economy-wide and electric sector goals. While the March 2020 executive order on climate action committed the state to deep carbon reductions, many stakeholders describe the inherent conflict between these ambitions, (which will require significant deployment of renewable energy) and the state's current land use planning goals (which have precluded certain areas from development a priori). Taking this discrepancy into consideration, many stakeholders suggest the need for greater collaborative effort by relevant state agencies to create a comprehensive roadmap that considers Oregon's long-term goals for climate, land use, social justice, and the environment simultaneously, and assesses the roles of the current regulatory processes and rules, while balancing costs to ratepayers and system reliability in such a roadmap.

+ **Regional collaboration is important for effectively integrating renewables.** In both the Industry and Market Assessment analyses, the importance of Oregon's relationship to neighboring states are emphasized. In the Market Assessment the implicit assumption that Oregon utilities will rely on resources throughout the Western Interconnection to meet its renewable energy needs will require coordination across jurisdictions in the region. In the Industry Assessment, multiple respondents call for even greater levels of regional coordination, particularly in regard to market design and transmission planning and optimization. Although many suggest the ultimate formation of a Western RTO could offer a solution to many of the challenges facing the industry[64], the CAISO's proposed EDAM and the Northwest Power Pool's proposed regional resource adequacy program are recognized as potential options that could lead to better coordination on renewable integration for states within the region. Similarly, the interstate transmission system – and BPA's and PacifiCorp's presence across multiple states in the region – is more appropriately considered and addressed at a regional level, as many of the transmission-related challenges present in Oregon are not unique to the state. While regional transmission planning processes exist today,

[64] This topic will require further study because of the questions and conversations surrounding it. It will be necessary to thoroughly understand several associated factors including costs, benefits, administration, and political implications surrounding a regional operator.

respondents call for more proactive and comprehensive assessment of the transmission needs associated with the aggressive renewable energy policies and goals of states within the region.

- **Oregon's technical potential for renewable energy development is vast and diverse and will likely not be a binding constraint to Oregon meeting its long-term energy goals.** The outcome of the renewable energy potential assessment shows that after accounting for technoeconomic, administrative, military-related, environmental and cultural land use factors, there is still a considerable abundance of renewable energy resource potential available for development. The results of the geospatial analysis reflect a combined available capacity of over one million megawatts of solar PV, onshore wind, offshore wind, and geothermal resource spread across the entire state; some of which have performance characteristics that are comparable or superior to some of the out-of-state resources that are currently being used to meet part of Oregon's renewable energy requirements. The potential could increase significantly when areas that require early or additional consultation and other potential development challenges are made more attractive to developers.
- **Portfolio diversity will be valuable for achieving high levels of renewable energy deployment.** The results of the market assessment show that diverse resources from diverse parts of the state and the region can contribute towards meeting the state's renewable energy needs. Commercial interest indicates continued development of renewable resources in the Columbia River Gorge area. If transmission access is created to the solar-rich central and southeastern areas of the state, developer interest in solar and storage resources would likely grow beyond its current level. Essentially, even though there is uncertainty in the specific relative costs of each resource type, Oregon's electricity system will require generation from solar PV, onshore wind, and operations of battery storage resources. Depending on how costs compare to these more established technologies, offshore wind and geothermal can also provide value. For example, the injection of 1.5 GW of offshore wind power into Western Oregon could expand options for the transmission system east of the Cascades. Furthermore, with the current constraints on the bulk transmission system, an emphasis on distributed resources which can be deployed close to load centers can offer significant value. However, the tradeoffs between the increased cost associated with high-value land and the reduced performance associated with rooftops (for solar PV systems) will need to be considered. Also, the implications of injecting high quantities of renewables into the local transmission and distribution systems will need to be studied, to find the right balance between utility-scale and distributed resources.

6.2 Potential Follow-up Analyses

The extent to which the answers to certain questions were explored in this study was limited by the scope of the project. This section outlines some topics that are worth additional analysis that could add value to the insights shared in this report.

Least-cost Optimization Analysis

6 Conclusions

The analysis carried out in the Market Assessment was limited in its approach and in the scope of the drivers of renewable energy development that were considered, because it needed to answer some fundamental questions that were necessary to get conversations started. This conversation on future renewable energy development in Oregon will require further studies with even more analytical rigor. A great next step would be a least-cost analysis that considers both supply-side and demand-side resource investments, dynamic system operations, transmission investments, and policy directives like resource adequacy, reliability, and long-term climate goals. Also important with such a least-cost study would be a consideration of ratepayer cost-impacts of the selected portfolios. Additionally, this analysis should study resources beyond the renewable resources in this study, particularly distributed energy resources, and short and long-duration energy storage resources. Finally, this proposed analysis would be even more valuable if it did not consider just Oregon-specific questions, but also looked at Oregon’s place in a regional market where other jurisdictions are answering similar questions.

Bulk transmission system investment and flow analysis

One of the key drivers of renewable energy development identified in this study is access to transmission. A proper understanding of several elements will be essential for the growth of the renewable energy development in Oregon. These elements include: a thorough assessment of all the available transmission capacity on the existing lines across the state and the region; an analysis of the current level of utilization of the existing transmission system and quantification of the benefits of increased optimization; and a quantification of the transmission need over the next decade and beyond and the cost implications for developing this transmission.

Local transmission and distribution system analysis

The role of distributed energy resources was highlighted by the results of the Market Assessment. However, this analysis made certain assumptions on the ability of the local transmission and distribution systems to be able to accommodate the injection of certain amounts of renewable energy resources. Similar to the bulk transmission system, the conversation begun by this study will benefit from a deeper dive into the local transmission and distribution systems. A good next step would be an analysis that investigates how much capacity currently exists and what upgrades and investments will be necessary to prepare these systems for the levels of renewable energy development that will happen in Oregon in the near-term and beyond.

7 Appendices

7.1 Literature Review

7.1.1 2020 Transmission Plan, BPA (2020)

Study Purpose	To provide a detailed assessment of the current state and development needs of the Bonneville Power Administration's transmission system in the Pacific Northwest.
Key Conclusions	• In the transmission needs assessment, the plan outlined four major projects that included transmission line reinforcements and transformer additions.
Relevance	
Link	https://www.bpa.gov/transmission/CustomerInvolvement/AttachmentK/Documents/2020-BPA-Transmission-Plan.pdf

7.1.2 2019 Integrated Resource Plan, Portland General Electric (2019)

Study Purpose	To provide a detailed plan for the utility's compliance with state energy policy, and to provide in-depth analysis of resource procurement needs and forecasted load growth.
Key Conclusions	• 2019 IRP preferred portfolio includes expansion of energy efficiency programs to achieve 157 MWa load reduction by 2025; also highlights 211 MW of summer demand response programs by 2025 and 41 MWa of Gorge wind by 2023; and • Preferred portfolio also includes 186 MWa of Washington and Montana wind by 2025
Relevance	The preferred portfolio of the utility's IRP, including its planned renewable resource additions in Oregon, served as important inputs for our modeling and scenario design.
Link	https://portlandgeneral.com/about/integrated-resource-planning

7.1.3 2019 Integrated Resource Plan, PacifiCorp (2019)

Study Purpose	To provide a detailed plan for the utility's compliance with state energy policy, and to provide in-depth analysis of resource procurement needs and forecasted load growth.

Key Conclusions	• 2019 IRP preferred portfolio highlights accelerated coal retirements and transmission development, facilitating 6,400 MW of renewables build by 2023; • Preferred portfolio outlines the development of over 9,000 MW of renewables over the 20-year planning period (2018-2038); and • Preferred portfolio includes development of solar in Oregon.
Relevance	The preferred portfolio of the utility's IRP, including its planned renewable resource additions in Oregon, served as important inputs for our modeling and scenario design.
Link	https://www.pacificorp.com/energy/integrated-resource-plan.html

7.1.4 Pacific Northwest Low Carbon Scenario Analysis, E3 (2017)

Study Purpose	To provide decision-makers with useful information on the potential policies through which the electric sector in the Pacific Northwest can most effectively contribute to meeting economy-wide emissions reduction goals.
Key Conclusions	• Most cost-effective opportunity for reducing carbon emissions in Pacific Northwest is to replace existing coal generation with mix of renewables, energy efficiency, and natural gas. • Renewable portfolio standards were not the most cost-effective policy driver of renewables development or emissions reductions and can lead to distortionary energy market effects. • Clean (zero-emitting), firm resources are an important part of the region's clean energy future.
Relevance	The scope of the present study was limited to studying pathways to meeting Oregon's renewable portfolio standards. The E3 study outlined above provides context for the efficacy of renewable portfolio standards and other policy tools in driving decarbonization in the electricity sector. Unlike the present study, whose primary focus is to outline plausible renewables development scenarios and the future geography of renewables development in Oregon as a result of the current RPS, the E3 study outlined above sought to study optimal resource portfolios in Oregon under different climate/energy policies.
Link	https://www.ethree.com/wp-content/uploads/2018/01/E3_PGP_GHGReductionStudy_2017-12-15_FINAL.pdf

7.1.5 Capacity Needs of the Pacific Northwest – 2019 to 2030, E3 (2019)

Study Purpose	To study regional capacity needs of the Pacific Northwest from 2019 to 2030.
Key Conclusions	• Pacific Northwest faces a significant capacity shortfall over the study period (3-7 GW shortfall through 2025; up to 10 GW shortfalls from 2025-2030). • The capacity shortfall is in part driven by new clean energy and emissions reduction goals (both state-mandated goals and goals voluntarily adopted by utilities) as well as planned coal retirements. • Economy-wide emissions reduction targets will likely add to shortfall through increased electrification.

Relevance	While considerations of resource adequacy and regional grid reliability were outside of the scope of the present study, the E3 study outlined above provides important context for other resource development and capacity expansion that will likely be taking place in the Pacific Northwest over the next 10-15 years. The region faces a significant capacity shortfall in the near future, which is in part due to the planned retirement of the region's coal generation fleet as well as projected increases in load due to electrification and increased demand for renewables due to the state RPS policies.
Link	

7.1.6 Pacific Northwest Zero-Emitting Resources Study, E3 (2020)

Study Purpose	To study the role of firm, zero-emitting resources in the energy future of the Pacific Northwest.
Key Conclusions	• Both existing and new clean, firm resources like nuclear, hydro, nuclear small modular reactors (SMR), biomethane-fired gas generators, etc. will play a key role in helping the PNW meet its carbon emissions reduction goals. • Least-cost capacity expansion models consistently choose to re-license Columbia Generating Station. • Nuclear SMR becomes an important clean, firm resource in futures where natural gas-fired plants are unavailable.
Relevance	The present study did not consider the development of clean, firm resources like nuclear SMR in Oregon. This study was primarily concerned with studying the development of site-based renewables to meet Oregon's renewable energy goals. However, it is important to consider the results of the above-outlined E3 study, which suggest that other types of resources–most notably clean, firm resources—will also have some role in Oregon's energy future.
Link	

7.1.7 7th Power Plan, Northwest Power and Conservation Council (2016)

Study Purpose	To study and address uncertainties in the future development of the power system of the Pacific Northwest, especially with regard to renewable integration and compliance with environmental and ecological conservation policies, as well as to provide guidance on which resources can help maintain a reliable and economic power system.
Key Conclusions	• Some utilities may require new gas generation build to meet near-term capacity needs even if other resources are available for development (i.e., the need to build adequate capacity to meet peak demand will likely take precedence over the long-term regional resource strategy outlined in the report). • Energy efficiency consistently identified as least-expensive and least-risky resources for meeting both environmental policies and maintaining reliable power system (i.e., energy efficiency alone is capable of meeting *all* load growth through 2030 in many modeled scenarios).

	• The report establishes a priority to develop energy efficiency resources from 2016-2022; it establishes a second priority to develop demand response resources in the Pacific Northwest, and to develop resiliency around extreme weather conditions that may affect hydro availability and increase reliance on regional imports. • Natural gas-fired generation was identified as the next most cost-effective resource after energy efficiency and demand response to meet the region's near-term capacity needs. • Federal emissions reduction targets/requirements are met by the outlined portfolio; further emissions reductions are achievable through a WECC-wide carbon tax or carbon cap-and-trade policy and further development of renewables. • Achieving a zero-carbon portfolio is not technically or economically feasible without development of new energy technologies. • Investing in additional transmission capacity is important for the region to develop its site-based renewable resources (wind, solar, geothermal, etc.)
Relevance	The 7th Power Plan provides a vision of the Pacific Northwest's energy landscape over the next 10 years. The plan addresses the region's significant capacity shortfall and suggests specific resources that utilities can develop to cost-effectively maintain grid reliability while meeting emissions reduction goals. It also suggests a limit on the ability of certain policies, like RPS, to cost-effectively limit greenhouse gas emissions and achieve a zero-carbon electricity grid. The plan highlights the importance of regional coordination especially with regard to transmission planning, which is also a theme of the present study.
Link	

7.1.8 Northwest Deep Decarbonization Pathways Study, Clean Energy Transition Institute (2019)

Study Purpose	To investigate deep decarbonization pathways in the Pacific Northwest from 2020 to 2050 and model both the technical and economic implications of decarbonization pathways. Here, deep decarbonization means reducing economy-wide carbon emissions by 86 percent relative to 1990 levels.
Key Conclusions	• Deep decarbonization is achievable in the Northwest. • Energy efficiency is a key strategy to achieving carbon reduction goals. • Deep decarbonization requires a nearly 100 percent clean electricity grid (96 percent renewable energy with a small amount of natural gas generation to cost-effectively maintain grid reliability). • Widespread electrification will increase demand for electricity through 2050.
Relevance	The CETI study outlined above provides additional context for decarbonization pathways in the Pacific Northwest. The study highlights the challenges that arise when considering

	a transition to a nearly 100 percent renewable electricity grid, and points to natural gas as a cost-effective way to maintain grid reliability. The study also highlights widespread electrification of the energy system as a means of achieving deep decarbonization, which will likely become a long-term driver of increased demand for renewable energy. While economy-wide decarbonization pathways are beyond the scope of the present study, we do consider a range of scenarios for future demand for renewable electricity in the Pacific Northwest.
Link	

7.1.9 Western Renewable Energy Zones Report, NREL (2009)

Study Purpose	To identify zones with greatest technical/economic potential for renewable energy development in the Western U.S. to assist the Western U.S. in planning to meet its renewable energy transition goals. In short, to provide a screening-level analysis of renewable energy potential in the Western U.S. and identify "renewable energy zones" where resources can be economically developed and delivered to load through existing or new transmission corridors.
Key Conclusions	• Renewable energy supply curves developed for each qualified resource area (QRA). • Levelized costs do not include long distance transmission costs. • Levelized cost of energy of resources in zones based primarily on quality of the resources.
Relevance	The NREL study outlined above uses a modeling methodology similar to that used in the present study. Similar to our study, the goal of the Western Renewable Energy Zones study was not to predict where development will happen, but to conduct a screening-level analysis of renewable energy resources throughout the Western U.S to identify zones suitable for utility-scale renewable energy development. The present study's methodology goes further to identify plausible renewables development scenarios in Oregon using a least net cost development framework.
Link	

7.1.10 Power of Place: Land Conservation and Clean Energy Pathways for California, The Nature Conservancy (2019)

Study Purpose	To study implications of land use restrictions for development of renewables and infrastructure to meet California's clean energy goals, and vice versa: to study the implications of clean energy goals for land conservation efforts and the impacts of renewables development on natural and working lands.

Key Conclusions	• Study used spatial datasets representing agricultural, cultural, and ecological siting criteria in 11 Western states to screen the available renewable resource potential in the West, then constructed least-cost portfolios from remaining resources to comply with clean energy goals. The environmental impact of the selected portfolios was then analyzed. • Study concludes that land protections are effective in avoiding environmental impacts and do not prevent California from being able to meet its GHG emissions reduction targets; however, land use restrictions can increase the cost of selected renewables portfolios. • Less viable wind is available due to land use restrictions, which raises portfolio costs. • Regional coordination identified as a potential solution to reduce portfolio costs while mitigating environmental impacts from land use and achieving emissions reduction goals.
Relevance	Similar to this study, the Power of Place report studied the intersection of renewable energy development and land use considerations. Although the Power of Place analysis uses a different methodology (least-cost optimization considering both a clean energy policy and a carbon reduction policy), at a very high level it answers questions that are similar to this study. The Power of Place analysis provided valuable datasets and a framework for the geospatial analysis used in the resource potential assessment that is described in Section 2.4.
Link	

7.1.11 Renewable Energy Transition Initiative 2.0, California Energy Commission (2017)

Study Purpose	To study implications of California's clean energy goals on transmission development in the state, and to identify feasible sites of renewable energy development within the state as well as transmission corridors that could feasibly be developed to unlock resource potential in identified renewable energy sites.
Key Conclusions	• Energy efficiency and distributed energy resources can offset demand for development of utility-scale renewables projects. • Lots of cost-competitive utility-scale solar resources exist across California. • Most of California's highest quality wind resources have already been developed or are constrained by environmental/ permitting barriers. • Over-development of solar resources will lead to frequent over-generation and curtailment, increasing overall portfolio costs. This challenge can be overcome by achieving geographic and technological diversity in California's renewable energy portfolio.

	• A number of potentially feasible transmission corridors from renewable energy development sites to California's load centers were identified as a result of this study.
Relevance	The structure and goals of RETI 2.0 are similar in concept to the ODOE Renewable Energy Market Assessment. RETI 2.0 emphasized stakeholder engagement to identify and overcome planning challenges, as does the present study. Furthermore, the study reflects a formal coordination between policymakers, transmission experts, and renewable energy developers/experts to plan the state's clean energy future. Unlike RETI 2.0, this study's stakeholder process did not identify specific transmission corridors or renewable energy development zones. This study uses geospatial data to identify potential renewable energy development sites in Oregon.
Link	

7.1.12 Investigating a Higher Renewables Portfolio Standard in California, E3 (2014)

Study Purpose	To study a 50 percent by 2030 RPS in California and grid operational challenges posed by such large-scale deployment of variable energy resources and to investigate the cost of such a portfolio and GHG emissions reductions achieved by it.
Key Conclusions	• One of the most pervasive operational challenges identified in the modeled development scenarios is over-generation from utility-scale solar. • Another important operational challenge is fast ramping requirements due to variable renewable output, and in particular to accommodate fast changes in solar generation. • The study suggests (1) enhanced regional coordination (2) demand response (3) energy storage and (4) diversified renewables portfolio as potential solutions to these operational challenges.
Relevance	The E3 study outlined above provides useful information for states planning to transition to highly renewable electricity systems. It identified operational challenges that accompany the large-scale integration of certain types of intermittent renewable energy into the power grid, as well as potential solutions to these challenges. The present study did not explicitly model some of these operational challenges as time-sequential power system operations were omitted from our modeling. We do represent one of the proposed solutions to over-generation, hybrid solar and energy storage systems, in our modeling. Furthermore, our modeling does capture the approximate value of specific renewables portfolios to grid reliability through a capacity value accreditation framework. However, portfolio design and optimization for grid reliability was beyond the scope of the present study.
Link	

7.1.13 Oregon Offshore Wind Site Feasibility and Cost Study, NREL (2019)

Study Purpose	To provide BOEM and state of Oregon with cost data based on geospatial site-specific data to allow for consideration of floating OSW in the state's future energy portfolio and inform Oregon's long-term resource planning activities.
Key Conclusions	• Study identified 62 GWs of available offshore wind potential in Oregon; 97 percent of this is at water depths > 60m, thus necessitating use of floating offshore wind turbine technology. • Estimates of the levelized cost of floating offshore wind energy in Oregon ranges from \$53/MWh to \$74/MWh in 2032. • Floating offshore wind turbine technology is relatively new and cost trajectories are uncertain.
Relevance	The NREL study outlined above provides useful context for the potential development of offshore wind energy in Oregon. In particular, the estimates of resource cost and available potential are useful benchmarks for the modeling and analysis carried out in the present study.
Link	

7.1.14 Exploring the Grid Value Potential of Offshore Wind Energy in Oregon, Pacific Northwest National Laboratory (2020)

Study Purpose	To study the grid value of offshore wind energy development in Oregon and the role offshore wind energy may play in Oregon's energy future.
Key Conclusions	• Three types of grid value for offshore wind were studied: (1) complementarity of offshore wind energy with Oregon's other renewable and hydro resources (2) complementarity of offshore wind with Oregon's hourly electricity consumption patterns and sub-hourly supply variability (3) the locational value of offshore wind to coastal electricity grids. • Oregon offshore wind energy was found to exhibit hourly complementarity with Oregon's other renewable resources, including Columbia Gorge wind and southern Oregon solar, as well as seasonal complementarity with the region's hydro-electric generation. • The notion of complementarity between variable renewable resources was expressed by the correlation coefficient between the hourly generation of these resources. Strongly negative correlation between the generation of pairs of resources implies complementarity between the resources, whereas strongly positive correlation between resource generation and load implies complementarity with load. Complementarity with hydroelectric power was assessed through analyzing offshore wind's complementarity with seasonal hydroelectric dispatch patterns.

	• The study estimates that up to 2 GW of offshore wind can be developed in Oregon without requiring substantial transmission upgrades. Developing such resources will strengthen coastal grids and change bulk transmission system flow patterns so as to allow for more integration of renewables from Oregon's interior, as well as reduce imports of electricity into Oregon.
Relevance	The Pacific Northwest National Laboratory study outlined above provides important context for the development of offshore wind resources in Oregon. The study highlighted an important dynamic that was not represented in the modeling of the present study, which is that the development of offshore wind resources would alter traditional flow patterns on Oregon's bulk transmission grid. This dynamic is important to consider, as considerations of flow patterns and transmission system utilization are important for developers and thus for defining future renewables development scenarios. Furthermore, considerations of resource complementarity are important from an operational reliability standpoint, however the level at which resource complementarity was assessed in the above-outlined study is likely not detailed enough to draw strong conclusions about which resources should and should not be developed in Oregon.
Link	

7.2 Geospatial Resource Potential Datasets

The GIS data layers used for the Resource Potential analysis discussed in Section 3.3 are shown below:

Data Layer Name	Data Source	Siting Level 1	Siting Level 2	Available for Portfolio Development
100 Year Floodplain (1% annual chance flood hazard)	FEMA	x		
Active mines	USGS	x		
Airport runways	FAA	x		
Airports	FAA	x		
Military areas (Military Installations, Ranges, and Training Areas (Boundaries))	DoD		x	
Military areas (Military Installations, Ranges, and Training Areas (Points))	DoD		x	
Special Use Airspace (exclude for areas with floor <=1000 ft above ground level only)	FAA		x	
Military Training Routes (exclude for areas with floor <=1000 ft above ground level only)	FAA		x	
Boardman General Area of Concern	DoD		x	
Population Density	ORNL	x		
Slope	USGS	x		
Urban Areas	USCB	x		
Water bodies and rivers	USGS	x		

City Limits	ODOT	x		
Highway Network	ODOT	x		
Land Cover (forests)	MRLC	x		
Railroads	ODOT	x		
Weather Radar	HIFLD		x	
Submarine cables	ANL EZMT	x		
National Wildlife Refuge (PAD-US)	Oregon Protected Areas	x		
State wildlife management areas (PAD-US)	Oregon Protected Areas	x		
Units of the National Parks System (excluding National Recreation Areas and National Trails) (PAD-US)	Oregon Protected Areas	x		
National Monument (PAD-US)	Oregon Protected Areas	x		
National Recreation Area (PAD-US)	Oregon Protected Areas	x		
National Scenic Trails (BLM WWWMP)	BLM WWWMP	x		
Wilderness Areas	Oregon Protected Areas	x		
Wilderness Area (PAD-US)	Oregon Protected Areas	x		
Wilderness Study Area (PAD-US)	Oregon Protected Areas	x		

State Wilderness Areas (PAD-US)	Oregon Protected Areas	x		
National coordination areas (Government Island, Ochoco and Summer Lake)	Oregon Protected Areas	x		
State Park (PAD-US)	Oregon Protected Areas	x		
State Natural Areas, Natural Heritage Areas (registered & dedicated, OPRD)	Oregon Protected Areas	x		
State Estuarine Research Reserves (South Slough, DSL)	Oregon Protected Areas	x		
National Wild and Scenic Rivers	Oregon Protected Areas	x		
State Scenic Waterway Classification Areas	ORE	x		
State Scenic Waterway Water Courses	ORE	x		
OSU Experimental Areas (Starkey, Squaw Butte) and Agricultural Experiment Stations (OSU)	Oregon Protected Areas	x		
National Historic Landmarks (BLM WWWMP)	BLM WWWMP	x		
National Natural Landmarks (BLM WWWMP)	BLM WWWMP	x		
National Register Historic Places (BLM WWWMP)	BLM WWWMP	x		
Right of Way exclusion (BLM WWWMP)	BLM WWWMP	x		
Visual Resource Management lands I (BLM WWWMP)	BLM WWWMP	x		

Tribal Lands (US Census)	Oregon Protected Areas			x
Habitat Conservation Plan	Oregon Protected Areas		x	
Natural Community Conservation Plan	Oregon Protected Areas		x	
Conservation Easements (NCED)	NCED		x	
NRCS easements	USDA		x	
DFW Wildlife Areas and Ecological Reserves (PAD-US)	Oregon Protected Areas		x	
Existing Conservation and Mitigation Bank (PAD-US)	Oregon Protected Areas		x	
Conservation lands (BLM West-Wide Wind Mapping Project)	BLM WWWMP		x	
National Conservation Area (BLM WWWMP)	BLM WWWMP		x	
Visual Resource Management II (WWWMP)	BLM WWWMP		x	
Threatened and Endangered Species Critical Habitat	USFWS		x	
Conservation Opportunity Areas	ODFW		x	
BLM Areas of Critical Environmental Concern	Oregon Protected Areas		x	
Habitat Areas of Particular Concern (HAPC)	EZMT/NOAA		x	

Research Natural Area – Proposed (PAD-US)	Oregon Protected Areas		x	
Bald Eagle (WWWMP)	BLM WWWMP		x	
Development Focus Area - solar and geothermal only (excluding wind) (WWWMP)	BLM WWWMP		x	
Golden Eagle suitable habitat (WWWMP)	BLM WWWMP		x	
Sage Grouse Priority Habitat Management Area exclusion (WWWMP)	BLM WWWMP		x	
Sage Grouse Priority Habitat Management Area, High Level Siting Requirements (WWWMP)	BLM WWWMP		x	
Marine Protected Area (PAD-US)	Oregon Protected Areas		x	
National Park Service Areas of High Potential Resource Conflict (WWWMP)	BLM WWWMP		x	
No Surface Occupancy (WWWMP)	BLM WWWMP		x	
Off Highway Vehicle (WWWMP)	BLM WWWMP		x	
Special Recreation Management Area (WWWMP)	BLM WWWMP		x	
National Inventoried Roadless Areas (USFS)	ANL		x	
National Wetland Inventory	Oregon Explorer			x
Local Wetland Inventory (5 sublayers)	ORE			x

More Oregon Wetlands	ORE			x
Globally important wetlands - Site Wind Right treatment	WHSRN			x
Westwide Prime farmland classification (NRCS)	ESRI		x	
Essential Salmonid Habitat	NOAA			x
Desert Tortoise Connectivity (BLM WWWMP)	BLM WWWMP			x
Sage Grouse General Habitat Management Area, High Level Siting Requirements (BLM WWWMP)	BLM WWWMP		x	
Sage Grouse General Habitat Management Area, Moderate Level Siting Requirements (BLM WWWMP)	BLM WWWMP		x	
Sagebrush Focal Area (BLM WWWMP)	BLM WWWMP			x
Historic or Cultural Area (PAD-US)	Oregon Protected Areas			x
Territorial Sea Plan Renewable Energy Facility Suitability Study Areas	OOI			x
Elk and Deer Winter Range (Oregon Department of Fish and Wildlife)	ODFW			x
Important Bird Areas (Audubon) (subset)	Audubon			x
America's Byways (FHA)	FHA			x
Oregon Scenic Byways (Oregon Department of Transportation)	ODOT			x

Visual Resource Management lands level III (BLM WWWMP)	[BLM WWWMP]			**x**
Landscape intactness	[HMI]			**x**