

Just about everything involves energy. It is a part of our daily lives, blending into the background of driving a car, turning on a computer, firing up a grill, or heating a home.

The 2018 *Biennial Energy Report* focused on foundational data and information about energy in Oregon. For 2020, ODOE asked stakeholders and the public what other context and information would be helpful and then leveraged ODOE expertise on a variety of topics including transportation, facility siting and permitting, nuclear safety and emergency preparedness, energy efficiency, renewable energy, electricity, and natural gas.

This section is intended to help the reader understand the first part of the energy story: how energy is produced, used, and transformed. This includes fundamental information for people new to energy or specific energy topics, along with those looking for data or a central place to help tell the story of how energy systems affect their work and interests. Energy policy is complex and, without being armed with technical information and understanding, it is sometimes difficult to be part of the conversations. The Energy 101 topics in this section are intended to help create a more diverse and inclusive conversation and to build our energy future together by bringing more stakeholders to the table. Narratives range from basic information about where our transportation and natural gas resources come from and how they get to consumers, to the role that codes, standards, and net-zero buildings play in reducing overall energy use. Several topics are directly linked to specific policy briefs included later in this report on complex concepts like resource adequacy and clean and zero-emission standards. This section also gives readers necessary background to understand the data and trends in Energy by the Numbers and cross-sectional discussions on climate, equity in renewable energy, and grid-interactive efficient buildings.

The second part of the story is how energy systems affect the lives of Oregonians. Information in this section includes an explanation of energy bills and how net metering works for technologies like rooftop solar. Readers can then learn more about the very real challenges of energy burden in our state, along with the growth and opportunities of clean energy jobs in Oregon. It is through foundational understanding of fundamental energy concepts that readers can make informed choices about the energy resources, uses, and investments that can change our work, lives, and communities.



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Energy 101: Energy Production in Oregon

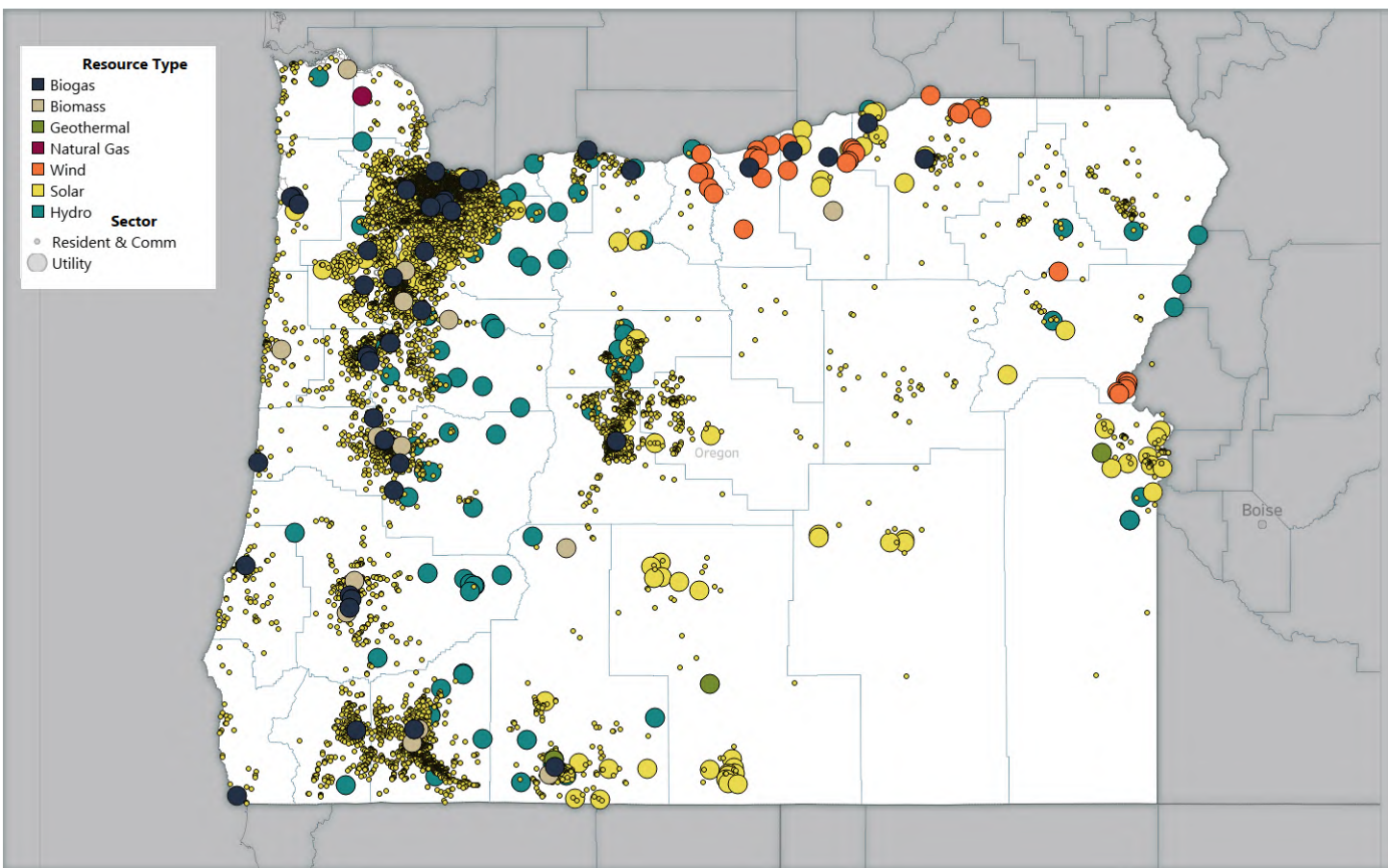
In this *2020 Biennial Energy Report*, energy production is divided into three categories – electricity, direct use fuels, and transportation fuels – with specific information on the types of energy produced in Oregon, along with more general information about the environmental effects of each resource no matter where it is produced. Other portions of the report also go into more detail about the benefits, effects, and tradeoffs associated with various resources.

Oregon ranks 33rd in the country for energy production.

Oregon ranks 4th in the country for total non-combustible renewable energy production.

Primary energy is used to describe energy sources in the form that they are extracted or collected from the environment that can be directly converted into a use while *secondary energy* describes energy that has been converted from its primary form into a second form for transportation or storage. This type of energy goes through multiple transformations before that energy is used. For example, sunlight, fuel oil, natural gas, wind, running water, and coal are all considered primary energy. Once energy has undergone a transformation, sunlight, wind, and running water into electricity, for example, or natural gas to steam, the resulting energy is secondary energy. Energy can undergo multiple transformations and each transformation creates losses due to inefficiencies in the process.

Figure 1: Primary Energy Production Facilities in Oregon^{1 2}



Energy Production Categories

Electricity. Much of the electricity generated in-state uses Oregon-based natural resources – wind or hydropower, for example. Oregon energy facilities also generate electricity using raw materials from out of state. All of the coal and almost all of the natural gas used at Oregon’s large scale in-state coal and natural gas power plants is imported. Oregon does produce renewable natural gas and biofuels that are used to generate electricity, they are also sometimes used for combined heat and power at mainly commercial and industrial facilities in Oregon. See the Energy by the Numbers section for more details about electricity generation and consumption in Oregon.

Direct Use Fuels. Direct use fuels include small amounts of natural gas and a variety of biofuels produced in-state: hog fuel (wood chips) used for industrial heat, commercial wood pellets for commercial industrial heat, renewable natural gas and other biofuels used for combined heat and power, and others.

Transportation Fuels. Oregon produces about 25 percent of the biofuels our transportation system uses; overall, biofuels make up 6.4 percent of Oregon’s use of transportation fuels.

Site vs. Source Energy

When tracking energy flow through complex distribution systems, the energy sector draws boundaries to prevent double counting. Typically, those boundaries are referenced using site energy and source energy. *Site energy* accounting refers to energy measured from the point of delivery to a building or facility – for example, utility bills measure site energy. *Source energy* accounting refers to the total amount of raw energy needed to supply a site; for natural gas this would include the original amount of fuel extracted to supply the quantity of energy used at a site, including any losses incurred through transport, storage, and delivery of the energy. For example, the source energy for a power plant that uses natural gas to provide electricity would include the amount of energy extracted for that purpose, any transportation losses in transit to the power plant, the heat lost during generation due to inefficiencies in the process, plus transmission and other losses from transporting the electricity to the eventual end use.

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Energy 101: Electricity Transmission

Transmission lines move large volumes of high-voltage electricity across long distances and are needed to connect large distant generating resources to electricity customers (also known as load centers). Transmission lines create a networked system by interconnecting a variety of load centers to generating resources. Most generators are located long distances from the towns, cities, counties, and rural areas they serve – for example, customers along Oregon’s coast often receive their power from distant generation east of the Coast Range. This transmission network is generally referred to as “the grid,” and more specifically referred to as the “Bulk Power System,” or the “Bulk Transmission System” when discussing high-voltage transmission lines.

Figure 1: Typical Sizes of Transmission and Distribution Systems

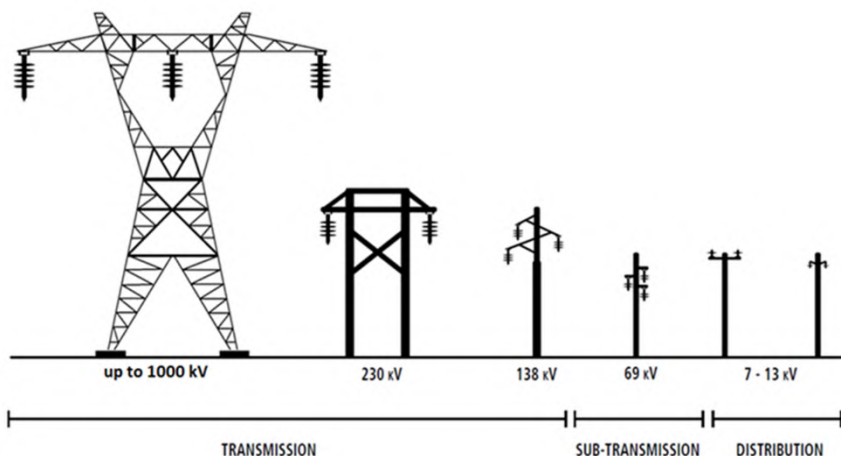
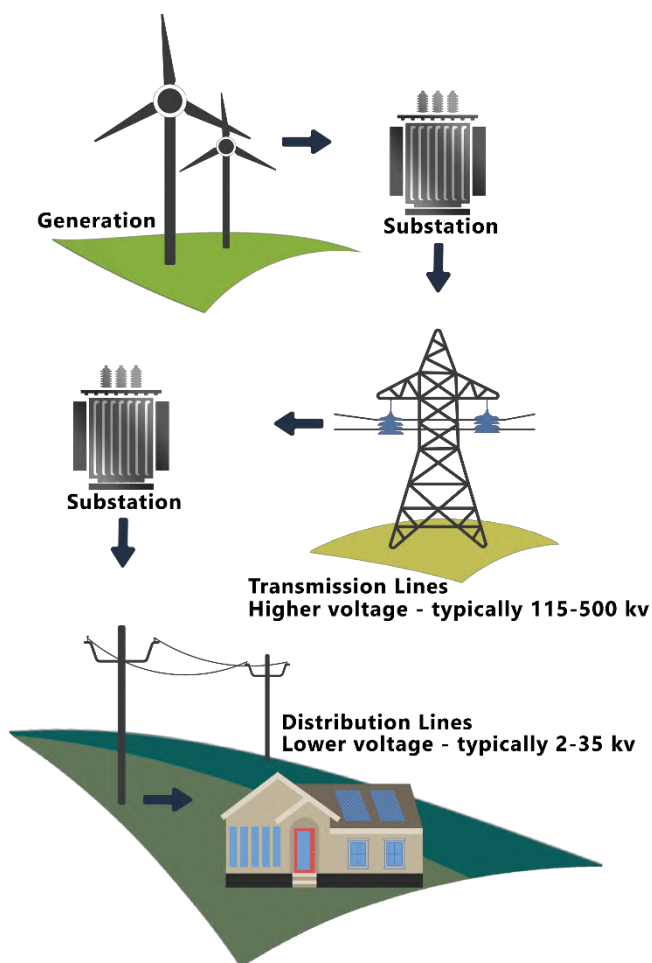


Figure 2: Electricity Supply Chain

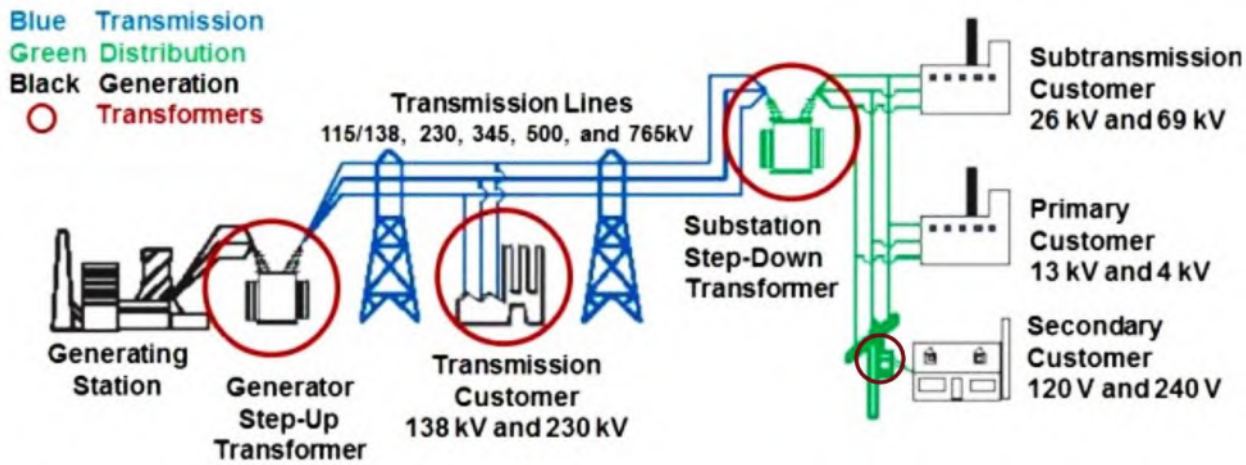


Transmission lines are critical to the delivery of large amounts of power to customers from electricity generating resources across a geographic footprint. The transmission network serves many important functions, including providing access to diverse energy resources, helping to ensure reliable electricity, and allowing generating resources to be centrally located and used to serve demand across a region. For example, as a sponsor of the proposed Boardman to Hemingway transmission line project, Idaho Power Company has described the need for that transmission line as:

Existing transmission lines between the Pacific Northwest and Idaho Power’s service area can’t carry any more energy when it is needed most. The Boardman to Hemingway line will provide the ability to deliver approximately 1,000 megawatts of clean, affordable power in each direction, helping meet customer needs, especially during summer months when air conditioning creates peak demand.¹

Electricity travels long distances most effectively and efficiently at high voltages. Generators produce electricity, and “step-up” transformers increase the voltage of electricity to travel along high-voltage transmission lines. Then, to decrease the voltage back down to the levels required to serve customers, the electricity passes through “step-down” transformers before being consumed by end users.

Figure 3: Detailed Electricity Supply Chain³



Transmission vs. Distribution Line

Connected to the other side of transmission lines and step-down transformers are the distribution lines, which carry lower voltage electricity shorter distances (i.e. the last few miles, to the grid’s distribution system customers). These are the wires that connect customers to the grid and supply them with electricity. The transmission and distribution systems are distinguished by the voltage level of the wires — a measurement of the capacity of the lines to carry energy. The transmission network is comprised of higher voltage lines – typically 115 kV to 500 kV (including lines that connect generation to the bulk transmission system – “gen-tie” lines); the distribution network is comprised of lower voltage lines typically between 2 kV and 35 kV.^{1 2 3} Transmission lines are carried on larger towers, such as the ones paralleling Interstate 5 through much of the Willamette Valley, while distribution lines are often carried on smaller wooden poles like those running up and down the streets of many residential neighborhoods.

A standard wall outlet delivers 120 volts. Six percent of the voltage of a 2 kV distribution line, or 0.02 percent the voltage of a 500 kV transmission line.

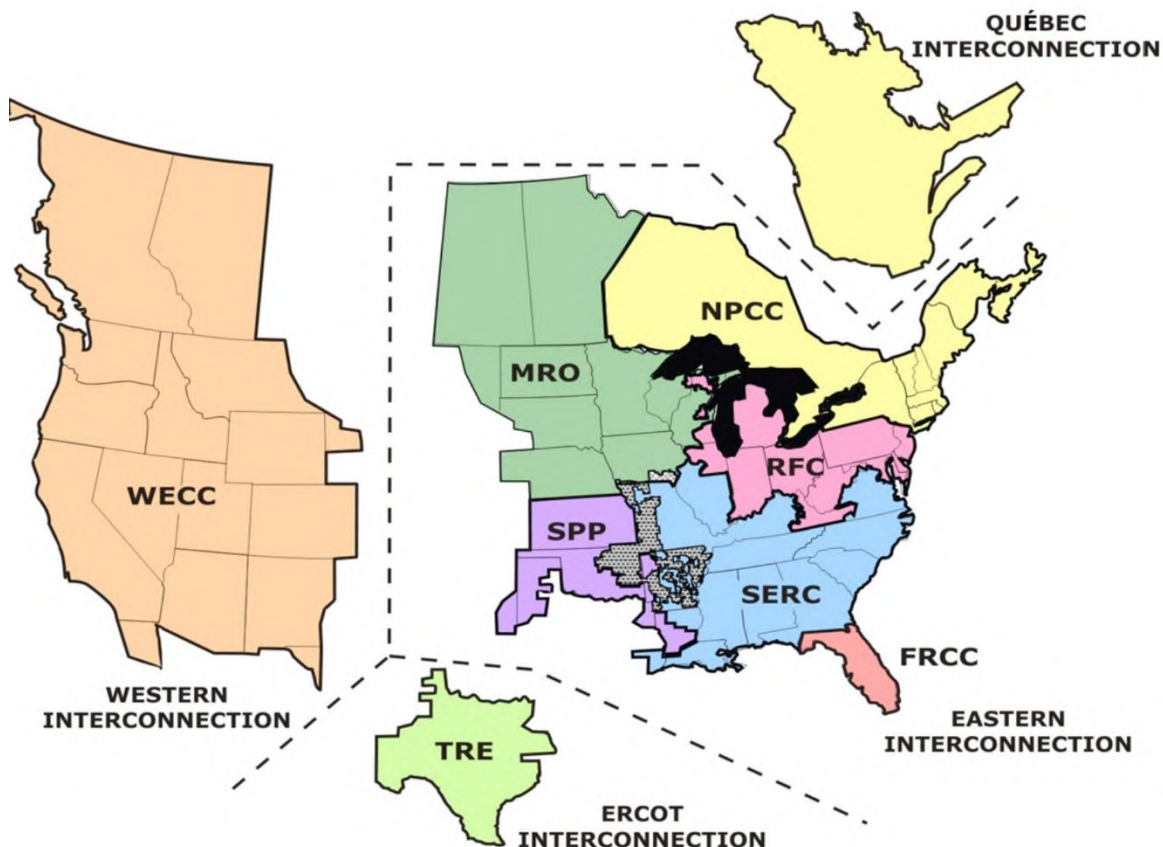
Pacific Northwest Transmission Lines: Location and Ownership

Connecting large generating resources to customers requires a great deal of transmission infrastructure – thousands of miles in Oregon and across the Pacific Northwest and over 360,000 miles nationwide.⁴ Oregon is located within the high voltage grid called the Western Interconnection. The Western Interconnection footprint is a vast area covering Montana, Wyoming, Colorado, New Mexico, Washington, Oregon, California, Nevada, Idaho, Utah, the Canadian provinces of British

¹ Subtransmission lines comprise the medium voltages (typically between 35 kV and 115 kV, though these can sometimes be classified as part of the bulk transmission network).

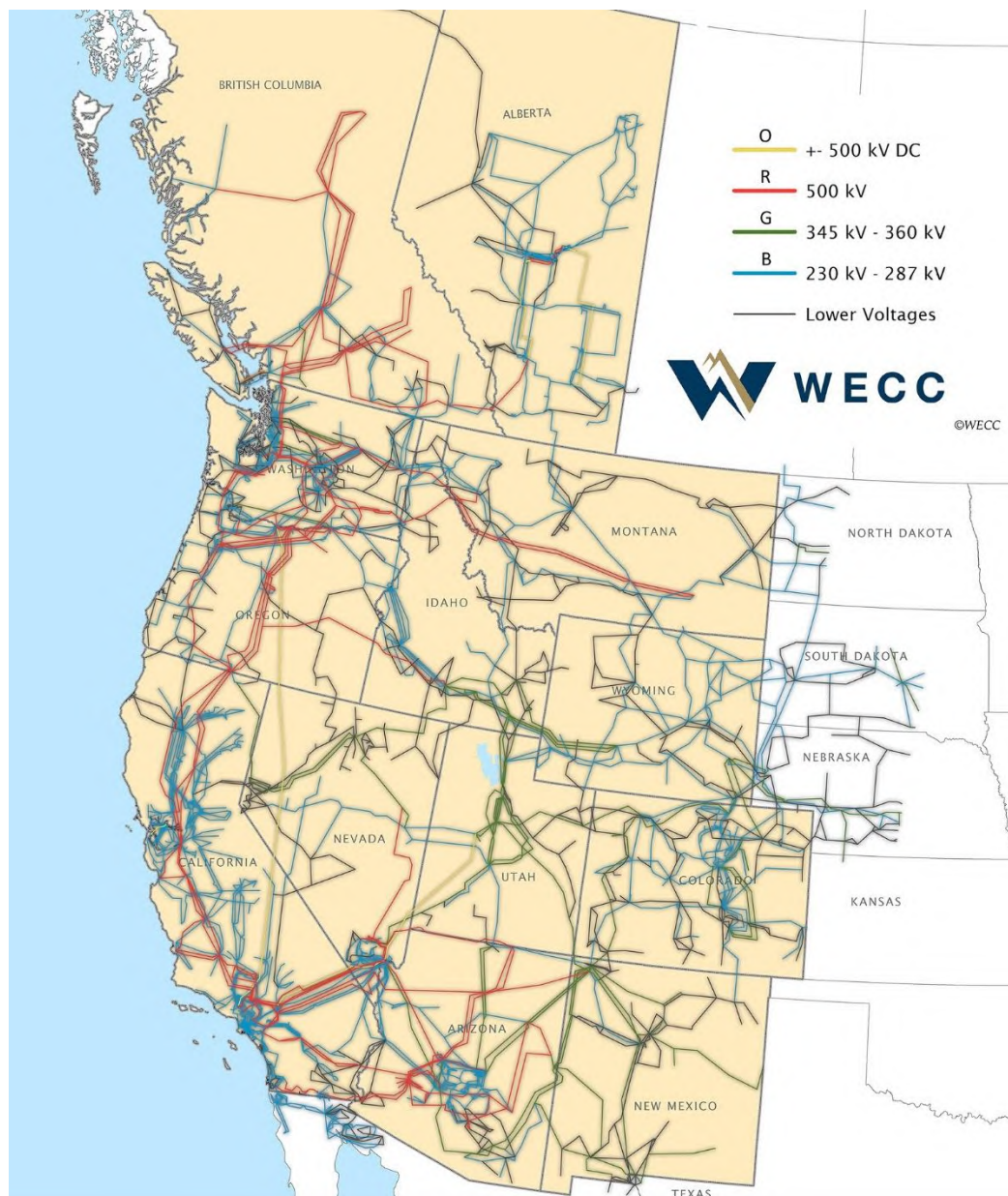
Columbia and Alberta, and Northern Baja, Mexico. The Western Electricity Coordinating Council (WECC) is the regional entity responsible for promoting reliability and security across this area, coordinating with approximately 345 member organizations.⁵ The WECC also enforces mandatory reliability standards for the electric power industry in the Western Interconnection pursuant to delegated authority from the North American Electric Reliability Corporation (NERC), which is responsible for compliance and enforcement of NERC electricity safety and reliability standards. In addition to the Western Interconnection, there are three other interconnections across the U.S. and Canada: the Eastern Interconnection, the ERCOT Interconnection in Texas (Electric Reliability Council of Texas), and the Quebec Interconnection in Canada.

Figure 4: Four Interconnections in North America⁵



Transmission Lines in the Pacific Northwest

Figure 5: Transmission Lines in the Western Electricity Coordinating Council⁶



Adapted from the WECC Interconnection Map

The largest owner of transmission lines in the Pacific Northwest is the Bonneville Power Administration (BPA), a federal power marketing administration.⁷ The largest owner of transmission lines in the Western Interconnection is PacifiCorp.⁸ Other large owners of transmission lines in the region include: Idaho Power, Avista, Puget Sound Energy, and Portland General Electric. Many additional entities across the Pacific Northwest own smaller amounts of transmission lines, including Oregon consumer-owned utilities such as: Harney Electric Coop, Central Electric Coop, Eugene Water & Electric Board, Central Lincoln PUD, Coos-Curry Electric Coop, and Tillamook PUD. Approximations for total mileages by owner is shown in Table 1.

Table 1: Miles of Transmission Lines by Owner

Owner	Transmission Line Miles
Bonneville Power Administration ⁹	15,209
PacifiCorp ¹⁰	16,600
Idaho Power ¹¹	4,857
Avista ¹²	2,770
Puget Sound Energy ¹³	2,608
Portland General Electric ¹⁴	1,264
Harney Electric Co-op ¹⁵	350
Central Electric Co-op ¹⁶	185
Eugene Water & Electric Board ¹⁷	129
Coos-Curry Electric Co-op ¹⁸	52
Tillamook People's Utility District ¹⁹	15.7

If you stretched all of Portland General Electric's transmission lines end-to-end, they would stretch from Portland to Denver, CO.



The electric power industry contains a diverse mix of entities such as investor-owned utilities (e.g. PacifiCorp, Portland General Electric, and Idaho Power), cooperatives (e.g. Harney, Central Electric, Coos-Curry), municipals (e.g. Eugene Water and Electric Board), peoples utility districts (e.g. Tillamook), federal power marketing administrations (e.g. Bonneville Power Administration), and independent power producers (e.g. Avangrid Renewables). Some entities own and operate assets across all segments of the power grid – generation, transmission, and distribution systems. Other entities own and operate assets in only one of these segments, such as only generation, only transmission, or only distribution.

Transmission line owners and operators are often affiliated with the same utilities that own and operate power generation to provide customers with electricity.

Figure 6: BPA Transmission System and Federal Dams²⁰

³BPA owns and operates 15,239 circuit miles of transmission lines across a six-state region that forms the backbone for delivering power from 31 federal hydroelectric dams in the Northwest. Both the Federal Columbia River Power System and Transmission System require regular and strategic investment to ensure a cost-effective level of reliability.

However, federal regulations adopted in 1996ⁱⁱ to promote competition and ensure non-utility generation resources have open access to transmission service require the employees of transmission line entities to be functionally and administratively separate from a utility's marketing and merchant employees (those involved with supplying generation to utility customers).^{iii 21 22 23} These Federal regulations also require transmission line owners to provide transmission users with timely and accurate transmission market data to support open competition for transmission service requests from utility and non-utility generation resources. Transmission line owners do this through an online platform called the Open Access Same-time Information System, or OASIS.²⁴

Transmission line entities can also be unaffiliated with utilities. For example, BPA (not a utility) owns and operates approximately 75 percent of the transmission lines in the Pacific Northwest,²⁵ whereas the California Independent System Operator operates all the transmission lines in California, but does not own them.

Planning and Building Transmission Lines

The western grid is a complex system that delivers power from generators to households and businesses across western states and provinces. Robust planning is necessary to ensure the western grid maintains safe and reliable operations over time with changes in population, economic activity, technology and public policy. Transmission planning occurs at the level of individual transmission owners and is critical to regional planning entities that assess the capacity, reliability, and the potential need for transmission expansion projects. These planning efforts produce recommendations on new transmission lines that are necessary to maintain the reliability of the grid.

Pacific Northwest Planning Entities and Operators

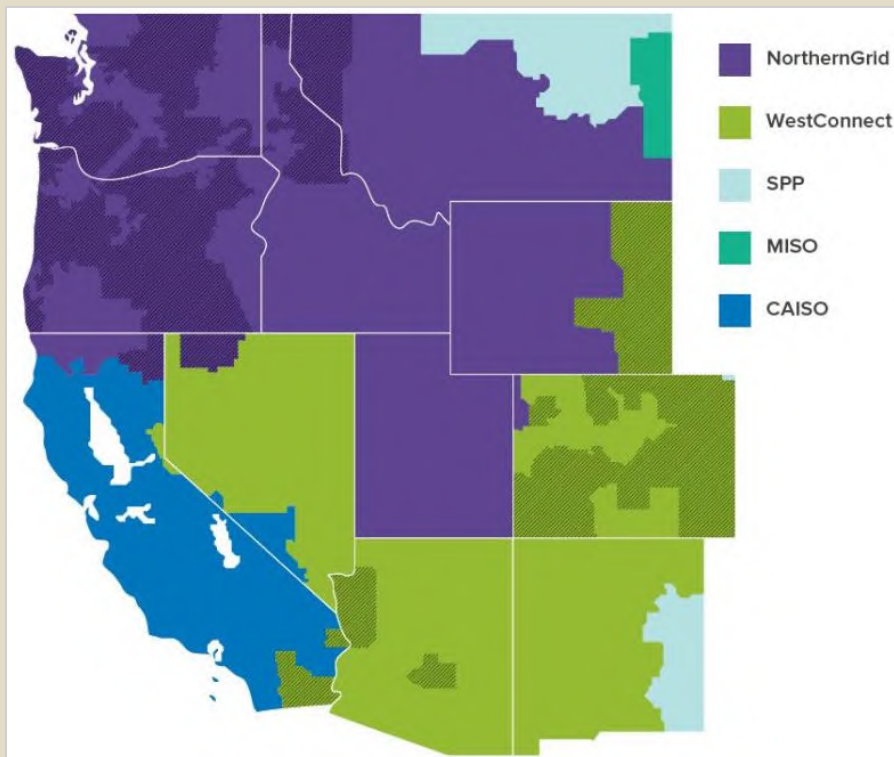
In Oregon and the Pacific Northwest, regional transmission operations and regional transmission planning are controlled by different entities – individual transmission owners control the operations and pricing for sending power across their lines, and the Pacific NW's regional transmission entity, NorthernGrid, is responsible for developing the regional transmission plan. In other regions of the country, regional transmission organizations or independent system operators, such as CAISO in California, do both planning and operations. RTOs and ISOs control operations and prices for sending power across transmission lines within their region and are also responsible for developing regional transmission plans.

ⁱⁱ Federal Energy Regulatory Commission Orders 888 and 889 directed public utilities regulated under the Federal Power Act to separate their power merchant functions from their transmission reliability functions; unbundle transmission and ancillary services from wholesale power services; and set separate rates for wholesale generation, transmission, and ancillary services.

ⁱⁱⁱ While the FERC orders that promote competition and open access transmission service do not apply directly to BPA, their intention is to promote a national policy of open transmission access. Thus, BPA elected to separate its power and transmission operations and unbundle its rates in a manner consistent with the Federal directives concerning open access transmission service. BPA develops its transmission rates in separate proceedings from its power rates.

NorthernGrid

NorthernGrid is the new regional transmission planning entity for the Pacific Northwest and Intermountain West. It launched on January 1, 2020, and combines and replaces the previous regional transmission planning entities for the Pacific Northwest – ColumbiaGrid, and the Intermountain West - Northern Tier Transmission Group. NorthernGrid began facilitating compliance with FERC transmission planning and reliability requirements on April 1, 2020.



NorthernGrid is staffed through a service agreement with the Northwest Power Pool, and has a large association of members that include Bonneville Power Administration and regulated investor owned utilities and non-regulated consumer owned utilities from Oregon, Washington, Idaho, Montana, Wyoming, Utah, and a small portion of northern California - along with non-member participation from state and tribal governments from those states.

NorthernGrid’s transmission planning activities are orchestrated and implemented through several committees that conduct or assist the planning, coordination, and development of the regional transmission plan required by FERC. Together, these committees and the regional planning process provide value to the region’s transmission planning and reliability through:

- Collaborative transmission planning for the Pacific Northwest and Intermountain West region
- A common set of transmission data and assumptions
- A single stakeholder forum

The cost of transmission lines is ultimately paid by utility ratepayers, and therefore state utility commissions – entities that monitor and regulate the investment decisions of privately-owned utilities, like the Oregon Public Utility Commission also have a role in the transmission planning process. Other entities involved in the planning and approval of new transmission lines include the various federal, state, and local authorities with jurisdiction over any permits that must be granted before new transmission lines are constructed.

Allocating Costs of Transmission Lines

Building transmission lines is a very capital intensive and expensive process; new transmission lines can cost upwards of \$1 million per mile for a new aboveground line.²⁶ Underground transmission lines can reduce risks associated with wildfires and threats to wildlife, but can be as much as 10 to 15 times the cost of aboveground lines.²⁷ However transmission lines are constructed, there are processes to determine who bears the initial costs of new transmission lines and how those costs are allocated and recovered in customer rates, depending on which state and federal authorities have jurisdiction to regulate transmission rates.

Before the Federal Energy Regulatory Commission adopted Orders 888 and 889, to promote competition and ensure non-utility generating resources have open access to transmission service (1996), the power industry mainly consisted of utilities that owned and operated generation resources and transmission lines without any separation of the utility employees working on either side.²⁸ This meant local utility companies often exercised control over the construction and operation of all the transmission lines and nearly all the generating resources (non-utility entities also develop and own some generation) necessary to serve customers within the territories of their systems. Single entities controlling investment decisions in both transmission and generation assets made the determination of who will build and pay for new transmission lines relatively easy – the local utility (after approval from its state regulator), and consequently, that utility’s customers. While this traditional paradigm was relatively straightforward and convenient, it also prompted concerns about whether the transmission sides of utilities were providing transmission service in favor of their own generators and discriminating against the generators of other utilities and non-utility generators (such as independent power producers).²⁹

Independent Power Producers

IPPs are non-utility entities that own electricity generation. They sell their power wholesale to utilities and power marketers (such as BPA) through bilateral negotiations of long-term contracts and spot transactions in wholesale markets. A subset of IPPs, which must register with the PUC as Electricity Service Suppliers, provide retail power to certain large commercial and industrial customers.

With the anti-competitive concern in mind, Congress changed the traditional transmission paradigm with its passage of the Energy Policy Act of 1992.³⁰ FERC’s 1996 orders carried out the act’s goals, and as a result, utilities have separated their transmission functions from their generation functions to help ensure generators owned by other utilities and IPPs receive open and non-discriminatory access to the transmission services they need. Open access can increase competition between utilities and IPPs for building new generation. While open access competition can lead to lower cost generation, it can also create complexities in allocating costs among generators and transmission owners.

Regional Transmission Markets

Pacific Northwest utilities and IPPs account for and pay for the transmission of power across the region through bilateral agreements with the owners and operators of transmission lines. This is in contrast to other regions of the U.S. where power transmission is accounted and paid for through the oversight and operations of a Regional Transmission Operator (RTO).

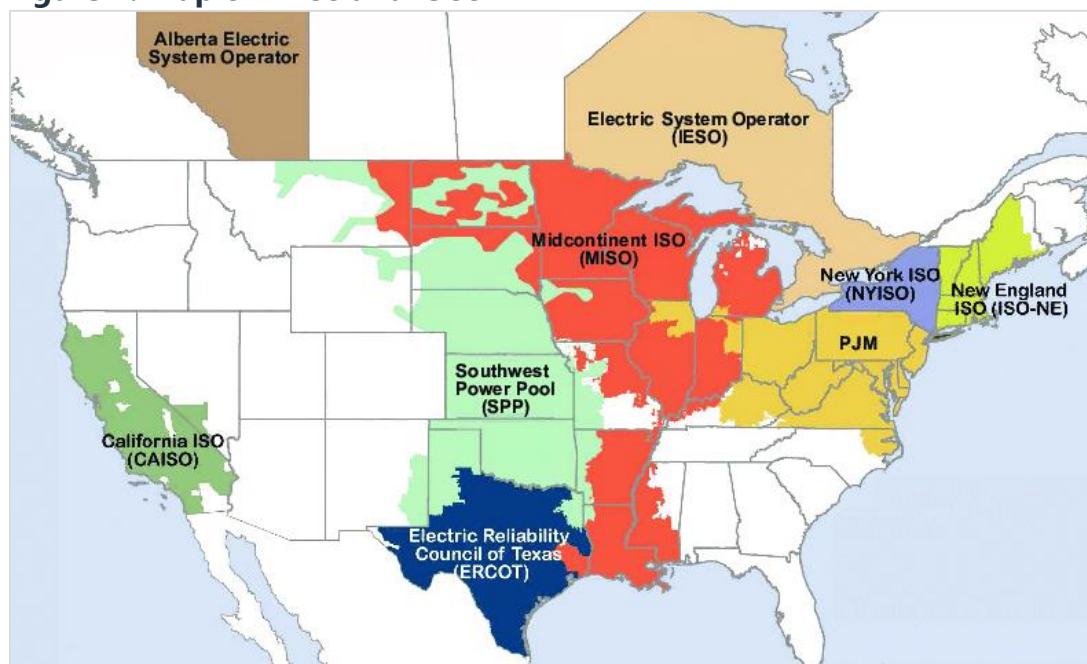
FERC Order 888 (1996) was adopted to promote competition and ensure non-utility generating resources have open access to transmission service, which prompted the concept of RTOs.³¹ Before that, electricity across the country was bought and sold through bilateral transactions and power pool agreements (e.g. Northwest Power Pool).³² After open access requirements were established, several groups of transmission owners across the country formed Independent System Operators (similar function of RTOs) to operate the transmission system independently of wholesale market participants and develop innovative procedures to equitably manage transmission services.³³

FERC Order 2000 (1999) furthered the goal of Order 888 by encouraging utilities across the country to join RTOs.^{iv} ³⁴ FERC's efforts, along with the efforts of industry and various states, led to the voluntary formation of many of RTOs (see map of current RTOs/ISOs below). RTOs and ISOs developed energy and ancillary services markets for buyers and sellers to bid for or offer generation. Energy markets are where electricity is bought and sold to meet load forecasts.³⁵ Ancillary services provide electricity resources that help balance the transmission system, including regulation functions that help stabilize the electricity system and reserve services that serve as backup power generation in the event additional electricity generation is required.³⁶ The bid-based markets are used by the RTOs and ISOs to determine the most economic dispatch of generating resources to meet customer loads.

The Northwest Power Pool

The NWPP is a voluntary organization comprised of major generating utilities serving the Northwestern U.S. and Canada. With the goal of working toward cooperative power system solutions for the benefit of its members, NWPP works on a range of topics, including arrangements for the sharing of generation supplies necessary to meet NERC reliability standards and serving as a central forum for addressing transmission concerns of its members.

^{iv} FERC Order 2000 – “On May 13, 1999, the Commission proposed a rule on Regional Transmission Organizations (RTOs) that identified and discussed our concerns with the traditional means of grid management. In that Notice of Proposed Rulemaking (NOPR), the Commission reviewed evidence that traditional management of the transmission grid by vertically integrated electric utilities was inadequate to support the efficient and reliable operation that is needed for the continued development of competitive electricity markets, and that continued discrimination in the provision of transmission services by vertically integrated utilities may also be impeding fully competitive electricity markets. These problems may be depriving the Nation of the benefits of lower prices and enhanced reliability.”

Figure 7: Map of RTOs and ISOs³⁷

Today, two-thirds of the nation's electricity load is served in RTO and ISO regions, while major portions of the country continue to operate under more traditional bilateral market structures, notably the West (including the Pacific Northwest, but excluding California) and the Southeast.

Drivers Affecting Transmission Systems in Oregon and the U.S.

Technology advancements and policies are driving changes to the transmission system. Below are examples of current and developing topics that transmission planners and operators are considering as they make plans for upgrading the bulk transmission system.

- **Increasing Renewables.** Cost-effective solar and wind resources have been driving the need for new, relatively short gen-tie lines to interconnect to the bulk transmission grid,³⁸ and in some cases (such as PacifiCorp's Energy Gateway project) the need for new, much longer bulk transmission lines to deliver the electricity they generate to distant loads.³⁹
- **Coal Retirements.** The number of operating coal plants has been declining⁴⁰ and analysis shows that downward trend will continue⁴¹ while more cost-effective power generation is being added. This is giving rise to changes where generators are located and means bulk transmission lines that connect new generating resources to customer load centers may see increases in electricity traffic, while other bulk transmission lines that had been sending coal power to load centers may see reduced traffic.⁴² Changing power flows can impact availability of transmission capacity, transmission congestion issues, and transmission planning.
- **Batteries.** Batteries are increasing in use due to declining costs and because they can be strategically located to improve operational efficiency of the grid. When batteries are located close to loads, they can be charged during off-peak hours to store electricity produced by distant generators, and then discharge locally during peak hours.⁴³ Using batteries to store electricity near load centers in advance of when it is needed has been investigated by Portland General Electric and others, and can avoid the need to utilize portions of precious peak-hour transmission capacity to deliver electricity to customers at critical times of the day.⁴⁴
- **Distributed Energy Resources (DERs).** The deployment and optimization of DERs will further the ability of local distribution systems to self-supply marginal portions of their overall power needs. Distributed Energy Resource is an umbrella term used to refer to any resource

interconnected to the distribution grid of a local utility, such as rooftop solar, diesel generators, energy efficiency, demand response, electric vehicles, and hardware or software control systems to communicate with the grid and/or optimize usage of other DERs.⁴⁵ As the potential for DERs expands, there will be an increasing need for utilities to evaluate DERs in their plans for new generation and transmission system capacity.

- **Increased Electrification.** Clean energy goals and requirements driven by customer preferences and state policy choices across the West may spur increased electrification of energy needs that have traditionally been met by non-electric energy supplies – such as transportation fuels and home heating. Increased demand for electricity can be met with increased energy efficiency, optimization of existing generating resources, and new generating resources – which could have implications for the bulk transmission system across the West and needs for new bulk transmission capacity.⁴⁶



Learn more about some of these efforts, including Distribution System Planning and Energy Markets, in fellow Energy 101s, Policy Briefs, and Technology Reviews.

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Energy 101: Natural Gas

Natural gas is a fossil energy source that formed beneath the surface of the earth millions to hundreds of millions of years ago. This gas was formed from the remains of plants and animals that built up in thick layers on the earth's surface and ocean floors. Over time these layers were buried under sand, silt, and rock. Pressure and heat changed some of this carbon and hydrogen-rich material into coal, some into oil (petroleum), and some into natural gas.¹



Natural gas is a combustible mixture of hydrocarbon gases. While natural gas is formed primarily of methane, it can also include ethane, propane, butane, and pentane. The composition of natural gas can vary widely before it is refined or processed.²

In its refined or processed form that is delivered to homes, commercial businesses, industry, and in small amounts to the transportation sector, natural gas is made up of almost pure methane, a molecule that has one carbon atom and four hydrogen atoms and is often referred to by its chemical representation CH₄. Natural gas is called "dry" when it is pure methane and "wet" when it contains other liquid natural gases like butane and ethane, usually around 15 percent of the mixture.³

Natural gas is clear and odorless. Natural gas companies add a chemical called mercaptan, which gives the gas a distinctive smell of rotten eggs. Because humans can detect mercaptan at very low levels, the smell serves as a safety mechanism, enabling quick and easy detection of leaking natural gas. Natural gas providers are required to odorize all service and distribution lines. Some of the larger natural gas transmission lines are also odorized, but this is not required.⁴

Where is Natural Gas Found?

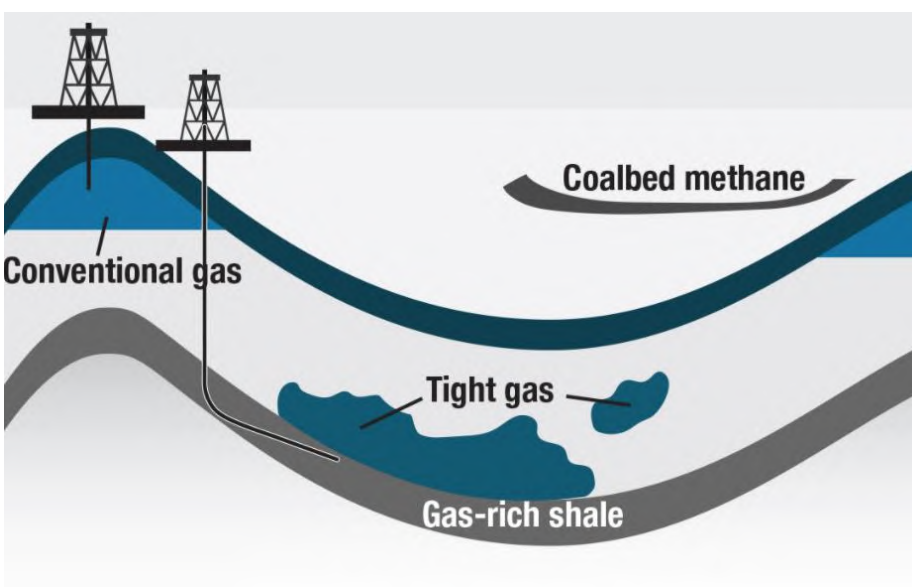
Natural gas can be found and extracted from several sources. It is sometimes found in large cracks and spaces between layers of rock and is referred to as conventional natural gas. In other places,

natural gas is found in the tiny pores or spaces within shale, sandstone and other sedimentary rock. Natural gas found in shale formations, called plays, is referred to as shale gas and gas found in sandstone or limestone formations is referred to as tight gas.

Collectively, shale and tight gas are sometimes referred to as unconventional natural gas.

Natural gas can also be found with crude oil deposits, referred to as associated natural gas. Another type of natural gas is found in coal

Figure 1: Where Natural Gas is Found⁵



deposits and is referred to as coalbed methane.⁵

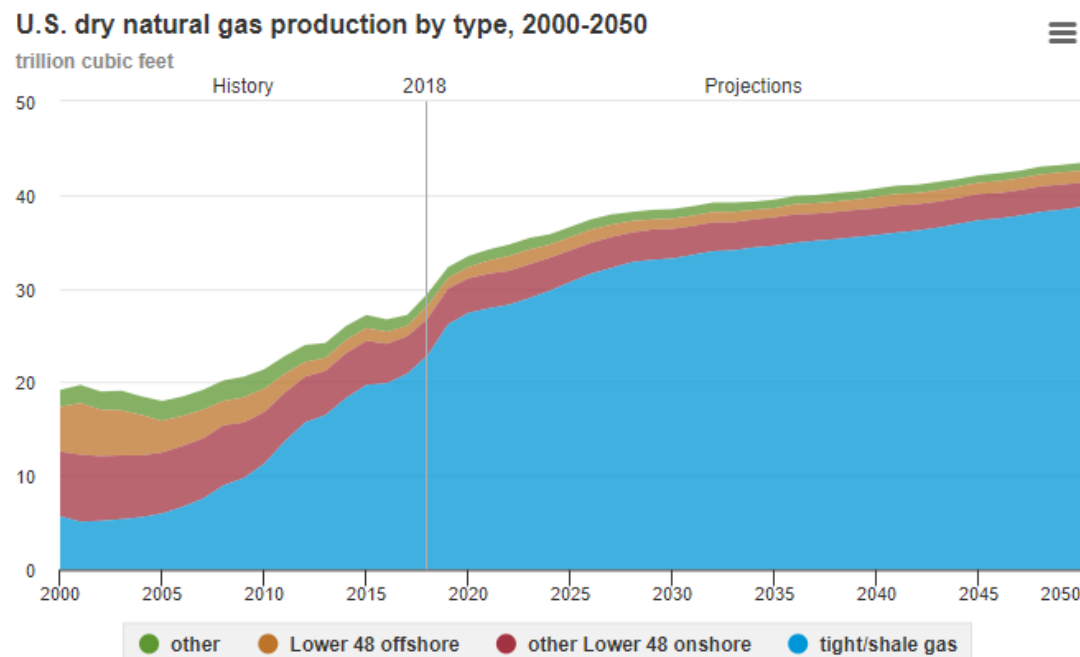
Hydraulic fracturing has made vast quantities of natural gas available that were previously economically inaccessible. The United States is ranked number one in production of natural gas and Canada is ranked number four in the world.

Table 1: World Natural Gas Production Rankings⁶

World Production – 381 Bcf/d (10.8 Bcm/d) (2018, preliminary)		
Rank	Country	Percentage of Total
1	United States	22%
2	Russia	18%
3	Iran	6%
4	Canada	5%
5	Qatar	4%

Most of the natural gas extracted and processed in the U.S. today and in the foreseeable future is from tight and shale gas plays.⁷

Figure 2: U.S. Dry Natural Gas Production by Type, 2000-2050⁸



Source: U.S. Energy Information Administration, *Annual Energy Outlook 2019 Reference*, January 2019

Like in the U.S., Canadian shale and tight resource production is growing, helping to offset declines in conventional production. In 2014, shale gas accounted for approximately 4 percent of total Canadian natural gas production while tight gas accounted for 47 percent. In 2018,

Canada's average marketable production was 29 percent conventional and 71 percent unconventional, which includes shale, tight, and coalbed methane.⁹ By 2035 the Canada Energy Regulator (CER, formerly the National Energy Board) expects tight and shale gas production together will represent 80 percent of Canada's natural gas production.¹⁰

Natural Gas Production

Because conventional oil and gas have accumulated in natural reservoirs and are typically in high-permeability source rocks, they can be acquired by vertical or directional drilling methods. A drill is attached to a series of pipes and is rotated at high speed into the underlying rock formations. Drilling mud is circulated into the hole to counter the pressure from below and cleanse the wellbore of rock fragments. When the drilling is done, a steel casing is inserted into the wellbore. Sections of the steel casing pipe are perforated with holes to allow oil or natural gas to rise to the surface by using the natural pressure from the well and pumping operations.

Unconventional gas production in formations of low-permeability shale, sandstone, or limestone requires hydraulic fracturing, often referred to as “fracking.” Fracking has been used in the industry for over 150 years; the first patent for it was obtained in 1865 for an improvement in artesian well development called exploding torpedoes.¹¹ Hydraulic fracturing in vertical wells has been used for over 50 years to improve the flow of oil or gas from conventional reservoirs.¹² The practice of horizontal drilling combined with multiple usages of hydraulic fracturing in a single well was pioneered in the late 1980s and continued to evolve into the next century. As can be seen in Figure 2 above, as horizontal drilling and hydraulic fracturing technology was further perfected around 2005, the unconventional natural gas boom began. The technique made extracting unconventional shale and tight gas fields economically feasible.

As illustrated in Figure 1, accessing shale and tight oil plays that are in layers or pockets requires drilling a vertical well and then angling the drill and pipe toward the resource from the side rather than from above. This enables access to a greater area of the resource and can make the well more productive. Wells can be drilled for miles both vertically and horizontally. After the well has been drilled, hydraulic fracturing uses water, chemicals, and sand at high pressure to create or widen existing cracks in the rock formations and pressurizes the gas (or oil) so that it can flow more easily to the surface. This hydraulic fracturing fluid is composed of water, proppant (typically sand) to keep the newly formed rock fractures open, and chemicals.

A public website known as **FracFocus** was established by members of the fracking industry. Reporting to the FracFocus web site is mandatory in some states and voluntary in others, and lists specific materials used in many, but not all, hydraulically fractured wells. Specific formulations of some chemicals are considered trade secrets and are exempt from reporting on the site.¹³

The amount of fluid varies by site due to rock formation, the operator, whether the well is vertical or horizontal, and the number of portions or stages of the well to be fractured. Water can be up to 97 percent of the fluid used and the amount of water per well can be anywhere from 1.5 million gallons to 16 million gallons.¹⁴ The chemicals are added for different purposes, based on the rock type and other considerations. Acids, for example, are used to dissolve minerals to help fossil fuels flow more easily; biocides eliminate bacteria; gelling agents help carry proppants into fractures; and corrosion inhibitors prevent steel parts of the well from being damaged by fracking fluid. The Environmental Protection Agency identified 1,084 different chemicals used in fracking formulas between 2005 and

2013. Common ingredients include methanol, ethylene glycol, and propargyl alcohol. Those chemicals, along with many others used in fracking fluid, are considered hazardous to human health.¹⁵

Much of the water and chemical additives remain deep underground in the geologic formation from which the oil or gas was extracted. However, some of the fluid returns to the surface and is referred to as “produced water”, which is fracking fluid mixed with water or brine from the formation.¹⁶ After a well is finished or brought online, large volumes of produced water are created. The produced water is typically disposed of by injecting it into the ground in the same geologic formation that the oil or gas was extracted from by wells designed for this purpose. In some cases, produced water can be treated and reused to hydraulically fracture another well. If the produced water is deemed to meet regulatory standards, the water can be discharged into local watersheds and (unless they include diesel fuel) fracking solutions are exempt from EPA regulation under the Safe Drinking Water Act.¹⁷ Practices vary between regions, depending on regulations, geologic conditions, and water availability.¹⁸

Hydraulic fracturing requires a lot of heavy equipment such as high-pressure and high-volume pumps, blenders for fracking fluids, storage tanks for water, sand, chemicals, and wastewater – along with high-powered drilling rigs, casing, and drilling pipe. Typically, all the equipment, fluids, sand, and chemicals must be brought in and taken away by large heavy-duty trucks during well development, well production, and well re-fracking activity, resulting in an average of four thousand to 16 thousand trips per well (depending on the basin where the drilling activity is located).¹⁹

Naturally Occurring Radioactive Materials and Oregon Disposal

Natural radioactivity is present throughout the earth’s crust, associated with uranium and thorium and their decay products. Certain industrial activities, like hydraulic fracturing, can result in the collection of such naturally occurring radioactive materials (“NORM”) in the production water. When the water is brought to the surface for processing and reuse, the equipment used to collect, process, filter, and use the water concentrates these radionuclides in pipes, filters, sludges, or other equipment. When NORM is processed and concentrated, it is called technologically enhanced naturally occurring radioactive material, or “TENORM.” TENORM wastes are not regulated federally, so it is up to each state to determine how best to manage such wastes. The increase in oil and gas fracking in recent decades led to an increase in TENORM wastes and presents a new challenge for radioactive waste management in North America.²⁰

In September of 2019, a citizen tip alerted ODOE to the fact that a hazardous-waste landfill in Gilliam County had accepted about two and a half million pounds of likely TENORM waste over an approximately three-year period. The waste came from the Bakken Oil Fields, primarily in North Dakota. Because Oregon law prohibits disposal of radioactive waste within the state,²¹ in February 2020, ODOE determined that this incident violated the state’s prohibition on disposal of such material and issued a Notice of Violation to the landfill operator.²²

ODOE is now working with the landfill operator and the public to assess the risk that this waste poses to Oregonians and to take steps to ensure that similar waste is not disposed of in Oregon in the future.^{23 24}

Processing Natural Gas

Once brought to the surface, natural gas must be processed to meet pipeline standards. Unrefined natural gas contains many contaminants that would damage natural gas pipelines that deliver processed gas. Some low-grade processing may be done at or near the production site, known as the wellhead. Unprocessed gas is transported from the wellhead to a central collection point using gathering pipelines. These pipelines generally operate at low pressures and flows and are smaller in diameter than transmission lines. The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration estimates that there are 240,000 miles of gathering pipelines in the nation.²⁵ A complex gathering system can consist of thousands of miles of pipes, interconnecting the processing plant with upwards of 100 wells in the area.

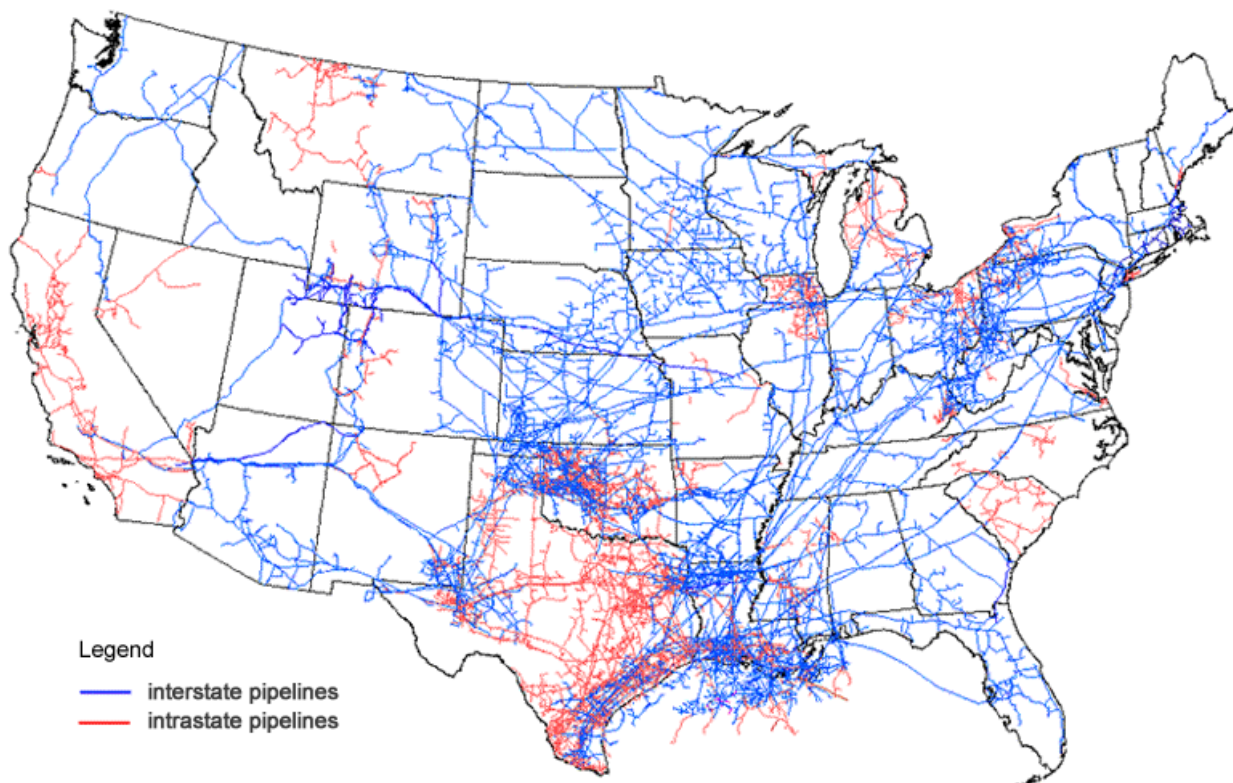
Before natural gas can be injected into transmission and distribution lines it must meet quality and purity standards. Therefore, most natural gas is processed in the region where it was sourced. This processing consists of separating all the various hydrocarbons and fluids from the methane to produce what is called pipeline-quality, dry natural gas. Associated hydrocarbons, known as natural gas liquids, including ethane, propane, butane, isobutane, and natural gasoline, are also separated and refined at these raw gas processing facilities. Processing natural gas to pipeline quality can be very complex and will vary depending on the contents of the gas. It usually involves four main processes to remove and separate its contents:

- Oil and Condensate Removal
- Water Removal
- Separation of Natural Gas Liquids
- Sulfur and Carbon Dioxide Removal

In addition to the four processes above, heaters and scrubbers are installed, usually at or near the wellhead. The scrubbers serve primarily to remove sand and other large-particle impurities. The heaters ensure that the temperature of the gas does not drop too low. With natural gas that contains even low quantities of water, natural gas hydrates can form when temperatures drop. These hydrates are solid or semi-solid compounds, resembling ice-like crystals. Should these hydrates accumulate, they can impede the passage of natural gas through valves and gathering systems.²⁶

As mentioned above, propane or liquid propane gas is a by-product of natural gas processing. In the United States about half the propane consumed is from natural gas processing, the other half is from crude oil refining.²⁷

After processing, the pipeline-quality natural gas is injected into gas transmission pipelines and transported to the end users, often hundreds of miles away from the wellheads and processing facilities. These pipelines are wide-diameter, high pressure interstate pipelines. Compressor stations (or pumping stations) keep the gas flowing through the system. These stations are typically powered by the natural gas in the pipeline itself. As is illustrated in Figure 3, the Northwest has far fewer transmission pipelines than other regions of the country.

Figure 3: U.S. Natural Gas Transmissions Pipeline System²⁸

Source: U.S. Energy Information Administration, *About U.S. Natural Gas Pipelines*

Environmental Impacts of Natural Gas

Natural gas is relatively clean burning and results in fewer emissions of all types of air pollutants, including carbon dioxide (CO₂), during combustion than burning coal or petroleum products to produce an equal amount of energy.²⁹ For example, about 117 pounds of CO₂ are produced per million British thermal units (MMBtu) equivalent of natural gas, compared with more than 200 pounds of CO₂ per MMBtu of coal, and more than 160 pounds per MMBtu of distillate fuel oil. The cleaner burning properties of natural gas have contributed to the increased use of natural gas as a lower emission option for electricity generation and transportation fuels in the United States.³⁰

The increased supply and lower price of natural gas, along with its lower toxic and greenhouse gas (GHG) emissions, has resulted in several coal-sourced electric generating plants to switch to natural gas. According to data from the U.S. Energy Information Administration (EIA), 121 U.S. coal-fired power plants were repurposed to burn other types of fuels between 2011 and 2019, 103 of which were converted to or replaced by natural gas-fired plants. At the end of 2010, 316.8 gigawatts (GW) of coal-fired capacity existed in the United States, but by the end of 2019, 49.2 GW of that amount was retired.³¹

While natural gas has lower emissions when combusted than coal or distillate fuels, natural gas primarily consists of methane – an extremely volatile GHG with high global warming potential when released into the air without combusting, or what is known as fugitive emissions. Methane radiates 28-36 times more global warming potential energy per ton in the atmosphere than CO₂.³² Typically, the greatest percentage of GHG emissions from natural gas occur when combusting the gas. The remaining percentage of lifecycle emissions occurs at the wellhead, processing, transporting, and final

distribution of the gas. As natural gas can easily leak from pipelines and abandoned wells, the lifecycle GHG emissions of natural gas can increase significantly if leakage is high.

In 2018, natural gas use in the residential and commercial sectors accounted for nearly 80 percent of CO₂ emissions for direct fuel use, mainly used for heating and cooking.³³ The U.S. Environmental Protection Agency estimates that in 2018, methane emissions from natural gas and petroleum systems and from abandoned oil and gas wells were the source of about 29 percent of total U.S. methane emissions and about 3 percent of total U.S. GHG emissions.³⁴ When comparing lifecycle GHG emissions, methane leakage reduces the overall benefits of cleaner burning natural gas.³⁵

Natural gas exploration, drilling, and production also pose other environmental impacts. Drilling a natural gas well on land may require clearing and leveling an area around the well site. Well drilling activities produce air pollution and may disturb people, wildlife, and water resources. Laying pipelines that transport natural gas from wells usually requires clearing land to bury the pipe. Natural gas production can also produce large volumes of contaminated water. This water requires proper handling, storage, and treatment so that it does not pollute land and other waters. Natural gas wells and pipelines often have engines to run equipment and compressors, which produce air pollutants and noise.³⁶

Some oil wells also produce natural gas, and where it is not economical to transport the gas, it is burned (flared) or vented at well sites. Emissions associated with flaring and venting are referred to as fugitive gas emissions. Flaring produces CO₂, carbon monoxide, sulfur dioxide, nitrogen oxides, and many other toxic compounds, depending on the chemical composition of the natural gas and on how well the natural gas burns in the flare. Venting simply releases the methane and any other contaminants into the atmosphere. While flaring can reduce overall emissions by converting methane into CO₂, it is still the most carbon intensive part of producing oil.³⁷ In 2016, the U.S. Environmental Protection Agency issued standards aimed at reducing these emissions; however, in August 2020 the EPA, under a new administration, rolled back some requirements and rescinded others, easing methane reduction requirements for the industry.³⁸ These fugitive emissions account for 6 percent of global GHG emissions every year.³⁹

Regulations and Standards for the Natural Gas Industry

There are several organizations that oversee, monitor, regulate, and set standards for the natural gas industry; some are identified below.

Domestic natural gas markets, particularly interstate markets, are regulated in part by the Federal Energy Regulatory Commission. For the most part natural gas moves by pipeline in the U.S. and the safety of those pipelines is in the jurisdiction of the Department of Transportation's Office of Pipeline Safety. The Energy Information Administration collects and publishes data on the industry.

In Oregon, the Oregon Public Utility Commission reviews filings and designs programs to:

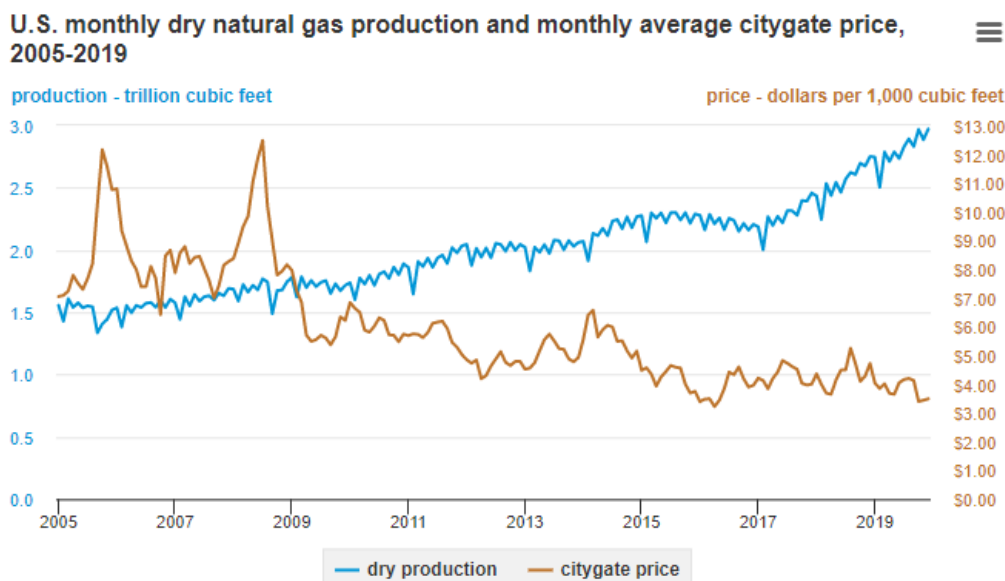
- Ensure safety, reliability, and quality of essential utility services.
- Scrutinize utility costs, risks, and performance to ensure just and reasonable rates for customers.
- Manage customer and community choices to ensure value for everyone.

- Anticipate, inform, and integrate policy, industry, market, and technology changes as the utility sector evolves.⁴⁰

Increased Natural Gas Production and Reduced Prices

Since 2005, U.S. natural gas production has nearly doubled due to the new accessibility of the nation's shale and tight gas formations brought on by the evolution of horizontal drilling and hydraulic fracturing techniques.

Figure 4: U.S. Dry Natural Gas Production and Citygate Price⁴¹



As with most commodities, increases in natural gas supply usually result in lower prices and decreases in supply can lead to higher prices. Conversely, increases in demand generally lead to higher prices and higher prices tend to lower demand. Higher prices can also encourage production, while lower prices tend to have opposite effects.⁴²

Note: Citygate is a point or measuring station at which a natural gas distribution utility receives gas from a pipeline company or transmission system.
 Source: U.S. Energy Information Administration, *Natural Gas Monthly*, July 2020

Three major supply-side factors affect prices:

- Amount of natural gas production.
- Level of natural gas in storage.
- Volumes of natural gas imports, exports, and transmission capacity.

Three major demand-side factors affect prices:

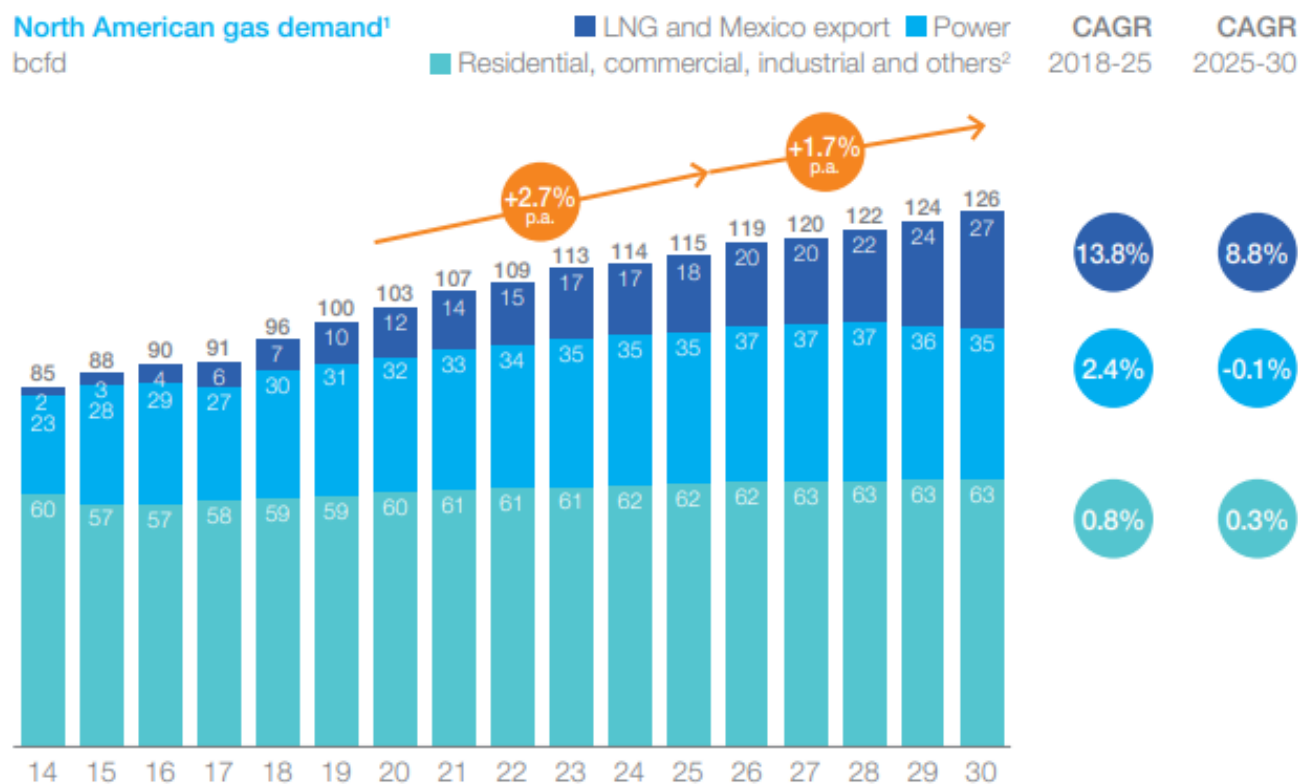
- Variations in winter and summer weather.
- Level of economic growth.
- Availability and prices of other fuels.⁴³

Crude oil and petroleum product markets respond quickly and often dramatically to world events, but natural gas markets have tended to be driven by regional factors and have been less connected to the international market. This is because natural gas is less fungible than oil, meaning that crude oil and petroleum products can be more easily moved and in much larger quantities from one location to another creating more of a global market. Transporting for most natural gas is done with pipelines which makes it more difficult to move over long distances and restricts widespread trading opportunities.

Liquefied Natural Gas (LNG) is the cooled-down (-260 degrees F) liquid form of natural gas. This denser form makes it easier to transport and provides the additional safety of non-pressurized transport. More countries have supported investments in the development of LNG, including infrastructure to receive shipments and deliver gas into pipelines. This has led to LNG increasingly becoming a global commodity.⁴⁴ A flood of new supply in the last decade, due in large part to the start of U.S. exports in 2016, has helped make the flow of those seaborne cargoes more frequent, global, and flexible.⁴⁵

As can be seen in the chart below, U.S. natural gas is seeing increased demand from both LNG exports and electricity (power) generated from natural gas. These increases are expected to continue out to 2030.⁴⁶

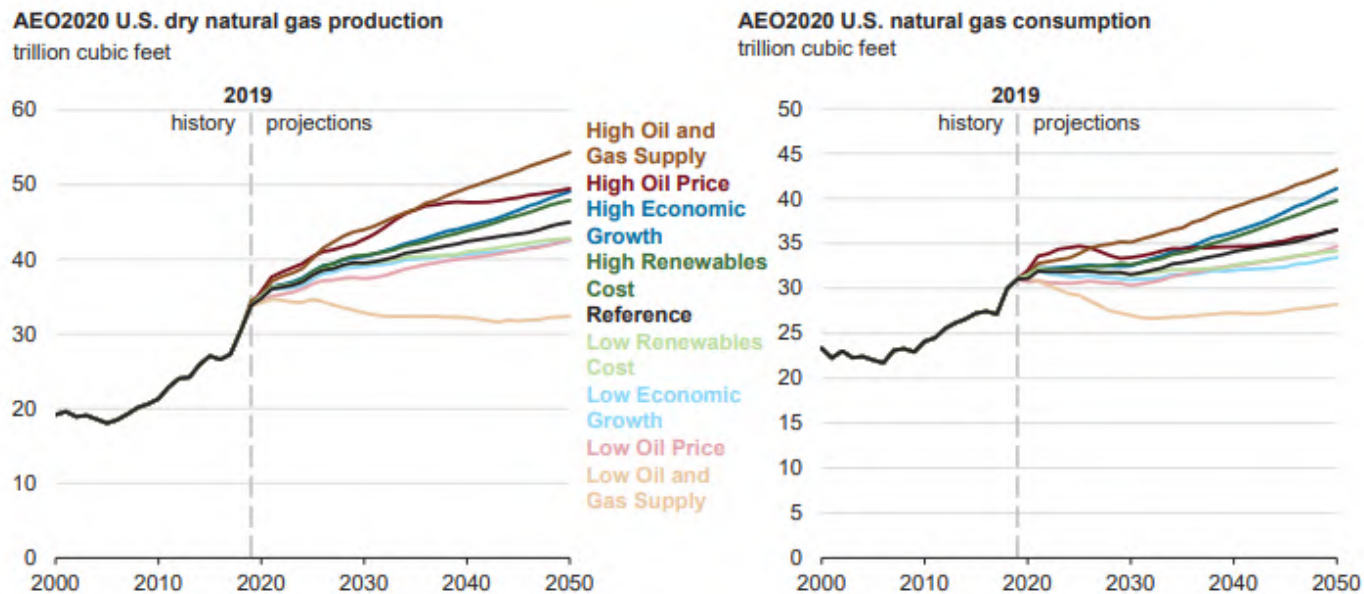
Figure 5: North American Natural Gas Demand – Historical and Forecast by Year⁴⁷



¹ Dry gas consumption in US and Canada ² Includes pipe, plant, lease, and natural gas vehicles (NGVs)
 Source: McKinsey Energy Insights Global Energy Perspective Model; EIA; NEB

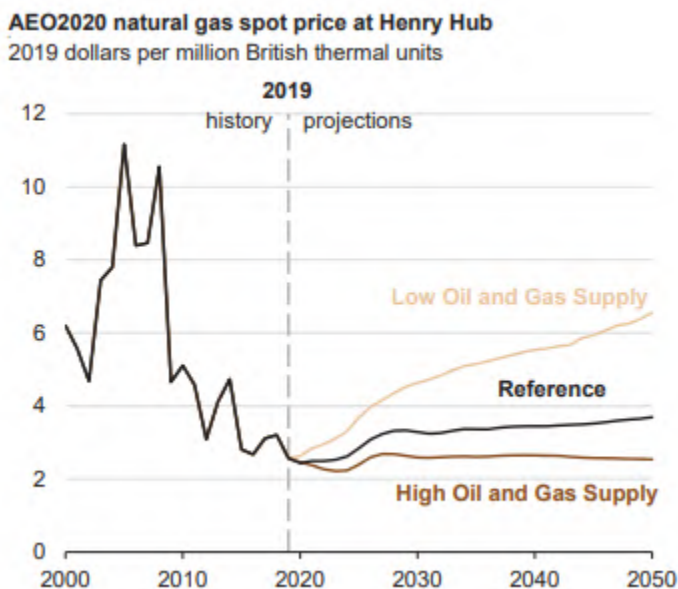
The U.S. Energy Information Administration (EIA) estimates several scenarios below for natural gas production and consumption in the U.S., with most of them showing an increase in consumption and production.

Figure 6: Energy Information Administration Annual Energy Outlook 2020 – Natural Gas Forecasts⁴⁸



The Energy Information Administration, in its 2020 Annual Energy Outlook, estimates in its reference case that growing demand in domestic and export markets leads to increasing natural gas prices.

Figure 7: Natural Gas Historical and Forecast Spot Prices – EIA Chart⁴⁹

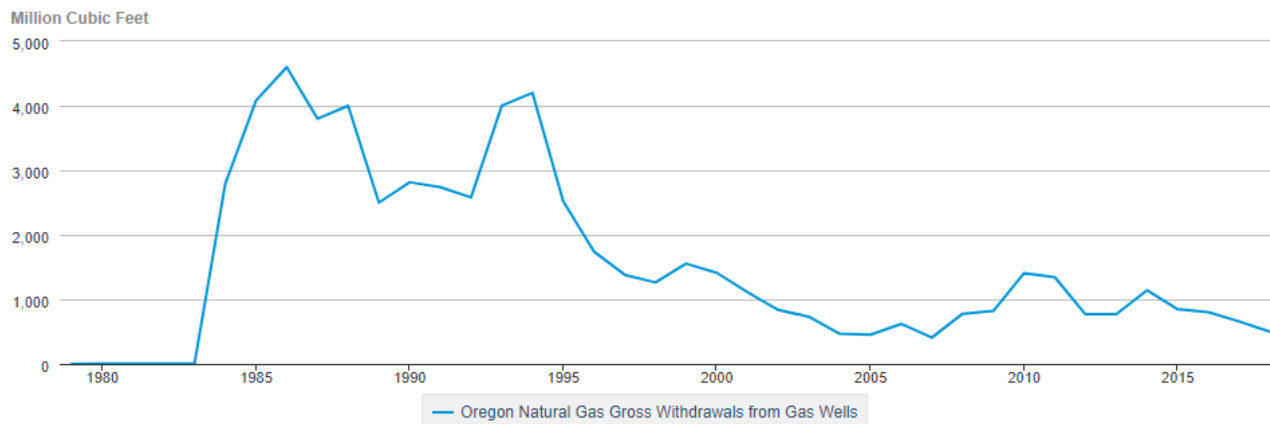


Oregon's Sources of Natural Gas

Oregon has very little in natural gas reserves. In 2018 the Mist field produced 499 MMBtu with 14 wells that accounted for less than 0.002 percent of the nation's natural gas production⁵⁰ and 0.2 percent of Oregon's total consumption⁵¹ of natural gas. Oregon has never been a major producer of natural gas and has seen reduced rates for the last 30 years compared to the first twelve years of operation of the Mist gas field site. The field is not extensive, but the gas is at relatively shallow

pockets (2200 feet) with a solid dome above it and saltwater below. This geology is good for gas storage and that is its main purpose today. Natural gas is pumped into the field in off-peak times such as summer, when prices are lower; and during times of high demand the pumps are reversed, and the gas is recovered to supplement regional supplies.

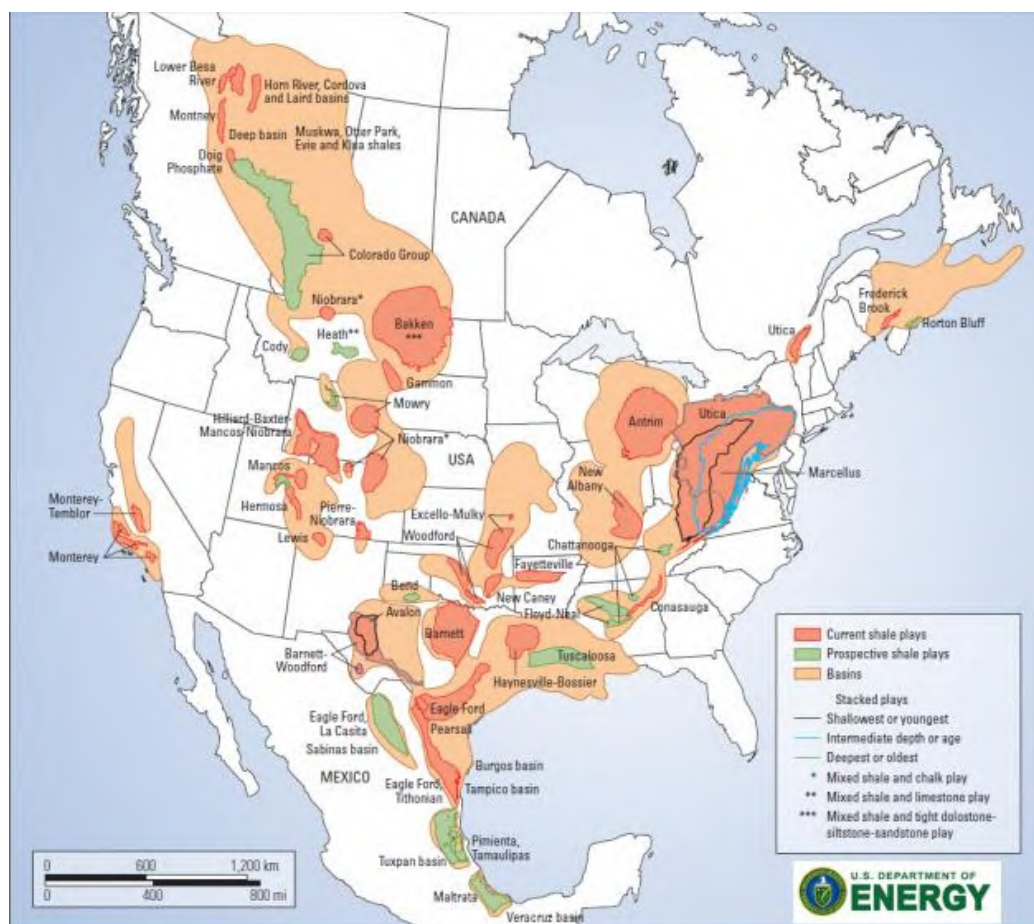
Figure 8: Oregon Natural Gas Production – Energy Information Administration⁵²



eia Source: U.S. Energy Information Administration

As illustrated in Figure 9, there are no major sources of natural gas in the Northwest.

Figure 9: North American Natural Gas Basins - EIA⁵³



In 2018, more than 90 percent of the natural gas that the United States consumed was produced in the U.S.⁵⁴ Most of the remaining 10 percent was imported from Canada. Because there are no major natural gas basins in Oregon, the natural gas that is consumed in the state must be brought in from outside of the state's borders. Due to Canada's proximity, natural gas resources, and mature infrastructure, most natural gas consumed in Oregon (up to two thirds) – depending on demand and market conditions – is imported from Canada.⁵⁵

Three transmission pipelines provide gas transport to and through our region from major supply basins in the Rockies, Northern Alberta, and Northern British Columbia.

Figure 10: Natural Gas Major Transmission Pipelines⁵⁶

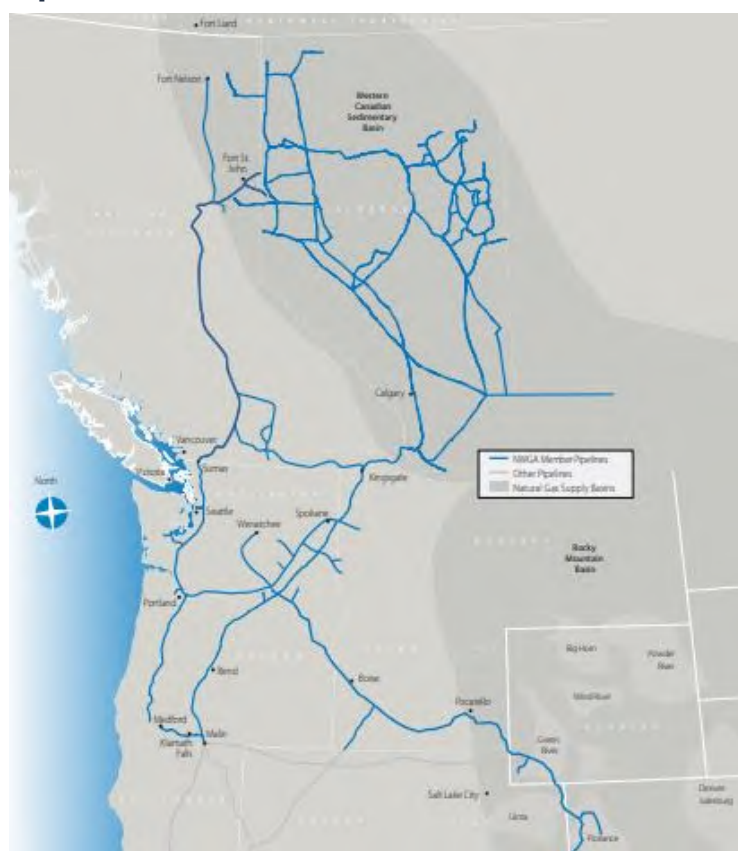


Figure 11: Northwest Pipelines, Storage, and Natural Gas Trading Hubs⁵⁷



The Enbridge BC Pipeline (1,776 miles, shown in red in Figure 11) serves as the main natural gas transmission line for natural gas development in British Columbia, Canada. It goes south from Fort Nelson to the U.S.-Canada border at Huntingdon-Sumas, a major natural gas trading hub. The pipeline transports about 60 percent of the natural gas produced in British Columbia and has been the backbone of B.C.'s natural gas industry since 1957. The pipeline also supplies about 50 percent of the natural gas demand in Idaho, Oregon, and Washington.⁵⁸

The Williams Northwest Pipeline system (shown in dark blue in Figure 11) was started more than 60 years ago and has grown from 1,500 miles to a 4,000-mile bi-directional transmission system crossing the states of Washington, Oregon, Idaho, Wyoming, Utah, and Colorado. This system provides access to British Columbia sourced natural gas (where it connects to the Enbridge BC Pipeline at the U.S.-

Canada border), Alberta sourced gas (via the connection shown in purple), U.S. Rocky Mountain gas, and San Juan Basin gas supplies.⁵⁹

The TransCanada (TC) Energy pipeline Gas Transmission Northwest (GTN) System Pipeline (shown in purple in Figure 11) begins at the U.S.-Canadian border in Idaho at the Kingsgate hub and travels south through the south east corner of Washington and then through central Oregon to the California border. The 1,378-mile pipeline delivers gas to the Pacific Northwest and California and has been in operation since 1961.⁶⁰ This border crossing provides access to the AECO-C/Nova Inventory Transfer market center that is located in Alberta and is a major long-distance transportation system which transports natural gas to points throughout Canada and to the United States. Alberta is the major Canadian exporter of natural gas to the U.S. and historically produces 90 percent of Canada's natural gas.⁶¹

There are several regional market hubs in the Pacific Northwest. Natural gas hubs are typically near or at gas infrastructure networks such as major pipelines and liquified natural gas terminals. A hub is used as a central pricing point for the network's natural gas.

AECO – This hub was described above and is in Alberta.

Rockies – This hub represents several locations on the southern end of the NWP system in the Rocky Mountain Region. The system sources Rocky Mountain natural gas-producing areas in Colorado, Utah, New Mexico, and Wyoming.

Sumas/Huntingdon – The Sumas, Washington pricing point is on the border and gives our region access to Canadian production from predominately Northern British Columbia.

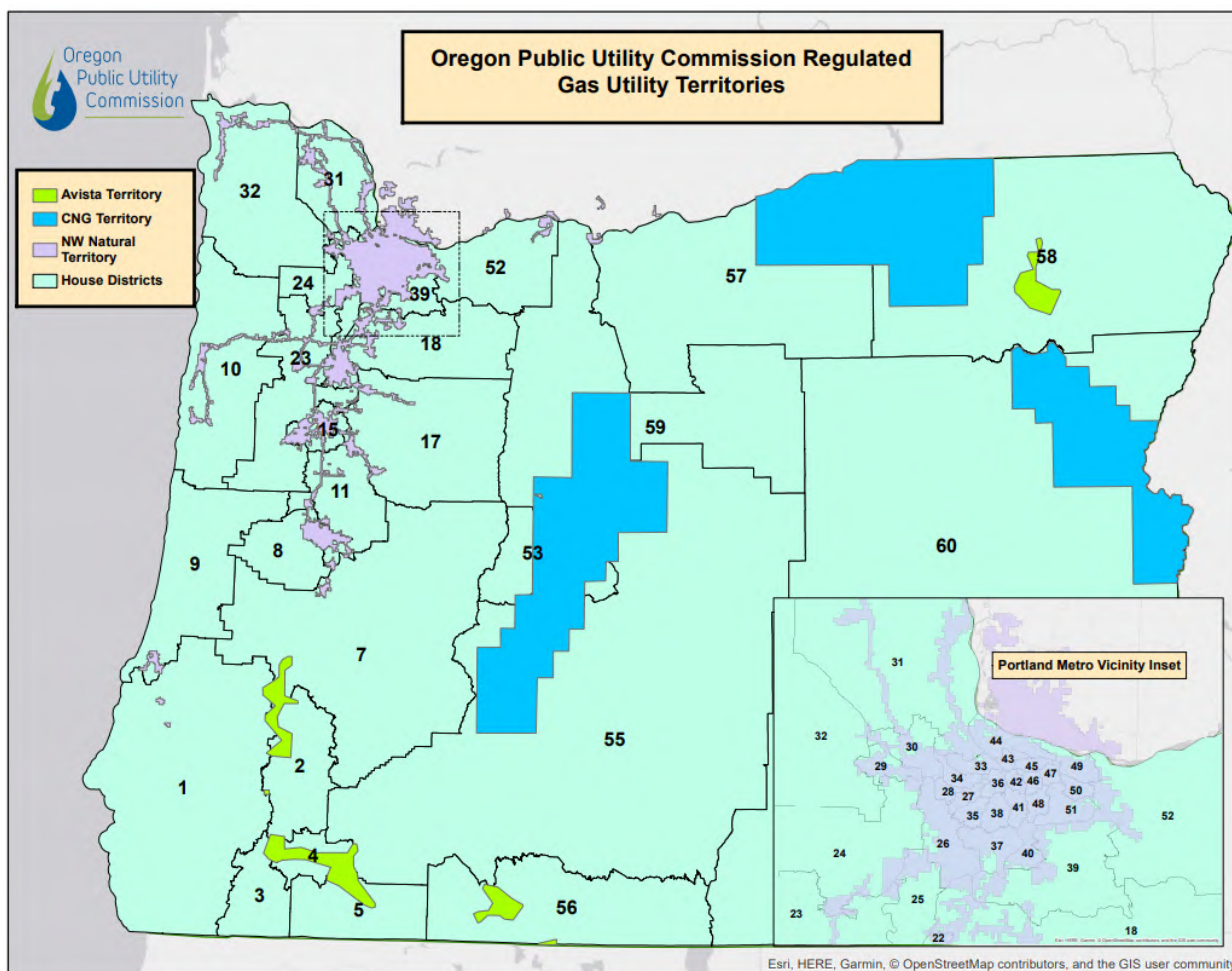
Malin – This pricing point in Malin, Oregon, is on the California/Oregon Border where TC Energy's GTN and Pacific Gas & Electric company connect.

Station 2 – Located at the center of the Enbridge Westcoast Pipeline system connecting to northern British Columbia natural gas production.

Stanfield – Located near the Washington/Oregon border at the intersection of the NWP and GTN pipelines.

Kingsgate – Located at the U.S./Canadian border in northern Idaho where the GTN pipeline connects with the TC Energy's Foothills pipeline.

Three companies provide natural gas service in Oregon, Avista Corporation, Cascade Natural Gas, and NW Natural. See Figure 12 below for the location of their service territories.

Figure 12: Natural Gas Utility Service Territories⁶²

These companies have a joint in-state workforce of over 1,160 employees serving more than 780,000 residential, commercial, and industrial natural gas customers.⁶³

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Energy 101: Oregon's Petroleum-Based Transportation Fuels

Introduction

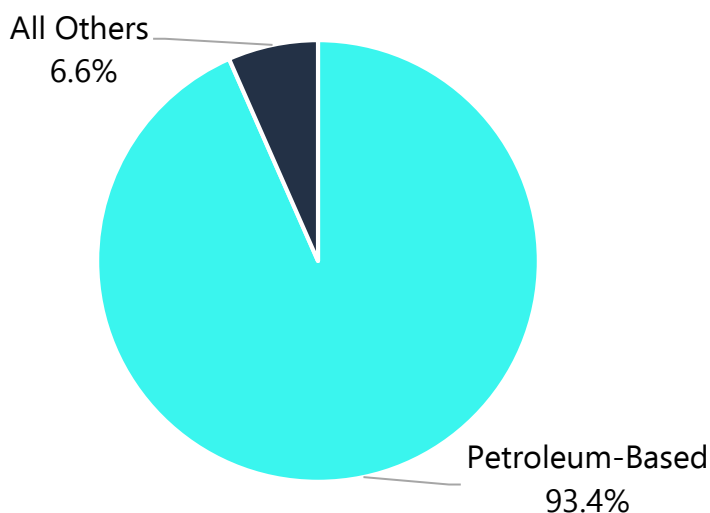
In 2018, Oregon's petroleum-based transportation fuels – gasoline, diesel, jet fuel, aviation fuel, and lubricants processed from crude oilⁱ – accounted for 93.4 percent of Oregon's transportation fuel consumption, with 6.6 percent of the fuels coming from alternative sources. For on-highway fuels, alternative fuel use is on the rise; it has increased from 1.2 percent in 2005 to 8.7 percent in 2019.¹

Low-carbon transportation fuels such as renewable diesel and electricity show great promise of increasing market share, but it has been a slow process to transition the transportation fleet and install the necessary infrastructure to enable increased adoption of these fuels. While petroleum-based fuels will continue to play a major role in the transportation sector, gasoline and diesel fuel's combined share of total transportation energy consumption in the U.S. is expected to decrease from 84 percent in 2019 to an estimated 74 percent in 2050.²

The Pacific Northwest has no crude oil resources and is isolated from the nation's major petroleum production regions in Texas, North Dakota, and Alberta, Canada. Because of this lack of resources and the added cost of getting the crude here, the region pays more for transportation fuels than many parts of the country. Over the last 10 years the mix of crude resources that feeds into northwest refineries has changed, resulting in changes in how crude oil gets here for processing and refinement. Large amounts of crude are now delivered by rail, and most of these crude rail shipments travel through the Columbia River Gorge and Portland before moving up to Washington refineries. Since 2011, Washington refineries have seen increased amounts of crude from the Canadian oil sands.^{17,18} This crude has a higher carbon intensity than other crude resources, meaning more greenhouse gas emissions are emitted per gallon of fuel, because it requires more greenhouse gas-emitting energy to extract and process.



Figure 1: Petroleum-Based vs. Alternative Fuels in Oregon (2018)¹



ⁱ This also includes asphalt and road oil, which are not technically fuels, but are processed from crude oil and used in the development and upkeep of roads and highways. The U.S. Department of Energy's Energy Information Administration includes these as "transportation fuels."

Overview

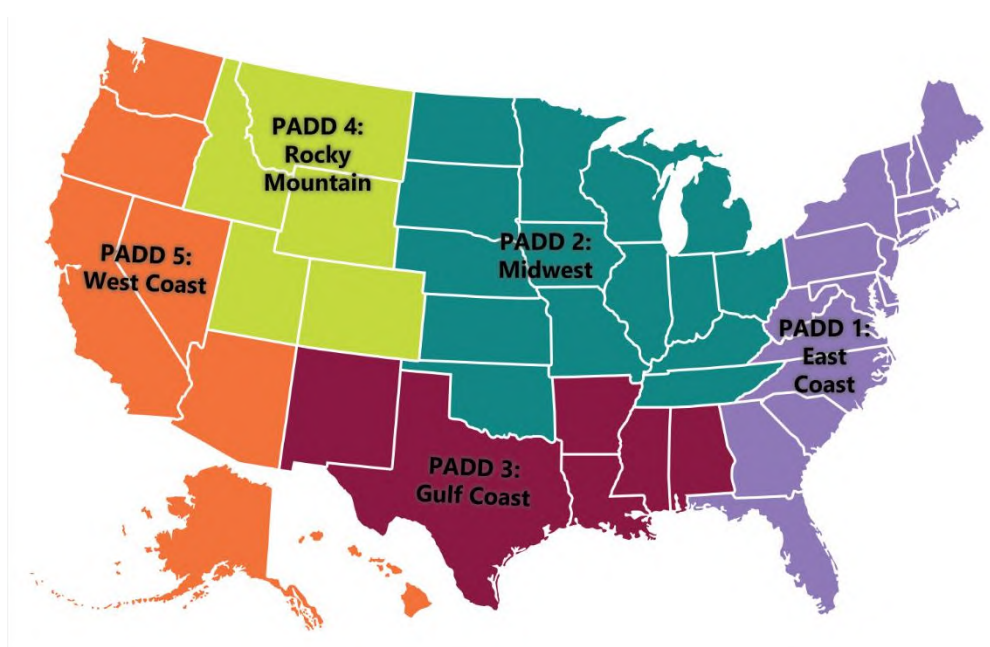
All petroleum fuels are derived from crude oil, which is called a fossil fuel because it is a mixture of hydrocarbons that formed from the remains of animals and plants (diatoms) that lived millions of years ago. Crude oil is found in liquid or gaseous form in underground pools or reservoirs, and within sedimentary rocks. It can also be found near the earth's surface in tar or oil sands. Crude oils vary in color due to their distinct chemical compositions. Two of the most important attributes when comparing the qualities of different crude oils are sulfur content and density. These have implications for how easily the crude can be extracted, processed, and refined. All of this has implications for greenhouse gas emissions and costs associated with the entire process from extraction to refinement.

Crude oil is extracted using several methods depending on the geology of where it is located. Once extracted, some crude oils, such as oil sands, need to be processed before they can be transported to a refinery or other processor. Crude is transported to refineries by pipeline, water vessel, rail, and sometimes truck.

Refineries separate the different parts of crude oil by selective boiling and condensation (distillation), which separates it into different liquids and gases, and then they blend or add other oils and liquids during processing to produce finished products. In addition to producing petroleum products such as gasoline, diesel fuel, heating oil, jet fuel, waxes, lubricating oils, and asphalt, the process also results in several byproducts that are used in other industries. These petroleum fuels are then transported, typically by pipeline or water vessel, to terminals where they are then shipped, usually by truck, to fueling stations.

Crude oil and petroleum product movements are tracked across the U.S. through five geographically divided areas of the country called Petroleum Administration Defense Districts – or PADDs. The districts themselves were initially created in World War II to track and ration gasoline. Since 1950 the PADDs have been used to collect data and information to better assess and understand the supply and demand of the domestic petroleum business.³ Oregon is part of PADD 5, a region that includes the western states of California, Arizona, Nevada,

Figure 2: Petroleum Administration for Defense Districts (PADDs)



Oregon, Washington, Alaska, and Hawaii. There are six distinct regional markets within PADD 5: Southern California and Southern Nevada; Northern California and Northern Nevada; Arizona; Hawaii; Alaska; and the Pacific Northwest, which consists of Washington and Oregon.

There are 22 operating petroleum refineries in PADD 5, five of which are located on the Puget Sound in Washington state. These five refineries provide more than 90 percent of the refined petroleum products used in Oregon.⁴ The remaining less than 10 percent comes from the San Francisco Bay Area and PADD 4 refineries in Salt Lake City, Utah, but can change to include other sources.⁵

Crude Oil Sources for Washington Refineries

The Northwest region has no major oil basins or shale plays and therefore must import crude oil from other states and countries to Washington's refineries to be processed into petroleum products (Figure 3 at right).

Figure 4 provides information on Pacific Northwest crude resources since 2011. The data presented here is a composite of multiple data sources to build a picture of crude oil resource trends over the last nine years, and is based on publicly-available data.

Comprehensive domestic crude oil input information into the five refineries in Washington has been inconsistent over the last nine years and is not available for 2012 to 2014 and 2016. As such, the data from these years are not included in the figure below. Since late 2016, quarterly data on all crude oil movement inputs has been collected and published. However, these reports do not make a distinction between Canadian conventional and Canadian oil sands.

Figure 3: Oil and Gas Basins and Prospective Shale Development

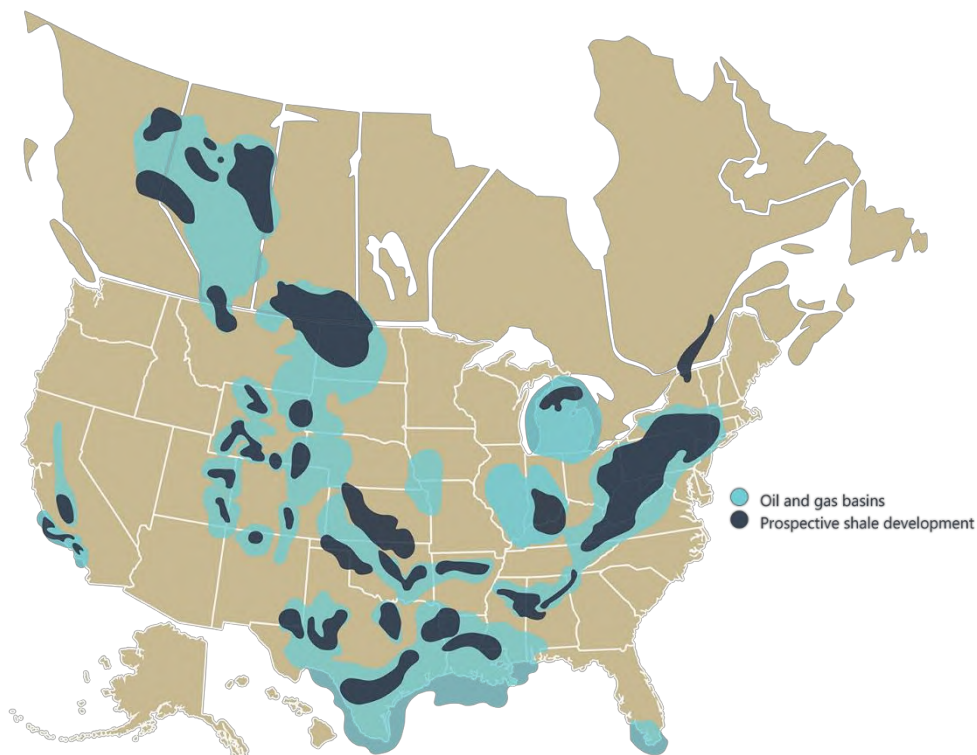


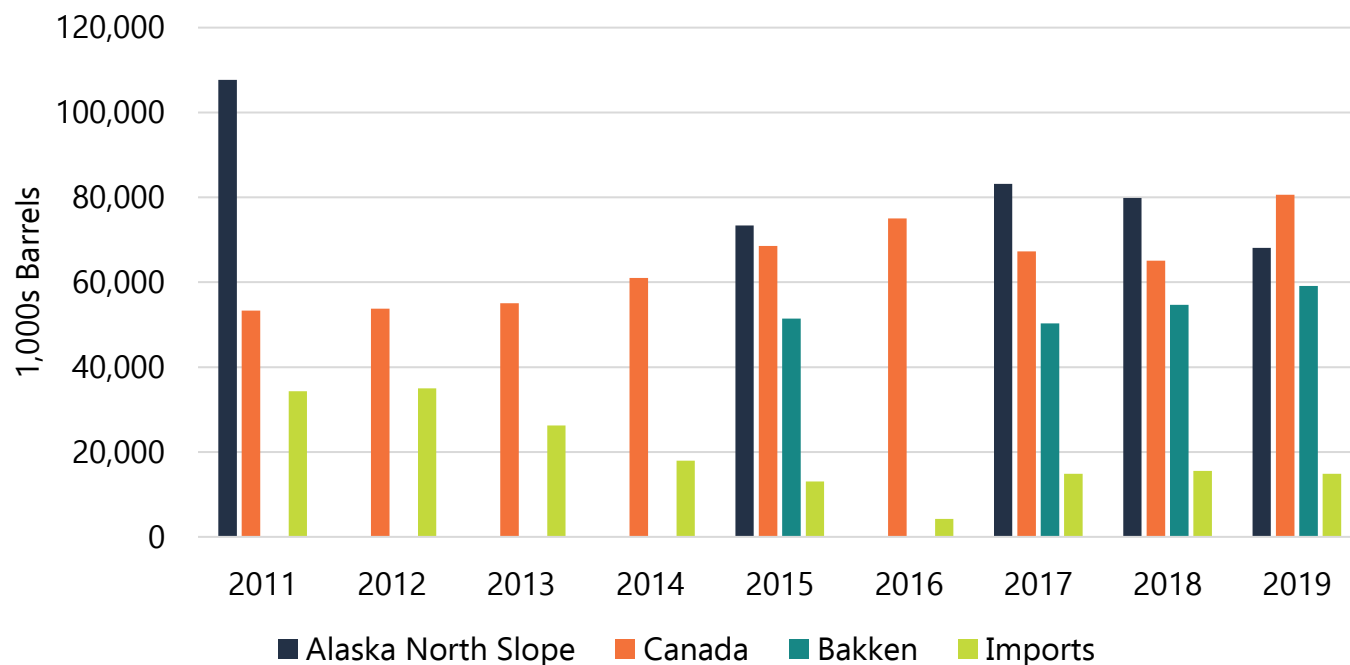
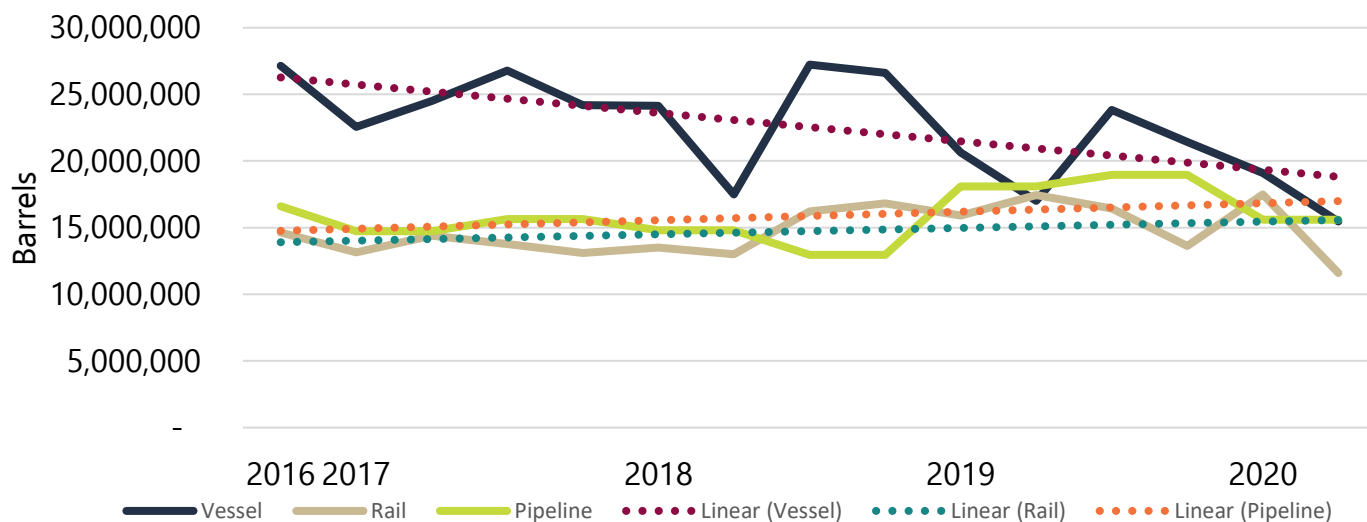
Figure 4: Washington Refinery Crude Inputs by Year⁶

Figure 4 shows that crude oil resources for Oregon's transportation fuels are increasingly originating in Canada and the Bakken oil fields in North Dakota with decreasing amounts from the Alaskan North Slope and off-continent crude oil importers such as Russia and Saudi Arabia. Crude from North Dakota increased dramatically from zero barrels delivered in 2011 to over 59 million barrels delivered in 2019, for a 27 percent share of total crude oil delivered. In this same time period, Canadian crude oil barrels delivered increased by 34 percent, from a 27 percent share to a 36 percent share of total crude.

Apart from Canada, the top five importers, for the 2011 to 2019 time period, in order are: Russia, Saudi Arabia, Angola, Argentina, and Brazil. Over this time, 19 other countries have delivered crude oil product to the five refineries in Washington in lesser quantities. Overall, off-continent imports have decreased by 60 percent between 2011 and 2019 from 37.2 million barrels to 14.8 million barrels.⁷

Figure 5 illustrates trends in crude oil shipments to Washington refineries by shipment type and origin. Shipments by vessel include Alaska North Slope and foreign shipments from countries like Russia and Saudi Arabia. As can be seen by the dotted trend lines in the chart, crude oils delivered by vessel are trending down and crude oils delivered by pipeline and rail are trending up.

Figure 5: Washington Crude Oil Deliveries⁸

2016 data only available for Q4.

Carbon Intensities of Different Sources of Crude

Lifecycle greenhouse gas emissions from petroleum production can be very different from source to source. Crude oils will have high GHG emissions per unit of energy produced if they rely on energy-intensive production methods or do not apply effective controls to fugitive emissions sources. In contrast, some crude oil sources can have lower greenhouse gas emissions if they rely on less energy-intensive production methods and have controls.⁹

Table 1 shows values used in 2015 by the Oregon Clean Fuels Program to set carbon intensity values, for gasoline and diesel as part of their analysis. These values represent the lifecycle GHG emissions from initial exploration to the refinery gate. As can be seen, the GHG emissions from Canadian oil sands are the most carbon-intensive of all crude oil resources refined in Washington state, followed by Alaska North Slope crude oil, and then Russian crude oil.

Table 1: Average Crude Oil Carbon Intensity by Geographic Crude Oil Source¹⁰

Crude Source	Average Crude Carbon Intensity (gCO ₂ e/MJ) ⁱⁱ
Oil Sands Canadian	23.88
Alaska	15.91
Russia	11.36
Bakken	9.73
Argentina	9.72
Saudi Arabia	9.24
Ecuador	9.19
Conventional Canadian	8.4
Brazil	5.87

ⁱⁱ MJ is the abbreviation for Megajoule, which is a measurement of energy. MJ is the standard for quantifying greenhouse gas in relation to energy units in the transportation sector. A MJ is equal to 947.82 Btus or British Thermal Units. A Btu is the amount of energy required to increase the temperature of one pound of water by one-degree Fahrenheit.

Oregon Clean Fuels Program Makes a Difference

In 2009, the Oregon Legislature adopted a new low-carbon fuel standard focused on reducing greenhouse gas emissions from the state's transportation sector, and tasked the Oregon Department of Environmental Quality to implement the new standard. In 2016, the Oregon Clean Fuels Program was born, with a goal to reduce transportation GHG emissions by 10 percent by 2025.

DEQ's Oregon Clean Fuels Program Manager Cory Ann Wind joined the Oregon Department of Energy in October 2020 to record a *Grounded* podcast episode about the program. "Oregon's program can seem complex," said Wind. "But what it comes down to is being a system of credits and deficits for businesses participating in the program."

The Clean Fuels Program takes into consideration the varied types of fuels that enter Oregon, since 100 percent of petroleum fuels are imported into the state, and develops a statewide carbon intensity average. Fuel providers participate in the program and earn credits for fuels that are less carbon intense than the statewide standard, or earn deficits for fuels that are more carbon intense. The providers are required to "retire" credits that are equal to the deficits they create – so a business that has more deficits than credits can purchase extra credits from a business that has credits to spare. The revenue from the credits sold pays for projects that lower GHGs, such as electric fleets and charging stations.

The standard changes annually to become more stringent to further reduce transportation GHGs. When the program began in 2016, it required a 0.25 percent reduction in carbon intensity. Now in its fifth year, the program requires a 2.5 percent reduction – this means those high-intensity fuels create more deficits that will need to be offset.

From the start of the program through the end of March 2020, the Oregon Clean Fuels Program has reduced GHG emissions by over 4.3 million metric tons. Going forward, Oregon DEQ will continue its good work to support cleaner air and a healthier environment for future Oregonians. Learn more about the program on DEQ's website: www.oregon.gov/deq

Tune in to hear Cory Ann's full *Grounded* podcast episode on your favorite podcast app or on ODOE's blog: <https://energyinfo.oregon.gov>



In 2020, the City of Ashland installed free public EV chargers using Oregon Clean Fuels Program credits.

Alaskan North Slope Crude Oil

Alaskan North Slope (ANS) crude oil is sourced from fields in the Prudhoe Bay area in the Arctic Circle. It is then transported across Alaska about 800 miles in the Trans Alaskan Pipeline System to the Valdez Marine Terminal, where it is loaded onto marine vessels and delivered to several ports. Alaskan crude oil makes a 1,400-mile journey to arrive at the five Northwest refineries. ANS crude oil has a relatively high carbon content and is typically the second-highest carbon intensity of the crude oils refined in the Pacific Northwest – only Canadian oil sands have a higher carbon intensity. Much of the lifecycle carbon from ANS fuel is due to the fossil energy expended to explore, drill, process, and store the crude oil in the harsh conditions of the Prudhoe Bay region as well as the two-stage transport of the fuel to the Northwest market.

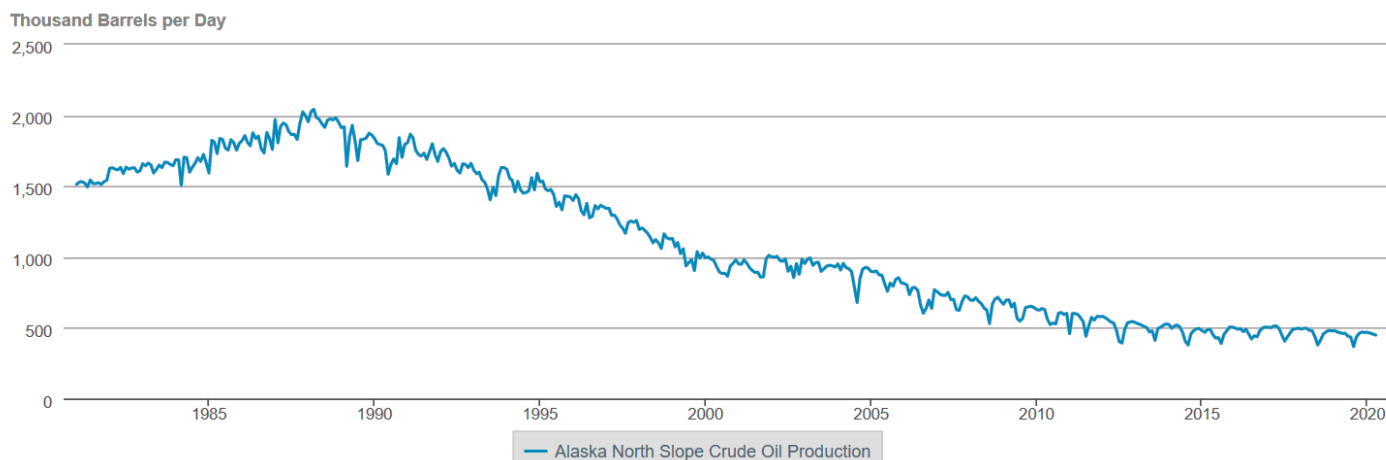
One of the primary reasons for the reduction of ANS crude oil going to Northwest refineries is that production has declined since 1988. Once producing over 2 million barrels a day, the field only averaged 466 thousand barrels a day in 2019 (a decline of over 75 percent).¹¹ In 2003, ANS accounted for 90 percent of Washington refinery crude oil inputs,¹² and by 2019 it had decreased to 31 percent (a decrease of 66 percent). Between 2017 and 2019 alone there was approximately an 18 percent decrease in Alaskan crude oil imported into Washington State refineries.¹³


Figure 6: Trans-Alaska Pipeline System



Solcom House: map in the public domain.

Figure 7: Alaska North Slope Crude Oil Production¹⁴



 Source: U.S. Energy Information Administration

Canadian Crude Oil

Canada was ranked fourth in production of petroleum in the world in 2018, behind the United States, Russia, and Saudi Arabia.¹⁵ Canada is the largest source of crude oil imports to the U.S., and accounted for 36 percent of crude oil inputs into Northwest refineries in 2019.

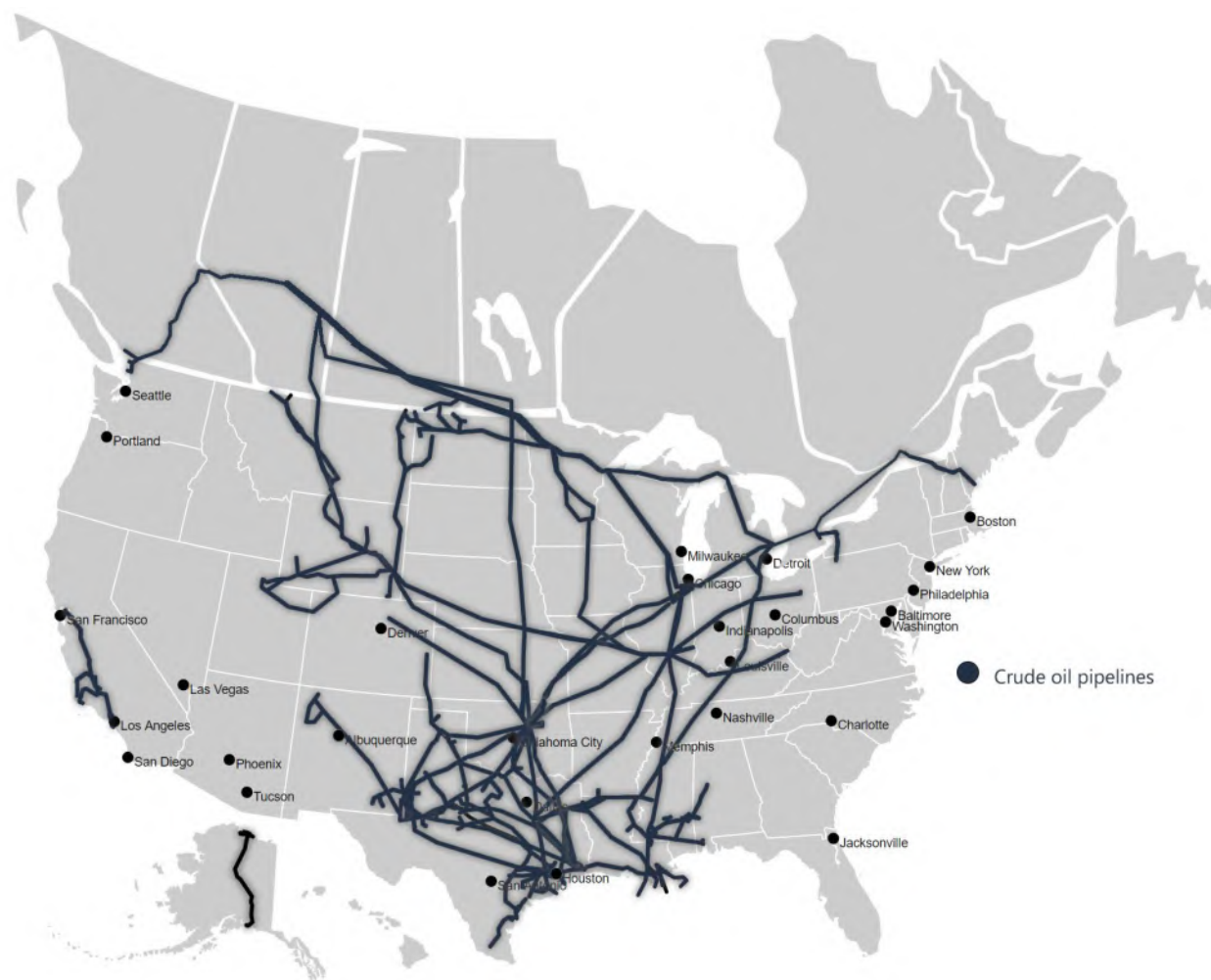
Canadian crude oil is imported to all five PADDs in the U.S. Despite Canada being the largest source of imports to our region, PADD 5 receives only a small percentage (about 6 percent in 2019) of Canadian crude oil imported into the U.S.

Table 2: Canadian Crude Oil Imports by PADD (1,000s of Barrels/Year)¹⁶

	2014	2015	2016	2017	2018	2019
PADD1	102,546	92,196	77,372	73,555	75,774	80,488
PADD2	712,605	758,347	788,469	859,480	903,077	927,144
PADD3	70,536	123,494	133,324	144,615	180,246	181,106
PADD4	90,356	101,637	96,485	97,061	111,103	111,976
PADD5	75,946	80,943	85,420	83,196	83,007	89,858

The Canadian crude oil imported to Washington refineries is sourced primarily from Alberta. The oil sands in this province are about 96 percent of the province's proved (recoverable) oil reserves and accounted for 64 percent of Canada's oil production in 2018.¹⁷ From 2011 to 2015 imports of Canadian crude oil to Washington refineries from Alberta increased by 36 percent, and oil sands crude increased from 7 percent¹⁸ to 11 percent, from 14.2 million barrels to 22.4 million barrels.¹⁹ Overall, Canadian imports to Washington refineries increased by 15 percent from 2015 to 2019. While the exact percentage of oil sands crude out of the total imported crude oil from Canada in 2019 is not publicly available, a recent report from the U.S. Energy Information Administration (EIA) states that the growth in Canada's liquid fuels production come from these oil sand sources.²⁰ Therefore, it is likely that oil sands imports will increase as a share of the Washington refinery input crude mix.

Oil sands are a mixture of sand, water, clay, and a type of oil called bitumen. Extracting bitumen is very energy intensive, which makes this form of crude oil highly carbon intensive²¹ and therefore emits the highest lifecycle GHG emissions of any of the crude oilsthat are input into the five Washington refineries.²² Alberta oil sands crude oil is three times more carbon intensive than conventional Canadian crude oil. In addition, extracting and processing bitumen has environmental effects, including air, land, and water pollutants that can affect the health of the area's residents.

Figure 8: Crude Oil Pipelines in North America

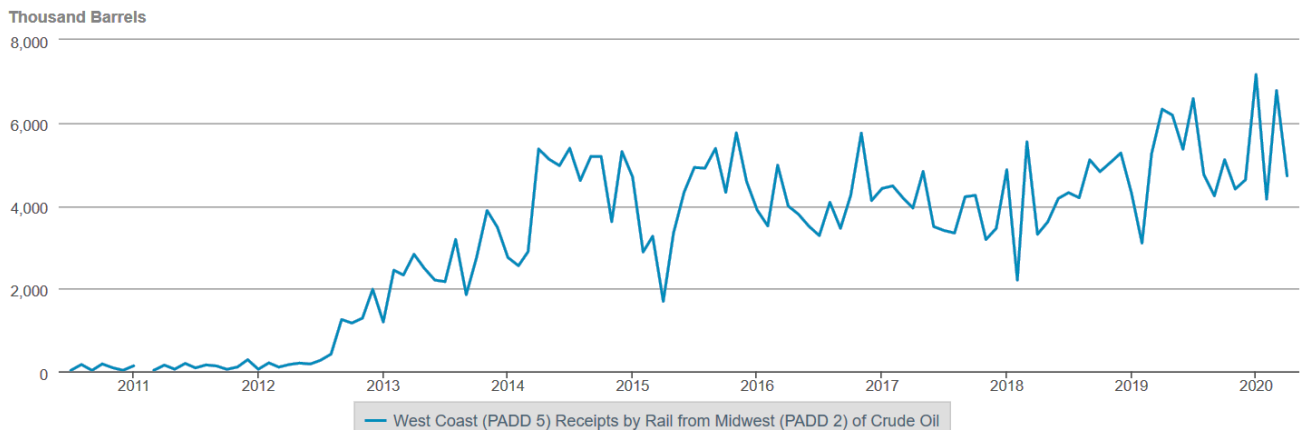
Canadian crude oil is primarily transported to the Washington refineries via the Trans Mountain Pipeline System. This system has been in operation since 1953 and spans approximately 715 miles. Beginning in Edmonton, Alberta the pipeline terminates in Burnaby, British Columbia on the western coast. Twenty-three active pump stations located along the pipeline route maintain the line's approximately 300,000 barrel per day capacity flowing at a speed of approximately five miles per hour. At the Sumas delivery point in Abbotsford, BC, the Trans Mountain Pipeline connects with the Trans Mountain Puget Sound Pipeline, a system that has been shipping Canadian crude oil products since 1954 to Washington refineries in Anacortes, Cherry Point, and Ferndale. This 69-mile pipeline system has a capacity for up to 240,000 barrels per day. Because these pipelines have been operating at capacity for many years, rail now supplements transport of the crude oil to Washington refineries.

Bakken Shale Oil

The Bakken shale, a region of oil located in Eastern Montana and Western North Dakota as well as parts of Saskatchewan and Manitoba, was discovered in 1951. Oil shale is oil-infused rock formations, which were not cost-effective to recover on a large scale until the introduction of modern horizontal drilling and hydraulic fracturing techniques about a decade ago.²³ The Bakken shale became commercially viable about the same time crude supplies from Alaska were declining and the Canadian

Trans Mountain Pipeline had reached capacity. Refiners in Washington state began to import Bakken oil to meet their input needs. Because there are few pipelines in or near the Bakken formation, much of its crude oil is transported by rail, including to the refineries in Washington.

Figure 9: West Coast (PADD 5) Receipts by Rail from Midwest (PADD 2) of Crude Oil²⁴



Source: U.S. Energy Information Administration

Bakken crude oil has averaged 25 percent of Washington refineries crude oil input from 2017 through 2019.²⁵ The journey of about 1,600 miles from the Williston oil basin in North Dakota to the refineries in Washington includes a stretch through Oregon’s Columbia River Gorge and then on into Portland. From 2018 to 2020 Q2, an average of 1,665 rail tank cars per week carrying an average of 49 million gallons of crude oil have made this rail journey.²⁶ Some additional crude oil is shipped through Oregon to destinations in California.

Figure 10: Estimated Crude Oil by Rail (January - March 2020)²⁷

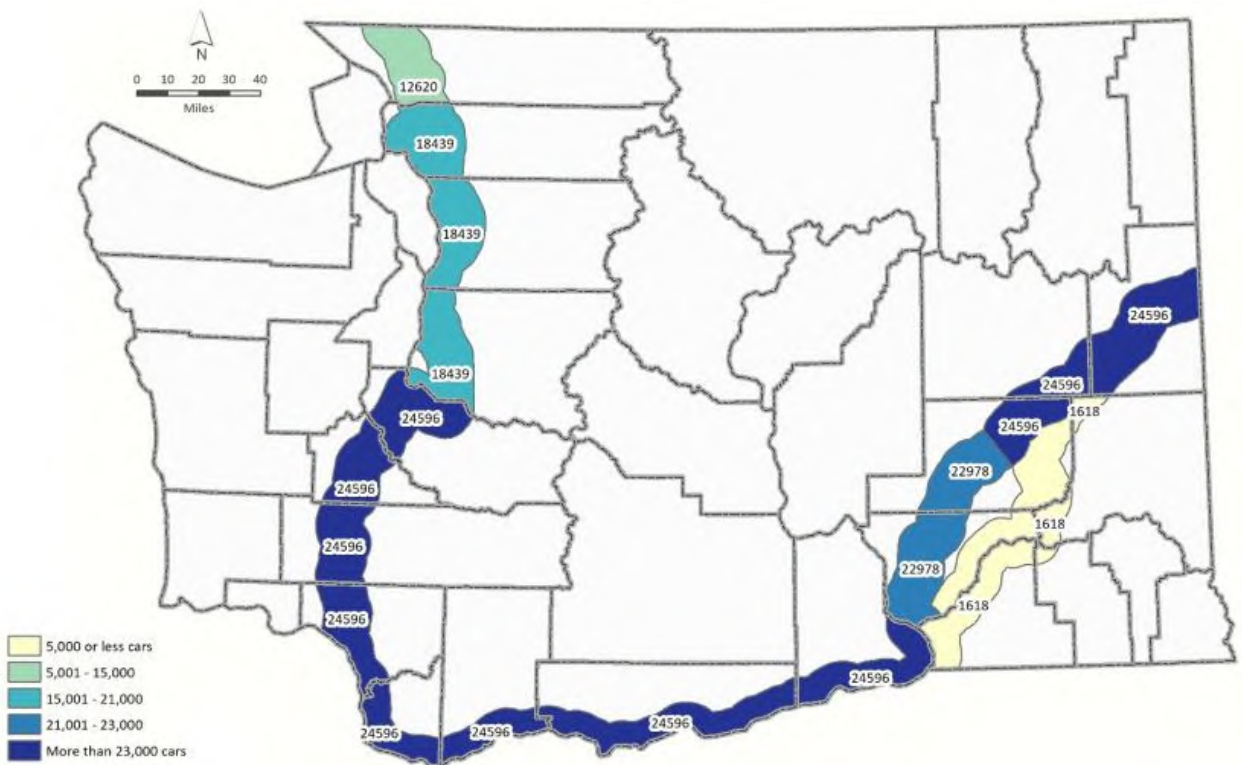
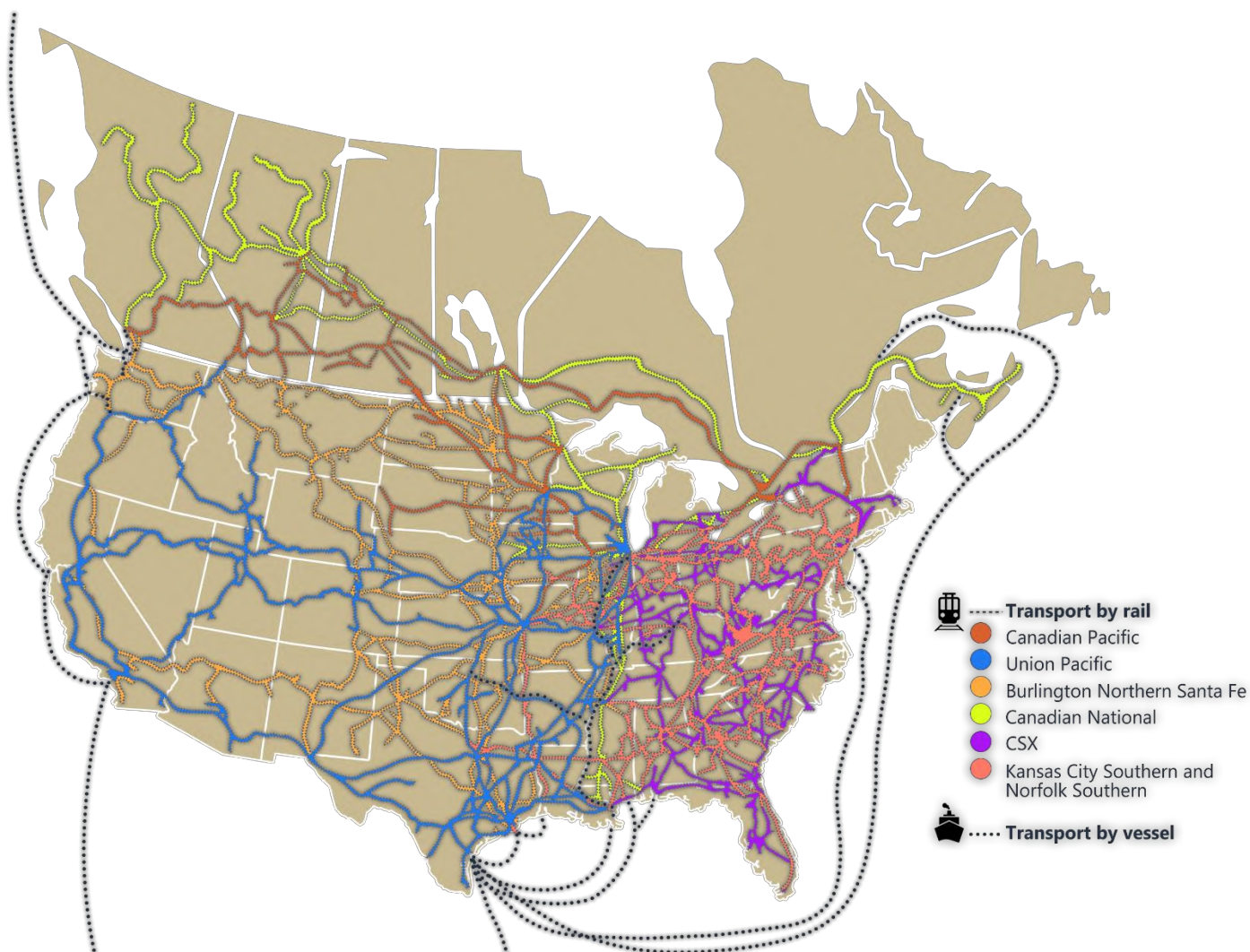


Figure 11: Oil Transport by Rail and Vessel in North America

Crude Oil Costs to Washington Refineries

Crude oil costs to the Washington refineries are not publicly available, however EIA does track refinery crude acquisition costs by PADD. The table below presents data from 2017 to 2019 and represents the composite cost of domestic and imported crude oil by PADD. Only PADD 1 on the east coast has higher costs than the west coast. PADDs 2 and 4 are significantly lower at 14 and 17.5 percent less, respectively. A large part of our increased cost is the lack of available in-region crude oil resources and therefore the increased transportation costs to get the imported crude oil here.

As illustrated in the map in Figures 2 and 3, PADDs 2, 3, and 4 have abundant crude oil resources while PADD 5 is geographically isolated from crude oil resources and must be transported over great distances to get to the region's refineries.

Table 3: Composite Cost of Domestic and Imported Crude Oil Acquisition Price by PADD²⁸

	2017	2018	2019	Average	Percent Difference to PADD 5
PADD 1	\$53.87	\$69.64	\$65.02	\$62.84	-0.7%
PADD 2	\$48.63	\$57.85	\$54.59	\$53.69	14.0%
PADD 3	\$50.73	\$65.95	\$60.19	\$58.96	5.5%
PADD 4	\$47.19	\$55.01	\$52.26	\$51.49	17.5%
PADD 5	\$53.08	\$69.81	\$64.34	\$62.41	N/A

Not only is PADD 5 isolated from major crude oil resource regions as mentioned above, it is also geographically isolated from other refining centers such as the Gulf Coast, where 52 percent of U. S. refining capacity is located.²⁹

The Pacific Northwest region's refineries produce about as much gasoline as the region consumes, creating a tight market.³⁰ This, coupled with the higher crude oil prices, cause PADD 5 (excluding California) to have the highest prices for gasoline in the nation. PADDs 1 through 4 from 2017 to 2019 averaged 12 to 22 percent lower retail gasoline prices than PADD 5.

Table 4: Composite Costs of Retail Conventional Gasoline by PADD³¹

	2017	2018	2019	Average	% Difference to PADD 5
PADD 1	2.358	2.639	2.488	2.50	-15.9%
PADD 2	2.297	2.577	2.456	2.44	-17.6%
PADD 3	2.184	2.456	2.281	2.31	-22.2%
PADD 4	2.407	2.775	2.646	2.61	-12.0%
PADD 5 <i>(minus California)</i>	2.718	3.113	3.069	2.97	N/A

The market is not as tight for diesel, with Pacific Northwest refiners producing more diesel than the region consumes, and therefore exporting diesel out of the region. Even though the region is oversupplied with diesel, the cost of the crude resource is still higher than the other PADDs, making diesel costs 4.7 to 12.3 percent higher than PADDs 1 through 4.

Table 5: Composite Cost of Retail Diesel On-Highway Costs by PADD³²

	2017	2018	2019	Average	% Difference to PADD 5
PADD 1	2.681	3.19	3.081	2.98	-5.0%
PADD 2	2.596	3.11	2.955	2.89	-8.1%
PADD 3	2.484	2.96	2.819	2.75	-12.3%
PADD 4	2.712	3.222	3.043	2.99	-4.7%
PADD 5 <i>(minus California)</i>	2.833	3.354	3.233	3.14	

Producing Petroleum Products

About 90 percent of petroleum products consumed in Oregon are produced by the Puget Sound refineries in Washington.³³ Washington has the fifth highest oil refining capacity of any state. As of 2018, there are five refineries in Washington with a joint capacity of 651,700 barrels per day (b/d).³⁴

Table 6: Refineries in Washington State³⁵

Location	Current Owner	Year Constructed	Major Products	Current Capacity (b/d)
Cherry Point	BP West Coast Products LLC	1971	Gasoline, Diesel, Jet Fuel, Calcinated Coke, Biomass Based Diesel	242,000
Anacortes	Shell Oil Products U.S.	1957	Gasoline, Diesel, Jet Fuel, Propane, Coke, Sulfur	145,000
Anacortes	Tesoro Refining & Marketing Co	1955	Gasoline, Diesel, Turbine & Jet Fuel, Liquid Petroleum Gas, Residual Fuel Oil	119,000
Ferndale	Phillips 66 Company	1954	Gasoline, Diesel, Jet Fuel, Liquid Petroleum, Residual Fuel Oil	105,000
Tacoma	U.S. Oil & Refining Co	1957	Gasoline, Diesel, Jet Fuel, Marine Fuel, Gas Oils, Emulsified & Road Asphalt	40,700

Delivery of Refined Petroleum Products for End Use

About 90 percent of Oregon’s transportation fuels are produced by the refineries in Washington and delivered via the Olympic pipeline and barge to seven Portland-area terminals. These terminals receive, store, blend, and transfer petroleum products.

Most of the remaining ten percent is delivered by barge,³⁶ and a very small amount by rail. Some of this product flows in a pipeline south to Eugene, and in another pipeline to the Portland International Airport. The Eugene distribution hub serves southern, central, and eastern Oregon. Additionally, over 240 towboats with tank barges carry refined petroleum products from the BP, the Chevron, and the Phillips 66 marine docks in the Portland area; and deliver it up the Columbia River to Pasco, Washington to service eastern communities in Washington, Oregon, and Idaho.³⁷

Oregon receives less than 10 percent of the state’s refined petroleum products from refineries in Salt Lake City, Utah and the San Francisco Bay Area.³⁸ From Salt Lake City, the refineries transport product via Tesoro’s Salt Lake Products Pipeline System to a distribution terminal in Pasco. From the Pasco facility, fuel is trucked into Oregon to service eastern Oregon communities. California Bay Area refineries supply minimal quantities of fuel to a Chico, California terminal and then the fuel is trucked into Oregon to supply southern Oregon communities.³⁹ An estimated 1,500 tanker trucks deliver fuel throughout the state to about 2,400 fueling locations.⁴⁰

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Energy 101: Energy Facility Siting and Permitting

New energy projects in Oregon are typically proposed and developed by utilities or independent developers. The federal government also owns and operates large scale energy projects in Oregon. For example, the Bonneville Power Administration, a federal government agency, owns and operates much of the high-voltage electric transmission system in Oregon and other neighboring states; and the U.S. Army Corps of Engineers and U.S. Bureau of Reclamation own and operate hydroelectric dams on the Columbia River. The state of Oregon regulates the siting of certain energy projects, but does not own or operate energy projects.

Energy Project Siting

The process of assessing exactly where to propose and build an energy project, the size of such a project, and even the type of energy project (wind or solar, for example) is highly complex. Years in advance, project developers must consider forecasted demand and spend considerable time and money conducting market studies, engineering assessments, real estate rights and land acquisition, environmental and cultural resources studies, transmission interconnection studies, and other assessments.

Electricity generation projects must be close enough to available transmission capacity to move electricity to where it is needed for homes and businesses. Natural gas pipelines must be able to move gas from where it is produced to where it is used in homes or factories. Wind energy projects must be located in areas with adequate wind resources, and solar energy projects must be located in areas with sufficient sunlight and available land. Ethanol projects must consider availability of feedstock and transportation costs. Developers of high-voltage electric transmission lines must consider multiple environmental factors and land-ownership constraints. Other types of energy projects must be located in areas with specific geographic features, such as geothermal power facilities or the NW Natural Mist underground natural gas storage facility in Columbia County, which was developed at a specific location with unique geology.

The length of time for developing and completing major energy projects is such that the demand for a specific type of project can change mid-way through the development process. A natural gas power plant may be proposed as a baseload facility, but based on changing market demand, might switch technology and application to a “peaker” facility, which can ramp up or down electricity production to balance variable renewable resources. A facility originally proposed as a wind energy generation project may add a solar photovoltaic and battery storage component, based on changing customer or market demand. For example, the Wheatridge Renewable Energy Facility in Morrow County was originally proposed and permitted by Energy Facility Siting Council (EFSC) as a wind energy facility, and through EFSC-authorized site certificate amendments, added both solar PV and battery storage components to the project.¹

Siting vs. Permitting

Siting: refers to the location, or site, of proposed energy facilities, and typically refers to the process by which those locations are selected.

Permitting: refers to the process for a facility to obtain permits that demonstrate compliance with laws and regulations to construct and operate an energy facility.

Considering the challenges of developing large-scale energy projects, and particularly renewable energy projects, ODOE and the U.S. Department of Defense have recently partnered to develop the Oregon Renewable Energy Siting Assessment project.

Energy Siting and Military Training and Operations

The State of Oregon and the United States Department of Defense (DoD) have a long history of working together to develop a stronger Oregon while fostering national security. Oregon is host to a number of unique and vital military capabilities in the form of installations, training & testing ranges, military training routes (MTRs), and Federal Aviation Administration (FAA) designated Special Use Airspace (SUA). The DoD's use of training areas and facilities in Oregon fulfill Congressionally mandated national security and military readiness obligations.

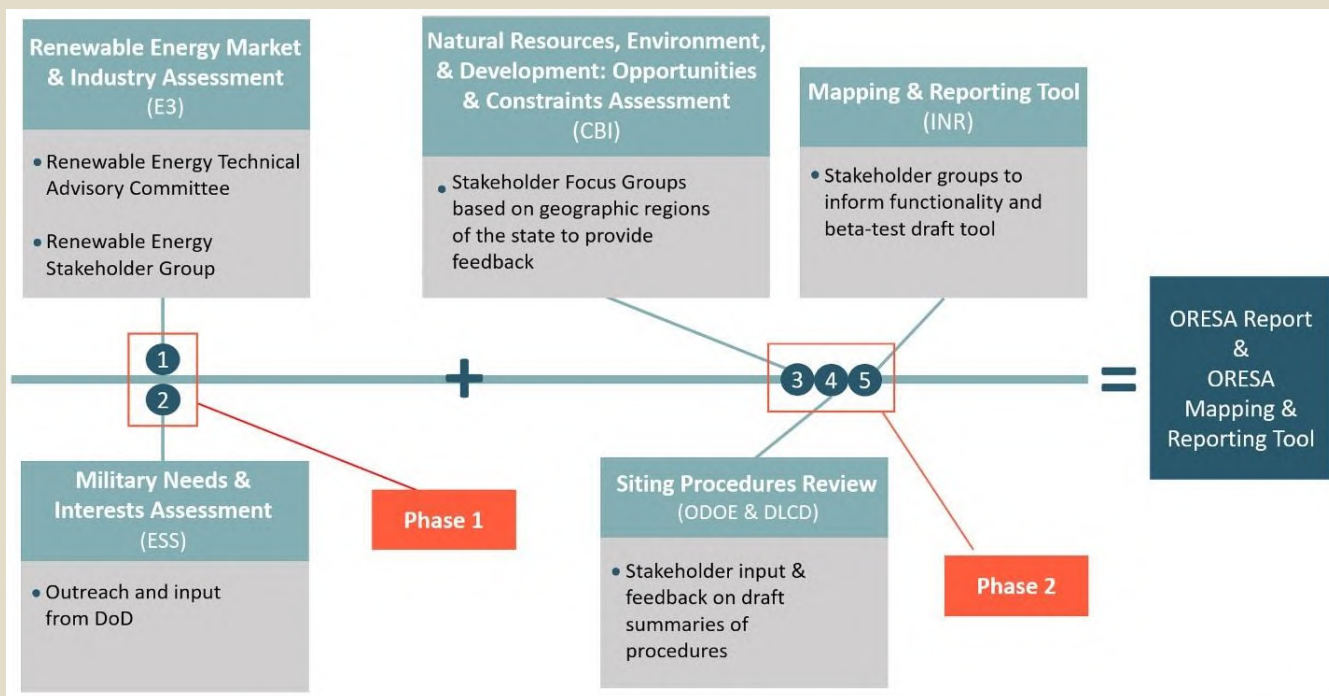
Facilities such as the Naval Weapons Systems Training Facility (NWSTF) Boardman, Camp Rilea, Camp Umatilla, Portland Air National Guard Base, Kingsley Field Air National Guard Base, and many other facilities within the state play a vital role in preparing active duty, reservist, and National Guard military personnel to meet the many security challenges faced globally and at home in the U.S.² For example, the FAA has designated airspace to allow military pilots to safely conduct training while limiting exposure to other non-participating aircraft.³ Incompatible development within these airspaces may increase safety risks and reduce the usability of the airspace for its designed purposes.

As articulated in the 2018 National Defense Strategy, the variety and velocity of global threats continues to rapidly evolve.⁴ We must anticipate, prepare, and mitigate risks to our critical defense, government, and economic infrastructure. In this environment, maintaining secure access to energy resources is critical to the execution of national security priorities, and ensuring the energy resilience of our military installations and defense critical electric infrastructure that support them.

Establishing compatibility between military installations and activities and the communities surrounding them is essential for preserving military mission capability, the health of local economies and industries, and the quality of life for residents. The DoD's Office of Economic Adjustment (OEA) supports states and communities to foster compatibility between land, air, and sea uses.⁵ OEA is funding the Oregon Renewable Energy Siting Assessment (ORESAs), a \$1.1 million 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. The project is also being supported by consulting firms with expertise in renewable energy, military compatibility, land use, and environmental, natural, and cultural resources.

There are two ORESA Project Deliverables: (1) ORESA Report and (2) ORESA Mapping and Reporting Tool. OEA's overarching goal is to support military compatibility through coordination and creation of outreach materials with local, regional, and state agencies to help raise awareness about the military through the ORESA project. Key project goals are to create relevant educational tools for stakeholders, agencies, local governments, and policy makers about renewable energy development, military training and operational areas, economic/community benefits, land use considerations, natural, cultural, and environmental

resources, and other regulatory requirements. Key project objectives are baselining data, information, and perspectives to create a transparent, consistent collection of trusted, accurate information in Oregon, without recommendations or endorsements, and noting where information may be imprecise or uncertain. To develop these deliverables, there are five project components.



At the time of publication of this report in November 2020, the ORESA project is in Phase 1.

Learn more:

www.oregon.gov/energy/energy-oregon/Pages/ORESAS.aspx

Energy Project Permitting

It may take a project developer many years of assessment and study before a specific project location and design is selected and a permitting proposal is filed with the applicable regulatory agency. Regulatory review and approval of energy projects in Oregon can be subject to the jurisdiction of federal, state, Tribal, or local governments, depending on the type of energy project, the size of the project, and the location. Some projects must receive permits from multiple agencies of federal, state, and local governments, and frequently, all three. Any project proposed on or crossing Tribal reservation land would require approval from the Tribal Government.

Federal Permitting

The federal government has primary permitting authority over certain proposed energy projects, as granted to it by Congress. This includes interstate natural gas pipelines, liquefied natural gas (LNG) terminals, and hydropower dams on navigable waters of the United States. For these types of projects, the Federal Energy Regulatory Commission (FERC) is typically the lead federal agency for permitting

review.⁶ As mentioned above, the federal government itself can be the developer and owner of energy projects; BPA builds and operates high-voltage transmission lines in Oregon and other neighboring states, and other federal agencies own and operate hydropower dams on the Columbia River. Energy projects, including generation and transmission, proposed by independent developers or utilities can be located on, or cross, land owned by the federal government – in Oregon, typically the Bureau of Land Management or U.S. Forest Service.⁷ In this case, the project developer would need a permit and land lease from the federal government. Finally, many energy projects may need specific permits or an authorization from a federal agency, such as a permit related to the U.S. Endangered Species Act, or a wetland or waterway permit from the U.S. Army Corps of Engineers. In all of these examples, state or local permits may also be required before an energy project can be built and operated in Oregon.

Typically, energy projects subject to federal permitting must complete an environmental review under the National Environmental Policy Act. NEPA was enacted in 1970 and provides a framework for conducting an environmental impact assessment in order to ensure that decision-makers have full information regarding a government agency's actions and how those actions may affect the environment. NEPA directs federal agencies that are planning projects or issuing permits to conduct environmental reviews that consider the anticipated impacts of the proposed project on the environment.⁸ Environmental impact assessments under NEPA are conducted in an open process with opportunities for public input.

Tribal Government Permitting

Any energy project proposed on, or crossing, Tribal reservation land must secure permits and land lease authorizations directly from the Tribal Government. State and local permitting processes are not applicable on Tribal reservation land. The nine federally-recognized Tribes in Oregon have different requirements and processes. The Legislative Commission on Indian Services (LCIS) supports coordination between state agencies and the nine federally recognized Tribal governments in Oregon.⁹

Eminent Domain Authority

Transmission lines and pipelines may be eligible for eminent domain condemnation authority. Eminent domain refers to the authority of governments to take private property for public use, or condemnation, following fair compensation.¹⁰ Utilities are authorized to condemn private property for use in locating transmission lines and pipelines. Eminent domain is reviewed by FERC for federal-jurisdiction projects such as interstate pipelines,¹¹ and by the PUC for non-federal jurisdiction projects, such as intrastate pipelines and transmission lines. Both processes also involve court decisions and independent property valuations.

State Permitting

Certain energy projects in Oregon must receive permits from the state of Oregon. Most large energy projects subject to state jurisdiction are permitted through the Energy Facility Siting Council (EFSC), which is staffed by ODOE's Energy Facility Siting Division. EFSC jurisdiction, however, does not include hydropower or energy projects located in Oregon's territorial sea. Hydropower projects, including pumped-storage hydropower projects, are subject to permitting through the Oregon Water Resources Commission, Oregon Water Resources Department, and FERC.¹² Energy projects proposed in Oregon's territorial sea are subject to permitting processes at multiple agencies including Oregon Department of State Lands (DSL) and Oregon Department of Land Conservation and Development (DLCD).¹³ Finally, it is important to note that as described in the federal government section above, certain energy projects may also require specific permits from multiple state agencies. For example, natural gas power plants are typically subject to EFSC jurisdiction for siting permits and would also be subject to Oregon Department of Environmental Quality (DEQ) jurisdiction for air quality permits.

Energy Facility Siting Council

The state has permitting jurisdiction through EFSC for certain energy projects based on statute.¹⁴ The types of energy projects that are permitted through the EFSC process include most natural gas power plants, large utility-scale wind and solar projects, certain high-voltage electric transmission lines, intrastate natural gas pipelines, natural gas storage facilities, nuclear installations, large ethanol production facilities, and a few less-common energy facilities such as synthetic fuel plants and uranium mills or mill tailing disposal facilities. EFSC functions as an independent decision-making body on energy facility applications and EFSC rulemakings.

The Energy Facility Siting Council is responsible for overseeing the development of large electric generating facilities, high voltage transmission lines, gas pipelines, radioactive waste disposal sites, and other projects. The Council has seven members who are appointed by the Governor and confirmed by the Oregon Senate. Appointees are selected to ensure broad geographic representation. EFSC members seek to understand, evaluate, and deliberate complex issues associated with proposed facilities and how those facilities affect people, habitat, and communities. Council meetings are open to the public, and public involvement is built into the Council's review. The volunteer Council members receive reimbursements for travel and meal expenses when they are performing Council business. Oregon Department of Energy employees serve as staff to the Council, handling the ongoing work related to the regulation of energy facilities. Staff are energy experts who research issues involved with locating, building, and operating large energy facilities. They make recommendations to the Council based on their research and analysis

EFSC members are limited to two four-year terms, and as such, there are regular openings on the Council. Those interested in applying to serve on the Council are encouraged to contact the Governor's Executive Appointments office or submit an interest form:

https://www.oregon.gov/gov/admin/Pages/How_To_Apply.aspx

An EFSC review incorporates local government land use permitting decisions into its process. EFSC review also includes certain other state agency permits – mostly related to water use that would typically be issued by the Oregon Water Resources Department, and permits related to wetlands and waterway impacts that would be issued by DSL. As noted above, EFSC review does not include jurisdiction over federally-delegated air or water quality permits, which remain the authority of DEQ under delegation from EPA.¹ EFSC review also does not include certain other ministerial permits that may be required for an energy project, such as a local government building permit; a developer would need to obtain these types of permits separately. However, EFSC does remind developers of their compliance obligations with all applicable local, state, and federal regulations as a condition of a site certificate. The condition allows EFSC to support those agencies in any efforts needed to ensure those compliance obligations outside of EFSC’s jurisdiction are met.

The EFSC review process involves coordination between the Council and its staff, and other state agencies that have specific expertise in potential impacts of a proposed energy project and can support EFSC’s review of compliance with applicable standards and rules. Typically, this includes state agencies such as Oregon Department of Fish and Wildlife, the State Historic Preservation Office, Department of State Lands, and Oregon Water Resources Department. Additionally, EFSC and staff work with local governments when conducting the review to ensure that issues of concern to a local government are considered in the review, as applicable. EFSC and staff work with Tribal Governments to review potential issues of concern to the Tribe. EFSC and its staff may meet in-person with Tribal Government staff or, if there is interest, with Tribal Council itself, during such a review. The EFSC process also allows for cost-recovery, including for Tribal Governments, for time spent reviewing application materials.

EFSC’s jurisdiction and standards have evolved over time. For example, all energy generation facilities used to be subject to a standard that required demonstration of need. That standard was eliminated in 1997 by the legislature for all generating facilities and replaced with a reliance upon competition in the market.¹⁵

Local Government Permitting

Energy projects that are not subject to EFSC jurisdiction must receive land use approvals from city or county governments. As noted above, state law establishes which types of energy projects are permitted by EFSC, and which types of projects are permitted by local governments. Electric distribution lines and natural gas distribution pipelines must receive a permit from city and county governments. Larger energy projects subject to local government jurisdiction typically require a conditional use permit from a local planning department or planning commission. However, counties (and cities) may have zoning regulations that allow the establishment of small energy projects subject only to a zoning permit or other type of review, without requiring a conditional use permit. Battery

¹ EFSC jurisdiction specifically excludes “federally-delegated permits,” which are permits and other requirements of the federal government, typically EPA, that are delegated to states to administer on behalf of the federal government. For energy projects, this typically includes air quality permits established by the federal Clean Air Act. It also includes permits related to stormwater discharge and runoff, typically considered in the National Pollutant Discharge Elimination System (“NPDES”) permits. Both examples here remain the jurisdiction of DEQ.

storage projects are always local jurisdiction for permitting, unless a developer seeks a permit for battery storage as part of an EFSC jurisdictional energy project.

Changing Jurisdiction and Permitting Requirements

The 2018 Biennial Energy Report included an overview of the need to balance between energy development and the protection of important resources.¹⁶ This section summarizes the thresholds for federal, state, and local permitting jurisdiction. In 2019, the Oregon Legislature passed, and the Governor signed into law, changes to the jurisdictional thresholds for energy projects, which affects where a project developer must go to get a permit – EFSC or a local government. The legislation, House Bill 2329, also created two categories of renewable energy projects within county jurisdiction, and added additional environmental review requirements and procedural steps to the county land use review process for the new tier of county-level jurisdiction. HB 2329 went into effect on January 1, 2020.¹⁷

Local jurisdictions reviewing projects under HB 2329 authority apply the standard land use requirements from local codes and other applicable state requirements, and are also subject to new criteria and procedures as established in HB 2329, including the following¹⁸:

- Notification to the following agencies upon receipt of an application:
 - Oregon Department of Fish and Wildlife;
 - Oregon Department of Energy;
 - State Historic Preservation Office;
 - Oregon Department of Aviation;
 - United States Department of Defense; and
 - Federally recognized Indian tribes that may be affected by the project
- Fish and wildlife habitat evaluation and necessary mitigation, including consultation with ODFW
- Historic, cultural, and archeological evaluation and potential mitigation
- Decommissioning assessment and financial assurances as specified by the county
- Energy Facility Siting Council standards that the county determines applicable
- A developer or local government can defer authority to the Energy Facility Siting Council

Table 1 below summarizes the current primary permitting jurisdictional authority for renewable energy projects in Oregon. The first category, reflected in the “County” column, shows what types of projects counties must review under applicable land use standards. The second (and new) category established by HB 2329, reflects the new increased size of energy projects reviewed at the county level, but that are subject to both local standards and the new criteria in the box above. Note that the table only shows the *primary* permitting authority, and that projects may require multiple permits from multiple agencies. For example, a wind power project, if under 150 MW, would be subject to county-jurisdiction primary permitting; however, that project may also require a removal-fill permit for impacts to wetlands, which would be issued by Department of State Lands.

Table 1: Renewable Energy Project Primary Permitting Jurisdictional Thresholds

Renewable Energy Project Type	Primary Permitting Authority					
	County	County with HB 2329	EFSC ¹⁹	Oregon Water Resources Commission	Oregon Department of State Lands	Federal Government
Solar Photovoltaic²⁰	< = 100 acres	> 100 acres & < = 160 acres	> 160 acres	N/A	N/A	N/A
High Value Farmland						
Arable Farmland	< = 100 acres	> 100 acres & < = 1,280 acres	> 1,280 acres (2 sq. miles)	N/A	N/A	N/A
Other Land	< = 320 acres	> 320 acres & < = 1,920 acres	> 1,920 acres (3 sq. miles)	N/A	N/A	N/A
Onshore Wind	N/A	< = 150 MW	> 150 MW	N/A	N/A	N/A
Geothermal	N/A	< = 55.5 MW	> 55.5 MW	N/A	N/A	N/A
Biomass	< 6 BBTU/day	N/A	> 6 BBTU/day	N/A	N/A	N/A
Offshore (wind and wave)	N/A	N/A	N/A	N/A	< = 3 Miles Offshore ²¹	> 3 Miles & < = 200 Offshore (Bureau of Ocean Energy Management)
Battery Storage	All projects	N/A	N/A ²²	N/A	N/A	N/A
Hydroelectric	N/A	N/A	N/A	Projects in waters of the state ²³	N/A	Projects in waters of the US (FERC)
Pumped Hydroelectric	N/A	N/A	N/A	Certain projects	N/A	All projects (FERC)

Another feature of HB 2329 is that for energy projects considered under local government siting jurisdiction, a developer may opt-in to EFSC's permitting process and authority. A local government also has the ability to transfer permitting jurisdiction for energy projects to EFSC. So far, no developer or local government has exercised the option of transferring authority over to EFSC. Since HB 2329 went into effect, ODOE has received notice of three projects that would have been EFSC jurisdictional prior to HB 2329, but will now be moving forward under county review.

Since HB 2329 went into effect, the following renewable energy projects, all above the county jurisdictional thresholds, have been submitted to EFSC for review.²⁴

- **Montague Wind Power Facility** in Gilliam County. Amendment 5 to an existing Site Certificate for a wind and solar facility, with 202 MW of wind currently in operation. The amendment seeks approval for expansion into an area to be used by solar facility components from approximately 1,800 acres to 2,700 acres.
- **Archway Solar Energy Facility** in Lake County. This is a proposed 400 MW solar project using up to 3,650 acres.
- **Bonanza Energy Facility** in Klamath County. This is a proposed 150 to 300 MW solar project with up to 1,100 MW of battery storage using up to 2,733 acres.
- **Wagon Trail Solar Project** in Morrow County. This is a proposed 500 MW solar project using up to 5,957 acres.
- **Nolin Hills Wind Power Project** in Umatilla County. This is a proposed 350 MW wind project with up to 117 turbines at a maximum blade tip height of 656 feet. The project may also include solar or battery storage.

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https://www.repi.mil/Portals/44/Documents/Buffer_Fact_Sheets/Navy/NWSTF_Boardman.pdf;

Camp Rilea - <https://www.oregon.gov/omd/rilea/Pages/Camp-Rilea.aspx>; Camp Umatilla -

<https://www.oregon.gov/omd/programs/Pages/Camp-Umatilla.aspx> ; Portland Air National Guard Base -

<https://www.goang.com/locations/oregon/portland-air-national-guard-base>

³ https://www.faa.gov/air_traffic/publications/atpubs/aip_html/part2_enr_section_5.1.html

⁴ <https://dod.defense.gov/Portals/1/Documents/pubs/2018-National-Defense-Strategy-Summary.pdf>

⁵ <https://www.oea.gov/>

⁶ Federal Energy Regulatory Commission, What is FERC?, <https://www.ferc.gov/about/what-ferc/what-ferc-does>

⁷ For a detailed synopsis of siting and permitting of transmission infrastructure, see U.S. Department of Energy, Quadrennial Energy Review Report, Chapter IX, Siting and Permitting of Transmission, Storage, and Distribution Infrastructure, April 2015,

<https://www.energy.gov/sites/prod/files/2015/08/f25/QR%20Chapter%20IX%20Siting%20and%20Permitting%20April%202015.pdf>

⁸ The Council on Environmental Quality, National Environmental Policy Act, <https://ceq.doe.gov/index.html>

⁹ Legislative Commission on Indian Services, <https://www.oregonlegislature.gov/cis>

¹⁰ ORS chapter 35 addresses eminent domain, broadly.

¹¹ See, for example, Federal Energy Regulatory Commission, An Interstate Natural Gas Facility on My Land? What do I need to Know? Page 18 (August 2015) <https://www.ferc.gov/sites/default/files/2020-04/AnInterstateNaturalGasFacility.WhatYouNeedToKnow.pdf>

¹² <https://www.oregon.gov/owrd/programs/WaterRights/HE/Pages/default.aspx>

¹³ Additional information can be found in Oregon's Territorial Sea Plan, Part 5.

https://www.oregon.gov/lcd/OCMP/Documents/TSP_Part5_FINAL_2019Combined.pdf

¹⁴ Oregon Revised Statute 469.300(11)(a).

¹⁵ Oregon Revised Statute 469.310. 1997 Oregon Laws, chapter 428, section 1. HB 3283

¹⁶ 2018 Biennial Energy Report – Chapter 3 – Page 27 - <https://energyinfo.oregon.gov/ber>

¹⁷ Oregon State Legislature - <https://olis.oregonlegislature.gov/liz/2019R1/Measures/Overview/HB2329>

¹⁸ Oregon Revised Statute 215.446

¹⁹ Statutory thresholds for renewable energy facilities under Oregon Energy Facility Siting Council jurisdiction are established under Oregon Revised Statute 469.300(11)(a)(A), (D), (G) and (J).

²⁰ The definitions for "high value farmland," "arable land," and "other land" are found at ORS 469.300(11)(a)

²¹ Oregon Revised Statute 274.870 - 274.895

²² The Oregon Energy Facility Siting Council reviews battery storage projects only as part of other large-scale energy projects.

²³ Oregon Revised Statute 543.010 - 543.060

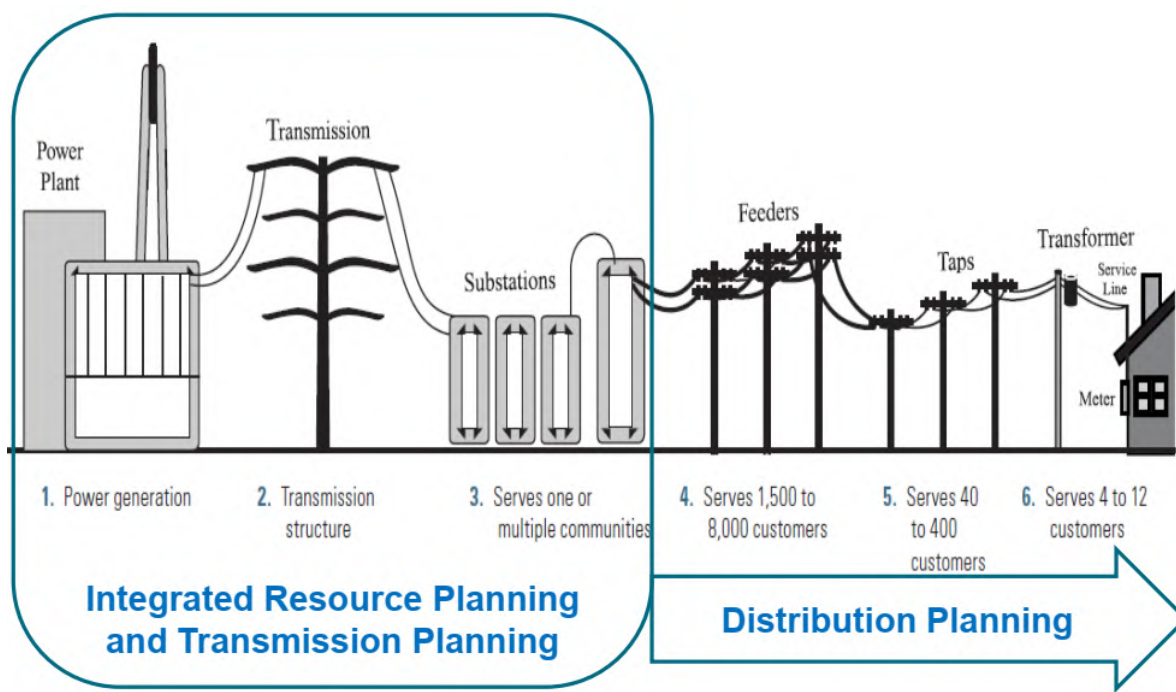
²⁴ <https://www.oregon.gov/energy/facilities-safety/facilities/Pages/Facilities-Under-EFSC.aspx>

Energy 101: Electricity Distribution System Planning

The power grid is generally divided into three segments that require continuous planning and investments to maintain reliable electric service: 1) bulk transmission systems; 2) generation and load resources; and 3) distribution systems.

The distribution system (or distribution grid) is responsible for delivering power the “last mile” to retail customers (though this can sometimes stretch further than one mile, especially in rural areas). Homes and businesses receive electric service by physically connecting to the poles and wires of the distribution system running up and down the streets of their neighborhoods. The distribution system receives power at substations from the bulk transmission system (see Figure 1 below).

Figure 1 – Three Segments of Grid Planning¹



The reliable delivery of power to customers requires effective planning for investments to expand and maintain the grid, and the processes and activities for distribution system planning are evolving.² Utilities have always engaged in some level of planning for investment in their distribution system.³ Emerging technologies, however, are increasingly providing customers and utilities with new opportunities to optimize how electricity is supplied and managed across the distribution grid. These technologies include advanced digital communication and control infrastructure and distributed energy resources. There are unique opportunities to shape the future of the electric system through investments and planning at the distribution system level.



Learn more about Advanced Meter Infrastructure in the Energy 101 and Technology Review sections

In recent years, electric utilities across the country have been evolving traditional distribution system planning through the development of distribution resource planning to integrate distributed energy resources (DERs). In 2013, California was one of the first states to require its utilities to engage in distribution resource planning with the passage of AB 327.⁴ That bill required the state’s IOUs to

develop distribution resource plans that included the following five elements to integrate DERs, some variation of which are at the core of distribution resource planning across the country:⁵

1. Evaluation of the locational costs and benefits of DERs.
2. Identification of standardized tariffs, contracts, or other pricing mechanisms for the deployment of cost-effective DERs.
3. Proposal for the integration of existing statewide programs, incentives, and tariffs focused on DERs (e.g., net metering) in a manner that maximizes the locational benefits and minimizes the incremental costs of deploying DERs.
4. Identification of incremental utility distribution investments necessary to integrate cost-effective DERs to yield net benefits for the grid.
5. Identification of barriers to the deployment of DERs.

More recently, several other states (including New York, Hawaii, and Minnesota) have also explored the development of more comprehensive distribution system planning and distribution resource planning. There is no one-size fits all approach, and states vary in their approaches and use of terminology.

Distribution System Planning vs. Distribution Resource Planning

The terms Distribution System Planning (DSP) and Distribution Resource Planning (DRP) are used inconsistently in the electric sector. For this section, the term **Distribution System Planning** refers to all utility planning activities to maintain and upgrade the distribution system itself (i.e., the poles, wires, substations). **Distribution Resource Planning** refers specifically to an emerging subset of distribution planning intended to optimize the use of distributed energy resources connected to that system (e.g., solar, battery storage, flexible loads).

Background on Traditional Distribution System Planning

Historically, most distribution systems have been designed to deliver electricity from a substation (which receives power from the bulk system) to the retail customer. Traditional distribution planning largely consisted of forecasting changes in customer loads served by this distribution system; planning upgrades and extensions to distribution lines based on load forecasts; and developing a schedule for replacing distribution equipment as it reached the end of its useful life, became obsolete, was damaged, or failed.⁶ Because of this relatively straightforward approach to assessing necessary upgrades and operational needs, this process involved relatively few stakeholders, and utilities largely designed and accomplished their plans internally.⁷

Drivers of Distribution Resource Planning

Over the last decade, the traditional one-way flow of power over the distribution grid to customers has been changing as the commercial availability of DERs capable of generating or storing electricity on the distribution system has increased.⁸ This increases the likelihood for bi-directional power flows on the distribution system.⁹ For example, a customer with rooftop solar or a battery has the potential

to export electricity onto the grid. Customers also increasingly have access to new technologies (e.g., smart thermostats and water heaters) which can be operated dynamically to optimize their usage based on two-way communication flows to respond to grid conditions. Distribution resource planning can benefit these customers by giving them more transparent insights into the costs and benefits of adopting DERs.

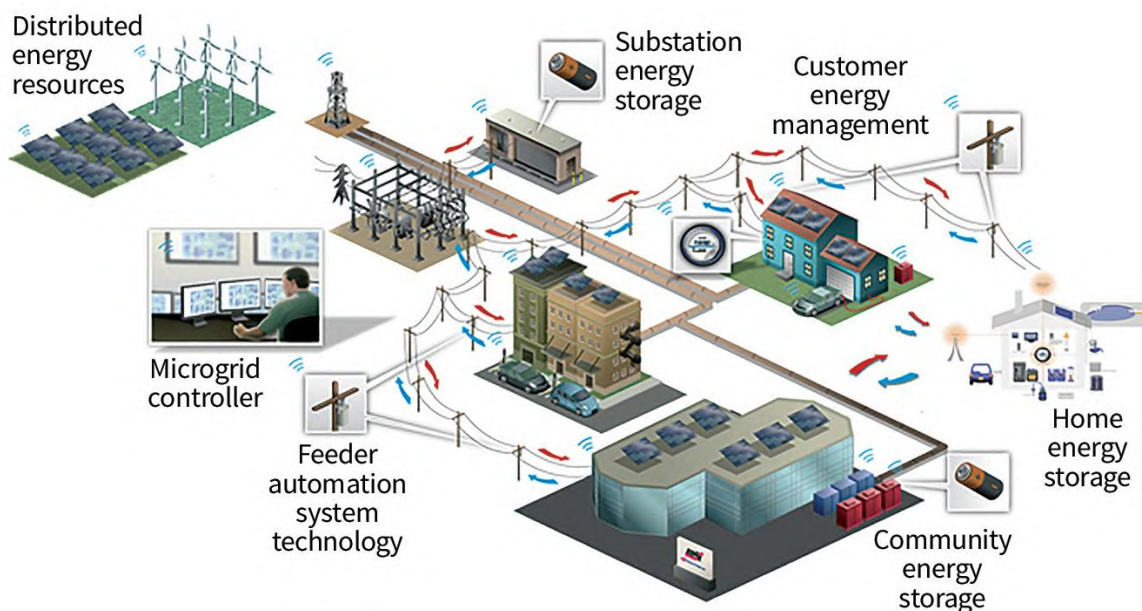
The process of distribution resource planning is also intended to help utilities develop a framework for better understanding of the total costs and benefits of these DERs (whether customer- or utility-owned) on the distribution grid. For example, it can help utilities make better informed decisions about deploying solar or battery resources on the distribution grid, closer to load, that can be used to better align generation and the provision of ancillary services with customer needs on their system. In addition, distribution resource planning can help utilities assess and realize net benefits (inclusive of costs) to the distribution system from DER deployments in areas that can delay or reduce investments otherwise needed to upgrade or maintain the system. DERs also have the potential to benefit the bulk power system by providing local support that helps maintain stability of the overall grid.¹⁰

What's a DER?

Distributed energy resource is an umbrella term used to refer to any resource interconnected to the distribution grid of a local utility. While definitions vary on the range of resources included, the Oregon Department of Energy considers DERs to be inclusive of the following:

- Generation sources (e.g., rooftop solar or diesel generators)
- Technologies that modify demand on the distribution system (e.g., energy efficiency and demand response)
- Electric vehicles and associated charging infrastructure; energy storage technologies (e.g. distributed batteries)
- Hardware or software control systems used to communicate with the grid and/or to optimize the usage of other DERs

Figure 2 – Example Vision of an Advanced/Modern Distribution System¹¹



Learn more about the benefits of advanced communication and control technologies and DERs in the Grid-interactive Buildings Policy Brief.

What Does This Mean for Oregon Utility Customers?

Distribution system planning in other states has enabled the strategic deployment of more DERs on the distribution grid. Broadly, DERs have the potential to provide many benefits to customers, including enabling them to self-supply some of their own electricity, support decarbonization of the grid, and provide some amount of resilient on-site power in the event of grid outages. In the case of electric vehicles, DERs can provide some customers with a cleaner and cheaper mode of transportation that can be conveniently fueled with electricity generated on site. Collectively, customers can also leverage DERs to interact in new ways with the grid and their utility, potentially saving money for themselves while helping to support the grid. For example, many utilities are beginning to explore the concept of leveraging aggregated deployments of DERs across the distribution grid to operate as a “virtual power plant” to help manage the grid.¹²

There are, however, equity considerations. For customers to acquire DERs it often requires an up-front capital investment, which can present a significant barrier to many customers. This has the potential to limit the ability of disadvantaged customers to benefit from these technologies. A more robust and inclusive distribution system planning process (see more on PUC Docket UM 2005 below) to optimize the deployment of DERs could help to address these equity considerations.

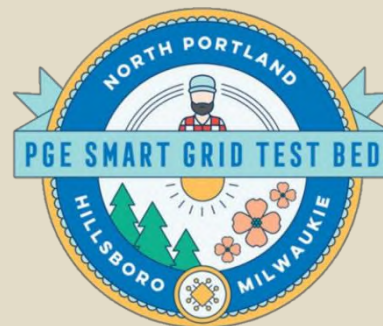
PGE’s Smart Grid Test Bed: DERs in Action

Portland General Electric’s Smart Grid Test Bed is a large, innovative pilot project that is allowing the utility to accelerate its vision for a clean energy future by partnering with thousands of customers across three different areas of its distribution grid: North Portland, Hillsboro, and Milwaukie.¹³ The Test Bed was borne out of the utility’s 2016

IRP and was known as the Demand Response Test Bed, intended to serve as a proving ground for the utility to deploy demand response resources at scale.¹⁴ Since then, the Test Bed has evolved into a national example of how utilities can engage with customers to harness the power of distributed energy resources such as—rooftop solar, batteries, smart thermostats and water heaters, EVs, and EV charging.¹⁵

Since launching in 2019, PGE’s primary focus within the Test Bed has been on engagement with its customers. The engagement has been designed to help them rethink how they use energy through new technologies, programs, and products while allowing them to retain control over their comfort levels and access to affordable, reliable, and clean energy.¹⁶ The utility has also invested in distribution system upgrades to feeders and substations to increase automation functionality, upgrade sensors and communication systems, and facilitate the transformation of the distribution system from a one-way to two-way flow of energy and information.

In July 2020, PGE announced the launch of a new pilot program within the Test Bed to incentivize the installation of 525 residential battery storage systems that the utility can dispatch as a “virtual power plant” contributing up to 4 MW of energy to the grid.¹⁷ The effort will allow PGE



to optimize the use of renewable energy on its system, while also providing participating customers with an energy resilience resource that can be relied upon in the event of a grid outage.¹⁸

While PGE continues to operate the Test Bed as a pilot program, the utility is learning lessons that will inform how it engages in distribution resource planning systemwide in the future to achieve its clean energy goals. In the meantime, it remains an innovative example of a utility leaning into the use of DERs to meet grid needs and the needs of its customers.

“The PGE Smart Grid Test Bed represents a leap forward in the relationship between customers and their energy providers . . . PGE is on a path to building a model that energy providers everywhere can learn from and replicate.”¹⁹

– Jon Wellinghoff, Former Chairman, FERC

Distribution Planning for IOUs in Oregon

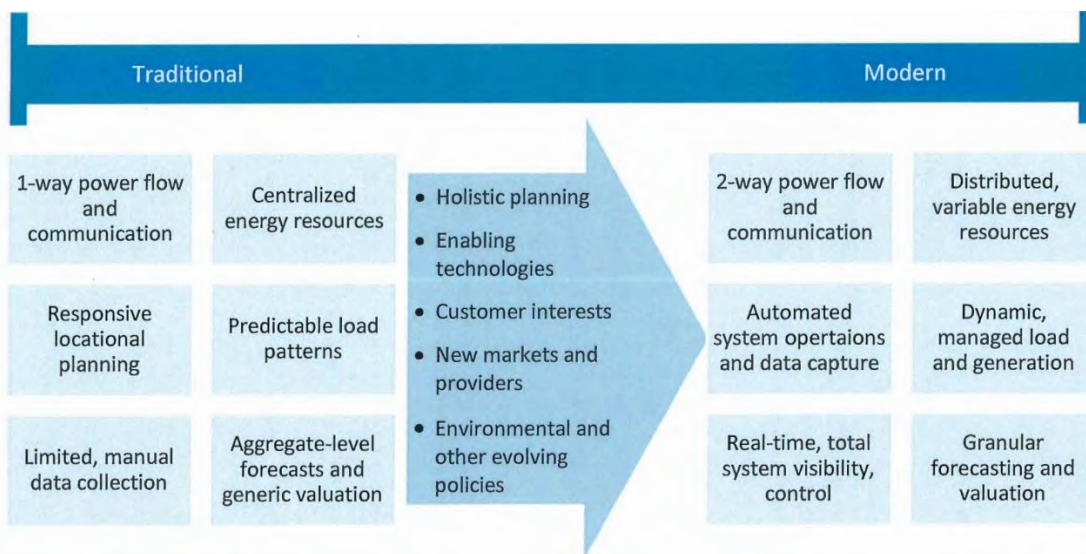
As DER adoption increases in Oregon, utilities are likely to seek ways to maximize the benefits of these resources on their distribution systems, whether utility- or customer-owned. The state currently has no standardized approach to distribution resource planning, and every utility is likely to have a unique adoption rate for DERs that could influence its need for developing such a planning framework. In 2019, Oregon PUC staff released a white paper that recommended developing a distribution system planning process that can leverage DERs to help meet system needs.²⁰

In its whitepaper, PUC staff identified that there has been less rigorous engagement in distribution system planning processes and investment decisions and identified four driving factors.²¹ First, PUC staff and stakeholders have had less visibility into these planning processes because they have been internal to the utility and traditionally focused on smaller investments to meet short-term reliability needs. Second, there have been few opportunities for engagement *before* these investments occur, with the primary mechanism for engagement occurring in the review of aggregate distribution investments *after* they have been made through the rate case process. Third, the PUC identified 11 different ongoing simultaneous planning processes, reports, policies, and programs that were related to the distribution system, making it difficult for stakeholders to stay informed. Lastly, these planning processes increasingly leverage emerging smart grid technologies and DERs whose technical nature can create barriers to efficient stakeholder engagement.

In addition, the PUC identified a need to better understand the costs and benefits associated with investments in the distribution system, and how those costs and benefits could be leveraged to provide maximum value to all customers, as a motivating factor for its investigation of distribution system planning more broadly.²² The white paper also cites several trends of increased commercial availability of advanced controls, sensors, communications, automation equipment, and other DERs. All these important issues contributed to the PUC’s decision to open Docket UM 2005 in March 2019 to investigate the benefits of a more robust and transparent distribution system planning process for Oregon’s investor-owned utilities (Portland General Electric, PacifiCorp, and Idaho Power Company).²³

The following graphic illustrates PUC staff's initial vision for how distribution system planning could evolve:

Figure 3: Oregon PUC Vision for Transforming to an Advanced/Modern Distribution System¹⁹



PUC staff have acknowledged that the breadth of technical, financial, policy, and planning issues implicated by distribution system planning may be challenging to reconcile. However, due to the quickly evolving nature of the discussion in the industry, they have decided to proceed with the understanding that some of the discussion may be iterative and require parties to adapt to evolving information.

One of the first steps was to develop a baseline of current activities that interact with distribution systems followed by an exploration of new opportunities through engagement with a robust stakeholder group. That engagement sought to identify the perspectives of various stakeholders, the potential direct implications of distribution system planning, and national best practices in the valuation of the benefits provided by DERs.

PUC Docket UM 2005: Next Steps

As it explores the development of enhanced distribution planning that's more robust, strategic, and adaptive, the PUC remains committed to ensuring that utilities maintain a safe, affordable, and reliable power system.²⁴ The PUC has also committed to streamlining distribution planning with other planning efforts and promoting more inclusive and meaningful stakeholder engagement in distribution planning.²⁵ The draft long-term goals for distribution planning as proposed by PUC staff are:²⁶

- **Distribution System.** Promote the reliability, safety, security, quality, and efficiency of the distribution system for all customers.
- **Customers.** Be customer-focused and promote inclusion of underserved communities.
- **Optimize.** Ensure optimized operation of the distribution system.
- **Accelerate DERs.** Accelerate integration of DERs and other clean energy technologies.
- **Regulatory.** Strive for regulatory efficiency through aligned, streamlined processes.

In October 2020, the PUC issued a proposed draft of its “Distribution System Planning Guidelines” within UM 2005, with the intent of finalizing the guidelines in 2021. The proposal details the scope of the initial plans to be developed by investor-owned utilities to include: baseline data and distribution system assessment, DER and load forecasting, plans for hosting capacity analysis for individual distribution feeder lines, community engagement plan, identification of grids needs and solutions to meet those needs, and near- and long-term action plans. The proposal also recommends a deadline of October 15, 2021, pending a commission order, for IOUs to file their initial plans with the PUC, with recurring filings every other year thereafter (for more information, see PUC Docket UM 2005).

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Energy 101: Resource Adequacy

We consume energy daily: when we charge our phones, flip a light switch, turn up the furnace to heat our homes, or fill up our car at the gas station. In terms of total end-use fuels consumed by Oregonians, 31 percent of the energy comes in the form of liquid transportation fuels (e.g., gasoline and diesel); 42 percent is electricity; and 26 percent is direct use of fuel oil or natural gas (e.g., for home heating or industrial processes).

Storing End-Use Fuels: Gasoline, Natural Gas, and Electricity

Electricity must be generated and delivered across a large transmission and distribution system, just in time to meet consumer demand. This differs significantly from other end-use fuels (and differs from virtually all other commodities and consumer products) that can be produced at an operationally or economically optimal time, and then stored for consumption at a later point in time.

This section refers to “end-use fuels” because of the important differences between primary energy sources and the end-use fuels that consumers actually consume to power their everyday lives. For example, crude oil is a natural resource extracted from the earth. This primary energy source must be refined into gasoline before it can be used in a vehicle. That gasoline, once refined from the original energy source, can be (and is) stored in large volumes as the end-use fuel that Oregonians consume. Similarly, natural gas, once captured and processed for injection into storage tanks or pipelines, is the end-use fuel that Oregonians consume in their homes and businesses.

Electricity is quite different. The primary energy sources used to generate electricity vary considerably – from the gravitational potential energy stored in volumes of water at altitude, to the nuclear potential energy contained within uranium isotopes, to the thermal kinetic energy of solar energy. A wall outlet cannot use that water, uranium, or solar energy until it has been converted into electricity—the end-use fuel.

Think about gasoline. What does it look like? Chances are you are imagining a physical volume of a brownish-colored liquid. You can literally fill a jar on the table in front of you with gasoline or diesel fuel, the two liquid fuels that predominantly power our transportation systems. Liquids are easily stored in large volumes. Think about natural gas or propane. What does it look like? This one is a bit more challenging, but you might imagine filling a balloon in front of you with some volume of natural gas, or a propane tank attached to your grill. Pipeline networks and large tanks can store vast quantities of these gaseous end-use fuels.



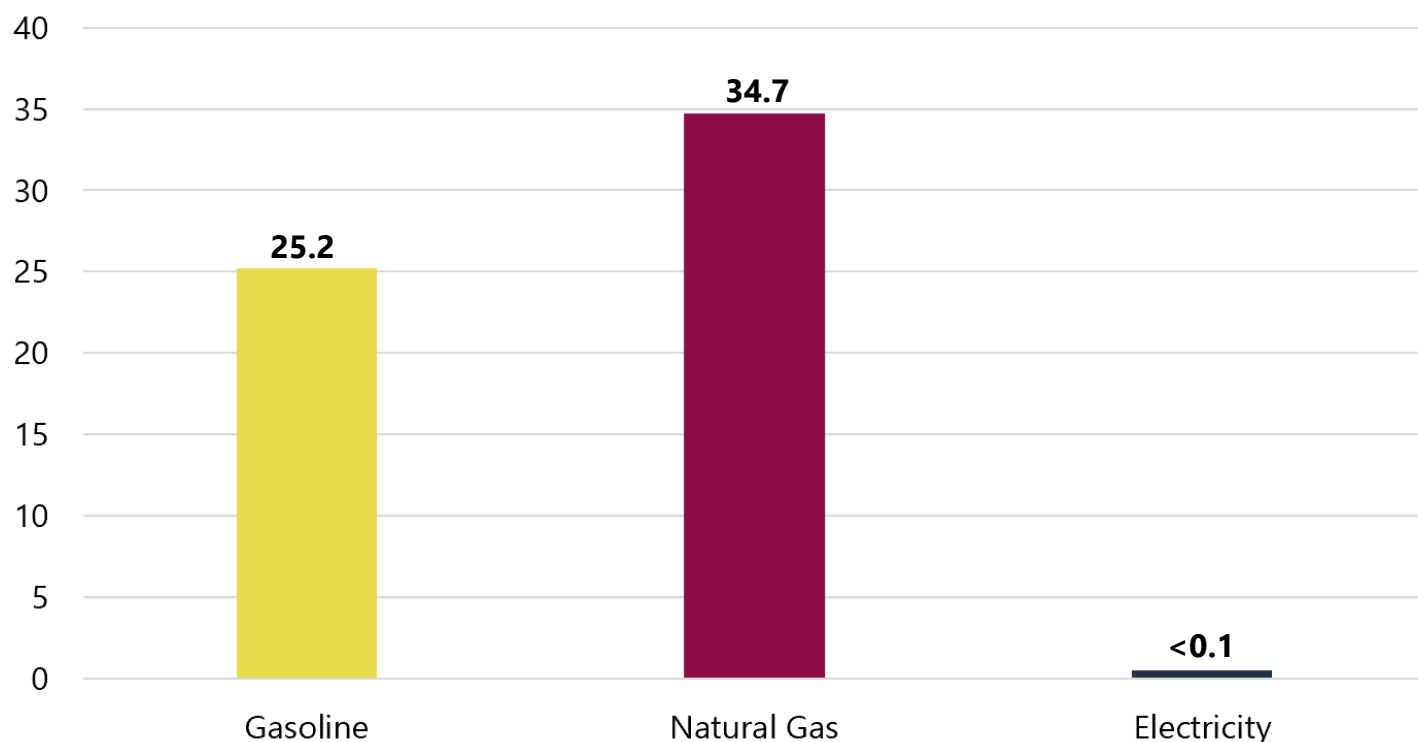
Now think about electricity. What does it look like exactly? Where might you store it? You might imagine a standard AA battery, which stores approximately 3 watt-hours (or 0.003 kWh) of energy.¹ The average residential customer in Oregon would need 9,000 AA batteries to power their house for a single day.¹ So while there are ways to store electricity, those storage systems have historically been limited in their ability to efficiently store energy over a long duration or in

¹ In 2018, the average residential customer of Oregon’s investor-owned utilities consumed 10,151 kWh of electricity over the course of the entire year, or approximately 27.8 kWh per day. (OPUC Utility Statistics Book)

large volumes (e.g., batteries), and/or cost a lot of money per unit of energy stored (such as large capital projects like a pumped hydro facility that stores water for use at a later time). As a result, nearly all electricity is consumed at the same instant that it is generated at a power plant. This simple physical reality of electricity as an end-use fuel, compared to liquid and gaseous fuels, has had an enormous effect on the infrastructure required to meet end-use consumer demand.

The consumption of end-use fuels of all kinds varies throughout the day, across different seasons, and from year to year. This variability in consumption must be met by changes in the available supply of energy to meet those needs. The flexibility in the availability of supply to match real-time, end-use consumption is assisted by storage systems in the case of liquid or gaseous fuels. For example, a gas station has significant volumes of gasoline stored on site, ready and available for consumption when a car pulls up to the pump. Meanwhile, a network of large tanks and an extensive underground pipeline system filled with natural gas acts as a massive storage system that is connected homes or businesses, ready to supply end-use fuel on-demand for a stove, furnace, or other appliance. Distributed storage systems (i.e., systems that are typically distributed closer to the end-use consumer than the source of production of the fuel) can be sized and adjusted as needed to ensure that adequate supply exists to meet fluctuating demand at all times. In short, these storage systems provide a significant buffer to accommodate fluctuations in end-use demand and allow for a more optimized operation of upstream extraction, production, and delivery systems.

Figure 1: Days of End-Use Fuel Storage in the U.S. Based on Average Daily U.S. Consumption by Fuel Type²



Derived from U.S. EIA data comparing average volumes of stored energy to average daily consumption for total gasoline (barrels consumed vs. weekly stocks); natural gas (mcf consumed vs. working natural gas in storage); and electricity (MWh of daily consumption vs. MWh of stored electricity).

The basic fact that electricity cannot be easily stored in large volumes, however, has resulted in a vastly different organization of the systems to deliver fuel to consumers. The electric system is sized to be able to satisfy the largest requirements for electricity—called peak demands—at all times, even though consumers use less (oftentimes significantly less) during most hours of the year. This results in an electric generation and delivery system that is, by design, underutilized much of the time, especially when compared to other end-use fuels, such as natural gasⁱⁱ and gasoline.³ This might manifest as a power plant that only operates at full output 50 percent of the hours of the year, or a transmission line that operates at less than full capacity. The natural rhythms of society result in changes in our demand for electricity over different hours of the day and months of the year — so that excess capacity must essentially be on standby, ready when needed to meet demand when it spikes.

As a result, the concept of peak demand over various time durations (hourly, daily, monthly, annually) has more effect on the design and the cost of electric delivery systems than it does with other types of end-use fuel delivery infrastructure systems. For this reason, capacity planning takes on an outsized role in the electric sector. Capacity planning is the process that grid planners and utilities must undertake to ensure that adequate generating capacity is online and operational to serve peak demand in the future. Increasingly, grid planners and utilities also have to consider “net peaks” within a day. Net peaks refer to the difference between forecasted electric demand and the electricity produced by variable output renewables, most notably solar, and may require the grid to have more flexible resources.⁴ Given the lead time required if it is determined that new generating capacity resources need to be developed (which can take several years or longer), this type of planning must attempt to forecast the future, taking into account potential variability in demand for power over different times of day and year or from year to year; changes to the supply of available power (e.g., a drought year may result in much less hydropower output than average); the impact of different weather patterns on consumption; and the near-term effects of longer-term factors, like climate change and an increasing electrification of end-uses (e.g., transportation electrification or conversion from a gas furnace to an electric heat pump).

These types of forecasts, involving a multitude of critical variables, are necessarily uncertain. The lack of end-use fuel storage in the electric system allows little room for error if utilities miss by forecasting less electric demand than what actually occurs. This creates a reasonable bias in favor of conservative forecasting to avoid having too little power available to serve demand in the years ahead. The alternative could be a system that fails to deliver enough electricity to customers and results in limited, or even widespread, blackouts.

Resource Adequacy

Collectively, the electric industry applies the term Resource Adequacy to the evaluation of whether a particular utility, area of the grid, or region has adequate electric generating resources available to meet future demand for electricity at different times (e.g., times of day, seasons, or years) and under various conditions (e.g., temperature extremes or precipitation patterns), including an additional

ⁱⁱ Note that while peak demand also has a significant impact on the natural gas system, it is fundamentally different because of the ability to store the end-use fuel throughout the delivery system from the point of gas collection or extraction, through the transmission and distribution system, and up to the point of consumption by consumers.

reserve margin to account for demand excursions or unexpected outages. This is sometimes thought of as demonstrating the *long-term supply reliability* for the power system, as measured over a period of several years. RA standards, meanwhile, have been developed to ensure the uniformity of this evaluation process. In many states, standards are applied by an Independent System Operator (e.g., CAISO in California) with a wide geographic view of the electric grid across multiple utility service territories. Because of other constraints on the system, such as transmission congestion, some states evaluate RA on both a system-wide and a locational basis.

Resource Adequacy (or RA) is the term that grid planners and utilities use to refer to the evaluation of whether adequate generating capacity will be available to meet forecasted demand over the next several years (typically from one to five years).

Table 1 below helps to illustrate the different timescales of power reliability, and distinguishes what is meant by RA as compared to other types of reliability:

Table 1: Power System Reliability Over Different Timescales ⁵

Short-term <i>(< 1 minute)</i>	System Stability	Short-term reliability (e.g., frequency response) focused on grid stability over very short time intervals
Medium-term <i>(Hourly or Daily)</i>	System Balancing	Medium-term reliability focused on managing imbalances on the system like those that occur between a day-ahead forecast and real-time conditions
Long-term <i>(1 to 5 years)</i>	Resource Adequacy	Long-term reliability focused on seasonal or year-to-year mismatches between supply-and-demand

Ultimately, when a utility, state, or region evaluates RA, they are asking themselves: what level of risk are we willing to accept that inadequate generating capacity will be available to meet future customer demand for electricity over the next several years? Because forecasting the future is necessarily uncertain, the evaluation of RA and development of new capacity resources ahead of expected need is an inexact process that requires balancing the risk of under-building resources and having a shortage of power available vs. the cost to consumers of potentially over-building to ensure that power is available when it is needed.

Evaluating and Maintaining Resource Adequacy

There is currently no statewide organized program for the evaluation or maintenance of resource adequacy in Oregon. Discussions are currently underway to consider the development of a more formal approach (described below).

Evaluating Resource Adequacy

Many individual utilities independently evaluate their own adequacy to serve their customers. Meanwhile, the Northwest Power and Conservation Council (NWPPCC) annually develops a long-term

regional assessment of RA that evaluates the adequacy of the power supply in the Pacific Northwest, five years in the future.⁶ The goal of the NWPCC's RA assessment is to "establish a resource adequacy framework for the Pacific Northwest to provide a clear, consistent, and unambiguous means of answering the question of whether the region has adequate deliverable resources to meet its load reliably and to develop an effective implementation framework."⁷ The assessment includes existing resources, expected future energy efficiency savings, and only those planned resources that have already been sited and licensed.⁸ This is intended to provide a signal to the region of the status of RA with adequate lead time for individual utilities or third-party developers to develop new capacity resources ahead of any forecasted shortfalls.

This is a *regional* assessment, the development of which is informed by contributions from utilities, state agencies, and other stakeholders from across the northwest.⁹ ¹⁰ Due to differences in hourly, daily, and seasonal electricity consumption patterns across different regions, synergies can often be achieved by evaluating the electric system over a wider geographic footprint. For example, one area of the region may experience its annual peak demand for electricity during cold winter mornings, while another area's peak might occur during the summer months when air-conditioning or irrigation pump loads are highest.

Maintaining Resource Adequacy

Individual utilities and their regulators (the Oregon Public Utility Commission in the case of investor-owned utilities, or individual governing boards in the case of consumer-owned utilities) in the northwest evaluate RA to meet future demand in their territories. Utility-specific efforts will often incorporate the NWPCC's assessment as an input that reflects the broader regional availability of generating resources in the years ahead. This can be important for a utility that is weighing the risks of relying upon capacity available on the market to meet some share of its expected demand. Ultimately, however, individual utilities are responsible for maintaining resource adequacy to ensure that they can serve the demand of their customers.

Customer Choice and Resource Adequacy

In recent years, there has been increasing interest in customer choice programs in the electric sector. Many of these efforts stem from the broader deregulation movement in the 1990s. In Oregon, certain commercial and industrial customers have had access since that time to choose their retail provider of electricity through participation in Long-Term Direct Access (LTDA) agreements, which allow independent power producers to register with the PUC as electricity service suppliers (or ESSs) to deliver retail service in lieu of a utility.¹¹ Meanwhile, in the last decade,¹² California has seen a surge in the number of municipal and county governments forming Community Choice Aggregation (CCA) programs to exercise choice over their community's retail electricity provider.ⁱⁱⁱ

Whether participating in LTDA as a commercial or industrial customer, or forming a CCA, customers are often motivated by actual or perceived cost-savings or other benefits associated with the exercise of choosing their retail electricity provider. For example, the customer(s) may seek an electricity

ⁱⁱⁱ California's CCA example is particularly relevant to this discussion given the challenges that state has faced in recent years specifically regarding the role of CCAs in contributing to the maintenance of Resource Adequacy. It is important to note, however, that Oregon law does not allow for the formation of CCAs.

resource mix that includes higher levels of renewable resources than the incumbent utility provides, or may seek to source power from more locally-sited projects.

How should retail choice customers contribute toward Resource Adequacy?

As described above, the maintenance of resource adequacy requires evaluation at both the regional and utility-specific levels. Utilities often need to engage in the inexact science of forecasting future customer demand to plan for new generating capacity. This becomes more challenging when customers “exit” the utility’s service territory (e.g., pursuant to LTDA, CCAs, or another customer choice program) to be served by a third-party. Who, in those cases, is responsible for procuring adequate capacity to ensure that RA is maintained?

This issue has emerged as a critical one in California given the scale of CCA formation in the state in recent years—21 CCAs operating across the state now serve more than 10 million retail customers.¹³ After wrestling with the issue for several years, the California PUC recently stepped in to establish a central buyer framework for RA that requires the state’s largest IOUs to procure the necessary capacity to meet projected load within their service territory boundaries, whether or not that load is served by CCAs.¹⁴

RA also surfaced as an issue in Oregon in 2019 as part of a broader, holistic investigation begun by the OPUC in June 2019 exploring the costs and benefits of Oregon’s LTDA programs. For more information on this and other related ongoing issues, see Oregon PUC Docket UM 2024.¹⁵

What’s Next for Resource Adequacy in Oregon

The electric system in the northwest has delivered incredibly reliable power to Oregonians for decades. This is in no small part due to the robustness of the Federal Columbia River Power System, which provides the foundation of the region’s electric system. Increasing constraints on that hydropower system, widespread retirement of coal plants across the west, and increases in variable renewable energy generation have combined to create new concerns about maintaining RA in the years ahead. As intended, the NWPCC’s regional assessment of RA has sent a signal that the region could be short of capacity by the mid-2020s. Being short of capacity could mean that the power system lacks the resources to meet demand at all times, which would increase the potential for rolling blackouts.¹⁶

Hydropower: An outsized contribution to maintaining RA in the Pacific Northwest

The federal hydropower system has made a unique contribution to maintaining power system reliability in the northwest for much of the last century. Since the 1930s, the federal government has made substantial investments to develop the hydropower resources in the region, which now total over 22,000 MW of nameplate capacity, with the capability of providing 9,818 MW of sustained peak capacity in January (the region’s highest electricity-use month) even during years with low water conditions. Non-federal hydropower resources, meanwhile, can provide an additional 11,336 MW of sustained peak capacity in January. Combined, these hydropower resources account for 54 percent of the region’s total sustained peak capacity in January, and

can account for an even greater share of the region's sustained peak capacity during non-critical water conditions.¹⁷

Northwest hydropower has provided the foundation of our electric system for decades and has historically provided a large share of the region's annual energy. In many respects, this has afforded the northwest electric sector with significant advantages not found elsewhere in the United States—in addition to often having an abundance of low cost, carbon-free energy to meet demand, the robustness of the hydropower system has been able to meet a significant amount of the region's capacity need. This has played a significant role in enabling the region (so far) to avoid the need for a more formalized approach to evaluating RA, such as those that exist in other regions.

As a result of the changes in the sector and continued, albeit modest, regional load growth, many of the state's largest utilities and BPA have recently joined together under the auspices of the Northwest Power Pool to explore the development of a formalized regional RA program, focused on short-term adequacy (from a period of days and weeks to months). The effort kicked off publicly in October 2019 when the NWPP convened a widely attended Northwest Resource Adequacy Symposium.¹⁸ The future remains uncertain with respect to the successful launch of an NWPP-led regional RA program. It is expected that the effort will result in the release of a final proposed design of such a program in 2021, with implementation to occur over the following several years.¹⁹

Unlike the current process for evaluating regional RA in the northwest—where the NWPCC's assessment informs the region of the long-term status of RA (from a few years to 20 years into the future), but individual utilities procure resources to meet their own capacity needs—the type of program being developed by the NWPP is expected to formalize a short-term regional assessment of RA that would be contractually binding on individual participating utilities and electricity service providers. Those entities would voluntarily join the program, but then would have a contractual legal obligation to procure their apportioned share of capacity resources necessary, as assessed by the NWPP, to maintain overall regional RA in the short-term (from a period of days and weeks to months).²⁰

There are also emerging discussions within Docket UM 2024 at the Oregon PUC about a proposed process to explore the development of an Oregon-specific RA program as a potential interim solution until the adoption of an organized, regional program.^{21 22} The NWPCC's regional assessment, in either case, would still provide complementary, valuable insight into the long-term adequacy of the power supply in the northwest.

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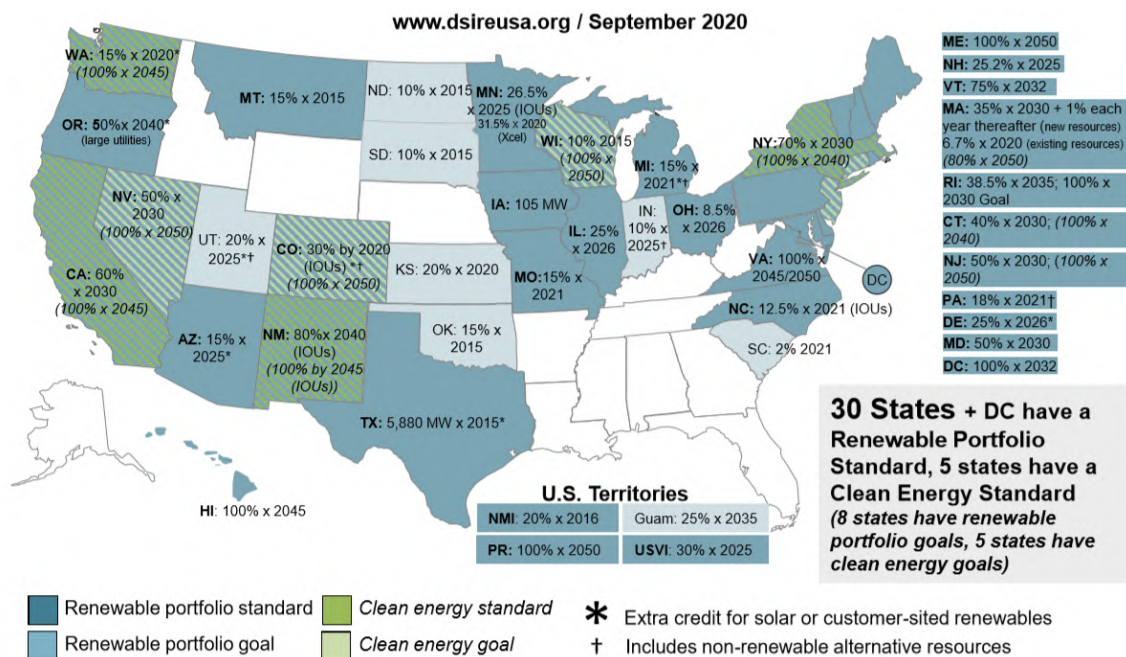
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Energy 101: Clean and Renewable Standards

Portfolio standards require utilities and other energy suppliers to procure a certain minimum amount of their energy portfolio from eligible resources. These policies create demand for targeted energy resources, increase their development and use, and help to overcome market barriers to adoption, thereby enabling society to capture the environmental, economic, and other benefits associated with these resources.¹ Portfolio standards can come in many forms and cover different energy resources. For example, energy efficiency standards help drive adoption of energy saving technologies and practices,² and low-carbon or clean fuel standards help incentivize innovation and adoption of less carbon intensive direct-use or transportation fuels.³ Two similar types of portfolio standards are in use today in the electricity sector: Renewable Portfolio Standards (RPS) and Clean Energy Standards (CES).ⁱ Currently 30 states and the District of Columbia have some form of RPS, CES, or a combination of the two; a further eight states have non-binding renewable portfolio goals.⁴

Figure 1: Renewable and Clean Energy Standards in the United States



Note: Virginia and Maine 100% RPS programs have unclear guidelines about qualifying resources and may be considered 100% clean energy standards.

In addition to states, sub-state jurisdictions like municipalities and counties, as well as individual electricity suppliers also set electricity portfolio standards or goals.⁵ While RPS and CES policies are similar in their goals, there are key differences between them. This section describes and compares RPS and CES policies. For a discussion of emerging trends in RPS and CES policies see the Renewable and Zero-Emissions Standards Policy Brief.

ⁱ Renewable portfolio standards may also be referred to as renewable energy standards or renewable electricity standards. Likewise, alternative names for clean energy standards include clean electricity standards and zero-emission standards.

Renewable Portfolio Standards

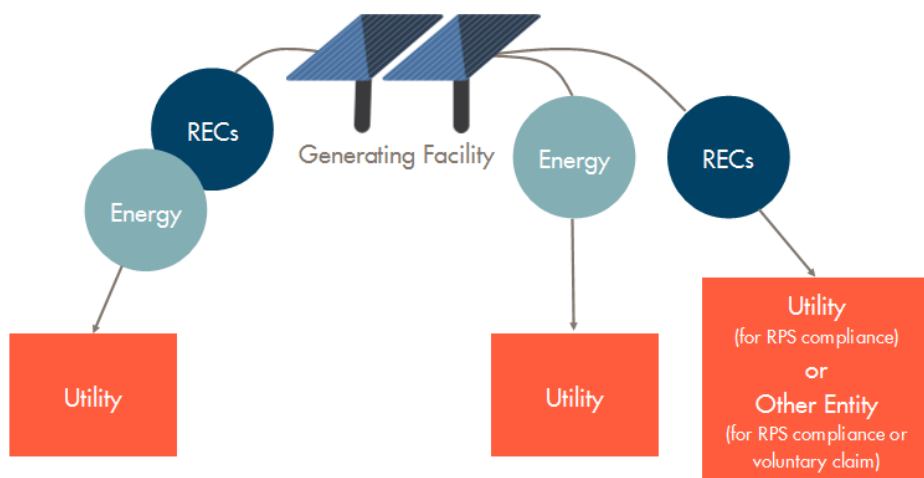
An RPS requires electricity suppliers to procure a minimum amount of electricity from eligible *renewable resources*.^{ii 6} The primary purpose of an RPS is to increase the development and use of renewable energy sources for electricity generation. There are a number of reasons why a state or jurisdiction might want to increase renewable electricity generation, including reducing emissions of pollutants to meet environmental and climate goals, diversifying the electricity grid, developing new industries, and providing new opportunities for local workforces. It is important to note that while an RPS can be a key policy in supporting climate change mitigation and economic goals, the primary purpose of an RPS is to increase generation from renewable energy resources; an RPS does not specifically target climate goals like reducing emissions.

State RPS policies can vary widely across several design elements including RPS targets, the sectors and electricity suppliers they include, and resource eligibility. Many states, like Oregon, set RPS targets as a percentage of retail electric sales.⁷ Other states, like Iowa and Texas, require specific amounts of renewable electricity capacity rather than percentages.⁸ RPS policies target the electricity sector, but do not address other parts of the energy sector such as direct-use fuels or transportation fuels. RPS requirements generally apply to retail energy suppliers and frequently apply only to investor-owned utilities (IOUs), though many states also include requirements for energy service suppliers, municipalities, and electric cooperatives – sometimes with lower targets.

Resources eligible for an RPS can vary depending on the goals of the policy, the types of resources jurisdictions want to promote, and how jurisdictions define a renewable resource. Eligible resources for an RPS always include wind, solar, and geothermal resources. Several states also include resources such as biomass, landfill gas, hydrokinetic marine (wave and tidal) energy, combined heat and power, and even energy efficiency. Hydropower resource eligibility is frequently determined based on the type and age of the facility. Many RPS policies aim to incentivize the development of *new* renewable resources, and therefore make older facilities ineligible, such as Oregon's treatment of its legacy hydropower.⁹ Some RPS policies include more specific requirements, called carve-outs, which require a certain percentage of the overall renewable electricity requirement to be met with a specific technology to incentivize the deployment of particular technologies, resources, or market segments.

RPS policies use a renewable energy certificate (REC) trading system to track compliance with RPS goals and to reduce the cost to comply with the RPS. A REC is a tradeable certificate that represents the ownership property rights (similar to intellectual property rights) to renewable attributes

Figure 2: Bundled vs. Unbundles Renewable Energy Certificates



ⁱⁱ An alternative to an RPS, which requires compliance, is a renewable energy goal which is non-binding.

of one-megawatt hour (1 MWh) of qualifying renewable electricity delivered to the grid. Once electricity is on a utility grid it is not possible to physically trace the electricity back to its origin, so RECs play an important role in accounting, tracking, and assigning ownership to renewable electricity generation and use. A REC can be sold together with electricity delivered, called a “bundled REC,” and the buyer can make a claim of consuming renewable electricity. A REC can also be sold separately from the associated electricity, called an “unbundled REC,” in which case the buyer of the REC can make a claim of consuming renewable electricity while the buyer of the physical electricity cannot. An electricity supplier that generates more renewable electricity than its RPS requirement may either trade or sell RECs to other electricity suppliers who do not have enough RPS-eligible electricity to meet their RPS requirements. Depending on the state, RECs can also be banked for future compliance use.

Benefits and Costs of RPS Policies

RPS policies, along with other state and federal policies and federal tax credits, are one of the key policy drivers for renewable energy growth in the United States. States have generally met established RPS goals, and approximately half of renewable energy deployment since 2000 is associated with state RPS requirements.^{iii 10} However, the role of RPS policies as a driver of renewable electricity deployment has diminished over time as states with RPS programs have met or exceeded targets and states without RPS programs have also deployed renewable resources, in part due to favorable economics for renewables.¹¹ In 2018, renewable electricity deployment associated with meeting RPS requirements represented just under 30 percent of all U.S. renewable energy capacity additions.¹²

Research estimating the costs and benefits of RPS policies has identified that benefits tend to outweigh costs. A study by the Lawrence Berkeley National Laboratory (LBNL) found that national costs of RPS compliance between 2010 and 2013 were approximately \$1 billion, which is on average less than 2 percent of average statewide electricity rates. At the same time, estimated benefits from reduced carbon emissions and public health benefits came to an average of \$5.2 billion (a more than 5 to 1 benefit to cost ratio).¹³ A second LBNL study forecasted future costs and benefits under existing RPS policies in 2016 compared to a scenario of no RPS policies.¹⁴ The study found that between 2015 and 2050 RPS benefits outweighed costs even when considering the highest cost and lowest benefit outcomes; the study estimated high-end costs of 0.75¢ per kWh, while air pollution benefits, health benefits, and greenhouse gas reduction benefits totaled at least 2.4¢ per kWh (a more than 3 to 1 benefit to cost ratio).¹⁵ Most RPS policies also have cost containment provisions. For example, the Oregon RPS has two mechanisms that serve as cost protections for Oregon consumers: a compliance cost cap of 4 percent of the utility’s annual revenue requirement, and an alternative compliance payment (ACP) mechanism that sets an annual per megawatt-hour rate utilities can pay in lieu of procuring renewable resources.¹⁶

ⁱⁱⁱ A Lawrence Berkeley National Laboratory study identified that while state RPS policies are associated with increased renewable deployment, it is challenging to directly attribute this increase to RPS policies.

Oregon's Renewable Portfolio Standard

Oregon established its RPS in 2007 with Senate Bill 838. The RPS required Oregon's large utilities to provide 25 percent of retail sales from eligible renewable sources by 2025, with interim goals along the way. The RPS defines large utilities as those that provide 3 percent or more of total state retail electricity sales; currently Portland General Electric, PacifiCorp, and the Eugene Water & Electric Board meet this threshold. The state's smaller utilities had lower targets, depending on the percent share of the state's total retail electricity load they supplied. In 2016, Oregon increased its RPS requirements from 25 percent by 2025 to 50 percent by 2040 in Senate Bill 1547 (Oregon Clean Electricity and Coal Transition Plan). The 50 percent target only applies to large investor-owned utilities that provide 3 percent or more of total state retail electricity sales. Compliance for consumer-owned utilities, including EWEB and small investor-owned utilities supplying less than 3 percent of total state retail electricity sales, was capped at 25 percent by 2025.

Eligible resources for the Oregon RPS include solar, wind, marine hydrokinetic, geothermal, certain biomass sources, some hydropower, and hydrogen gas. The Oregon RPS restricts eligibility in most cases to facilities built after January 1, 1995 to encourage development of new renewable resources. SB 1547 also created another type of REC (Thermal RECs or T-RECs). Thermal energy generated at a facility that also generates electricity using RPS-eligible biomass sources is also eligible for the RPS (for more information about the Oregon RPS, see the 2018 ODOE *Biennial Energy Report*).

Clean Electricity Standards

A clean electricity standard refers to a portfolio standard that requires electricity suppliers to procure a certain amount of electricity from "*clean*" zero- or low-carbon emitting resources.¹⁷ CES policies are typically technology-neutral, and may include procurement from resources including hydropower, nuclear energy, coal or natural gas fitted with carbon capture, and other low- or zero-emission technologies, as well as renewables. The primary purpose of a CES is to increase the use of carbon-free sources for electricity generation in order to set and meet more ambitious carbon reduction and climate policies. Like RPS policies, CES can help achieve other goals such as increasing renewable electricity generation, diversifying the electricity grid, developing new industries, and providing new opportunities for local workforces. However, the primary goal is to decarbonize electricity generation. The argument for CES policies is that they allow jurisdictions a wider scope to set and meet more ambitious targets for carbon-free electricity, create a backstop against future growth of fossil fuels, and signal demand for emerging carbon-free technologies to the market.¹⁸

Compliance tracking and cost containment for CES policies may vary depending on the goals of a jurisdiction. One method is to adopt a similar credit system as an RPS that assigns credits per MWh of clean electricity generation to represent ownership property rights associated with clean electricity attributes. Alternatively, CES policies could adopt a tiered credit structure that awards credits of different values to different resource types, as is the case in New York which uses both RECs and Zero Emission Credits.¹⁹ Another alternative, which some research suggests could increase efficiency, is a

credit system based on emissions rates rather than technology type.²⁰ Under this method, facilities would be compared on an emissions rate basis to a reference type of emitting generator, either a new coal plant or some type of natural gas plant, and would receive credits accordingly. Some jurisdictions may opt to forego credit systems and mandate compliance without a credit trading plan. Regardless of the design, policymakers will face several tradeoffs and must consider the most appropriate path to meet their specific goals.

Benefits and Costs of CES Policies

CES policies have not been in place for as long as RPS policies, so detailed research on costs and benefits is less available. That said, in theory a CES has potential to achieve an equivalent level of emissions reductions as an RPS at lower cost because a greater number of technologies will compete to reduce emissions, which increases market efficiency and lowers overall compliance costs for a given level of emissions reduction.²¹ CES policies can, however, include non-emitting generation resources like nuclear power, or fossil generation with carbon capture; which can have associated economic, environmental, and public health costs.

Washington Clean Electricity Standard²²

In 2019, Washington state passed the Clean Energy Transformation Act (CETA). CETA requires all retail sales of electricity be “greenhouse gas neutral” by 2030, and by 2045, 100 percent of retail sales of electricity must be from either RPS-eligible renewables or from “non-emitting” resources. The bill defines “non-emitting” resources as resources that do not emit greenhouse gases as a by-product of energy generation. The difference between the 2030 target and the 2045 target is that, for the period between 2030 and 2045, utilities can meet up to 20 percent of their compliance with alternative compliance measures, including alternative compliance payments, purchasing unbundled RECs, or investing in additional energy efficiency projects.

Clean Energy Standards²³

The term Clean Energy Standard is often used synonymously with Clean Electricity Standard. A Clean Energy Standard, however, can apply to energy resources beyond those used for electricity generation. The purpose of a Clean Energy Standard is to have a policy that requires clean energy targets across all energy resources, including electricity but also energy resources for direct use like space heating, industrial processes, and transportation. Many states have multiple standards to cover all energy sectors, like energy efficiency standards and clean fuel standards, but an umbrella Clean Energy Standard would cover all sectors. While there are no states with an umbrella Clean Energy Standard, there are municipalities that have adopted Clean Energy *Targets*. For example, in 2017, Multnomah County and the City of Portland adopted a resolution to meet 100 percent of community-wide electricity needs with renewable resource by 2035, and all energy needs by 2050.

Comparison of RPS and CES Policies

While the terms RPS and CES are sometimes used interchangeably, there are meaningful material differences between the two policies. Primarily, RPS policies aim to incentivize the development of *new* renewable resources, and exclude generation sources that are not considered “renewable,” but that may be low-carbon or zero-carbon emitting resources such as nuclear power or fossil fuel-generated electricity with carbon capture and storage (CCS) technology. CES policies, on the other hand, aim more directly to reduce carbon emissions by incorporating low- or zero-carbon emitting resources regardless of whether or not they meet the definition of renewable energy.

Table 1: Primary and Secondary Objectives of Different Standards

Policy	Objectives
Renewable Portfolio Standard	Primary: Increase renewable electricity resources Secondary: Meet climate, environmental, and other goals
Clean Electricity Standard	Primary: Reduce GHG emissions in electricity generation Secondary: Technology adoption goals (e.g., renewable energy resources)
Clean Energy Standard	Primary: Reduce GHG emissions in all energy use (electricity, direct use, and transportation fuels) Secondary: Technology adoption goals (e.g., renewable energy resources)

**Note: Some jurisdictions have renewable goals or clean goals, which have the same objectives but are voluntary rather than mandatory.*

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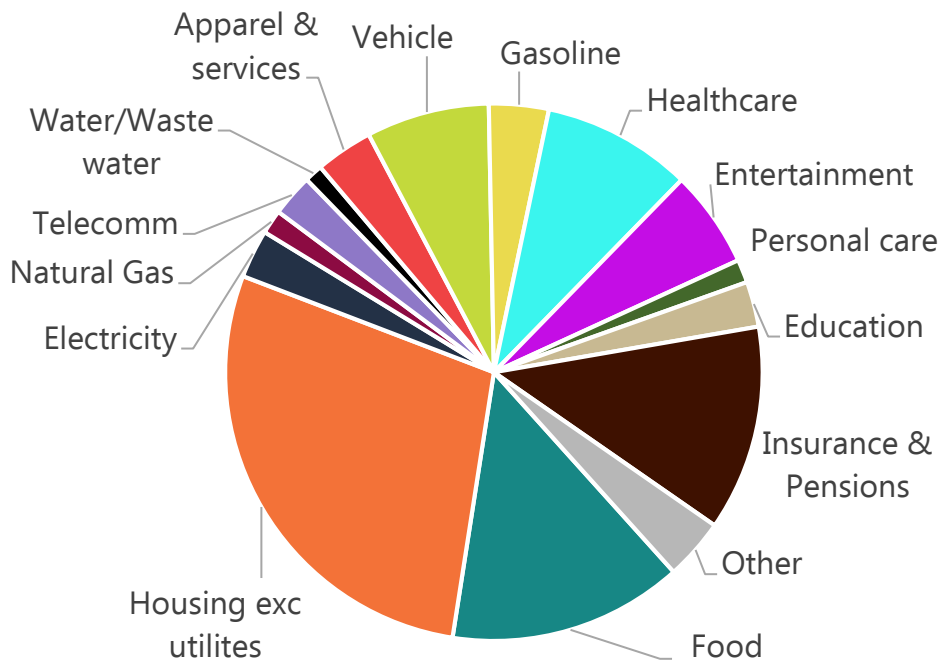
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Energy 101: Bill Basics

Energy is part of everyone's household budget. Lighting, heating, cooling, cooking, and refrigeration all require energy in the forms of electricity and direct use fuels like natural gas, propane, fuel oil, and even wood. Water and wastewater have a big energy component because of the energy needed to obtain, distribute, and treat water. Transportation has an energy bill too, every time you buy gasoline or plug in your electric car. Telecommunications, from internet to TV to cell phones, all require electricity to operate and provide the services used a part of our daily lives.¹

Figure 1: Typical Share of Household Expenses



This section looks at Oregonians' typical main energy costs: electricity, natural gas, and transportation.

Energy Bill Basics

The key to deciphering charges on an energy bill is understanding the terminology used to describe each charge. Following are some general energy terms and types of charges that apply to most energy bills:

Meter. Meters measure how much energy is consumed. Some electric utilities are updating their meters to "smart meters," which help track when energy is used in addition to how much.

Rate Schedule. Rates vary between residential, commercial, and industrial customers, based on the type of service and the maximum demand. More than one rate can be used for the energy a building or facility uses. Schedules can be created for specific uses, like traffic signals, streetlights, irrigation and drainage pumping, or for time-of-day service or special pilot programs like demand response.

Every Utility Bill has certain things in common:

Basic Charge or Service Charge. A minimum cost of service, regardless of the amount of energy used. This funds some of the utility provider's costs like maintenance and customer support.

Use Charge. Utilities charge by how much energy is used, measured in kilowatt hours for electricity, and therms for natural gas. There are additional types of use charges that are explained later in this section.

Dates of Service. The date range when the charges were incurred.

Balance. The previous months charges, any payments and current balance will be shown.

Location of Service. The address or other identifying information for the account.

Taxes and Fees. City, county, and/or state taxes may be applied to your utility bill. Specific fees, such as low-income assistance and the Public Purpose Charge, are described in other locations.

Some utility bills include the following:

Voluntary Green Energy Plans. Some electric and natural gas utilities offer programs for customers who want to support renewable energy development. In Figure 2, the customer is enrolled in PGE's Green Source program. Oregon's two largest electric utilities have the country's highest participation rates in voluntary green energy programs.² NW Natural's Smart Energy Program, the nation's first voluntary offset program, procures offsets from regional renewable projects.

Low Income Assistance. This charge provides funding for low-income residential customers who are unable to pay their electric bills in times of crisis.

Investor Owned Utilities may have additional types of charges because of how they are regulated.

Adjustments. Investor-owned utility rates are regulated by the Public Utility Commission and changes to the rates must go through an oversight process. These rate adjustments are for a particular purpose. The reason for the adjustment must be reviewed and approved by the PUC. Each utility has its own set of rate adjustments, some are credits, and some are charges.

Public Purpose Charge. For PGE and Pacific Power, a 3 percent Public Purpose Charge is added to each bill. This charge funds energy efficiency projects, renewable resources, weatherization for low-income households and energy efficiency improvements. It also funds an energy efficiency program for schools. NW Natural, Cascade, and Avista natural gas companies also have a public purpose charge to fund energy efficiency programs. Energy Trust of Oregon administers a portion of the Public Purpose Charge and the Natural Gas programs. Oregon Housing and Community Services receives a share of the Public Purpose Charge for programs and School Districts receive Public Purpose Charge funds directly from PGE or Pacific Power.

Figures 2 and 3 below are sample electric and natural gas bills, plus additional common types of charges. Detailed descriptions of each type of charge can usually be found on each utility's website. If a charge on your bill is not shown here, refer to your utility's website or contact customer support for more information.

Residential Electric Bills

Use Charges:

Demand Charges. Utility customers are charged based on the maximum amount of electricity they use. Utilities may add demand charges, particularly for commercial and industrial customers, based on the customer's highest electricity use during a particular time interval (usually 15 minutes). Customers with large equipment that uses significant electricity may incur high demand charges.

Transmission & Distribution Charges.

These charges fund the utility's costs to bring power to the customers including installation and maintenance of utility poles, lines, transmission towers, and other equipment.

Adjustments:

Regional Power Act (RPA) Exchange Credit.

Residential, farm, and farm irrigation and drainage pumping service types are eligible for this credit which passes benefits from a settlement between the utility and the BPA on to the customer.

Regulatory Adjustments.

This credit reflects the effects of regulatory adjustments, such as net gains from property transaction or costs associated with implementing SB 1149. This adjustment is non-recurring and therefore varies.

Energy Efficiency Funding Adjustment.

This charge funds new energy efficiency measures for the programs administered by the Energy Trust of Oregon. These programs are available to customers of investor-owned utilities.

Energy Efficiency Customer Service. This charge funds activities to assist customers with project facilitation, technical assistance,

Figure 2: Sample Residential Bill: Investor-Owned Electric Utility

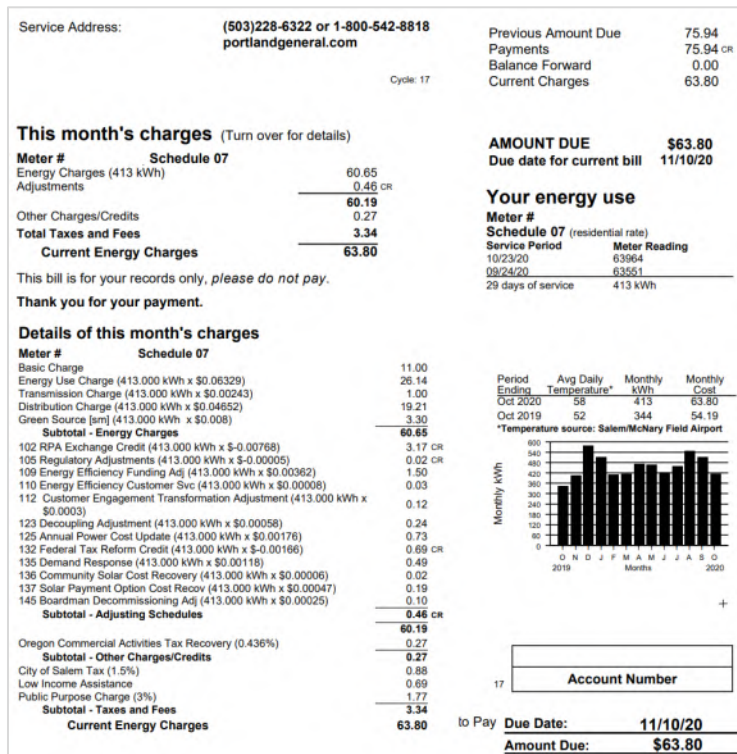
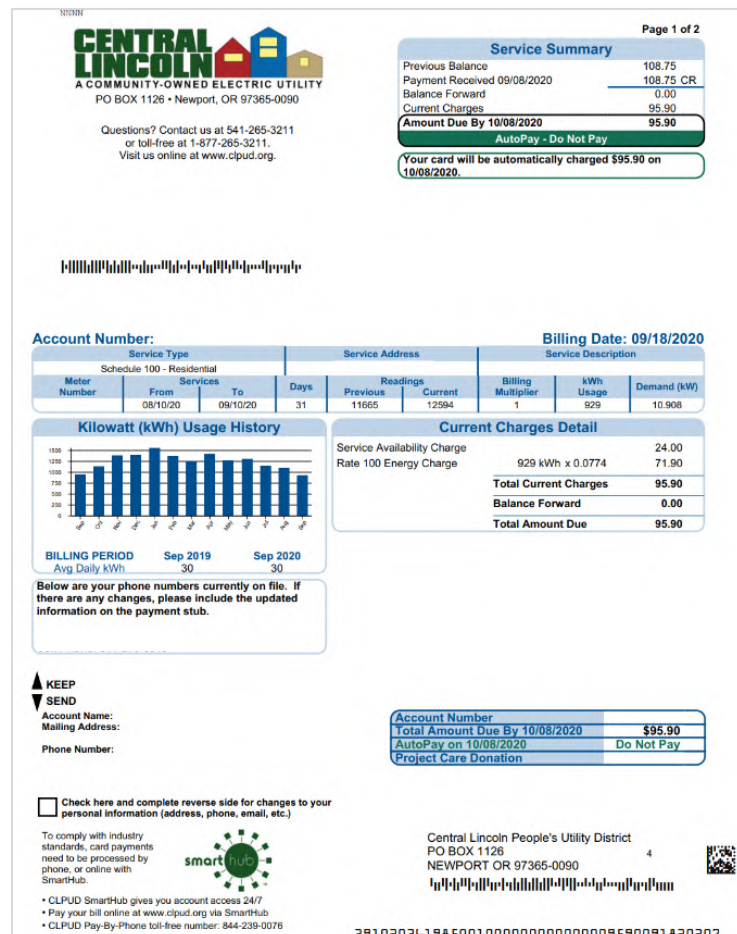


Figure 3: Sample Residential Bill: Consumer-Owned Electric Utility



education, and support for programs administered by the Energy Trust of Oregon.

Customer Engagement Transformation Adjustment. This charge funds PGE's Customer Engagement and Transformation Project.³

Decoupling Adjustment. This rate adjustment allows for charges to mitigate a portion of the transmission distribution and fixed generation revenue variations caused by variations in customer energy usage.

Demand Response Cost Recovery. This charge recovers the expenses for demand response pilot programs not included in other rates.

Solar Payment Option Cost Recovery. This charge recovers costs for the Solar Payment Option pilot not included in other rates.

Spent Fuel Adjustment. This credit passes on excess funds from the Trojan Nuclear Decommissioning Trust fund and any ongoing refunds from the USDOE.

Boardman Decommissioning Adjustment. This charge funds the decommissioning expenses related to the Boardman power plant.

Time-Of-Use. The charge for electricity can change depending on the time of day. The day is broken into periods of time designated 'on-peak' or periods where many customers use increased amounts of energy, and 'off-peak' or periods where customers consistently use less energy. On-peak energy use results in increased energy costs per kWh.

Other fees for low-income assistance and the Public Purpose Charge are explained above.

Commercial Electric Bills

Larger electric customers, like businesses and schools, have other charges that may show up on their bills.⁴

Use Charges:

Load Size Charge. This rate is in addition to the basic use charge and accounts for additional and larger equipment needed to provide larger service connection.

Demand Charge. see previous definition

Delivery Charge. This charge covers costs related to electricity poles, lines, transformers, and other equipment used to deliver electricity.

Supply Energy Charge. This covers costs of supplying electricity based on the number of kWh used. For Pacific Power there are two rates, the rate for use between 1 and 1,000 kWh is lower to encourage customers to save energy.

Adjustments:

Federal Tax Act Adjustment. This credit passes on deferred tax savings associated with the 2017 Federal Tax act.

Oregon Corporate Activities Tax Adjustment. This charge covers taxes paid because of the Oregon Corporate Activity Tax.

Fees:

Public Purpose Charge. See definition at the beginning of this section.

Energy Conservation Charge. This is a state mandated charge covering energy conservation measures related to the Oregon Renewable Energy Act.

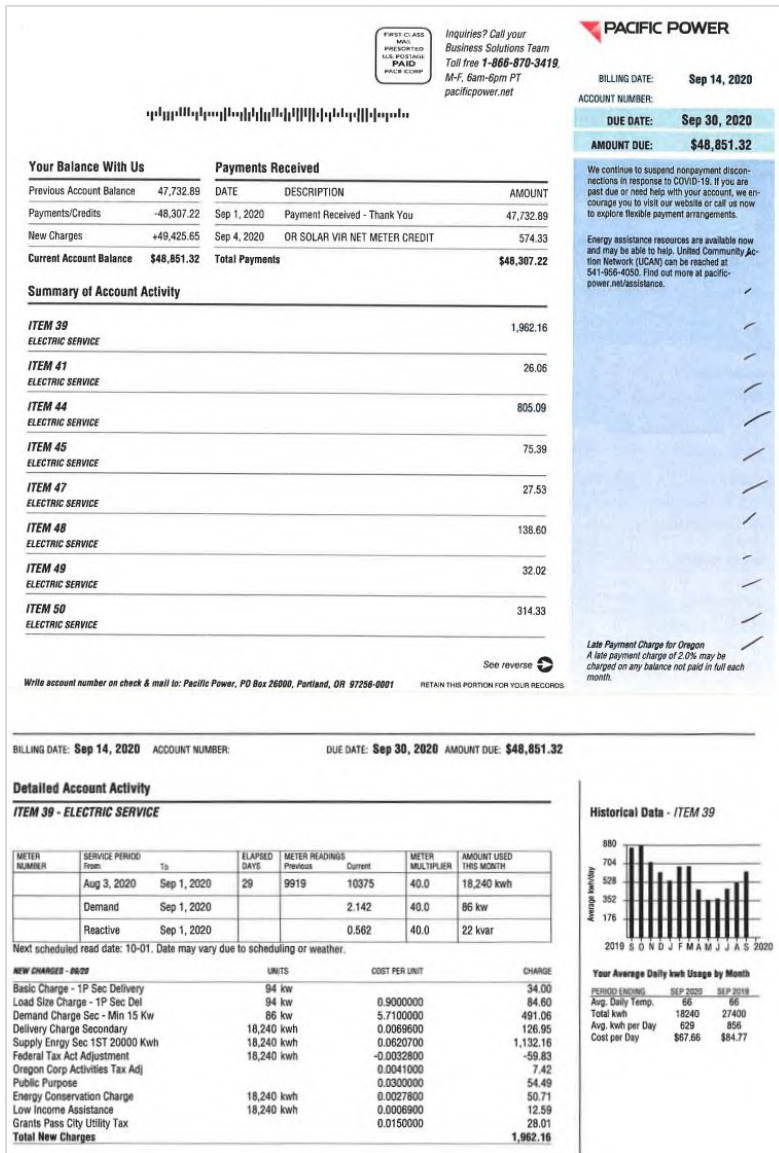
Other Charges Large Electricity Consumers May See:

Power Factor. Electricity; often charged for separately on commercial and industrial bills. Some large power customers may see power factor charges on their electric bill. Power factor is the ratio of working power to apparent power. Working power is the actual power used to run equipment and apparent power is the combination of working power and additional power resulting from an inductive load like a motor. Utilities work with customers to maximize power factor to ensure the full benefit of their electricity use, with the additional advantage of supporting longer equipment life. Managing power factor can reduce or eliminate power factor charges because it makes managing demand easier for utilities.

Ratcheting or Declining Rates. Some utilities offer increasing or declining rates as the amount of energy purchased increases. This type of rate can be used to incentivize reductions in energy use in the case of ratcheting rates. Typically, commercial and industrial customers have high enough use to take advantage of declining rates. In Oregon, some electric utilities offer ratcheting rates, while some natural gas utilities offer declining rates.

Interruptible Energy Rates. Some utilities offer a discount to large customers that are willing to have their services temporarily interrupted by the utility. This allows utilities to better manage demand across their network of customers. Both natural gas and electric utilities may offer this type of rate.

Figure 4: Sample Commercial Bill: Investor-Owned Electric Utility



Natural Gas Bills: Residential and Commercial

Monthly Service Charge. A minimum cost of service, regardless of the amount of energy used. This funds some of the utility provider’s costs like maintenance and customer support. The base charge will vary depending on the type of service.

Natural Gas Usage. Delivered via pipeline, natural gas is metered and measured in therms. One therm is equivalent to 100,000 Btu or 100 cubic feet of natural gas. For natural gas this measurement indicates both the volume of natural gas used as well as the quantity of energy consumed.

Declining Rate. The first 10,000 therms are charged at a higher rate than the next 5,670.9 therms on the commercial bill. This provides a discount to large consumers.⁵

Firm Service Distribution Cap, Pipeline Cap, and Storage Charges. As part of this rate schedule the service is ‘firm’ which means that it cannot be interrupted by the utility, and additional charges allow the utility to recover costs for distribution (pumping, meters, and other equipment), pipeline maintenance, and storage of natural gas. All these costs are greater for maintaining commercial supply than for residential, therefore they show up as line item costs in the commercial bill.

Smart Energy. This is NW Natural’s voluntary green energy program. See definition at the beginning of this section.

Public Purpose Charge. See definition at the beginning of this section.

Figure 5: Sample Residential Bill: Investor-Owned Natural Gas Utility

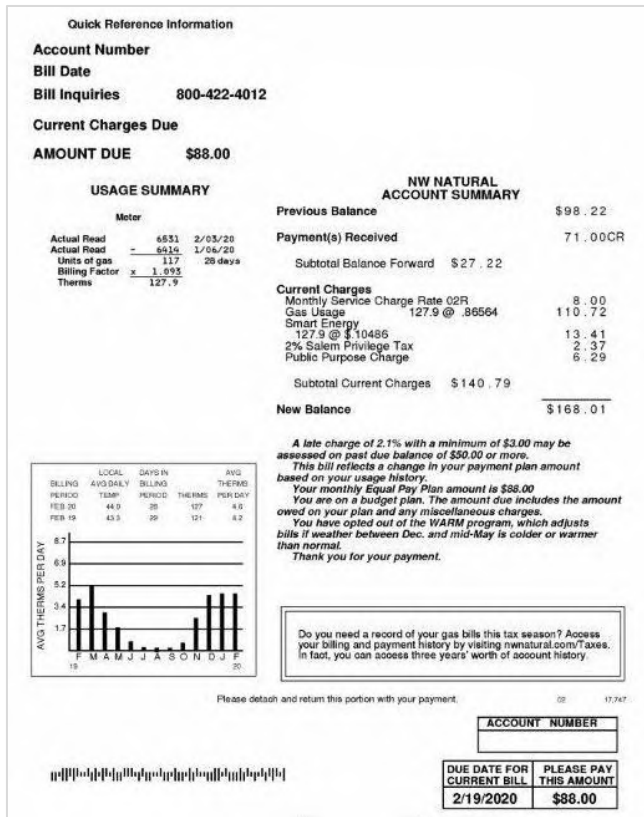
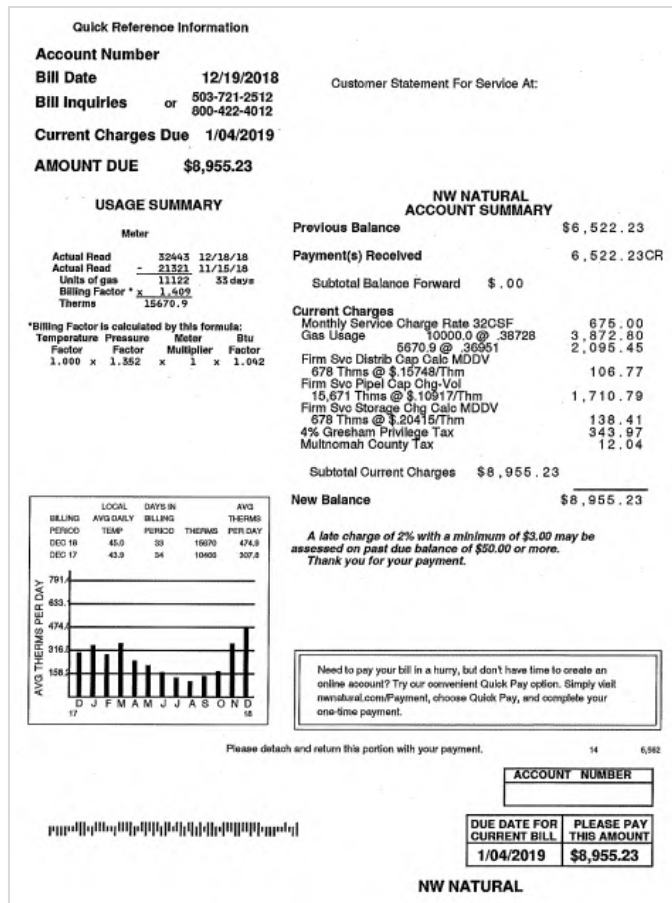


Figure 6: Sample Commercial Bill: Investor-Owned Natural Gas Utility

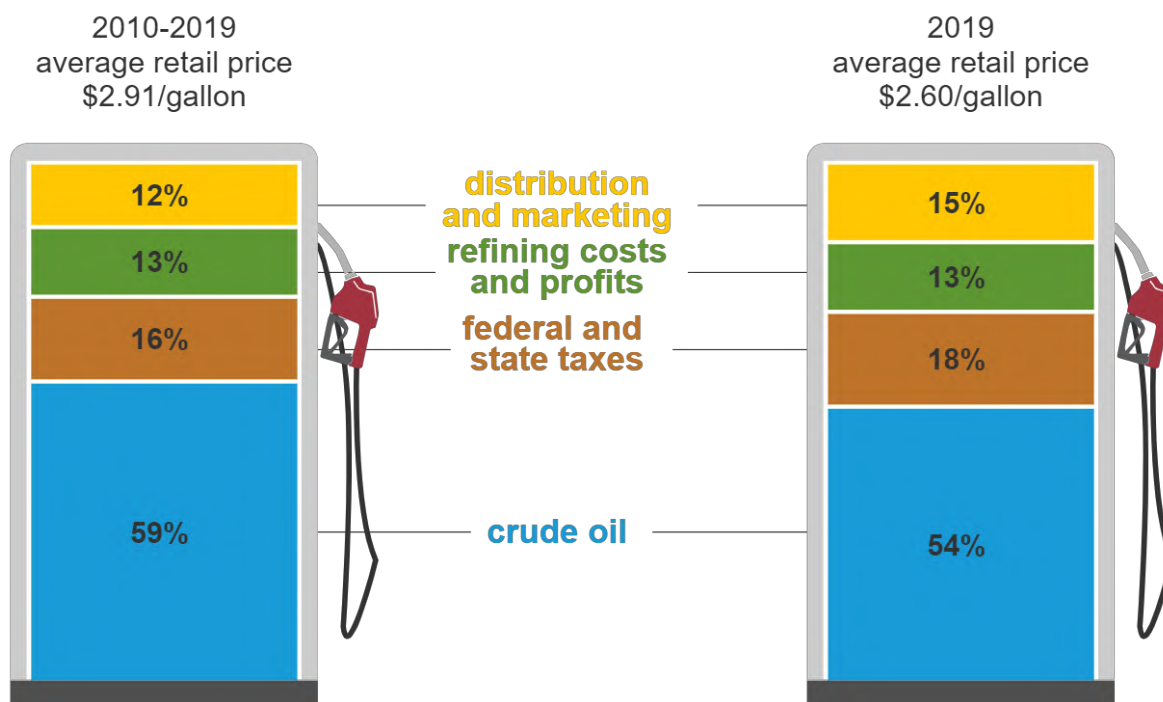


Transportation Energy Costs

Transportation energy is typically discussed in terms of petroleum products and, for most households, this means gasoline. Diesel, electricity, and biofuels are also used for transportation. Typically, the only additional charge on petroleum products is for taxes. However, other factors influence the price of fuel.

Fuel Tax. State taxes are levied on transportation fuels by the gallon to fund the creation, preservation, and maintenance of Oregon's roads and highways. Some cities also levy taxes on fuels by the gallon to preserve and maintain local roads.

Figure 7: What We Pay for Per Gallon of Retail Regular Grade Gasoline⁶



For electric vehicle drivers, transportation energy costs will appear in their home electricity bills (for at-home charging). On the road, EV drivers may have access to free charging at some locations, or pay-as-you-go at other stations (See the EV Charging Technology Review for more).

Cutting Costs: Energy Efficiency

Energy use, and therefore cost, is affected by more than just the behavior of the energy consumers. The efficiency of the equipment (home heating and ventilation units, vehicles, etc.) also makes an impact on the rate of energy consumption. For example, the age and efficiency of heating and air conditioning equipment, lighting, and appliances in a building can drastically increase or reduce the overall energy bills for a home or building. In addition, the structure itself can impact the energy consumption of a building. Double or triple pane windows are far more efficient than single pane windows at preventing heat transfer, which allows for hot summer weather to infiltrate a home in the

summer, increasing air conditioning needs, and allowing the heat inside a building to escape to the outdoors during the cool months of winter.

Homeowners and rental property owners have the option to pursue incentive programs through their utility to improve the efficiency of their properties. Those interested in purchasing high efficiency vehicles may also be eligible for incentives or tax credits. Learn more about energy efficiency policies and programs in Oregon in the Energy Efficiency Policy Brief.

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Energy 101: Equity and Energy Burden

Equity

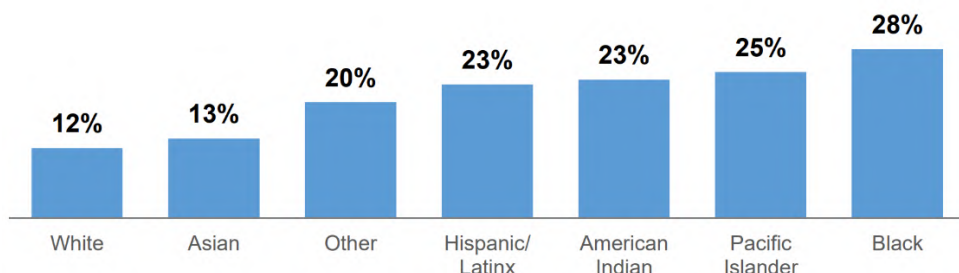
In 2020, Governor Kate Brown’s Office of Diversity, Equity, and Inclusion directed state agencies to consider equity when making decisions regarding state resources through an Equity Framework.¹ The Framework provides a definition of equity acknowledging that not all people, or all communities, are starting from the same place due to historic and current systems of oppression. Equity is the effort to provide different levels of support based on an individual’s or group’s needs in order to achieve fair outcomes. Equity actionably empowers communities most affected by systemic oppression and requires the redistribution of resources, power, and opportunity to those communities.² Equity has been mostly explored in the energy industry through consideration of affordability and access to different types of energy resources.

Certain demographic groups — people of color, women, Oregonians with a disability, and rural communities — face greater obstacles.³ In 2018, 13 percent of Oregonians had income levels below the federally defined poverty threshold, representing 516,000 Oregonians, including 134,000 children.⁴ Poverty rates in communities of color were as much as double the poverty rate for white Oregonians from 2014-2018.⁵ There are 156,000 households in Oregon on the edge of homelessness, who spend at least 50 percent of their income on rent and have a range of risks that make their house insecure – unexpected medical bills, a lay-off, utility shut-off, or a car repair.⁶

Figure 1: Poverty Rates in Oregon for Communities of Color⁷

Poverty rates higher for communities of color

Poverty rate for Oregonians by race and ethnicity



Source: OCPP analysis of 2014-2018 5-year American Community Survey Public Use Microdata.

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Low-income households, communities of color, and rural communities in Oregon frequently experience higher energy burdens than the average household and are disproportionately affected by the effects of climate change.⁸ Housing and transportation burdens significantly impact the affordability of living in the state of Oregon, and are just a part of a wide range of issues households with low incomes face (e.g. housing costs, transportation, groceries, medical expenses, and other basic needs).⁹

Energy Burden

Energy burden is the percentage of household income spent on energy and transportation costs as an indication of energy affordability. Note that much of the data and discussion here is based on analysis

prior to the Covid-19 Pandemic – Oregon energy burden challenges are magnified by job losses, health concerns, and an economic recession.¹⁰

Home energy burden focuses on energy bills for a home in comparison to the total income of the household. If a household is spending greater than 6 percent of their income on home energy costs, they are considered burdened.¹¹ If a household is spending 10 percent or more of their income on home energy costs, they are considered severely energy burdened.¹² High home energy burdens put people at risk of falling behind on payments and being disconnected from service due to nonpayment.¹³

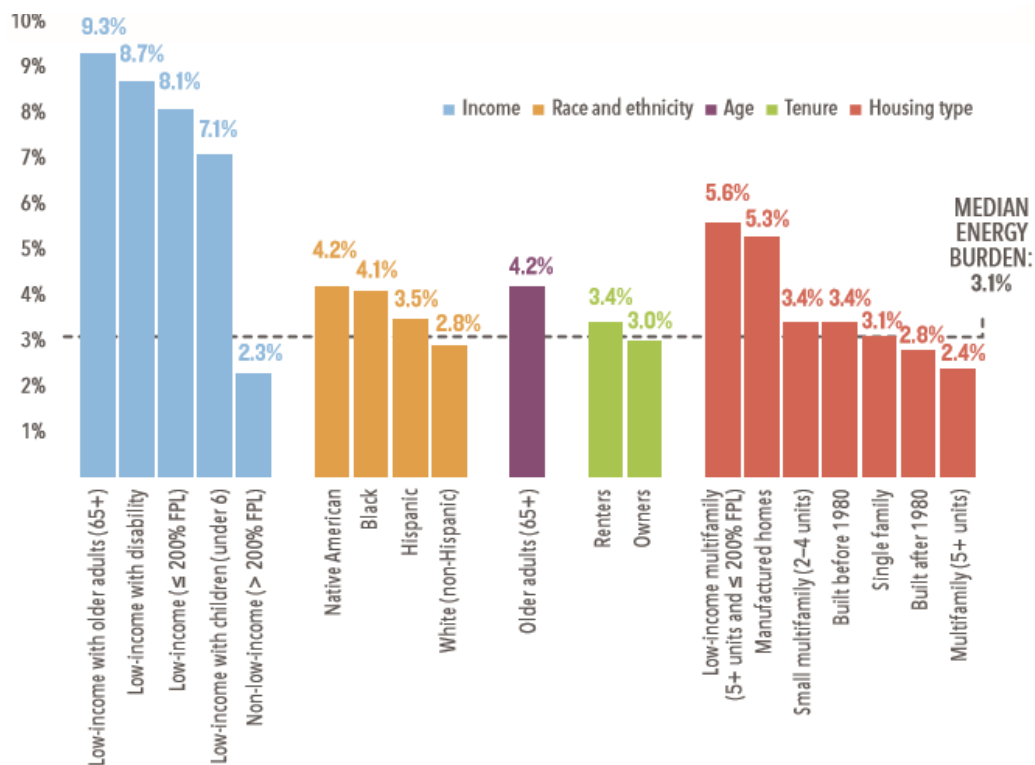
Transportation burden is represented by the total annual transportation costs of households in comparison to income of the household. Transportation costs can be affected by specific factors like auto ownership, auto use, and transit use. Household and neighborhood characteristics of where someone lives, such as household density and access to services and jobs, also influence how much someone drives, which affects their costs.¹⁴ Another metric that provides insight into a household's transportation costs is vehicle miles traveled (VMT). VMT is the total distance traveled by all motor vehicles in a specified system of roads for a given time. VMT cost is the fuel, maintenance, and repair costs of the measured travel.¹⁵

Home Energy Burden in Oregon

The American Council for an Energy Efficient Economy (ACEEE) conducted a study of 25 cities to assess home energy burden in low-income and underserved communities. This national study found that U.S. households spend an average of 3.1 percent of their income on home energy bills.¹⁶ The figure below shows

energy burden findings by subgroup – low-income households, Black, Hispanic, Native American, renters, and older adult households all have disproportionately higher home energy burdens than the national median household.¹⁷ Note that many highly burdened groups are intersectional, meaning that they can face compounding, intersecting causes of inequality and injustice, with energy burden potentially representing just one facet of inequity.¹⁸

Figure 2: National Energy Burden Across Subgroups¹⁸



National energy burdens across subgroups (i.e., income, race and ethnicity, age, tenure, and housing type) compared to the national median energy burden

Affordability Gap (HEAG) Analysis evaluates home energy burden nationally and in states, including Oregon. The energy affordability gap is the difference between a household’s actual energy costs and an “affordable” energy burden level – which is considered to be six percent of the household’s income.¹⁹ HEAG data informs Oregon Housing and Community Services’ Affordable Housing Assessment Tool, which classifies 391,263 of Oregon’s 1,591,835 households as struggling to pay their energy bills – indicating that about 25 percent of Oregon households are energy burdened.²⁰ In addition, 100,456 households with incomes below 50 percent of the Federal Poverty Level paid an average of 23 percent of their annual income for their home energy bills.²¹

Drivers of High Home Energy Burden

To understand how Oregonians could overcome home energy burden, it is helpful to understand the drivers for high home energy burden. Energy burden involves two key components: energy costs and income. Low-income households typically pay less overall on energy bills compared to average households, but they pay more for energy as a percentage of their income. This is both an economic and a housing energy efficiency concern. Table 1 below categorizes drivers of high home energy burdens as physical drivers, socio-economic drivers, behavioral drivers, and policy-related drivers.

Table 1: Key Drivers of High Home Energy Burden

Drivers	Examples of factors that affect energy burden
Physical	<ul style="list-style-type: none"> • Housing age (i.e. older homes are often less energy efficient) • Housing type (e.g. manufactured homes, single family, and multifamily) • Heating and cooling system (e.g. system type, fuel type, and fuel cost) • Building envelope (e.g. poor insulation, leaky roofs, inefficient and/or poorly maintained heating and cooling systems (HVAC), and/or inadequate air sealing) • Appliances and lighting efficiency (e.g. large-scale appliance such as refrigerators, washing machines, and dishwashers) • Topography and location (e.g. climate, urban heat islands) • Climate change and weather extremes that raise the need for heating and cooling
Socio-economic	<ul style="list-style-type: none"> • Chronic economic hardship due to persistent low income • Sudden economic hardship (e.g. severe illness, unemployment, or disaster event) • Inability to afford (or difficulty affording) up-front costs of energy efficiency investments • Difficulty qualifying for credit or financing options to make efficiency investments due to financial and other systemic barriers • Systemic inequalities relating to race and/or ethnicity, income, disability, or other factors

Behavioral	<ul style="list-style-type: none"> • Information barriers relating to available bill assistance and energy efficiency programs and relating to knowledge of energy conservation measures • Lack of trust and/or uncertainty about investments and/or savings • Lack of cultural competence in outreach and education programs • Increased energy use due to occupant age, number of people in the household, health-related needs, or disability
Policy-related	<ul style="list-style-type: none"> • Insufficient or inaccessible policies and programs for bill assistance, energy efficiency, and weatherization for low-income households • Utility rate design practices, such as high customer fixed charges, that limit customers' ability to respond to high bills through energy efficiency or conservation

Table adapted from ACEEE Study on Energy Burden²²

Looking specifically at housing type as a potential physical driver of home energy burden, most Oregonians – about 65 percent – live in single family detached units and about 35 percent of households in Oregon live in multifamily or other housing.²³ Home energy burden decreases on average for households in large multifamily housing, and home energy burden increases on average for households living in manufactured or mobile housing.²⁴

Supporting Oregonians to Overcome Home Energy Burden

Experiencing high home energy burdens may affect the mental and physical health of families by increasing financial stress. Energy Burden may also be an indicator of poor efficiency of a home. If homes are not properly heated, cooled, or ventilated because of the efficiency of the home or because a family can't afford to do so, it may lead to cases of asthma, respiratory problems, heart disease, arthritis, and rheumatism.²⁵ Children and the elderly are most susceptible to these negative health conditions.²⁶ Increasing investment in energy efficiency programs to encourage retrofits is a strategy that can complement bill assistance and weatherization programs to help reduce high energy burdens in underserved communities.²⁷

To address energy burden and the affordability gap, Oregon invests in programs for bill assistance and weatherization. In addition, energy efficiency, renewable energy, and utility rate design have been or may be used to support energy burdened households.

Energy Bill Assistance Programs

Oregon Housing and Community Services (OHCS) administers programs for the State of Oregon that provide a variety of housing stabilization services, including weatherization and assistance with energy utilities. OHCS delivers these programs primarily through grants, contracts, and loan agreements with community action agencies or local community providers.²⁸

Split Incentives and Rental Properties²⁹

Typically, energy efficiency programs pay incentives to homeowners and businesses to encourage retrofits and efficiency upgrades. In the case of rental properties, tenants may not be allowed to install equipment or upgrades. Landlords may not be financially compelled to save energy costs by installing efficiency measures because they don't pay the energy bill for the rented spaces. This is an example of inequity in efficiency programs, requiring programs to be designed to specifically address the unique circumstances.

Upstream incentives are paid to distributors and reduce the cost of an efficient product. Successful upstream incentives for landlords could involve a reduced price on more efficient equipment to install as part of regular maintenance, or if the incentive is very attractive, could inspire the early retirement of equipment instead of waiting until failure. Replace-on-failure doesn't always happen at an opportune time, and landlords or operators may have to make a quick decision on equipment and not have time to weigh the advantages of more efficient products.

Conversations with building owners about value can sometimes help them recognize the benefits of efficiency improvements, even if they don't get energy savings on their own bills. For example, the rent on a very efficient apartment may be higher, bringing more monthly revenue to the landlord and lower energy bills for the tenants. Non-energy benefits, such as comfort, quiet, and improved indoor air quality from efficiency and ventilation upgrades, can make their properties more attractive.

Energy bill assistance is typically provided on an as-needed basis and requires reapplication for future assistance. It also does not generally result in long-term or persistent savings. Energy bill assistance reduces energy burden by directly providing subsidies to assist low-income households in paying utility bills. The primary advantage of energy assistance is that it can provide immediate, emergency assistance to low-income households and avoid a shutdown of power.³⁰ Programs to alleviate energy burden commonly use income thresholds based upon state median income and federal poverty level to determine eligibility. The Oregon Housing and Community Services Department (OHCS) has income eligibility guidelines to demonstrate when households may be eligible for energy and weatherization assistance programs (see Table 2).

Table 2: Oregon Housing and Community Services Program Income Guidelines^{31,32}

Weatherization Assistance Program		Energy Assistance Programs
At or below 200% of Federal Poverty Level		At or below 60% of State Median Income
Annual Income	Household Size	Annual Gross Income*
\$25,520	1	\$25,983
\$34,480	2	\$33,978
\$43,440	3	\$41,973
\$52,400	4	\$49,967
\$61,360	5	\$57,962
\$70,320	6	\$65,957
\$79,280	7	\$67,456
\$88,240	8	\$68,955
\$97,200	9	\$70,454
\$106,160	10	\$71,953
\$115,120	11	\$73,452
\$124,080	12	\$74,951
\$8,960	Each Additional Family Member	\$1,499

Oregon Housing and Community Services (OHCS) administers two energy assistance programs; the federally funded Low-Income Home Energy Assistance Program (LIHEAP) and the ratepayer-funded Oregon Energy Assistance Program (OEAP). LIHEAP helps low-income consumers pay their home energy expenses. LIHEAP is a block grant, and Congress determines total funding annually, which is allocated to states and tribes using a formula. For 2020, Oregon received \$39 million, including \$671,578 in LIHEAP funds directly provided to federally recognized tribes in Oregon.³³ The LIHEAP program supported 374,098 Oregon households at less than 150 percent of federal poverty level,³⁴ covering 49,992 average annual low-income heating and cooling bills from households participating in the program.³⁵ LIHEAP provides home energy assistance to low-income Oregonians, especially households with the lowest incomes and the highest home energy need in relation to income. The purpose of this program is to supplement home heating and cooling costs. LIHEAP is a fuel blind energy assistance program provided on a first come first served basis. The LIHEAP program includes bill payment assistance, heating or cooling equipment repair and replacement, and energy education. Funding for this program comes from the United States Department of Health and Human Services.³⁶

- \$554 is the average affordability gap for energy burdened households that are less than 200 percent of the federal poverty level.³⁷
- \$289,334,345 is the total energy burden of the low-income population in Oregon. Determined

by the difference between a household's actual energy costs and an "affordable" energy burden level equal to six percent of the household's income.³⁸

- 374,098 Oregon households at less than 150 percent of federal poverty level that received support³⁹
- 49,992 average annual low-income heating and cooling bills covered by LIHEAP⁴⁰

Klamath Tribes: Perspectives on Low-Income Home Energy Assistance⁴¹

The Klamath Tribes are one of the nine federally recognized Native American Nations in Oregon and consist of three tribes: the Klamath, Modoc, and Yahooskin. This highlight includes information that was coordinated with staff at the Klamath Tribes – ODOE is grateful for their assistance.

Oregon's LIHEAP allocation for 2020 included \$671,578 directly for federally recognized tribes in Oregon. The Klamath Tribe was allocated \$274,403.⁴² The Klamath Tribes' Community Services Department manages the Low-Income Home Energy Assistance Program (LIHEAP) for the Klamath Tribes. LIHEAP provides heating assistance, cooling assistance, crisis assistance (e.g., when insufficient heating creates a life-threatening situation), and weatherization assistance. The Tribe reports that most requests for assistance are for weatherizing windows and adding insulation, and some Tribal members also request assistance for roof projects.

Demand for assistance under LIHEAP is approximately four times greater than available funding. The Community Services Department maintains a long waitlist, and many applicants wait an average of four years to receive services. Given funding constraints, only around 10 Klamath tribal households can be served each year. Each of these households receive services worth approximately \$3,500, which is often insufficient to complete the requested amount of weatherization and repairs. Another challenge has to do with available contractors. Only a limited number of contractors qualified to perform these services are in Klamath County, and for many contractors outside of the county, the \$3,500 value of any given project may be insufficient to cover their costs when those costs include travel time. Finally, there are barriers related to complexity of the process to obtain funding, procurement policies, and limited Tribal staff resources.

Ideas to help overcome these barriers have included interest in forming partnerships with non-tribal agencies. The Community Services Department administers between 10-12 programs annually and receives funding from over a dozen different sources. Department staff often work in several different roles to administer each program, as well as manage multiple projects, events, and services. Due to staff shortage and high workload, staff's ability to become experts in a specific area – such as procurement and contracting – is limited. Partnerships with non-profit organizations and local community action partnership agencies that are also working on weatherization, insulation, and other energy assistance could create opportunities for technical assistance and shared efforts in administering projects. For example, the Tribes could identify eligible Tribal households and a non-tribal agency could coordinate with contractors to complete a broader set of weatherization projects. In addition, the Klamath Tribes have explored obtaining matching funds from state and local government to double the impact from funds obtained through their LIHEAP grants.

The Oregon Energy Assistance Program (OEAP) is a low-income electric bill payment assistance program funded by and for customers of Pacific Power and Portland General Electric. This program is designed to support customers and reduce service disconnections. Program priority assistance is focused on customers facing imminent electricity service disconnection.⁴³ In addition to OEAP, an inventory by OPUC and OHCS illustrates the wide range of over 400 programs across the state that provide bill assistance, bill discounts, and weatherization support.⁴⁴ All of Oregon's electric and natural gas utilities have funding and programs to help senior citizens or low-income customers pay their bills.⁴⁵ For example, NW Natural offers the Oregon Low Income Gas Program⁴⁶ and Avista offers the Low-Income Energy Rate Assistance Program for its gas customers.⁴⁷ Customer-contribution-based programs from gas companies include Winter Help from Cascade Natural Gas,⁴⁸ Project Share from Avista,⁴⁹ and Gas Assistance Programs from NW Natural.⁵⁰

Community Action Agencies (CAA) are local non-profit organizations working to alleviate and eliminate poverty. OHCS provides funds to these local community agencies that provide bill payment assistance programs. These programs support low-income households to make their energy costs more affordable. They also help prevent the loss and restoration of home energy service. Payments are made to the utility company on the customer's behalf. Many of these Community Action Agencies also provide weatherization and energy efficiency services to low-income households. These services increase energy savings while making homes more comfortable.⁵¹

Considering Rate Design

Lower utility rates for lower income Oregonians could reduce energy burden by lowering the cost of energy for low-income households. In Oregon, this would require a restructuring of utility rates to account for income. SB 978 (2017) directed the PUC to facilitate a public process to examine how industry trends, technologies, and policy drivers affect the Commission's regulation of investor-owned energy utilities and, in turn, the utility business model.⁵² The PUC's report on this public process noted that the Oregon Legislature may need to consider new ways to mitigate energy burden of low-income Oregonians in investor-owned utility service territory, including changes to ratemaking laws that currently limit the Commission's authority.⁵³ Other states have developed "Percentage of Income Payment Programs" or rate discount programs to address affordability gaps, and these types of programs were discussed by Oregon Public Utility Commission, Oregon Housing and Community Services, and stakeholders through a working group in 2018.⁵⁴ In 2020, the Oregon Legislature considered, but did not pass (after walk-outs prevented the quorums needed to hold votes on legislation), HB 4067, which would have allowed the PUC to consider differential energy burdens on low-income customers and other economic, social equity, or environmental justice factors that affect affordability for certain classes of customers.⁵⁵

Weatherization Support

Weatherization assistance is an energy efficiency program targeting customers living in existing, and often older, residential and multifamily buildings. Weatherization services typically refers to programs that address the efficiency of the building envelope and building systems (such as unit heating, cooling, lighting, windows, and water heating) through energy audits and upgrades.⁵⁶ Weatherization programs specifically for moderate and low-income households are supported by utility, state, and federal funding. By providing financial assistance in the form of energy efficiency upgrades, weatherization programs can reduce the energy costs of low-income consumers. Oregon's state

weatherization program is administered by OHCS, which contracts with local community action agencies to conduct energy audits and install energy efficiency measures for income-eligible households.⁵⁷

Energy Efficiency

Energy efficiency measures can go beyond weatherization upgrades and further lower energy burden by reducing the amount of energy needed to provide the same level of energy services, such as lighting and heating for a home. One advantage of energy efficiency as a tool to reduce energy burden is that it results in persistent savings, or a continual reduction in energy burden, while also potentially providing non-energy benefits to the household, such as improved health, comfort and safety.⁵⁸ Energy efficiency home improvements may also result in reduced greenhouse gas emissions and increased health at a societal level.⁵⁹

Energy efficiency projects are infrastructure investments to reduce energy use and associated household energy bills while increasing comfort of the home. Utilities invest ratepayer funds in energy efficiency programs to support customers and reduce potential demand for costly electricity generation facilities, which reduces utility system costs.⁶⁰ Disbursement of funds is often predicated on whether energy efficiency measures are cost-effective by comparing the energy savings against the utility avoiding costs of building new generation or other utility system upgrades. Regulators and utilities use cost-effectiveness tests to determine if financial support from utility ratepayers is reasonable.⁶¹

On-Site Renewable Energy

Renewable energy can also lower energy burden by reducing the amount of energy households must buy from the electric grid and thus lower their electric bill. Renewable energy can deliver persistent savings to the household and create societal benefits through greenhouse gas emissions reduction.⁶²

Ten-Year Plan: Reducing the Energy Burden in Oregon Affordable Housing

Recognizing the importance of energy burden, in EO 17-20, Governor Brown directed Oregon Housing and Community Services, Oregon Department of Energy, and Oregon Public Utility Commission to publish the *Ten-Year Plan: Reducing the Energy Burden in Oregon Affordable Housing*, a report identifying the challenges of energy burden, current data, and potential solutions. The report found energy efficiency and weatherization programs may significantly reduce household energy burden by reducing the amount of energy needed to make the home comfortable year-round.⁶³ Additional solutions to investigate include: targeting multifamily buildings with energy efficiency investments, using demographic data in program evaluation, and strengthening low-income targets and goals for utility programs.⁶⁴

Affordable Housing Assessment Tool

As directed by Governor Brown in EO 17-20, Oregon Housing and Community Services developed an Affordable Housing Assessment Tool to identify energy burden, community needs, and existing resources to inform policy makers, advocates, and the public that are evaluating potential solutions to the problem. The map provides information by county and locations of affordable housing, and has data filters to compare a variety of demographic and program data. Learn more:

http://bit.ly/OHCS_AHA

The Ten-Year Plan estimates cost effective energy efficiency improvements in housing for low income Oregonians would lead to \$141,089,441 in total potential savings in energy costs.⁶⁵ While energy efficiency can alleviate a substantial portion of the energy burden by reducing energy costs, it does not alone solve the problem of energy burden problems. Energy burden involves two key components – energy costs and income – and energy efficiency does not involve the household’s income or ability to pay. Energy efficiency, however, may also result in improved health of the occupants, habitability of their home, and significant greenhouse gas savings.⁶⁶

10 Year Energy Burden Plan Key Findings:

- \$141,089,441 total potential energy cost savings through cost-effective energy efficiency in low-income population⁶⁷
- 488,065 metric tons CO₂e total potential GHG savings through cost-effective energy efficiency in low-income housing⁶⁸

Transportation Energy Burden

Transportation related costs are important to understanding energy burden for households, and are often the second largest household expense after housing costs.⁶⁹ Transportation costs have typically involved costs related to transportation fuels, but are heavily determined by where people live and how easily they can access public transportation and alternative options. This is especially the case for households that are low-income or in poverty.⁷⁰

Beyond transportation fuel costs, for many communities in Oregon, public transportation provides a basic, affordable travel option and vital access to employment, services, groceries, and education.⁷¹ Where public transportation is inaccessible or inconvenient, heavy reliance on personal vehicles can mean higher household expenditures for vehicle, fuel, insurance, and maintenance.⁷²

The Center for Neighborhood Technology (CNT) created the Housing + Transportation Affordability Index, which analyzes overall household costs including transportation and housing costs. Housing costs for owners include mortgage payments, real estate taxes, property insurance, utilities, heating fuels, mobile home costs, and condominium fees. For renters, housing costs amount to contract rent plus the estimated average monthly cost of utilities and heating fuels. CNT’s housing cost calculation uses energy data that differs from other sources ODOE uses to examine household energy costs. Oregon County Profile data uses actual average electricity and natural gas use and cost from the Oregon Public Utility Commission and Oregon utilities serving the county.⁷³

Transportation costs are modeled and combined based on auto ownership, auto use, and transit use for an area.⁷⁴ For purposes of this model, auto ownership includes average vehicles per household, auto use is vehicle miles traveled (VMT) per automobile, and transit use means the percent of commuters utilizing public transit.⁷⁵ Note that the VMT estimates from the national CNT source was used in this effort, which differs from VMT collected by ODOT. The CNT H&T data calculates VMT *per vehicle*, based on a model of urban, suburban, and rural driving habits combined with state population estimates. In comparison, ODOT calculates VMT *on roads*, as submitted annually to FHWA, by conducting physical counts of vehicles with sampling rates that favor state-owned roads.⁷⁶

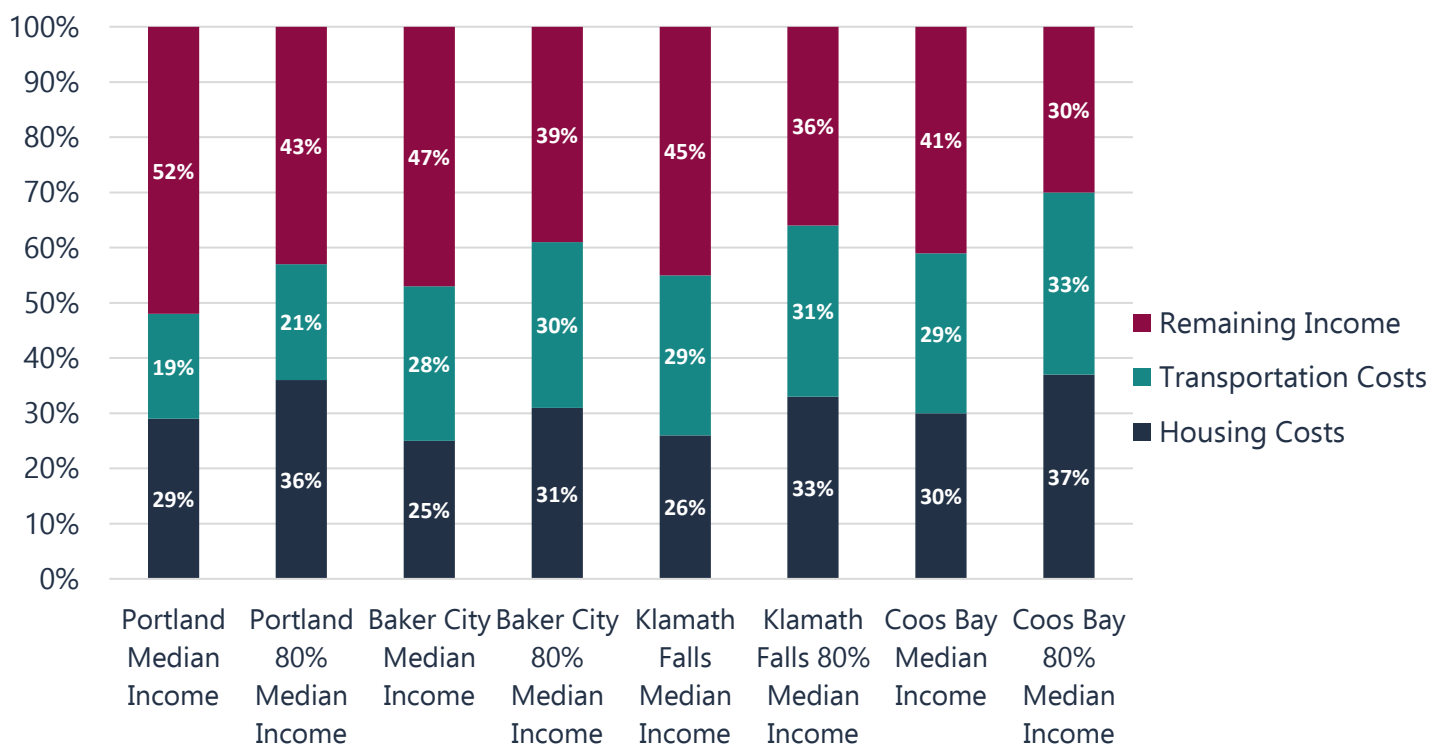
The Housing + Transportation Affordability Index recognizes the efficiency of communities and neighborhoods in their evaluation of housing and transportation costs. Compact neighborhoods with

walkable streets, access to jobs, public transit, grocery stores and services have high location efficiency. These communities require less travel time, money, and greenhouse gas emissions for residents to meet their everyday needs.⁷⁷

The Index analyzes median and moderate-income households – which are defined as 80 percent of median income households. Note that in some parts of Oregon, there can be a significant mix of income levels in an area – which may not provide an accurate count of low-income households. Based on the Housing + Transportation Affordability Index, CNT recommends total housing and transportation costs be no greater than 45 percent of a household’s income to be considered affordable.⁷⁸ CNT includes payments for utilities and fuels, which encompasses the home energy burden analysis above that focuses on energy bill assistance, weatherization, energy efficiency, and other options to support Oregonians experiencing home energy burden. Note that above, when examining only household energy costs, greater than 6 percent of household income is considered home energy burdened.

The Housing + Transportation Affordability Index found that the number of communities considered affordable drops dramatically when the definition of affordability includes not just housing costs but transportation costs as well.⁷⁹ For Oregon, the index shows housing and transportation costs in households with median and 80 percent of median income in 20 Oregon metropolitan areas.⁸⁰ 80 percent of median incomes provides insight into households with lower income – for example, Portland’s median income is \$60,286 per year and 80 percent of median income is \$48,229 per year – and demonstrates a greater percentage of these households spend their limited incomes on housing and transportation costs. Figure 3 provides examples across the state for housing and transportation costs in households with median and 80 percent of median income in Portland, Baker City, Klamath Falls, and Coos Bay.

Figure 3: H + T Affordability Analysis of Oregon Cities



Oregon Department of Transportation (ODOT) has described opportunities to reduce transportation burdens for Oregonians in its Public Transportation Plan.⁸¹ As communities grow, more public transportation services are typically available, depending on total population, population density, and other factors. Transit services may begin in smaller communities by filling specific needs with demand response services, carpools, or contracted taxis. As a community grows, often more services and types of services are added, such as routed bus services or high capacity transit. In each case, the services available reflect the unique characteristics of the community and its history, funding, and prior decisions about public transportation.⁸² In addition, strategies for networks of bikeways and pedestrian opportunities to connect to destinations and other modes of travel, including public transportation, can support a broader set of travel options for Oregonians.⁸³ ODOT partners with Department of Land Conservation and Development through the Transportation and Growth Management Program to provide funding to communities to support smart growth with the following principles:⁸⁴

- Integrated multi-modal transportation and land use planning;
- Efficient use of land and resources;
- Well-designed, walkable communities;
- Good connections between local destinations;
- Pedestrian-, bike-, and transit-friendly development; and
- Stewardship of existing resources and investments.⁸⁵

Every Miles Counts

The Every Mile Counts initiative is an effort to address greenhouse gas emissions in the transportation sector by four state agencies – led by the Oregon Department of Transportation in collaboration with the Oregon Department of Energy, Department of Environmental Quality, and Department of Conservation and Land Development. The workplan for the agencies includes actions to identify, address, and integrate equity into their activities in order to mitigate impacts on underserved communities. ODOT has contracted with Kerns & West to conduct cross-agency equity engagement workshops to better understand equity issues in the transportation sector that will inform the work of the Every Mile Counts initiative.⁸⁶ To learn more visit:

www.oregon.gov/odot/Programs/Pages/Every-Mile-Counts.aspx

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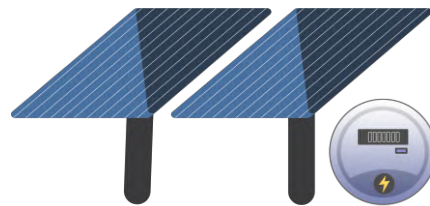
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Energy 101: Net Metering

Net metering is a policy that enables an electric utility customer to receive value for the electricity that they generate on site. Onsite production is most commonly from a solar photovoltaic (PV) system and is used to reduce the amount of electricity the customer purchases from the utility. Because electric consumption and onsite generation do not always occur at the same time, net metering measures all onsite consumption and all excess generation (generation above what is being used at the time) in each billing period. That allows the electric utility to only bill the customer for the net electricity consumed during that period. To do this, the electric utility installs a special meter at the customer's site. During conditions when the solar production exceeds the onsite consumption, the customer's meter records the flow of excess energy onto the utility system. This excess generation is then subtracted from the customer's consumption of electricity from the utility system on the customer's electricity bill.



Laws and Rules Governing Net Metering in Oregon

Since 1999, Oregon law has required electric utilities to offer net metering to Oregon customers installing renewable energy systems up to 25 kilowatts (kW) in size.¹ This law was amended in 2005, enabling the Oregon Public Utility Commission to adopt rules allowing customers of investor-owned utilities to install larger systems.² In 2007, the Oregon PUC adopted net metering rules for Oregon investor-owned utilities, including an allowance for non-residential net metered projects up to 2 megawatts (MW) in size.³ For consumer-owned utilities, net metering policies are developed by each COU's governing body or board.

Net Metering Differs Across Oregon Utilities

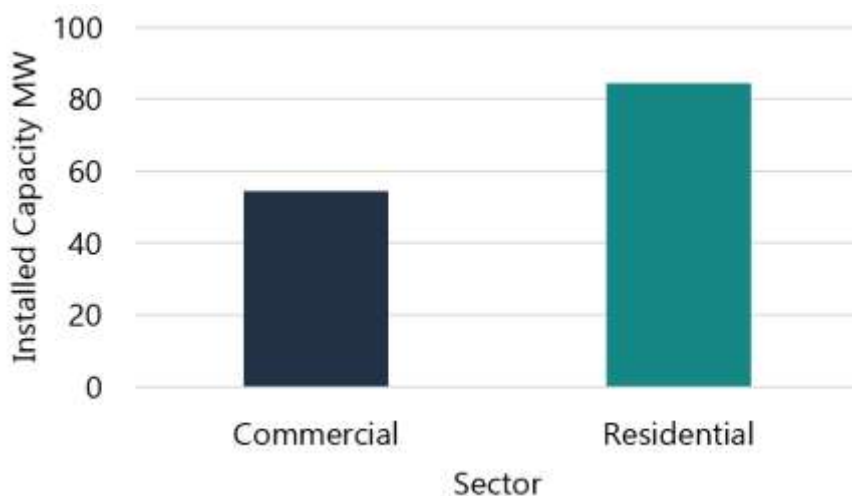
There are currently two big differences between net metering policies across the state. First is generator size: Oregon COUs are only required to offer net metering for systems up to 25 kW consistent with statute, while under PUC rules, the IOUs allow non-residential system sizes up to 2 MW.

Second is treatment of excess generation: Oregon statute directs utilities to offer net metering through which the customer is credited for onsite electricity production at the end of each billing cycle.² The statute also describes that excess generation at the end of the billing cycle may be reimbursed at the utilities' avoided cost of power.² Under PUC rules, the IOUs offer "annualized" net metering where, if the customer generates more than is consumed in a billing period, the excess generation may be applied to future consumption for up to one year. Excess generation credits remaining at the end of a 12-month period are forfeited by the utility customer and credited to Oregon's low-income assistance programs.³ Annualized net metering enables solar net-metering customers to get closer to "net zero energy" by carrying forward the value of generation in the sunny summer and to offset consumption in the winter.

Net Metered Systems in Oregon

As of November 2019, there are more than 18,000 net metered PV systems in Oregon, including more than 16,700 for Oregon homes and more than 1,800 for commercial properties. Together these systems total about 140 MW of capacity.⁴ Oregon statute allows for a variety of onsite generation technologies to qualify for net metering, though the vast majority of systems are solar electric generators.² For example, from 2002 through 2017 there were more than 15,000 applications approved for net metered residential PV systems in the Oregon Residential Energy Tax Credit Program, representing nearly all of the net metered systems in Oregon.⁵ Over the same period, there were 56 applications for net metered wind generators and nine for net metered micro-hydro generators.

Figure 1: Total Capacity of Net Metered Systems by Sector in Oregon (as of November 2019)



Over the same period, there were 56 applications for net metered wind generators and nine for net metered micro-hydro generators.

Current Discussions in Net Metering

Solar is a variable resource, meaning it only generates electricity when the sun is shining and produces more or less electricity based on the amount of sunlight available. This can pose challenges for utilities integrating these variable resources into the grid, especially in high solar penetration markets like California and Hawaii; Hawaii has the highest penetration of residential solar in the U.S. with 19 percent of homes utilizing rooftop PV at the end of 2019.⁶ System constraints may impede the ability to export solar energy onto the grid during period of peak solar output. Integration issues are most pronounced in the late afternoon and early evening when solar resources decline and loads on the electric system increase. In locations where solar is installed in large enough numbers to cause integration issues, there may be a need for the utility to install additional protective equipment.

In Oregon, solar generation is relatively small when compared to overall loads, resulting in few issues of integrating these resources onto the grid. For example, the 16,700 residential net metered PV systems have a combined nameplate capacity of about 85 MW on only about 1 percent of all households in Oregon.⁷ 85 MW is about 1.1 percent of the peak load in Portland General Electric and Pacific Power territories combined. If 10 percent of all Oregon households installed net metered PV systems, it would result in about 1,225 MWs of additional capacity, or about 16.5 percent of the peak load experienced by PGE and Pacific Power combined.⁸

If 10 percent of all Oregon households installed net metered PV systems, it would add about 1,225 MWs of capacity.

It should be noted that net metered PV systems are not the only resources affecting solar integration. Utility scale solar projects contribute their peak output at the same time as most net metered systems, and the combined output of all resources must be considered. Energy storage systems, such as batteries paired with residential PV systems, have the potential to better support grid integration because they can help manage the variability of solar energy generation.⁹

To provide utilities with the support to manage the amount of variable resources on their systems, many states have established net metering capacity limits. These policies enable utilities to limit the number of net metered systems in their service territories. Oregon law allows utilities to limit the cumulative capacity of net metered systems to 0.5 percent of the historic single hour peak load for the utility. However, while PGE and Pacific Power have both surpassed this threshold, they continue to approve net metering applications. The aggregate capacity limit in Washington was also 0.5 percent of the utility's peak load until Senate Bill 5223 increased the threshold to 4 percent in 2019.¹⁰ Other states have seen even more legislative adjustments to net metering limits. In Vermont, the aggregate capacity limit was raised from 2 percent of peak load in 2008 to 4 percent in 2011, and 15 percent in 2014 before the cap was eliminated in 2017.¹¹

Equity Considerations

There is an equity concern with net metering. Utilities charge customers for the amount of electricity they use, but they also charge them a fixed monthly fee regardless of electricity use. If a net metering customer were to offset most or all of their electricity use with sufficient generation, they would pay only the fixed monthly fee. To the extent that a utility counts on variable rate revenue to cover fixed operating costs, net metering customers would not be contributing their fair share and would be subsidized by all other customers. The fact that many net metering households tend to be of higher income¹² brings up an equity issue by potentially shifting cost to low- and moderate-income customers.

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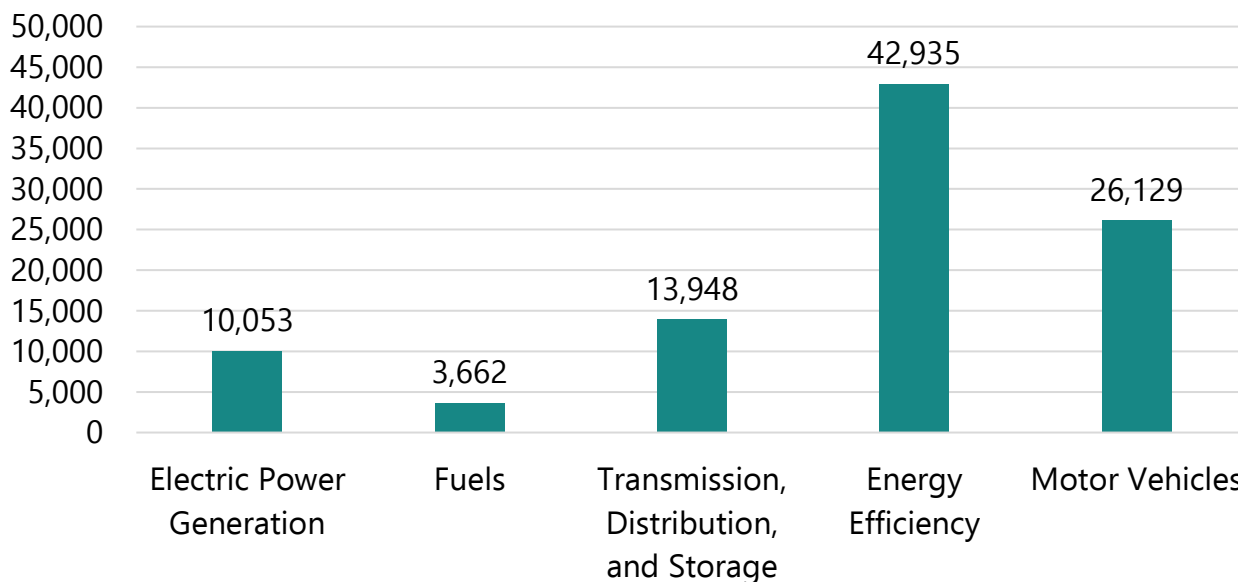
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Energy 101: Energy Jobs in Oregon

In 2019, Oregon's energy industry employed 96,727 Oregonians.¹

Figure 1: Energy Jobs in Oregon (2019)



The 2020 U.S. Energy and Employment Report, issued in 2020 by the National Association of State Energy Officials and Energy Futures Initiative, categorized figures for energy-related employment in the following groups: **traditional energy**, **energy efficiency**, and **motor vehicles**.

Traditional Energy Jobs

Electric Power Generation / Fuels / Transmission / Distribution / Storage



Oregon Traditional Energy Jobs: 27,663

In 2019, about 6.8 million U.S. jobs (4.6 percent of Americans) were in the traditional energy and energy efficiency sectors. Before the COVID-19 pandemic, electric power generation employers across the U.S. projected 4.8 percent job growth in 2020.² Potential energy job growth predictions were driven by strong employment growth in 2019 in natural gas (9.4 percent more jobs), solar (2.3 percent) and wind generation (3.2 percent), the fastest growing new sources of electricity.³ In Oregon, about 1.4 percent of the state's employment is in the traditional energy sector.⁴

Electric Power Generation

The 2020 US Energy and Employment Report defines the electric power generation job category as, "all utility and non-utility employment across electric generating technologies, including fossil fuels, nuclear, and renewable energy technologies. Also included in the employment totals are any firms engaged in facility construction, turbine and other generation equipment manufacturing, operations and maintenance, and wholesale parts distribution for all electric generation technologies."⁵

Electric Power Generation Jobs in Oregon:⁶

Solar Jobs: 5,759



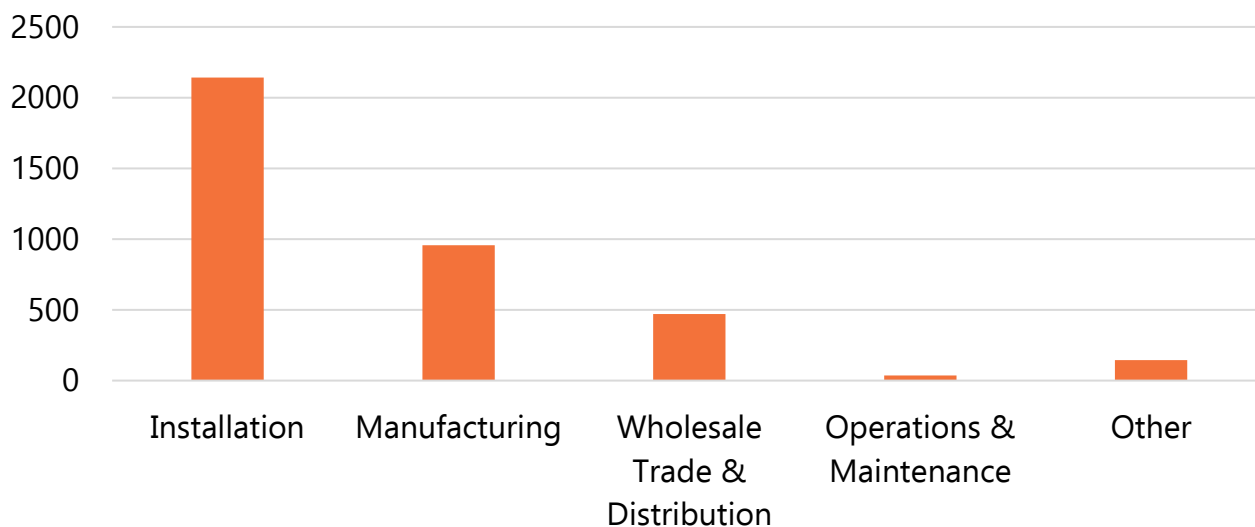
Hydroelectric Jobs: 1,625



Wind Jobs: 1,407

Nationally, 249,983 people work in the solar industry;⁷ Oregon makes up about 2.3 percent of those jobs, with 166 solar companies operating in the state.⁸ In 2019, there were 3,750 Oregonians directly working on solar projects most of their time. The industry added 96 new solar jobs in Oregon in 2019, resulting in 2.6 percent job growth. The following chart demonstrates how the solar jobs in Oregon are categorized, with most of the jobs focused on installation of solar equipment.⁹

Figure 2: Oregon Solar Jobs by Sector



The electric power generation category also includes Oregonians employed in the construction and maintenance of facilities that convert resources to electricity, as well as the manufacturing of equipment for those facilities. In Oregon, that includes people building and maintaining natural gas-fired power plants, hydropower dams, and solar and wind facilities. Generating facilities represent 27 percent of jobs, while manufacturing represents 26 percent.¹⁰

Fuels

The 2020 US Energy and Employment Report defines the Fuels job category as, “all work related to fuel extraction, mining, and processing, including petroleum refineries and firms that support coal mining, oil, and gas field machinery manufacturing. Workers across both the forestry and agriculture sectors who support fuel production with corn ethanol, biodiesels, and fuel wood are also included in the fuel employment data.”¹¹ The fuels sector employs 3,662 workers in Oregon. Woody biomass jobs – which include Oregonians in agriculture and forestry fields – make up the largest segment of fuel sector employment at 36.8 percent. In Oregon, there are 15 woody biomass power facilities, primarily burning wood from mills and land owned by the Bureau of Land Management to generate electricity.¹²

Petroleum products distribution is the next largest fuel employer in Oregon, with 570 jobs.¹³ While the use of heating oil in homes has decreased in Oregon, demand from the transportation sector has maintained the employment need. Oregon has very little in-state production of direct use fuels, so most jobs are in transportation, storage, and retail. For example, the propane industry employs 328 people in Oregon in transportation, storage, and retail jobs.¹⁴ Natural gas fuel extraction and distribution employs 162 Oregon workers. The state currently has one underground natural gas extraction facility in Mist, and 25 biogas facilities operating around the state capturing gases from agriculture waste, wastewater, and landfill waste.¹⁵

Transmission / Distribution / Storage

The 2020 US Energy and Employment Report defines the transmission, distribution, and storage jobs as those supporting, “infrastructure for electric power and fuel links energy supplies to intermediate and end users.”¹⁶ Transmission, distribution, and storage – the energy system that connects energy resources to end use consumers – employs 13,948 workers in Oregon. Construction jobs make up the largest percentage of jobs in this category, at 36.3 percent, as energy infrastructure is continually being built and maintained.

In 2019, Oregon’s energy utilities employed 4,167 people.¹⁷ Oregon has both privately and publicly owned energy utilities distributing natural gas and electricity to customers. Employment at utilities varies, including lineworkers and pipelayers, customer service representatives, government relations, management, and resource planning.

Energy Efficiency Jobs

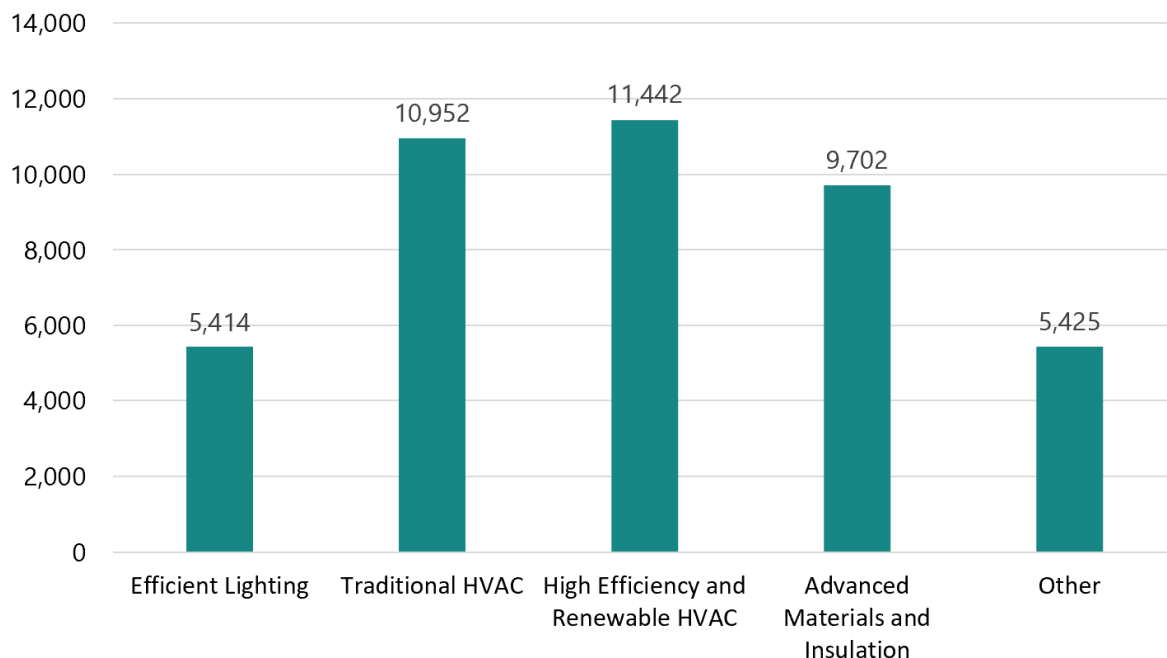


Oregon Energy Efficiency Jobs: 42,935

Energy efficiency employment covers the production and installation of energy-saving products and services that reduce end-use energy consumption by Oregon homes and businesses. The largest number of these employees work in high efficiency HVAC and renewable heating and cooling firms, followed by traditional HVAC.

About 87 percent of energy efficiency jobs are in the construction industry, including efficient lighting, HVAC, advanced materials, and insulation.¹⁸ These construction positions are not new to the industry, but are critical to marketing and implementing of energy efficiency measures. Many utility and government employees work in energy efficiency, but are categorized in other areas based on their employer. Similarly, utility employees working in energy efficiency are grouped as utility employees.

Figure 3: Energy Efficiency Jobs in Oregon



Motor Vehicles Jobs

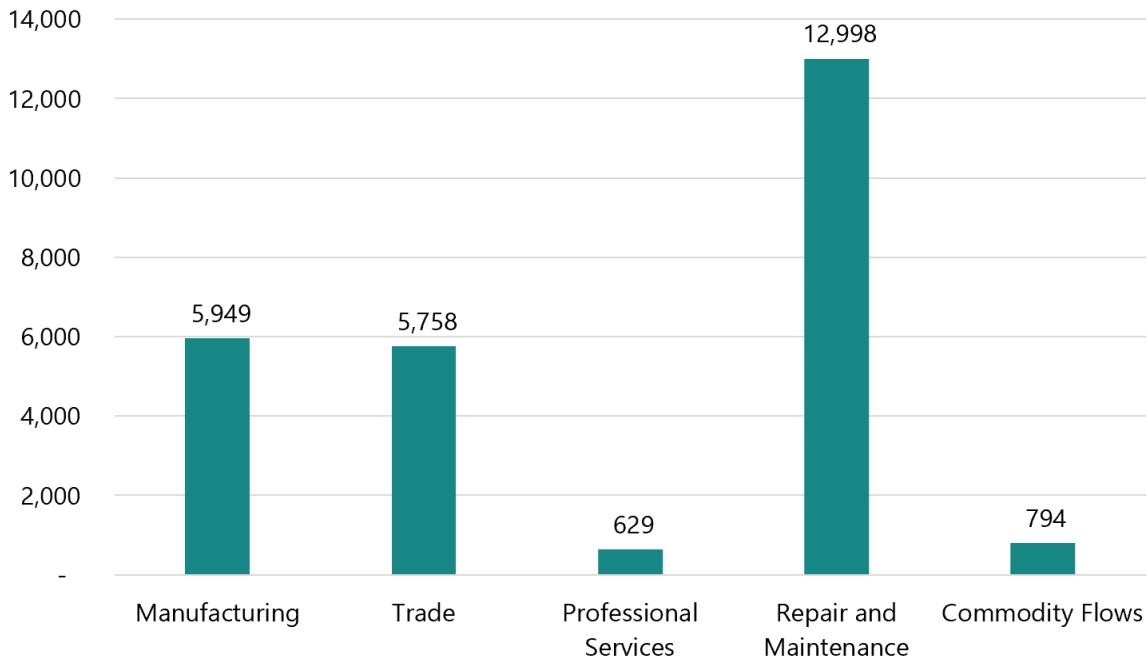


Oregon Motor Vehicle Sector Jobs: 26,129

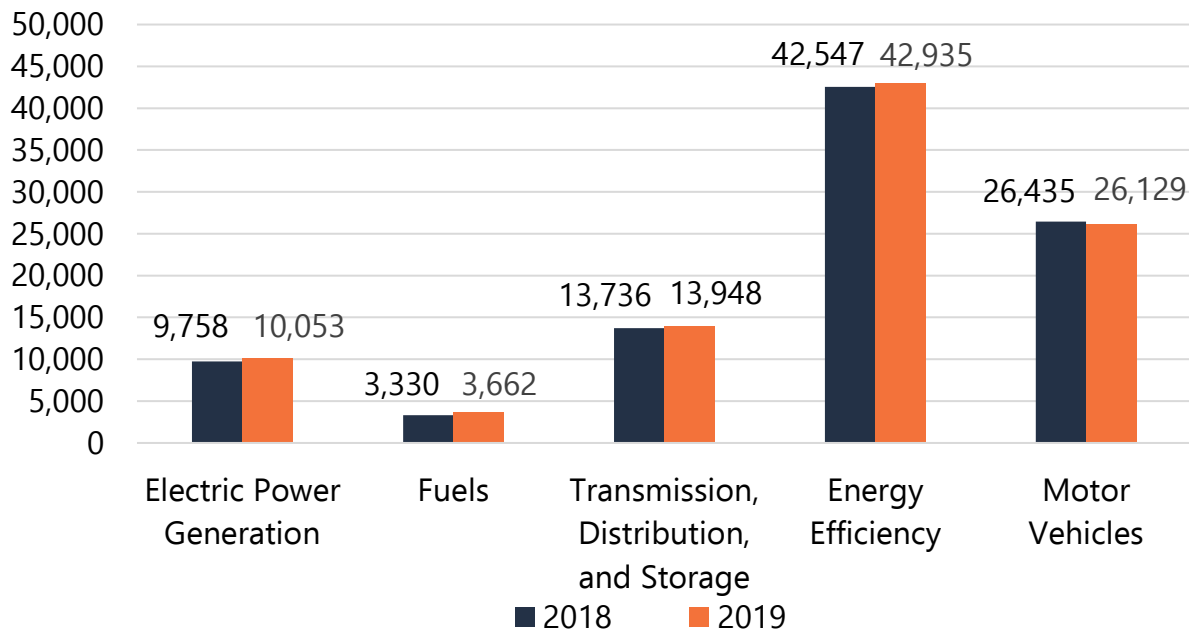
The motor vehicle sector employed 26,129 people in Oregon in 2019. Repair and maintenance is the area that employs the most people, followed by manufacturing.¹⁹ In Oregon, there are about 4.1 million registered vehicles and 3.1 million licensed drivers, so the demand for qualified engineers and technicians remains high.²⁰ Electric vehicle adoption continues to increase, with 31,977 registered electric vehicles in Oregon as of July 1, 2020.



Learn more about electric vehicles in the Technology Review and Policy Brief sections.

Figure 4: Motor Vehicle Jobs in Oregon

Trends in Energy Sector Jobs

Figure 5: Energy Sector Job Growth in Oregon: 2018 vs. 2019

Energy Jobs: Oregon vs. National

Oregon's energy sector employment trends differ from the national energy sector.²¹ For example, while Oregon has a lower percentage of jobs in fuels, the state outpaces the nation in the percent of energy efficiency jobs.

Table 1: U.S. Energy Jobs vs. Oregon Jobs

Energy Job	U.S. Total	U.S. %	Oregon Total	Oregon %
Electric Power Generation	799,742	10%	10,053	10%
Fuels	1,148,893	14%	3,662	4%
Transmission, Distribution, and Storage	1,383,647	17%	13,948	14%
Energy Efficiency	2,378,893	29%	42,935	44%
Motor Vehicles	2,556,492	31%	26,129	27%
Totals	8,267,667		96,727	

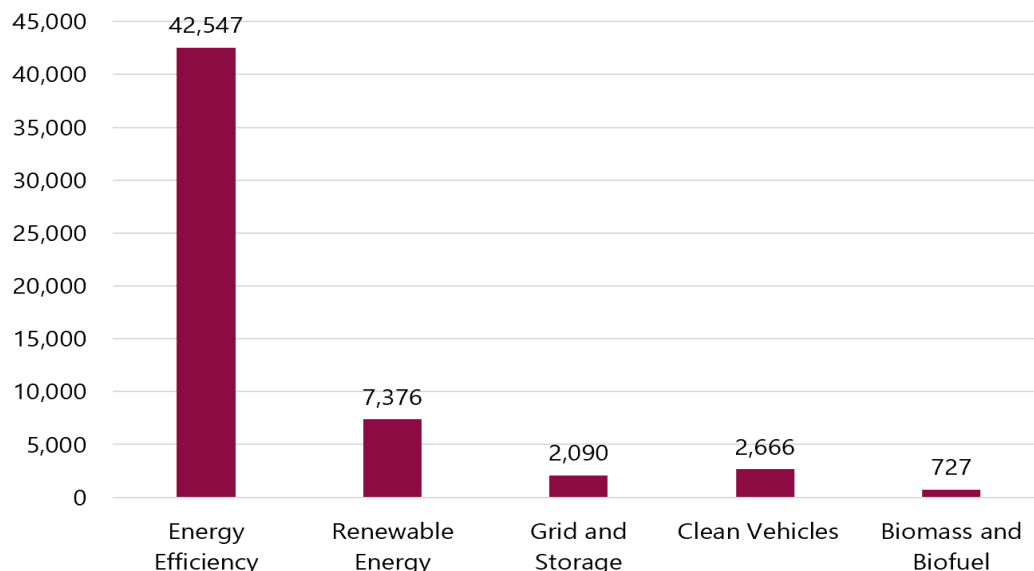
There are many factors that influence state energy employment. One of the most significant factors for Oregon is how our energy flows as we produce, import, and consume energy.

Clean Energy Jobs in Oregon



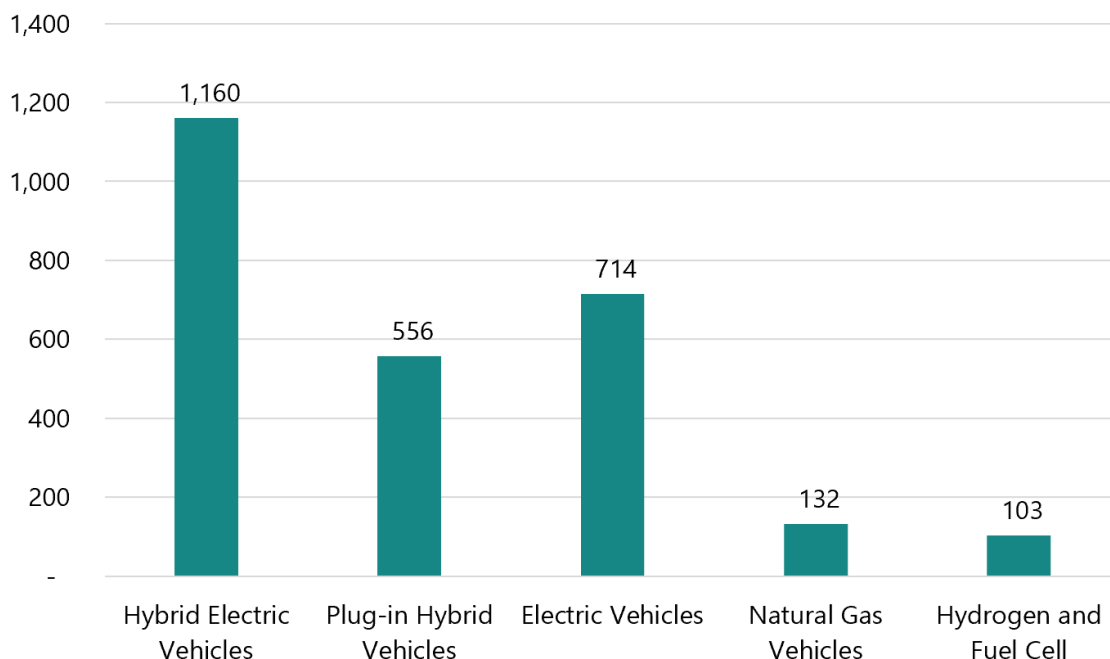
Oregon Clean Energy Jobs: 55,406

Oregonians in clean energy jobs – including renewable energy, energy efficiency, and resilience – work to reduce energy use and mitigate the environmental impacts of energy consumption. Oregon has seen significant growth in clean energy jobs with the development of solar, wind, and biofuel facilities, and through greater emphasis on improving the efficiency of our transportation sector and built environment. In Oregon, energy efficiency is the largest clean energy employer, followed by renewable energy.²²

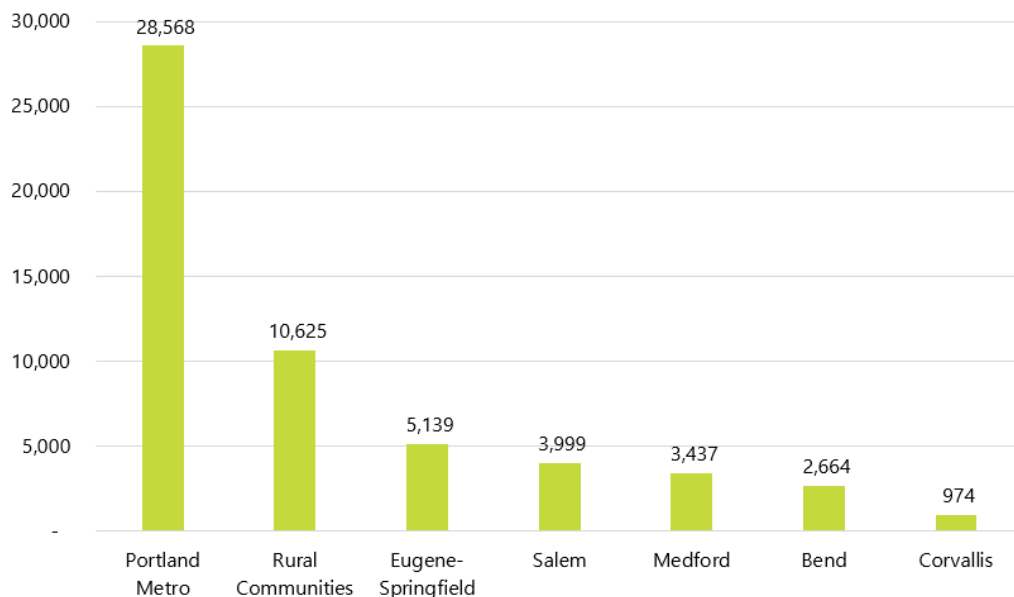
Figure 6: Clean Energy Jobs in Oregon

The clean vehicles category includes electric and other alternative transportation fuels options, which are increasing in popularity in Oregon and are important to reducing harmful greenhouse gas emissions and the state's dependence on imported fossil fuels. The growth of electric vehicle adoption may change employment in the motor vehicle industry. Scientists and engineers are needed to develop new technologies, and trades, like electricians, are needed to build infrastructure for home and business charging. The United States Bureau of Labor Statistics examined the potential for job growth nationally in the electric vehicle sector and found "new types of automobile manufacturing jobs will also be created; however, many of these jobs will be filled by current manufacturing employees or those that were displaced by recent downsizing of the automobile manufacturing industry."²³ Electric vehicles also have lower maintenance needs, therefore demand for automobile repair and maintenance jobs may decline as electric vehicles gain popularity. Clean vehicle jobs in Oregon are divided across a few transportation fuels options.²⁴

Figure 7: Clean Vehicle Jobs in Oregon



The development of clean energy jobs has provided job growth in Oregon metro areas. Rural areas have also reaped benefits of clean energy job growth, as 10,625 rural Oregonians work in clean energy. Renewable energy infrastructure is often built in rural Oregon communities, which leads to new construction, utility, and maintenance jobs that can bolster local economies.²⁵

Figure 8: Clean Energy Jobs in Oregon Urban and Rural Communities

Energy Jobs: Demographics and Equity

Nationally, energy sector jobs skew male and younger. Women make up 47 percent of the overall workforce, but just 23-32 percent of the energy workforce. Employees older than 55 make up 23 percent of the overall workforce, but just 13-21 percent of the energy workforce.²⁶

In Oregon, the solar workforce also lacks some diversity, according to research conducted by the Solar Foundation. Women and people of color each represent 19 percent of Oregon's solar workforce. The foundation also found that in Oregon and Washington, women are significantly less likely to hold solar industry management positions compared to men – just 17.5 percent of management positions are held by women, while 82.5 percent are held by men. Additionally, 93.2 percent of management positions are held by white individuals, while 6.8 percent are held by Latinx individuals, 1.1 percent by Black or African American individuals, 1.1 percent by Asian individuals, and zero percent by Native Hawaiian, Pacific Islander, American Indian, or Alaskan Native individuals. Among the Oregon and Washington solar industry companies interviewed by the Solar Foundation, 17 percent have adopted strategies to increase ethnic, racial, female, and gender non-binary representation to address diversity concerns.²⁷

A Changing Job Market

In the United States, the energy sector is adapting as energy costs change, and as we shift how we generate and use energy to reduce carbon emissions and meet industry and government clean energy goals. In 2019, the energy sector outperformed the American economy in job growth, representing 8 percent of new employment opportunities while making up only 5.6 percent of the overall workforce.²⁸

In 2019, coal lost almost 8,000 jobs nationally. Natural gas generation added 9,100 jobs and renewable technologies created 10,900 new jobs. In the fuel sector, corn ethanol employment declined, but woody biomass and other biofuels increased. Natural gas employment growth continues to drive fuel employment increases nationally.²⁹

Future of Energy Jobs

The energy sector is transitioning, and so is its workforce. Government, education facilities, and employers are investing in workforce development programs and early education to train current and future workers in new technologies in the clean energy sector, such as renewable energy engineering. Efforts are being made to diversify the energy sector and attract women and minorities into STEM careers.

The U.S. Department of Energy is fostering the development of future workers in the energy sector through its “JUMP into STEM” program, an online building science competition for undergraduate and graduate students at U.S. colleges and universities. The JUMP into STEM initiative seeks to inspire the next generation of building scientists, focusing on creative solutions and diversity in the building science field. The diversity objective is inclusive of an interdisciplinary mix of majors and representation by women and minorities. JUMP into STEM attracts students from majors such as computer science, data science, statistics, mathematics, physics, economics, sociology, meteorology, architecture, and various engineering disciplines in addition to the traditional building professional degrees of civil and mechanical engineering.^{30 31}

In Oregon, workforce training programs for electric vehicle charger installation and maintenance are designed to meet the growing need for EV infrastructure. Central Oregon Community College (COCC) offers automotive technology degrees and certificates on a range of vehicles, including a Hybrid Electric Vehicles Technician program and a Clean Energy Diesel Technician program. Tesla is partnering with COCC to recruit students to attend the company’s 12-week START program, teaching students to become Tesla Technicians. Tesla has also worked with Linn Benton and Portland Community Colleges on the START program.³²

Oregon Institute of Technology (OIT) was one of the first universities to offer a bachelor’s degree in Renewable Energy Engineering and now offers a Master of Science in renewable energy engineering. Graduates of OIT’s program go into engineering jobs “where a major emphasis is in power generation, power and energy systems design or applications, and energy conversion technologies.”³³

Home energy scoring policies and programs are creating a need for skilled home energy assessors. In Oregon, licensed and certified home energy assessors are trained to determine the efficiency of the home. The assessors assign residential buildings a home energy performance score using a scoring system developed by the U.S. DOE and adopted by the State of Oregon. Assessors are certified by the Oregon Department of Energy and licensed by the Oregon Construction Contractors Board after completing the training approved by ODOE. Currently, there are 180 assessors providing this service in Oregon – and more than 19,864 homes scored since 2018.^{34 35 36} Not only has home energy scoring created new energy-related jobs, it has also given homeowners and homebuyers valuable energy information.

The State of Oregon STEM Investment Council seeks to increase the proficiency of Oregon students in advanced mathematics and science, and double the number of students who earn a post-secondary degree requiring proficiency in science, technology, engineering, or mathematics. The Oregon STEM Investment Council’s Education Plan highlights the “unprecedented job and career opportunities to Oregonians students who’ve acquired the talent, passion, and initiative that come from studies in science, technology, engineering, and math (STEM).” These skills will lead to successful careers in electronics, software, biomedical research, and the clean energy sector.³⁷

COVID-19 and Energy Jobs

The COVID-19 pandemic has created an economic recession affecting energy jobs across the country. As businesses and industry suspended operations in Spring 2020 during “stay home” orders, the national clean energy industry shed an estimated 594,300 jobs in March and April – a 17 percent decrease in clean energy employment that erased the job growth of 2019.³⁸

Oregon lost an estimated 7,405 clean energy jobs in that time. The hardest-hit Oregon counties include Multnomah (1,771 jobs lost), Washington (1,654), Clackamas (513), and Lane (437).³⁹

Manufacturing plants of clean energy products, building materials, lighting, solar panels, and wind turbine parts were temporarily closed or had to reduce operations. Many other energy sector workers were furloughed or underemployed, which is not captured in the total jobs losses previously mentioned. It is likely job losses in clean energy will continue unless significant investment is made to bolster the industry. Economic forecasts have projected the clean energy sector has the potential to lose a quarter of its workforce, or 850,000 jobs in 2020.⁴⁰

U.S. energy sector recovery began over the summer of 2020 with modest growth. The clean energy sector added 3,200 jobs in July 2020 and many industries are at full operation with new protocols to address pandemic safety concerns and protect employees and customers. Oregon added 56 clean energy jobs in July 2020.⁴¹

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Energy 101: Energy Efficiency

Energy efficiency is doing the same work while using less energy. It involves an efficiency measure or method to reduce energy consumption by using less energy to attain the same output. Energy conservation reduces energy consumption in a different way – it minimizes activities that consume energy. There are many types of strategies, policies, and programs used to encourage or require energy efficiency, which are covered in depth in Chapter 6 of the 2018 *Biennial Energy Report*. This Energy Efficiency 101 provides a brief background and description of electric and natural gas energy efficiency policies and programs.

Energy Efficiency Policies

Electric Energy Efficiency Planning and Cost-Effectiveness

Energy efficiency and conservation are primary considerations in regional electricity planning. The 1980 Northwest Power Act (Power Act, Public Law 96-501)¹ prioritizes conservation as the first resource to develop for the region. The act established the Northwest Power and Conservation Council (NWPCC), which produces the Northwest Power Plan every five years. Each plan sets goals for electric energy efficiency, projects future power needs, and analyzes potential energy efficiency opportunities.² For more background about the power planning process, see the Council's summary "Regional Power Planning in the Pacific Northwest."³

The Power Act requires electric energy efficiency programs to acquire conservation and efficiency that has a lower cost than other resources, like new generation. This is called cost-effective resource acquisition and is the primary consideration for determining energy efficiency program funding.

The combined cost of an energy efficiency measure, including rebates, incentives, and customer costs is called Total Resource Cost, or TRC. If the TRC is less than the cost of new generation or production, the measure is deemed cost-effective. The Power Act also grants electric energy efficiency a 10 percent adder in the cost-effectiveness calculation. In other words, if the calculated cost of an energy efficiency measure is \$100, the cost applied to the TRC calculation can be reduced ten percent to \$90.⁴

Natural Gas Energy Efficiency

Oregon is served by three natural gas distribution utilities – Avista, Cascade, and NW Natural – and Energy Trust of Oregon is the administrator of most energy efficiency programs for these three utilities. Energy savings goals are developed through coordination between Energy Trust and the utilities; these goals are not part of the NWPCC Power Plan – which is focused on electricity planning. Each natural gas utility prepares an integrated resource plan (IRP) for a public process at the Public

839b(e)(1). The plan shall, as provided in this paragraph, give priority to resource which the Council determines to be cost-effective. Priority shall be given: first, to Conservation; second, to renewable resources; third, to generating resources utilizing waste heat or other generating resources of high fuel conversion efficiency; and fourth, to all other resources.

{Northwest Power Act, (4)(1), Stat. 2705}

Utility Commission, which includes system planning, demand and customer forecasts, future gas supply, and the role of energy efficiency as a resource in these scenarios.ⁱ

Cost-effectiveness evaluations in natural gas programs are based on resource acquisition – when an efficiency measure costs less than delivering natural gas to customers (also called “avoided cost”) it is considered cost-effective.ⁱⁱ Cost-effective energy efficiency measures are ultimately paid for by all customers, like all other energy resources and services, through charges on their utility bills. These charges may be labeled as conservation investment, efficiency, or public purpose charge on customer bills. Energy efficiency programs for natural gas also include direct funding to community action agencies for income-based weatherization, which can include insulation, air sealing, and heating system repairs. Utilities may also operate financing promotions for new efficient equipment.

Natural gas utilities and Energy Trust have met or exceeded the energy efficiency goals established in their IRPs. Each year, they save about 6,000,000 therms of natural gas. What does six million therms of savings represent? Therms are the fuel units on natural gas utility bills used to measure consumption. According to the 2019 Oregon Public Utility Commission Statistics Book, the average residential customer uses 673 therms of natural gas per year.⁵ This means that energy savings each year prevent the need to purchase an additional six million therms, which is equivalent to the average use of nearly 9,000 homes.



Learn more in the Energy 101 on Energy Bill Basics.

Innovative Programs to Support Energy Efficiency

Targeted Natural Gas Energy Efficiency

NW Natural is partnering with the Energy Trust of Oregon on a first-of-its-kind program to address peak events through targeted energy efficiency investments.⁶ The pilot looks at the cost-effectiveness of targeted energy efficiency investments to reduce the effects of peak load on the distribution system. Energy efficiency reduces overall energy use, which can reduce the peak load requirements at a localized level. Reducing peak energy demand can delay or avoid the need to invest in additional infrastructure investments to meet the peak load. This benefits all natural gas customers by reducing overall costs to the utility. Energy efficiency programs can be combined with other programs, like demand response, to leverage additional savings on infrastructure investments.

Electricity Energy Efficiency Program Funding

Bonneville Power Administration and the consumer-owned utilities served by BPA efficiency programs have been delivering electricity savings for decades. Efficiency programs are funded through BPA wholesale power rates and by individual consumer-owned utility rates. Individual consumer-owned utilities self-fund energy efficiency measures and projects, which are supported by charges on customers’ bills.⁷

Idaho Power, which serves a portion of eastern Oregon, operates a ratepayer-funded efficiency program for their Oregon and Idaho customers. Energy Trust of Oregon administers electricity energy efficiency programs on behalf of Portland General Electric and Pacific Power. Energy Trust programs

ⁱ BER 2018 Ch 6

ⁱⁱ <https://edocs.puc.state.or.us/efdocs/HAA/haa163419.pdf>

are funded by a Public Purpose Charge (PPC) on customer bills established by law as a result of SB 1149 (1999).⁸ This charge and the operation of Energy Trust began in 2002.⁹ Energy Trust also receives incremental funding from PGE and Pacific Power customer rates to acquire efficiency beyond what is paid for by the Public Purpose Charge, as directed in SB 838 (2007).¹⁰

Oregon Housing and Community Services receives funding from the Public Purpose Charge for income-based weatherization programs. School districts receive direct funding from the PPC for energy efficiency and renewable energy projects.¹¹ For more detailed information about the Public Purpose Charge, see the biennial PPC Report to the Legislature.ⁱⁱⁱ The Northwest Energy Efficiency Alliance (NEEA) develops market transformation efficiency, funded by Energy Trust and regional utilities. Their work creates future savings as new efficiency equipment is brought to market (see subsection below for more information on market transformation).

Savings targets for the region are in each Northwest Power Plan. 2021 is the final year for the 2016 Seventh Power Plan and the 2021 Power Plan production is underway. In September 2020, the Council received its annual Conservation Progress Report.¹² The NWPCC Conservation Progress Report shows that the various electric efficiency programs and practices across the region save energy, reduce greenhouse gases, and reduce the need for new electricity generation.¹³

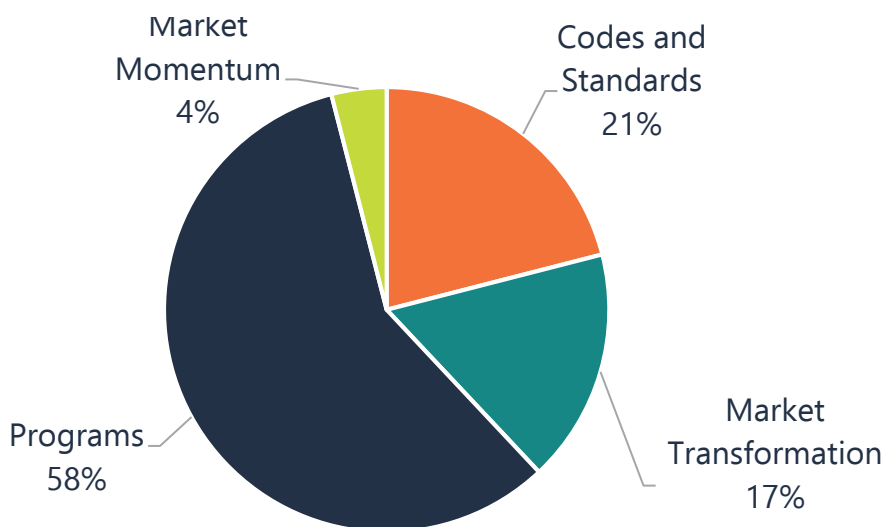
NWPCC estimates that Oregon's share of the Seventh Power Plan target is about thirty percent of the total. Looking at savings from Oregon programs in relation to the estimated share of the target, Oregon is on a downward trend since 2017.

Market Transformation, Building Energy Codes, Appliance Standards, and Market Momentum

From 2000 to 2019, 21 percent of regional cumulative savings come from codes and standards. Seventeen percent came from activities like Northwest Energy Efficiency Alliance efforts that work to bring new technologies to market, known as market transformation.¹⁴ Four percent of regional cumulative savings came from market momentum, which is a Bonneville Power Administration calculation of all the energy efficiency occurring that is not directly reported by utilities, energy efficiency programs, and NEEA market effects.¹⁵

The Northwest Energy Efficiency Alliance (NEEA) develops market transformation efficiency, funded by Energy Trust and regional utilities. Market transformation is accomplished when emerging technologies experience increased sales volumes that

Figure 1: 2000-2019 Regional Savings Share by Activity



ⁱⁱⁱ Oregon Department of Energy 2019 <https://www.oregon.gov/energy/Data-and-Reports/Documents/2020-Public-Purpose-Charge-Legislative-Report.pdf>

allow installers and manufacturers to achieve economies of scale.¹⁶ The result is lower prices for consumers, which in turn supports more volume. Ideally this cycle continues until the technology becomes more affordable and widely adopted. NEEA's work creates future savings as new efficiency equipment is brought to market.¹⁷ Over time, these new technologies can be incorporated in regulatory programs such as codes and standards. For example, NEEA provided research for clothes washer efficiency that helped create a federal standard.¹⁸

Energy codes to increase efficiency of new buildings are adopted statewide in Oregon as part of the building code adoption process.¹⁹ Energy codes are a subset of building codes, which establish baseline requirements and govern building construction. Energy codes and standards set minimum efficiency requirements for new and renovated buildings, assuring reductions in energy use and emissions over the life of the building.²⁰ Oregon's Energy Building Code is among the strongest in the nation for both residential and commercial buildings.²¹ Executive Order 20-04, issued by Governor Kate Brown in March 2020, charts a course for the next three code update cycles, and by 2030 new buildings in Oregon are expected to use 60 percent less energy than they did in 2006.²²

Appliance and equipment efficiency standards improve energy efficiency and reduce energy costs. Federal efficiency standards completed through 2016 are expected to create utility bill savings for consumers estimated at more than \$1 trillion by 2020 and more than \$2 trillion by 2030.²³ For appliance and equipment efficiency standards that are not covered in Federal rules, Oregon has adopted appliance standards for products to provide additional energy and cost savings for consumers. The Oregon Department of Energy is updating efficiency standards for 11 new products, with legislative action underway to conform the new rules to Oregon's energy efficiency statutes.

There are several additional policies, programs, and strategies not covered in this section that are helping the state acquire energy efficiency, such as government leading by example and energy savings performance contracting (see Chapter 6 of the 2018 *Biennial Energy Report*). Looking forward, energy efficiency remains a cornerstone of Oregon energy policy and planning. The 2021 Northwest Power Plan is underway, and it will develop new goals for potential energy savings.

Energy efficiency programs are pathways to more than savings and avoided new generation and resources. An increased emphasis on diversity, equity, and inclusion is shaping programs to deliver to underserved communities. In addition, climate action planners look to efficiency as a key cost-effective method to reduce greenhouse gases. For more about energy efficiency policies see the Energy Efficiency Policy Brief.

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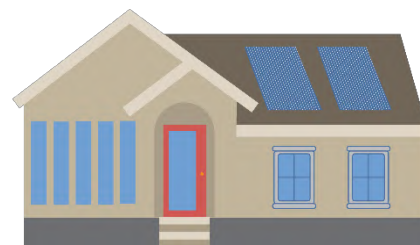
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Energy 101: Codes and Standards

Codes and standards deliver energy efficiency at low cost. In 2019, 30 percent of the cumulative energy savings in the Pacific Northwest came from codes and standards.¹ Additionally, from 2000-2018, 11% of regional savings came from market transformation efforts by the Northwest Energy Efficiency Alliance (NEEA) – work that directly leads to updates of codes and standards.



Standards

Energy efficiency standards, also referred to as appliance standards, establish a minimum energy efficiency level that certain products must meet in order to be sold or installed. Manufacturers must design and test their products to ensure that performance levels are met, and typically must also label their products to indicate the appropriate information to the consumer. These standards protect consumers by saving energy and phasing out inefficient products that are costly to operate. Both the federal government and individual states have roles in establishing efficiency standards.

Energy efficiency standards are an important energy-saving tool as new buildings progressively become more efficient and as an increasing share of energy consumption comes from the products and appliances that are “plugged in” or movable, often called the “plug load.” Residential and commercial building energy codes have traditionally regulated space conditioning, water heating, and the building envelope, but not appliances that are part of a building’s plug load. The plug loads can represent as much as 30 percent of commercial building use.² For residential buildings, the appliances, electronics, and other known plug loads represent 20 percent or more of total electricity consumption in non-gas homes and 33 percent of electricity consumption in gas-heated homes.³ Plug loads represent a significant portion of consumer energy consumption, and appliance standards support energy efficiency and greenhouse gas reductions to address this end-use.

Federal Standards Activity and Impact on Oregon

The federal government has set standards for appliances since the 1970s. Beginning with the Energy Policy and Conservation Act in 1975, the United States Department of Energy (USDOE) has developed test procedures, standards, and labeling requirements for consumer products. The National Appliance Energy Conservation Act of 1987 established standards for many common appliances and directed the USDOE to review and update these standards. The Energy Policy Act of 2005 established new standards for 16 products at the national level and directed the USDOE to set standards for an additional five. In 2007, the Energy Independence and Security Act provided new or updated standards for 13 products.⁴

Overall, the federal government has set standards for more than 60 products across various categories of residential, commercial, and industrial appliances, lighting, and plumbing products. Federal standards were estimated to save consumers \$80 billion nationally in 2015, with \$850 million savings for Oregonians in that same year.⁵ Many of the products we use every day, such as refrigerators, dishwashers, and furnaces, have an energy efficiency standard. Overall, products covered by standards represent about 90 percent of home energy use, 60 percent of commercial building use, and 30 percent of industrial energy use.⁶

Federal appliance standards generally preempt state standards. Once the federal government creates a standard and it becomes effective, the federal standard applies to all states, and states may not establish a standard for that product that is different than the federal standard. For products that do not have national standards, states may create and enforce standards. If the federal government enacts standards for products that already have state-specific standards, states may only enforce their standards until the federal standards become effective. As noted in the previous section, many of Oregon's previously adopted standards have since been preempted by federal standards.

The **Appliance Standards Awareness Project** maintains a comprehensive summary of all federal standards, initial legislation, publication dates, effective dates, and future schedules.

appliance-standards.org/

At the federal level, standards have not advanced significantly since the last Biennial Energy Report. The USDOE has approved only five standards since 2016, and these were carried over from the previous executive administration. In 2019, the USDOE reversed a previously expanded definition of general service light bulbs, which allowed more lamps to continue their exclusion from efficiency standards.

The USDOE must review each national appliance standard every six years and publish either a proposed rule to update the standard or a determination that no change is warranted. As of August 2020, the USDOE has missed legal deadlines for twenty-eight product standards. Based on the current rate of progress, they will likely miss several more appliance standards deadlines by January 2021.⁷

Efficiency Standards Activity in Oregon

While some appliance standards are set at the federal level, there are also products that do not yet have a national standard and for which a new state standard could achieve meaningful energy and water savings and greenhouse gas reductions. Oregon has periodically enacted efficiency standards as a method of saving consumers money and saving energy.

Oregon first put standards in place in 2005, joining a list of just a few states to do so.⁸ Starting with 11 product categories, Oregon added six more product categories in 2007 and in 2013 added three more. Thirteen of the products for which Oregon has established standards have since been preempted by standards adopted by the federal government.

State regulatory provisions relating to equipment energy efficiency, both substantive and procedural, are contained in both statute (ORS 469.229 through 469.261) and administrative rule (OAR 330-092). The definitions specifying which products are covered by state minimum energy efficiency standards, as well as the standards themselves, are currently contained in statute. Statute also includes authority for ODOE to adopt new standards and update existing standards in rule if certain criteria are met and requires legislation to be introduced at the next Legislative Assembly to bring state statute into conformance with any rule updates. Administratively, ODOE rules currently provide effective dates for standards, processes for manufacturers to register compliance and appeal findings of non-compliance, and labeling requirements for products. Recent Executive Orders 17-20 and 20-04 have directed ODOE to review and report on standards opportunities in Oregon and to adopt rules establishing standards for certain products. Please refer to the Policy Brief section of the Biennial Energy Report for additional information on recent state activity.

Energy Efficiency in Oregon Building Codes

Energy codes are part of the building code and provide requirements for new construction and renovations to improve the energy efficiency of the buildings. The energy code regulates building controls and building elements such as insulation, lighting applications, heating, ventilation, and air conditioning equipment. Architects, engineers, builders, and contractors must design and construct buildings to meet or exceed energy code requirements.

Unlike some appliance standards, energy codes are not set and enforced at the national level. Energy codes, and building codes in general, are established by states or local jurisdictions. There are, however, model energy codes that are developed nationally that states can look to for reference. These model energy codes include the International Energy Conservation Code (IECC) and ASHRAE Standard 90.1. States and jurisdictions may choose to adopt a wholesale version of the model codes, make local amendments, or develop a separate local code. Significant industry and public input for code development helps national organizations craft model codes that are adoptable and enforceable by jurisdictions. Local jurisdictions adopt codes through established state, county, city, or other jurisdictional process that are specific to that location. Enforcement, including plan review and inspection, is often performed through local building official departments.

Figure 1: Status of State Energy Code Adoption for Residential Buildings¹⁰

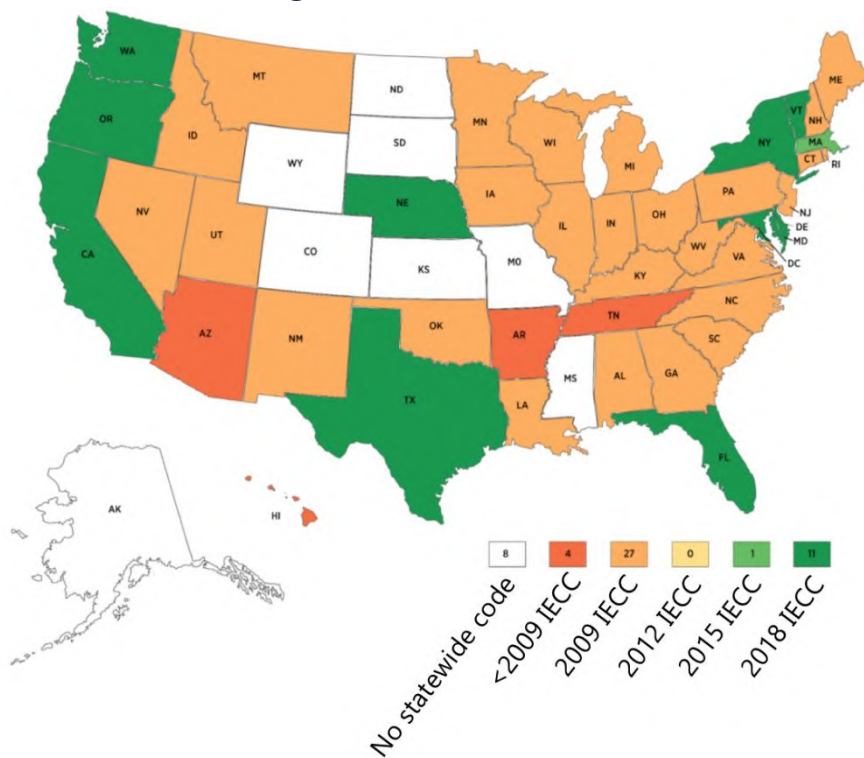
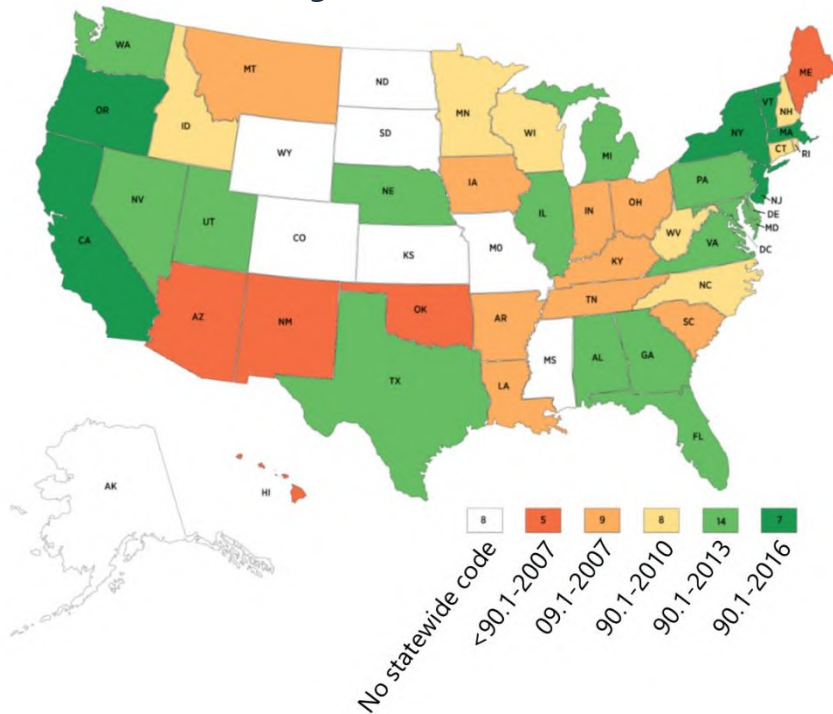


Figure 2: Status of State Energy Code Adoption for Commercial Buildings¹⁰



Oregon looks to the most efficient model codes to create an energy code that is applicable and consistent across the state. Oregon's energy code is regulated and administered by the Building Codes Division within the Department of Consumer and Business Services, which works with building officials, technical committees, advisory boards, and the public to adopt, amend, and interpret the Chapter 13 energy efficiency provisions of the Oregon Structural Specialty Code (OSSC) and the Chapter 11 energy efficiency provisions of the Oregon Residential Specialty Code (ORSC).⁹

Oregon's statewide energy code dates back to 1974, when the Oregon Uniform Building Code first included thermal insulation requirements for buildings. Since then, Oregon has maintained and continued its status as a leader in energy efficiency codes. The USDOE produces a comparison chart for energy codes across the US.¹⁰ Oregon is among the top dozen states for most-efficient residential and commercial codes. Note that like product standards, the west coast states have similar energy codes, making compliance more predictable for companies that build in those contiguous three states. One way that Oregon achieves savings in its current building code is by having an options menu for residential buildings that allows builders to make upgrades to heating, ventilation, and cooling equipment as a path to compliance. Upgrading the HVAC system is a popular and low-cost option for builders, and a leadership approach by Oregon when federal standards improvements are lagging industry practice.

The current commercial code is based on ASHRAE 90.1 in accordance with EO 17-20. Because ASHRAE 90.1 is updated every three years, Oregon can adopt subsequent versions each cycle. EO 17-20 requires the residential code to be equivalent to the USDOE Zero Energy Ready Home Ver.06 performance by 2023.

Reach Code 101

Oregon has a statewide code, meaning all jurisdictions have the same codes for construction, including life safety, plumbing, electrical, structural, and energy components. A jurisdiction may petition for a local amended code, but they must demonstrate that amendments will not weaken requirements or be an undue burden on industry.

Reach codes, or stretch codes, refer to codes that are purposely designed to go beyond the requirements of the base code. For energy efficiency, they require additional energy measures and provide templates for those wishing to exceed the base code requirements. Reach codes are often optional choices for builders or owners to pursue. For jurisdictions that want to offer an optional path for builders to improve efficiency in their communities, they may locally support a voluntary Reach Code that requires more efficiency. Reach codes can be designed to incorporate and test requirements that may become part of a future base code, preparing the market for components that may become mandatory in future years. Incentives can be coupled with reach code requirements to increase and reward participation.

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Net Zero Energy Buildings

While there is no universal definition and there are nuances to how net zero energy buildings are classified, a net zero building is generally understood to be a building that combines energy efficiency and renewable energy generation to consume only as much energy as can be produced through renewable resources over a specified time period. An important note is that net zero energy buildings still consume energy, and may at times draw energy from the electric grid and at other times supply energy to the grid. The concept of “net zero energy” indicates that over the course of a year, these balance out. Net zero energy buildings are also sometimes referred to as “zero net energy buildings” or simply “zero energy buildings.”



Net zero performance is accomplished through a combination of high-performance building design features, energy-efficient operation, and on-site renewable energy generation. Some of the variations to net zero energy building classifications include:

Site-based net zero energy. A building that renewably generates as much energy as it uses, when measured at the building site (typically through utility meters). Site use energy in this case includes electricity, natural gas, and other fuels. Renewable electricity production would meet all of the building’s site energy consumption by meeting the electricity needs and also offsetting any fuel use by generating equivalent additional electricity for the grid.

Source-based net zero energy. A building that renewably generates as much energy as it uses, as measured at the energy source. This definition attempts to incorporate the overall efficiencies of both energy generation and energy distribution. This approach commonly uses an average site-to-source conversion factor to do so. For example, if an electricity generation system is 33 percent efficient overall, then it takes approximately three units of energy at the generation source to deliver one unit of energy at the end-use. These average site-to-source factors can be appropriate for some sites or regions, but may not always be accurate for individual sites or regions with specific utility and generation resources.

Net zero energy with off-site generation. This definition is similar to either the site or source-based net zero energy approaches, but allows for some portion of the renewable energy to be generated off site. This can be beneficial for sites with limited capacity for renewable generation or sites where it is infeasible to install adequate renewable energy to offset building energy consumption.

Electricity-only net zero energy. This net zero energy approach accounts for only the electricity portion of a building’s overall energy consumption when calculating the amount of renewable generation necessary to provide a net amount of electricity over the course of a year to offset all the electricity use in the building.

Net zero greenhouse gas emissions. This approach considers greenhouse gas emissions, rather than energy, when calculating offsets. There is a direct relationship between energy use and greenhouse gas emissions; however, this method accounts for the different greenhouse gas emissions factors and intensities of various energy sources.

Net zero energy ready. This is a general term for a building designed to operate with sufficiently low energy consumption such that it could be offset with on-site renewable generation, but that it does not yet have any renewable energy capacity. Often the infrastructure to accommodate future installation of renewables exists, but the actual renewables, such as solar photovoltaic, have yet to be installed.

There have been national efforts to better define and standardize net zero energy buildings, including by the United States Department of Energy.¹ ASHRAE is also currently undertaking an effort to define a “Standard Method of Evaluating Zero Energy Building Performance” through its Standard Project Committee 228P development work.² California has issued broad goals for net zero energy residential new construction by 2020 and commercial new construction by 2030, along with source-energy based definitions for net zero energy buildings.³ California’s Title 24 residential building code 150.1(c)(14) requires, as of January 2020, mandatory on-site solar photovoltaic systems sized to offset the home’s electrical consumption, as determined by an equation in the code.⁴ Efficiency advancements in building materials and equipment, coupled with photovoltaic technology improvements and cost reductions,⁵ are bringing more frequent achievement of net zero energy buildings closer to reality. There are numerous examples of projects across the country that are verified or near-net zero energy, and the New Buildings Institute maintains an interactive “Getting to Zero” database which tracks verified and emerging net zero energy buildings.⁶

Net Zero Energy Building Policy

Many jurisdictions, building owners, and those in the architecture, engineering, and construction industries have embraced net zero energy buildings as a goal. However, there are many building types, particularly those with higher energy use intensities, such as restaurants, hospitals, and data centers, for which net zero energy remains mostly infeasible. In addition to technical energy efficiency limits, complications such as physical site constraints, site solar access, net-metering limitations, grid interconnection issues, fuel source limitations, affordability, and cost-effectiveness contribute to difficulty in achieving net zero energy buildings. As such, there is no “one size fits all” policy that states or municipalities can look to advance net zero energy building policy.

Building code advancements can help achieve progress toward net zero buildings, but must be accompanied by other efforts. The organization Architecture 2030 is advocating for net zero energy buildings through the 2030 Challenge⁷ that targets progressive reductions toward net zero energy for new construction in 2030. Architecture 2030 has also developed the Zero Code⁸ framework for net zero buildings along with guidance for the role of off-site renewable energy procurement for net zero energy buildings⁹, which those interested in defining broader net zero energy policy can use. The net zero energy building inventory increases annually, and the presence of more net zero energy buildings in our future will rely upon continuing coordination between the design and construction communities, building code offices, energy utilities, regulatory government agencies, building owners, and others working together toward a common goal.

Oregon will see more net zero energy buildings in its future if communities, utilities, government, and others work together toward a common goal.

Yellowhawk Tribal Health Center Sustainability Shines

The Yellowhawk Tribal Health Center, located on the Confederated Tribes of the Umatilla Indian Reservation, is at the forefront of sustainability in Oregon. The health center is enrolled in Energy Trust of Oregon's Path to Net Zero. Not only is it the first emerging net zero energy health care building in Oregon, but it is the first tribal building to make this commitment as well.

Designed to operate at an efficiency 60 percent greater than typical buildings of its type and achieve an estimated \$58,000 in annual energy cost savings, the health center has potential to reach net zero energy operation in the future with installation of additional solar panels. The infrastructure necessary for this has already been constructed on the roof of the building, so achieving net zero certification is well within reach for the health center. Energy saving features include efficient LED lighting, high-performance heating, ventilation and air-conditioning, and an improved building envelope.



States and jurisdictions, including Oregon, have included elements of net zero buildings in specific policy directives. Oregon Executive Order 17-20¹⁰ targets equivalent performance to the U.S. DOE Zero Energy Ready Home specifications in the residential building code by 2023 and includes a directive for new state agency construction to be designed to be able to operate as carbon-neutral buildings after 2022. Executive Order 20-04¹¹ continues the trend toward increased efficiency in new construction and net zero energy buildings by targeting a 60 percent reduction in new building annual site consumption of energy by 2030, excluding electricity used for transportation or appliances, from a 2006 code baseline. This advancement in efficiency makes net zero energy achievable for some residences and building types, when coupled with installation of renewables.

Executive Order 17-20 also includes a requirement for solar-ready provisions in the building code to make future installations of onsite renewables more accessible for building owners, which was incorporated into the Oregon residential building code¹² for new construction in October 2020. As of 2019, the Oregon commercial energy code requires completion of the "2019 Oregon Zero Energy Ready Commercial Code Compliance Form" that, while not specifically requiring onsite or offsite

renewables in the code, includes a requirement for an estimation of building energy consumption, renewables needed to achieve net zero energy, and the onsite renewable generation potential. This helps raise awareness of net zero energy buildings and what is needed to achieve that level of performance. Utility programs, energy policies, energy codes, voluntary performance standards, and interested building/homeowners all contribute to advancing net zero buildings.

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