

2026 BIENNIAL ENERGY REPORT

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2026 BIENNIAL ENERGY REPORT

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Cover Image: Solar at State of Oregon motor pool in Salem, OR.

Executive Summary

In 2017, the Oregon Department of Energy introduced House Bill 2343 to the Legislature. The bill charged the department with developing a new Biennial Energy Report to inform local, state, regional, and federal energy policy development and energy planning and investments. The report – based on analysis of data and information collected and compiled by the Oregon Department of Energy – provides a comprehensive review of energy resources, policies, trends, and forecasts, and what they mean for Oregon.

What You Can Expect to See in the 2026 Biennial Energy Report

The 2026 report is divided into several sections, focusing on where Oregon is today in the clean energy transition and what energy options exist to forge ahead on the path to a clean, affordable, and reliable energy future, as outlined in the **Oregon Energy Strategy**. Data and examples included in the report illustrate how the energy sector is evolving, with more renewable energy available than ever before, new clean and renewable technologies on the horizon, and more resources to help Oregonians make informed decisions about their energy choices.

The report begins by looking at **Energy by the Numbers** – detailed information on how energy flows through Oregon, from production and imports to use and exports, the state's overall and sector-based energy use, energy production and generation, energy expenditures, and the strategies Oregon has employed to meet growing energy needs.

Next up is a snapshot of the **Timeline of Energy History in Oregon**. This interactive tool enables readers to move through the years and learn more about what has shaped the state's energy history. Photos, videos, and audio clips accompany the timeline events. View the history timeline online: https://energyinfo.oregon.gov/timeline

The **Resource and Technology Reviews** section covers a spectrum of traditional and innovative energy resources and technologies, from the basics about electricity generation and clean vehicle technologies to emerging technologies like enhanced geothermal and advanced nuclear energy. The topics covered are prevalent in Oregon or of interest to ODOE's various stakeholders.

The **Energy 101** section aims to help readers understand the basics about how energy systems are planned and managed, along with innovative actions within communities and sectors. This information is meant to provide a foundation for those new to energy and those who are already steeped in the sector. Topics this year range from industrial symbiosis to the basics on electric utilities, to a deep dive into the effects of federal changes on Oregon's energy and climate programs.

The final section includes more detailed **Policy Briefs** that dive into the increase in data centers, emerging sustainable aviation fuels, and how medium- and heavy-duty electric vehicle charging can also serve the grid. The primary purpose of the report – and these policy briefs – is to inform energy policy development, energy planning and energy investments, and to identify opportunities to further Oregon's energy strategy and goals.

The focus of the 2026 report is to cover relevant aspects of energy that bolster the Oregon Energy Strategy's five pathways to a clean energy future that is affordable and reliable. Even as we work to

move to cleaner energy resources, climate change is increasingly taking a toll on our energy systems. At the same time, energy demand is growing faster than it has in several decades, led by the proliferation of data centers and industrial growth. It will require innovative technologies, economies, and investments to meet these challenges, many of which are highlighted in this or previous reports.

While the challenges are great, this report empowers Oregonians with data and information to make informed energy choices to address these challenges and take advantage of opportunities to create a safe, equitable, clean, and sustainable energy future.

The 2026 Biennial Energy Report may be found in its entirety at

https://energyinfo.oregon.gov/ber

or

https://www.oregon.gov/energy/Data-and-Reports/Pages/Biennial-Energy-Report.aspx

The Department of Energy welcomes comments, questions, and requests for presentations or webinars on report topics. Visit https://odoe.powerappsportals.us/en-US/ber-comment/.



Letter from ODOE's Director

Every two years, when the Oregon Department of Energy begins our work on the Biennial Energy Report, we reflect on what has changed in the energy sector and what we expect to see on the horizon. This exercise helps us determine the topics to cover in our report that will help Oregon leaders, Tribes, households, businesses, and communities make informed decisions about energy. One thing we know for sure: the energy sector is ever-changing, but the changes seem to be accelerating.

Oregon is seeing significant changes in energy demand, driven primarily by large energy users like data centers. In this Biennial Energy Report, we dive into how data centers affect energy and other resources, and how communities across the state are considering ways to address this growing energy user. We also outline the changes we've seen to policies and approaches at the federal level, including funding and program awards to Oregon, and acknowledge that some programs and federal funding awards remain in question.

As decision-makers consider future policies or laws, we want them to have foundational information about energy in Oregon, so we have Energy 101s on the energy facility siting process and the basics about electric utilities that serve the state. As we do each year, we begin the report with Energy by the Numbers, a section focused on the current state of energy in Oregon, from use and generation to costs and greenhouse gas emissions. This year, we see a noteworthy change in by-sector energy use. The commercial sector has now overtaken the residential sector, due primarily to the increase in data center energy use. A set of energy resource and technology reviews provide background information on resources like solar and wind, as well as technologies like electric vehicles and charging.

In our 2022 Biennial Energy Report, we left leaders with an idea:

> "The state would benefit from an energy strategy to align policy development, regulation, financial investment, and technical assistance in support of an intentional transition to a clean energy economy."

The Oregon Legislature agreed, and in 2023 directed ODOE to develop an Oregon Energy Strategy. We were proud to publish the strategy in November 2025 after engaging with other state agencies, energy experts, Tribes, community partners, and the public. Change remained the theme as the strategy was developed during a time of unclear federal policies and priorities, a limited state budget, increased incidences of extreme weather and wildfires, rapidly growing electric loads, and continuing innovations in clean energy technologies. The Oregon Energy Strategy outlines five pathways that together will advance Oregon's energy future: energy efficiency, clean electricity, electrification, low-carbon fuels, and resilience. Alongside the pathways are policies and actions that can provide long-term guidance and near-term solutions to advance energy and climate objectives while addressing reliability and affordability.

In this Biennial Energy Report, we follow through on some Oregon Energy Strategy actions, such as developing reviews on emerging clean energy technologies (enhanced geothermal, advanced nuclear, offshore wind, and others). We share information on sustainable aviation fuels, which could support the low-carbon fuels pathway and hard-to-electrify sectors, and dive into how electric trucks and

buses can support both the electrification and clean electricity pathways. An Energy 101 leans into the Oregon Energy Strategy's Environmental Justice Framework and focuses on community benefits agreements, which can be developed to address outreach and engagement, support workforce needs, prioritize environmental justice communities, and focus on equitable practices during energy policy and development decisions.

In service of our mission, ODOE provides a venue for problem-solving Oregon's energy challenges – like developing the Oregon Energy Strategy – and we act as a central repository for energy data, information, and analysis. We're proud to serve in this role, and to produce the Biennial Energy Report to help keep Oregon on the leading edge of energy policies, technologies, and trends.

I hope you use the information in this report to engage in discussions and consider options for addressing the energy challenges we face today. ODOE staff are available to have a conversation, explore solutions, or attend a workshop or present on an energy topic for your organization or community.

Even though we know things will always continue to change, we want to work together to follow a course to a safe, equitable, clean, and sustainable energy future.



Director Janine Benner
Oregon Department of Energy



Tribal Land Acknowledgement

Indigenous Tribes and Bands have been with the lands that we inhabit today throughout Oregon and the Northwest since time immemorial and continue to be a vibrant part of Oregon today. We would like to express our respect to the First Peoples of this land, the nine federally recognized Tribes of Oregon: Burns Paiute Tribe, Confederated Tribes of Coos, Lower Umpqua & Siuslaw Indians, Confederated Tribes of Grand Ronde, Confederated Tribes of Siletz Indians, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes of the Warm Springs Reservation, Coquille Indian Tribe, Cow Creek Band of the Umpqua Tribe of Indians, and The Klamath Tribes.

It is important that we recognize and honor the ongoing legal and spiritual relationship between the land, plants, animals, and people indigenous to this place we now call Oregon. The interconnectedness of the people, the land, and the natural environment cannot be overstated; the health of one is necessary for the health of all. We recognize the pre-existing and continued sovereignty of the nine federally recognized Tribes who have ties to this place and thank them for continuing to share their traditional ecological knowledge and perspective on how we might care for one another and the land, so it can take care of us.

We commit to engaging in a respectful and successful partnership as stewards of these lands. As we are obliged by state law and policy, we will uphold government-to-government relations to advance strong governance outcomes supportive of Tribal self-determination and sovereignty.

About the Oregon Department of Energy

Our Mission

The Oregon Department of Energy helps Oregonians make informed decisions and maintain a resilient and affordable energy system. We advance solutions to shape an equitable clean energy transition, protect the environment and public health, and responsibly balance energy needs and impacts for current and future generations.

Our Values

Accountability | Equity | Fiscal Responsibility | Inclusion | Innovation | Integrity | Professional Excellence

Our Position

On behalf of Oregonians across the state, we achieve our mission by providing:

- A Central Repository of Energy Data, Information, and Analysis
- A Venue for Problem-Solving Oregon's Energy Challenges
- Energy Education and Technical Assistance
- Regulation and Oversight
- Energy Programs and Activities

www.oregon.gov/energy | AskEnergy@energy.oregon.gov | 800-221-8035

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Energy by the Numbers

Energy by the Numbers focuses on the metrics and data available to track how Oregon produces, purchases, and uses various types of energy.

This section includes energy use data on electricity, transportation energy, and direct use fuels by resource and by sector. Where possible, data showing how Oregon's energy system has changed over time have been included to provide context and history. We also discuss energy production — where and what kind of energy Oregon produces, where and how we generate electricity, and what direct use and transportation fuels are produced in state.

Readers will find data on what Oregon spends on energy, how some Oregonians experience energy burden, and what the energy industry gives back to Oregon in terms of jobs. The section also demonstrates how energy efficiency continues to serve as an important resource for Oregon. It concludes with highlights on the four end use sectors: residential, commercial, industrial, and transportation, including energy use, expenditures, and greenhouse gas emissions – and how each sector uses energy to provide goods and services.

Key Energy Indicators

The Oregon Department of Energy's Strategic Plan includes an initiative to develop Key Energy Indicators that will help the state monitor and assess Oregon's energy landscape, progress on energy-related goals, and general status of Oregon's energy systems. KEIs can indicate progress toward energy-related statutory and administrative targets and goals as well as non-energy goals, such as job creation and economic development. Look for this special symbol in this section to see some of the data points we expect to include as key indicators for energy in Oregon.

Over the next two years, ODOE will be assessing current KEIs against the findings of new policy guidance in Oregon, such as the Oregon Energy Strategy, to identify what additional KEIs could help provide insight into Oregon's energy and climate objectives. We will share the new KEIs and how they inform our progress as a state in the 2028 report.



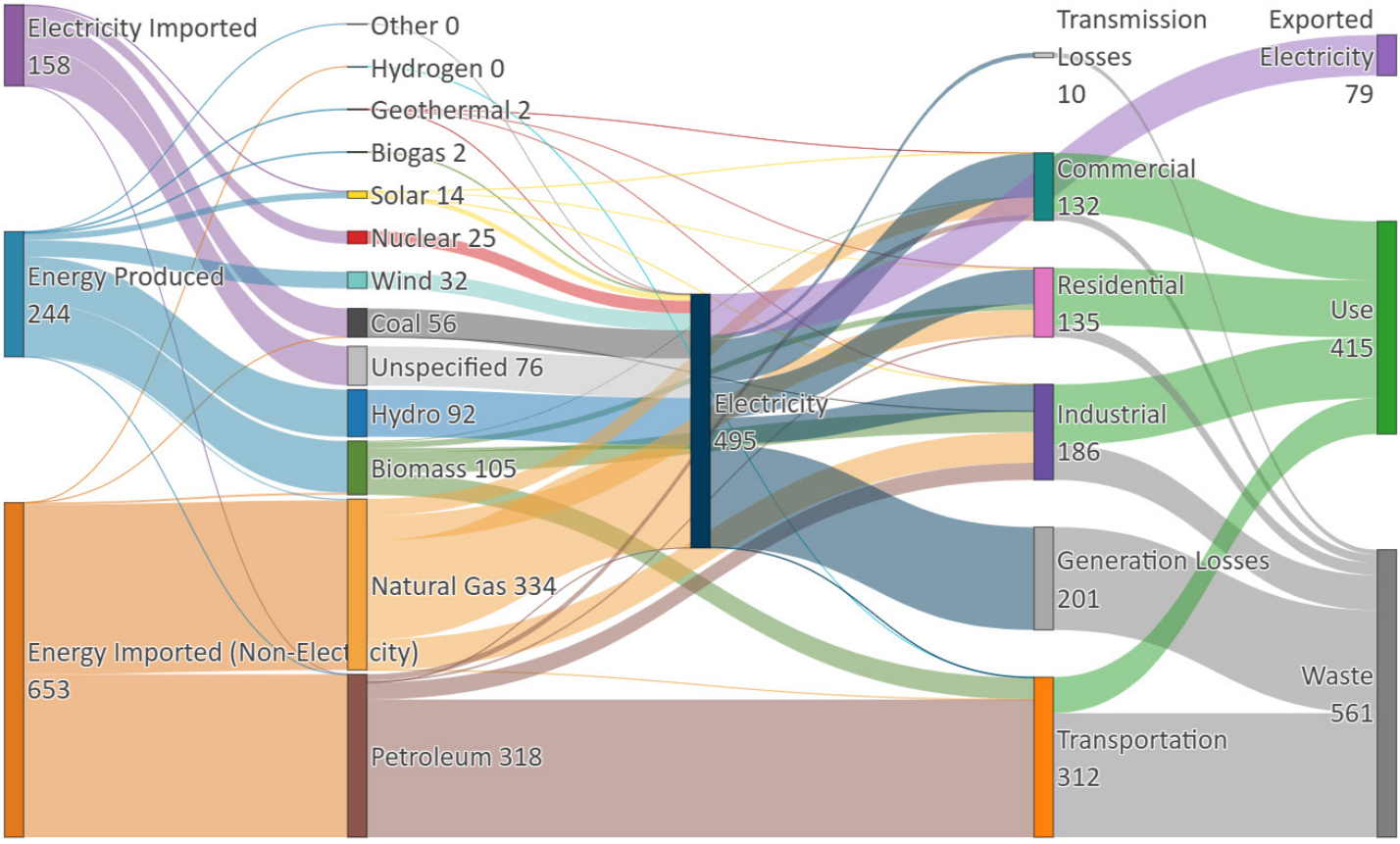
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Understanding Oregon's Energy Story[1] [2]

Oregon's energy story has evolved over time to include new technologies, to address changes in the availability of different generation resources, and to meet state energy goals. The Pacific Northwest has a long history of using hydropower resources, but 20 years ago, solar- and wind-generated energy was scarce.

Today, Oregon's energy resources are more diverse. In the chart below, start at the left to see imported energy and energy produced in Oregon. **The numbers represent trillions of Btu of energy.** The energy lines flow through to show the different types of resources we use – including the energy produced in Oregon and what is imported as direct fuels or electricity – and how that energy is ultimately used in Oregon's energy story. The energy we produce and import helps meet various needs, from vehicles and industry to heating, cooling, lighting, and supporting electronics in homes and businesses. Some energy ultimately goes unused due to system inefficiencies, and some is exported to other states.



Numbers represent trillions of Btu of energy

Btu: A **British Thermal Unit** is a measurement of the heat content of fuels or energy sources. Btu offers a common unit of measurement that can be used to count and compare different energy sources or fuels. Fuels are converted from physical units of measurement, such as weight or volume, into a single metric of Btu to more easily compare data and show changes over time.



The chart provides a macro level look at the energy Oregonians produce, import, consume, and export. **Energy Produced** includes forms of energy that Oregon produces in-state, such as hydroelectric, wind, and biomass energy. **Electricity Imports** include electricity that is generated in other states and brought in for use in Oregon. **Energy (non-electricity) Imports** includes other forms of energy brought into the state for various uses, such as gas to power transportation and fuels to heat Oregon homes.

The flow to **Waste Energy** includes all the energy that is not harnessed, from the point of extraction to the point of use. This amounts to 57 percent of the energy produced (561 trillion Btu).[i] Waste energy is lost as heat during combustion, electricity generation, transmission losses, and while being used for industrial processes and at homes and businesses, along with other factors.[ii]

Between 2022 and 2024, the residential and commercial sectors experienced shifts in energy consumption. **Residential** sector energy consumption decreased from 145 to 135 trillion Btu (a decrease of about 7 percent), while **commercial** sector energy consumption increased at the highest rate from 106 to 132 trillion Btu (a nearly 25 percent increase), likely an expression of data center growth in the state. Meanwhile, **industrial** sector energy consumption decreased from 201 to 186 trillion Btu, a decrease of about 7 percent. **Transportation** energy consumption decreased from 317 trillion Btu in 2022 to 314 trillion Btu in 2024, a 1 percent decrease.[1] [3]

Changes in previously published Biennial Energy Report data:

This report relies on data from the U.S. Energy Information Administration. Periodically, the EIA revises energy use and production estimates, which can result in discrepancies when compared to previously published data. The EIA updated their methodology for calculating waste energy for renewable electricity generation resources, like solar and wind. They also regularly update estimated values for energy consumption as new information is available. These changes in methodology are typical for the complexity of data collection and analysis that occur when developing the EIA data. While these updates might only affect one or two values, the changes have a cascading effect on all calculations, meaning that some values reported in the 2024 report differ slightly from referenced data in this report. For example, in the previous paragraph, the 2022 values referenced for the residential, commercial, industrial, and transportation sectors differ by about 2-3 trillion Btu compared to data in the previous report. Changes do not fundamentally affect the efficacy of the information presented in this report. More information on how the data is analyzed for this report is available in the About the Data section.

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i Calculation does not include energy that is exported from Oregon.

ii Electrical system losses for various generation sources are estimated using methods that match with those used by the United States Energy Information Administration.[1]

Energy Sources Used in Oregon



Solar.
Photovoltaic technology converts energy radiating from the sun into electricity. Solar systems are located on homes, businesses, and large utility-scale arrays. From 2014 to 2024, solar generation in Oregon increased from 118,075 megawatt-hours to 2.16 million MWh (an 18-fold increase).[4,5]



Nuclear.
Generation of electricity from a nuclear reactor where thermal energy is released from the fission of nuclear fuel. Oregon's nuclear power comes from the Columbia Generating Station in Washington State, and the electricity is marketed by the Bonneville Power Administration.



Hydropower.
Electricity generation from the flow of water through dams or pipes. Oregon has 91 hydropower facilities of varying sizes, including four federal facilities on the Columbia River that span the Oregon and Washington border, and two facilities that span the Oregon and Idaho border.[4]



Wind.
Generation of electricity by the force of wind turning turbines. As of 2024, Oregon has 48 operating facilities in the state with a total capacity of 3,863 MW, with one 200 MW facility under construction.[4]



Geothermal.
Energy extracted from hot water or steam from natural underground sources can be used for water/space heating or the generation of electricity. Oregon has two geothermal electricity generation facilities with a capacity of 35.03 MW.[4]



Natural gas.
Fossil fuel extracted from beneath the earth's surface. Oregon has a single natural gas field located in Mist. Oregon imports most of the natural gas it consumes for electricity and as a direct fuel. There are 13 utility scale natural gas electricity generation facilities in Oregon with a combined capacity of 4,353 MW.[4] Natural gas is also used directly for residential, commercial, industrial, and transportation uses.



Coal.
Combustible rock burned to support industrial processes and create electricity. Oregon's last coal-fired power plant, the 575-MW Boardman facility, closed in October 2020 and was demolished in September 2022.[6,7] The state imports coal-generated electricity from neighboring states.



Biomass.
Includes renewable biogas and biofuels derived from the energy of plants and animals. Wood and wood waste is Oregon's greatest source of biomass, which is used for space heating, cooking, electricity generation, and transportation. Oregon has 14 utility-scale biomass and 47 biogas operating facilities converting waste products to electricity.[4] Oregon produces some renewable natural gas, a biogas that has been purified to be a substitute for fossil natural gas, often to meet specifications required for injection into a natural gas distribution pipeline. Oregon also produces plant-derived ethanol fuel and biodiesel from used cooking oil to be used as transportation fuels.



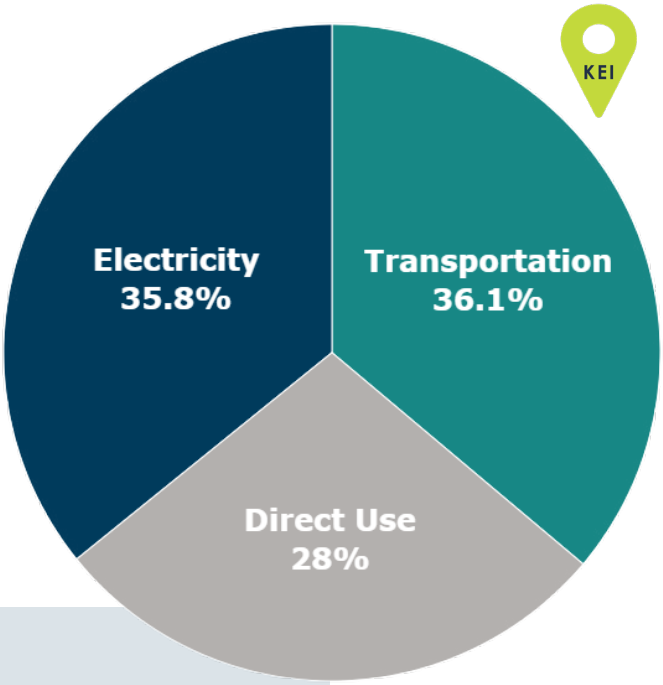
Petroleum.
Fossil fuel extracted from beneath the earth's crust. It includes gasoline, diesel, heating oil, lubricants, and other fuels used for space heating, industrial equipment, and transportation. Oregon imports the petroleum that it uses.

Energy Use in Oregon

Consumption by Source[1]

Oregon relies on energy from a variety of resources. We import energy such as gasoline, natural gas, propane, and other fuels. We use electricity from in- and out-of-state sources — including hydropower, natural gas, coal, nuclear, wind, and other renewable resources.[2] The energy use totals (in trillion Btu) in the pie chart to the right are source energy totals reflecting the primary energy required to meet demand in Oregon.

For this introduction to Oregon's energy use, the report separates energy into three main types:



35.8%

of Oregon's 2024 energy consumption[2]

Electricity: This is where most people begin when thinking about energy—the critical resource that powers our day-to-day lives. The electricity Oregonians use comes from facilities across the western United States including Oregon. This percentage also accounts for the energy in fuels that come from out of state, such as natural gas, but generate electricity in-state, as well as the energy losses associated with electricity generation.

28.0%

of Oregon's 2024 energy consumption[3]

Direct Use Fuels: This category includes fuel oil and natural gas used to heat homes and commercial spaces, fuels used for other residential purposes, such as gas stoves, solar thermal heating, and fuels used directly in industrial processes.

36.1%

of Oregon's 2024 energy consumption[4]

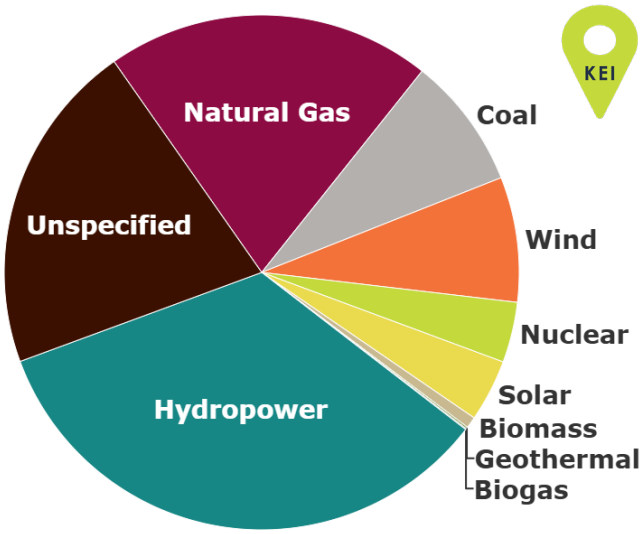
Transportation Fuels:

This includes personal, passenger, and commercial vehicles (on and off the roads), plus airplanes, boats, barges, ships, and trains. Nearly all transportation-related sources of energy are imported from out of state for in-state use.

Electricity

35.8% of Oregon's 2024 energy consumption[5]

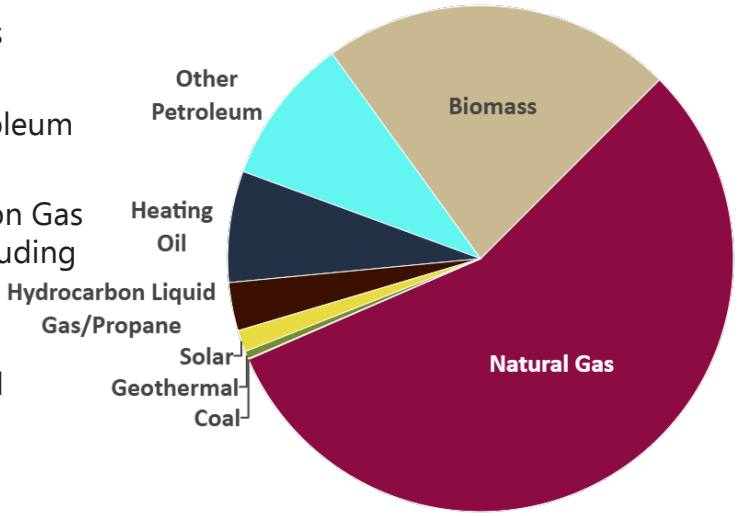
33.9%	Hydropower
20.9%	Unspecified
20.5%	Natural Gas
8.3%	Coal
7.9%	Wind
3.9%	Solar
3.8%	Nuclear
0.7%	Biomass
0.1%	Geothermal
0.06%	Biogas



Direct Use Fuels

28.0% of Oregon's 2024 energy consumption[3]

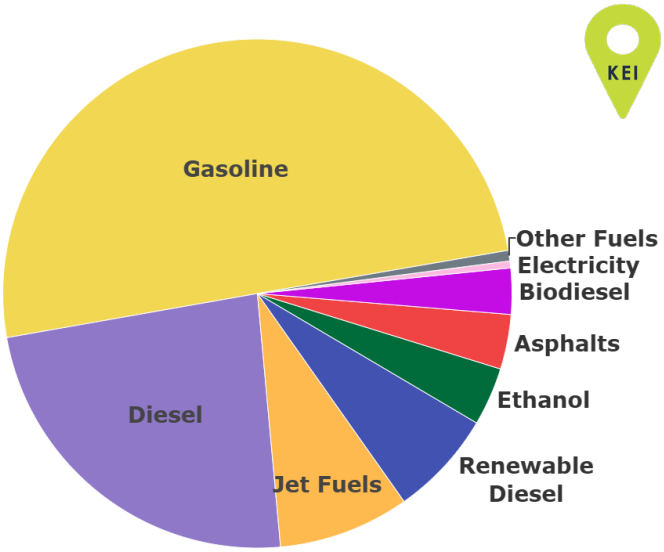
56.0%	Natural Gas
22.5%	Biomass
9.4%	Other Petroleum
7.1%	Heating Oil
3.1%	Hydrocarbon Gas Liquids Including Propane
1.4%	Solar
0.5%	Geothermal
0.04%	Coal



Transportation Fuels[6]

36.1% of Oregon's 2024 energy consumption[4]

50.1%	Gasoline
23.7%	Diesel
8.4%	Jet Fuel
6.7%	Renewable Diesel
3.7%	Ethanol
3.5%	Asphalt/Road Oil
2.9%	Biodiesel
0.4%	Electricity
0.7%	Other Fuels



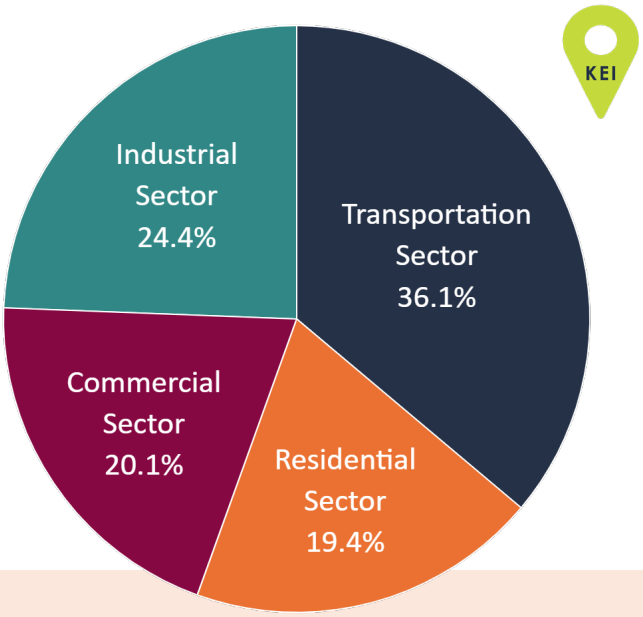
Note to readers: Fuel percentages are rounded to the nearest tenth and not all are listed.

Energy Use in Oregon

Consumption by Sector[3] [4]

Energy consumption is also tracked by how it is used among four main end-use sectors: Residential, Commercial, Transportation, and Industrial.

In Oregon in 2024, those four sectors combined consumed 893.6 trillion Btu of energy,[3,4] including each sector's respective share of electrical system losses, as discussed earlier in Understanding Oregon's Energy Story.



19.4%
of Oregon's 2024 energy consumption[3]

Residential:

This category includes single family, multi-family, and manufactured homes for Oregonians. Energy is used for lighting, heating and cooling living spaces, cooking, and operating appliances. Electricity is the most used energy resource in homes – with heat pumps, electric furnaces, and electric resistance heaters as examples of primary electric heat options.

20.1%
of Oregon's 2024 energy consumption[3]

Commercial:

This category includes businesses that provide goods and services, government and office buildings, grocery stores, shopping malls, and data centers. Energy is used to heat and cool spaces, power equipment, and illuminate facilities. It used to be Oregon's smallest energy-consuming sector but has grown by about a third, primarily due to the expansion of data centers in Oregon.

24.4%
of Oregon's 2024 energy consumption[3]

Industrial:

This category includes facilities used to produce, process, and manufacture products – including agriculture, fishing, forestry, manufacturing equipment (including chip manufacturing), mining, and energy production. Energy powers industrial equipment and machinery to manufacture products. This sector has seen contractions in aluminum, forestry, and manufacturing, and expansions in technology manufacturing. The change in use happened along with improvements in efficiency of industrial facilities and equipment.

36.1%
of Oregon's 2024 energy consumption[4]

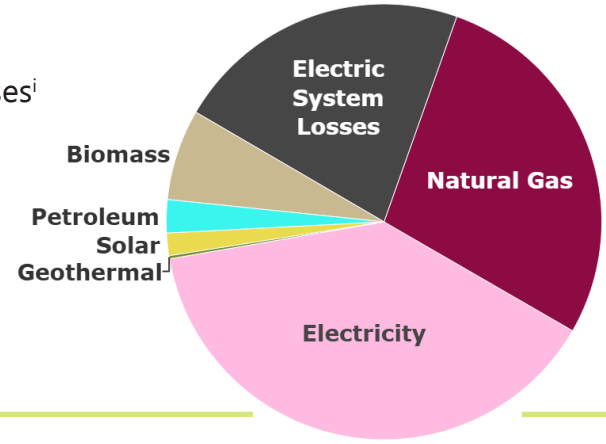
Transportation:

Personal cars, fleets, shipments, airline travel, and more make up Oregon's transportation energy use. Petroleum is the most used resource and the largest contributor of greenhouse gas emissions in Oregon. Alternative fuels like electricity and biofuels are a growing part of this sector.

Residential[7]

19.4% of Oregon's 2024 energy consumption

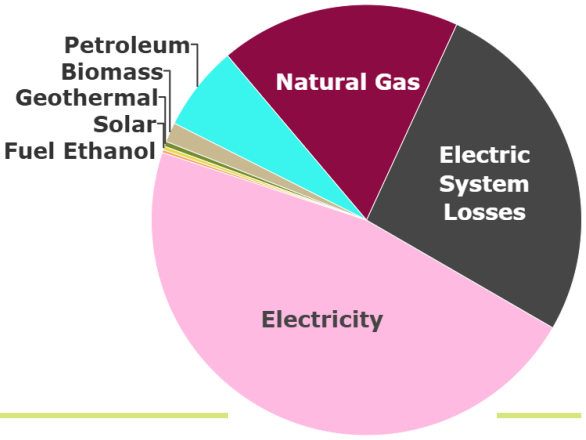
22.0%	Electrical System Losses[i]
38.9%	Electricity
27.9%	Natural Gas
6.8%	Biomass
2.5%	Petroleum
1.7%	Solar
0.2%	Geothermal



Commercial

20.1% of Oregon's 2024 energy consumption

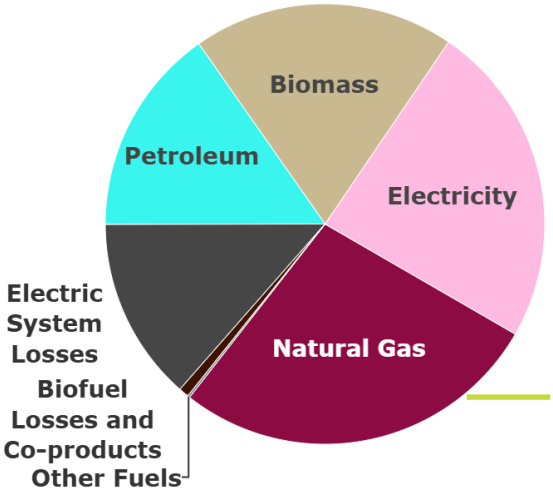
46.7%	Electricity
26.4%	Electrical System Losses
18.1%	Natural Gas
6.4%	Petroleum
1.5%	Biomass
0.4%	Geothermal
0.3%	Solar
0.2%	Fuel Ethanol



Industrial

24.4% of Oregon's 2024 energy consumption

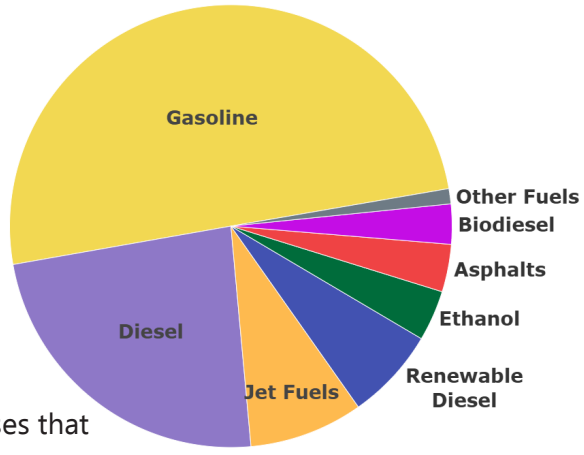
27.2%	Natural Gas
23.8%	Electricity
19.2%	Biomass
15.3%	Petroleum
13.5%	Electrical System Losses
0.1%	Geothermal
0.05%	Coal
0.04%	Solar



Transportation Fuels

36.1% of Oregon's 2024 energy consumption[4]

50.1%	Gasoline
23.7%	Diesel
8.4%	Jet Fuel
3.7%	Ethanol
3.5%	Asphalt/Road Oil
2.9%	Biodiesel
0.5%	Lubricants
0.4%	Electricity
0.2%	Bio-CNG
0.1%	Aviation Gas



i Electricity generation and transmission result in energy losses that are estimated and included in EIA consumption data.

Energy Use in Oregon

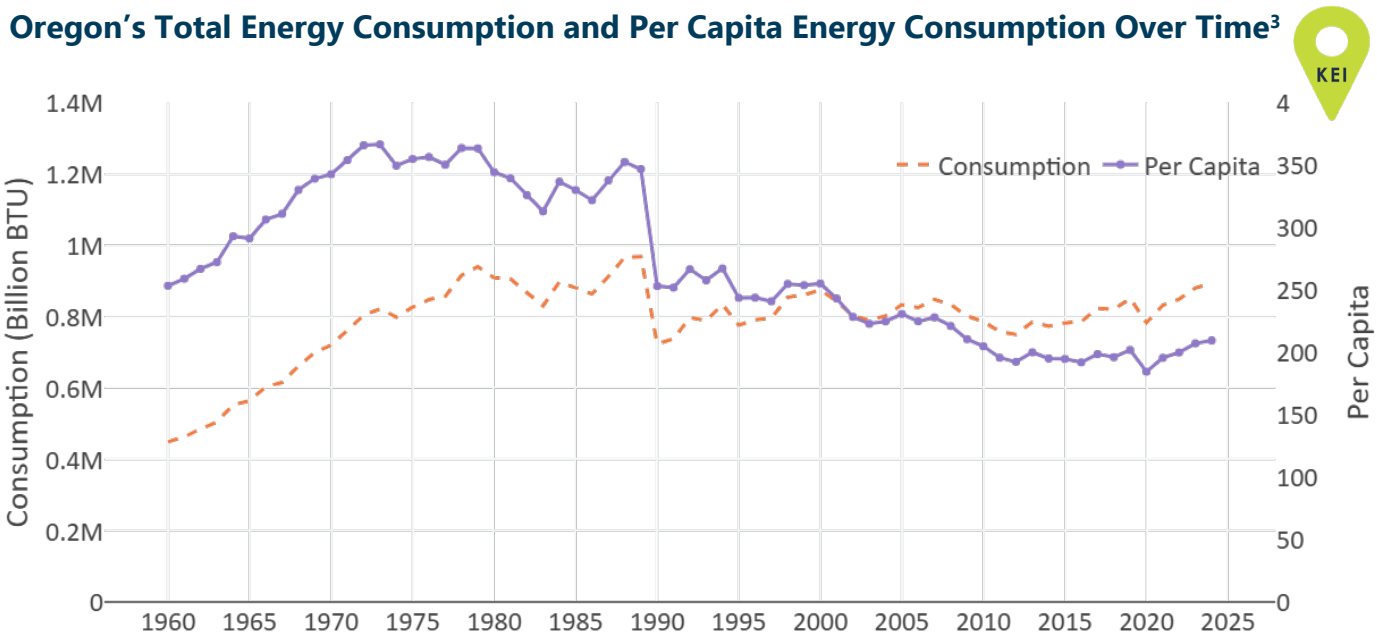
Oregon's Energy Consumption Over Time

13th

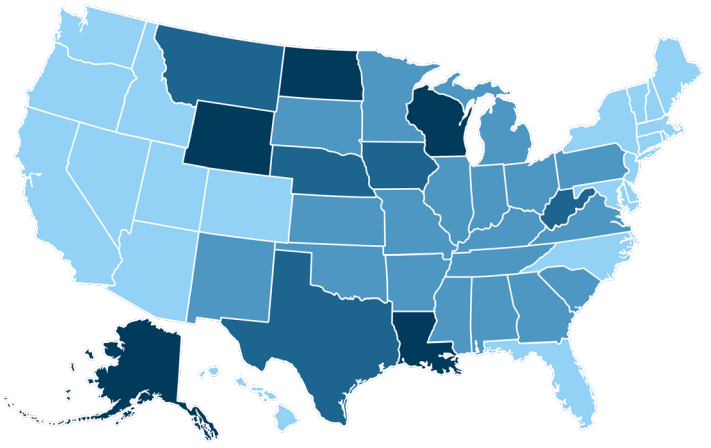
Oregon's rank for lowest per capita energy use among states in 2024[3]

Oregon saw an overall trend of increased energy use for almost four decades — an average of 3.6 percent growth per year from 1960 to 1999.[3] During that time, the state shifted from a reliance on fuel oil and wood to an increased use of natural gas and electricity in homes and businesses. Oregon reached its highest energy consumption for both stationary and transportation uses in 1999. Since then, total energy use decreased (see line graph below) until about 2013, when consumption began trending generally upward with a brief downward spike from 2020-2021 during the COVID-19 pandemic. Although energy consumption per capita does not directly correlate with overall energy use, it provides insight into energy efficiency trends. Even as Oregon's population and economy grow, the amount of energy consumption per capita has remained relatively flat because of energy efficiency savings.[3]

Oregon's Total Energy Consumption and Per Capita Energy Consumption Over Time[3]



U.S. Per Capita Consumption (2024)[3]



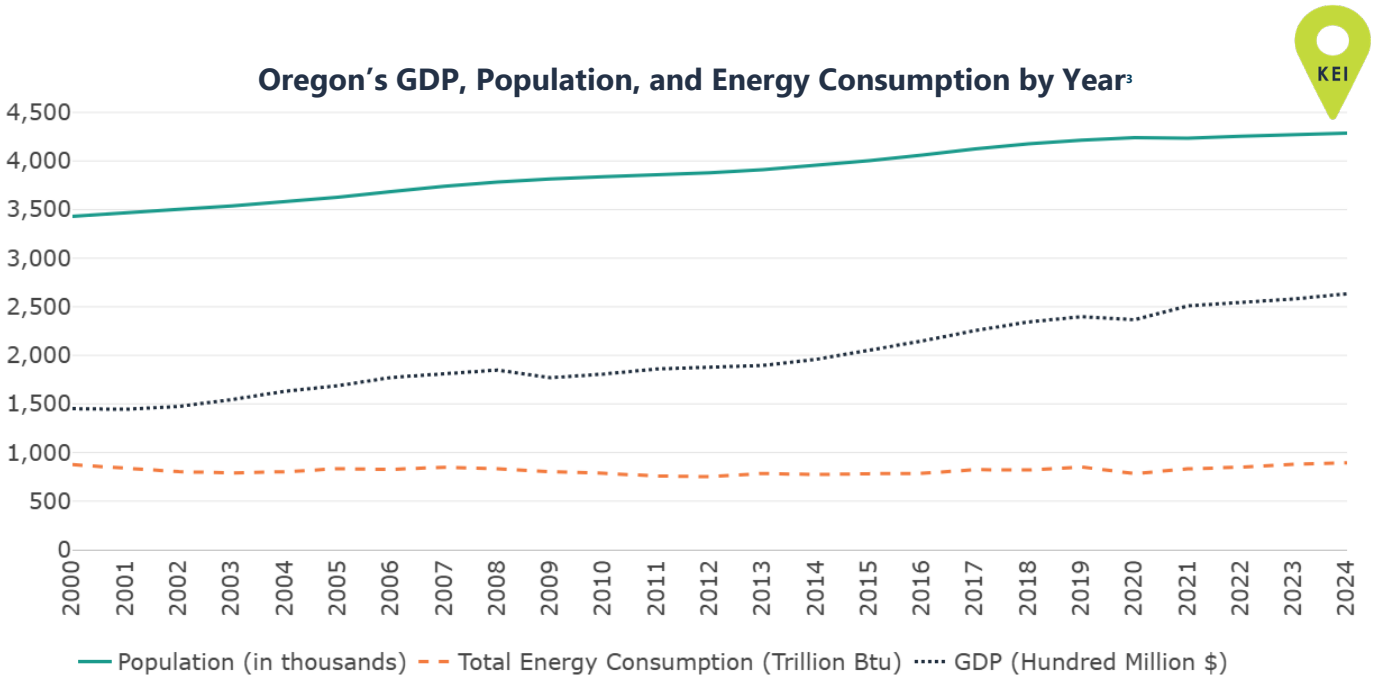
- ≤ 250 Million Btu
- 250 to <400 Million Btu
- 400 to <600 Million Btu
- ≥ 600 Million Btu

Energy Efficiency

While energy efficiency is not "consumed" like other resources, it can be considered the second largest resource available in Oregon after hydropower. Efforts to increase energy efficiency effectively reduce overall energy consumption, eliminate waste, and reduce the need to build more energy generation facilities or import fuels, providing the same energy services for less energy use and expense. Historically, Oregon has consistently met increased demand for electricity by implementing energy efficiency strategies. The Oregon Energy Strategy identifies energy efficiency as a critical pathway for meeting the state's energy and climate objectives.

Energy Consumption and Economic and Population Growth

Energy efficiency and changes in our economy have led to decreases in Oregon's total and per capita energy use over time. Oregon's emphasis on energy efficiency has helped reduce both total and per capita energy use despite an increasing population and a growing economy, thereby avoiding the need to build new electricity generation plants to match the growth – though the region has seen some generating facilities closed and new ones come on board during this time. The graph below shows that since about 2000, economic growth (measured by gross domestic product or GDP) does not directly correlate with increases in energy consumption. In fact, as the economy and our population have grown, our energy consumption has stayed relatively flat with a slight decline until the most recent years. Recently, there has been an increase in energy consumption, which in 2023 exceeded Oregon's 2000 energy consumption level, mainly due to increases in electricity generation to meet growing demand.[3]



This displays all three data sets on the same axis; refer to the legend each to find the scale and units for each. This chart shows overall trends of population, energy consumption, and GDP in comparison to each other. The chart is not adjusted for inflation.

Consumption & Use

In the energy sector, *consumption* typically describes the amount of energy used. *Use* sometimes has the same meaning, but is often specifically applied when talking about the purpose of energy. For example, a home's annual electricity *consumption* goes toward a variety of *uses* like lighting, heating, and appliances. Or a furnace is *used* for heating but *consumes* electricity and natural gas. For this report, consumption and use are included in a wide variety of ways and sometimes interchangeably.

Electricity Use

Resources Used for Oregon's Electricity Mix

In 2024, Oregon used 62.4 million megawatt hours of electricity from in-state and out-of-state sources. Hydropower, natural gas, and a mix of resources purchased on wholesale electricity markets referred to as unspecified power make up the bulk of Oregon's electricity resources. The combination of resources supplying electricity to Oregon is commonly called the electricity resource mix. The share of each resource in the mix is constantly changing and evolving.

Renewable energy makes up an increasingly larger share of Oregon's mix each year. In 2021, the Oregon Legislature passed House Bill 2021, requiring Oregon's largest electric utilities, Portland General Electric and Pacific Power, to reduce greenhouse gas emissions to 80 percent below baseline emissions levels[i] by 2030, 90 percent below by 2035, and 100 percent by 2040.[1] The largest sources of electricity are labeled below; the other resources not listed in the bubble chart are each under 2 percent.[2]

8.3%

Percentage of Oregon's 2024 electricity mix that came from coal.[2]

2040

Year by which Oregon's two largest utilities and Electricity Service Suppliers will need to reduce emissions for electricity sold in the state by 100 percent below baseline emissions levels.[1]

Change in Methodology

In 2024, in response to feedback from utilities and after consultation with other state agencies and stakeholders, ODOE changed the way it calculates the Electricity Resource Mix, which is the data source for this section on Electricity Use. Instead of doing a detailed, complex analysis of the specific resources that make up the "unspecified" market purchases by utilities (a calculation only used by ODOE to develop the ERM), ODOE now uses the same data reported in the Oregon Department of Environmental Quality's Greenhouse Gas Emissions Reporting program. The change was necessary because ODOE determined the limited data and assumptions used to produce the unspecified mix in the past could no longer support a viable methodology.

While DEQ's program provides emissions factors for the resources Oregon's utilities use to meet load, they do not assess or report the resources and emissions from utility purchases or sales in real-time[ii] and day-ahead markets. Instead, DEQ assesses GHG emissions from all these market purchases using the default rate that California calculates and uses to estimate "unspecified" electricity emissions.[iii] It is based on the average emissions from a natural gas combined cycle power plant.[5] [6] ODOE's previous analysis showed that unspecified market purchases included diverse resources available across the western U.S., such as hydro, coal, and natural gas. Since resources contributing to market purchases are now combined into the less specific "market purchases" category, the total amounts of individual resources may appear lower than in previous years. However, as utilities in states with clean electricity standards work to achieve their targets, and market purchases are used more and more, more transparency in the resources and emissions that make up these purchases may be needed.

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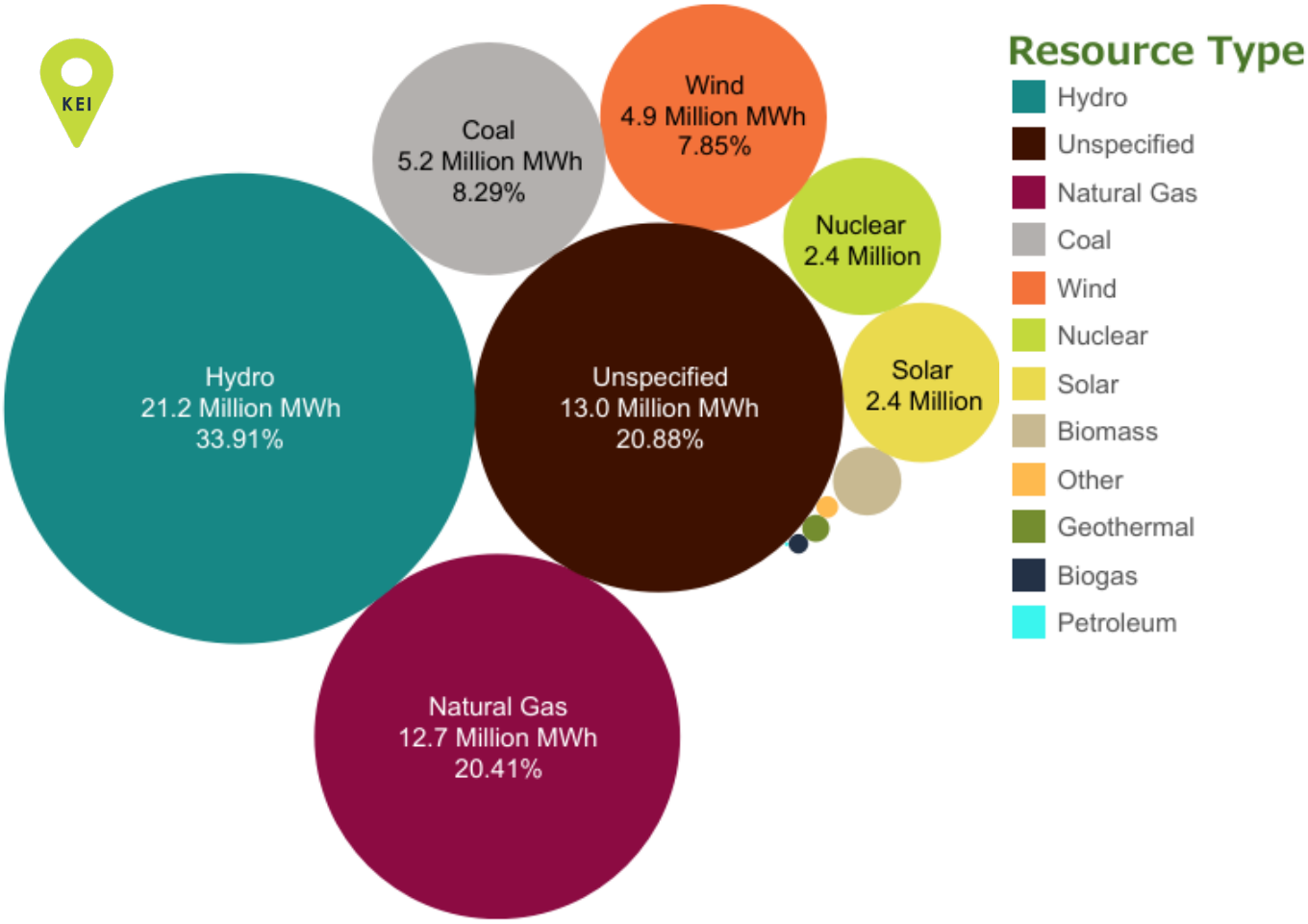
i Baseline emissions is the average of emissions from 2012-2014.

ii Real-time markets support electricity sales for multiple utilities to balance fluctuations in supply and demand within the current hour.[3]

iii The DEQ Greenhouse Gas Emissions Inventory program refers to market purchases as "unspecified emissions," and assigned an emissions rate of 0.428 metric tons of carbon dioxide equivalent per megawatt-hour.[4]

Resources Used to Generate Oregon's Electricity[2]

Based on 2024 data, this chart shows the energy resources used to generate the electricity that is sold to Oregon's utility customers.



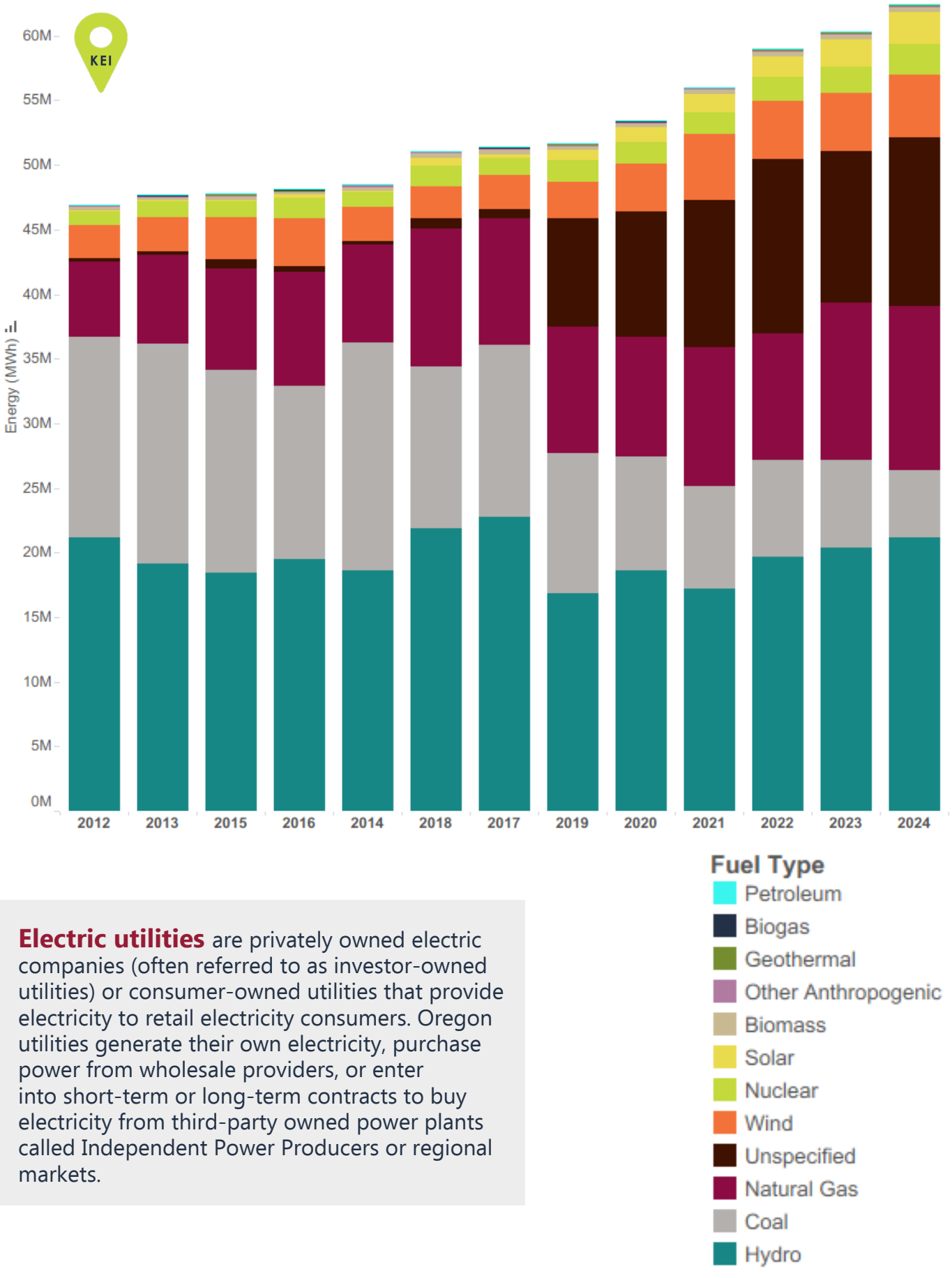
Oregon's electricity resource mix displays the proportion that each resource (solar, wind, hydropower, etc.) contributes to the total amount of electricity that Oregonians consume each year. The chart on the following page presents Oregon's mix from 2012 to 2024 and shows two notable trends: First, total annual electricity consumption has increased from 47 to 62 million megawatt hours between 2012 to 2024, driven by factors like economic and population growth and increased customer demand. Second, the percentage that each resource contributes to total electricity for consumption changes year-to-year. Although the methodology for calculating the resource mix changed between 2021 and 2024 to include a bulk category for unspecified market purchases, some trends are still evident in the data. Hydro is still a predominant resource for the region. Coal continues to decline as plants are shuttered, and natural gas, wind, and solar are increasingly a larger proportion of the mix.[iv]

Fluctuations in the sources of electricity consumed in Oregon are the result of several factors, including the regional nature of energy markets, resource availability, market dynamics and utility contracts, public policy, and other factors.

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iv Note that changes to the methodology that occurred in 2024 make this comparative analysis more complicated. The addition of the Unspecified category does not attribute use to a particular resource, though this portion is likely made up of the most abundant resources in the region Hydro, Natural Gas and Coal.

Oregon's Electricity Mix Over Time (2012-2024)[1]



Electric utilities are privately owned electric companies (often referred to as investor-owned utilities) or consumer-owned utilities that provide electricity to retail electricity consumers. Oregon utilities generate their own electricity, purchase power from wholesale providers, or enter into short-term or long-term contracts to buy electricity from third-party owned power plants called Independent Power Producers or regional markets.



Hydropower availability drives year-to-year fluctuations in Oregon's electricity resource mix. Oregon and the Pacific Northwest are rich in hydropower, which is consistently a low-cost resource. Utilities typically dispatch the lowest cost generating resources like hydro, wind, and solar. These types of resources are used first when they are available, and then, if unmet customer demand remains, utilities will look to other types of sources, such as natural gas power plants, to meet additional demand. It is worth noting that the availability of renewable resources — such as wind, solar, and hydropower — also varies over the course of a day, from season-to-season, and year-to-year based on natural cycles, weather patterns, and changing climate conditions.

Utilities also meet customer demand through real-time supplemental purchases from regional markets. These real-time purchases typically come from resources that the utility does not own or for which it does not have any prior contractual arrangement. This electricity is considered "unspecified," signifying that the purchasing utility does not have a right to designate the electricity as coming from a particular resource, such as solar or wind, often because they have sold the renewable energy certificates, or RECs.

Learn more about Oregon's Electricity Resource Mix

The Oregon Department of Energy updates the state's electricity resource mix each year. On the agency's website, find the statewide mix, a map of generation facilities, electricity mixes by utility, greenhouse gas emissions, and more.

www.tinyurl.com/OregonERM

SCAN OR CLICK

Electricity Imports and Exports

Oregon is fortunate to have an abundance of renewable energy resources and is one of the leading producers of renewable energy in the country.[7] This abundance is one of the reasons Oregon can export significant amounts of the renewable electricity it generates — particularly from hydropower.

Oregon imports all the petroleum and coal, and nearly all the natural gas fuel used to generate electricity at in-state facilities. Oregon does not have any coal mines and only extracts small amounts of natural gas at one facility in Oregon.[8]

Oregon also imports electricity from all over the western U.S.; this imported electricity comes from various resources.[8]

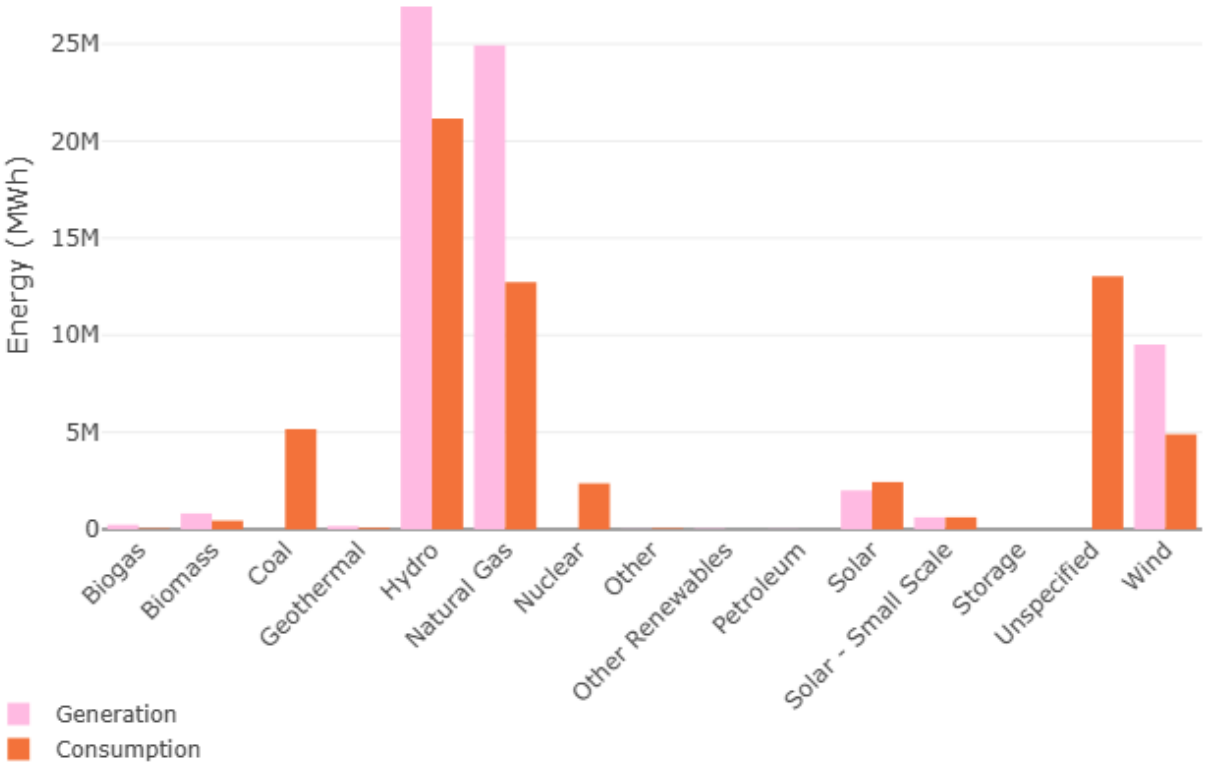
Oregon 2024 Exports (as a percentage of electricity generated in Oregon)

- 48.5% of wind generation[9]
- 21.4% of hydroelectric generation[9]

Oregon 2024 Imports (as a percentage of electricity consumed in Oregon)

- 100% of coal electricity[9]
- 100% of nuclear electricity[9]
- 17.8% of solar electricity[9]

Oregon's Electricity Generation and Consumption (2024)[10] [11]

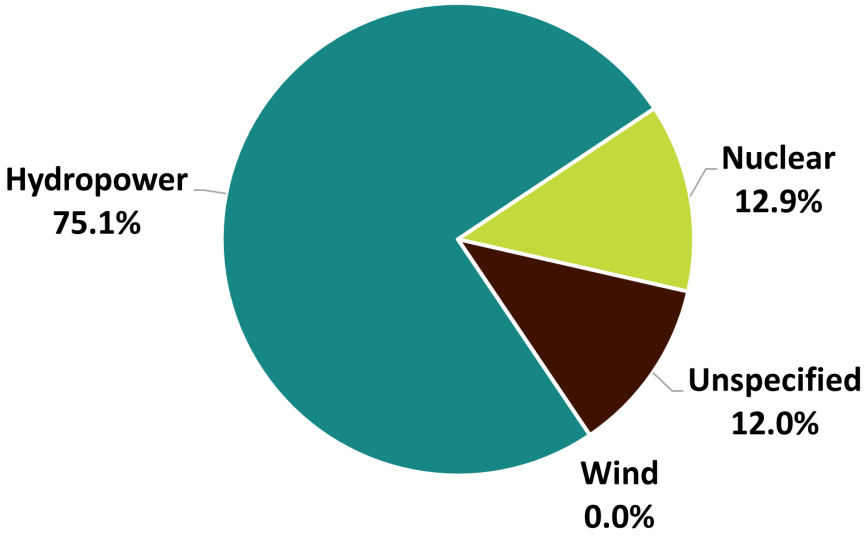


Megawatt (MW): One million watts of electricity capacity — the equivalent of 1,340 horsepower, or enough power to simultaneously illuminate more than 100,000 standard 60-watt-equivalent LED lightbulbs. **Megawatt Hour (MWh):** A unit of measurement for energy output that represents the amount of energy supplied continuously by 1 MW of capacity for one hour. **Average Megawatt (aMW):** Represents 1 MW of energy delivered continuously 24 hours/day for one year, or 8,760 MWh.

Bonneville Power Administration

Consumer-owned utilities in Oregon purchase most of their electricity from the Bonneville Power Administration, a federal agency that markets wholesale electric power from 31 federal hydroelectric facilities in the Northwest, a non-federal nuclear power plant, and several other small non-federal power plants. The dams generating the hydroelectric power are operated by the U.S. Army Corps of Engineers and the Bureau of Reclamation, while the nuclear facility is operated by Energy Northwest. BPA provides about 29 percent of the electricity used in Oregon.[2]

Bonneville Power Administration 2024[2]



Market Purchases

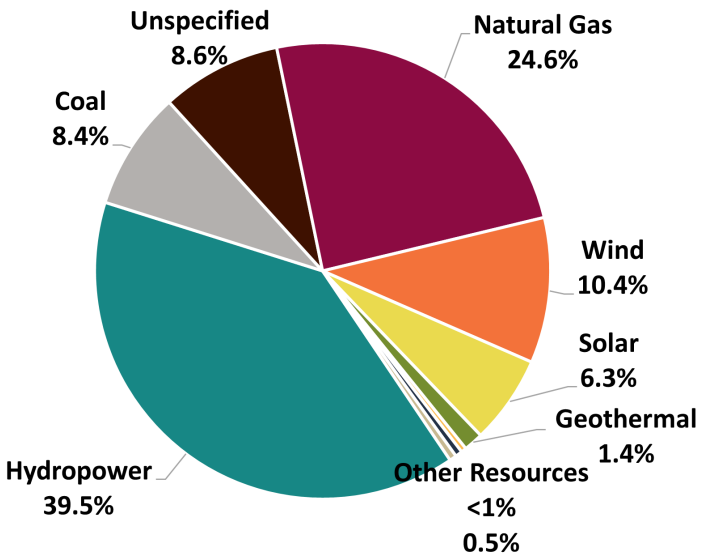
Oregon generation facilities sell electricity to Oregon utilities and the regional power market. Oregon electric utilities own facilities that generate power, but they also purchase power from the regional market to meet customer demand. Some market purchases can be tied to specific resources, but in most cases the specific generation resource is not known. In Oregon, these unspecified purchases accounted for 13 million megawatt-hours in 2024.[2]



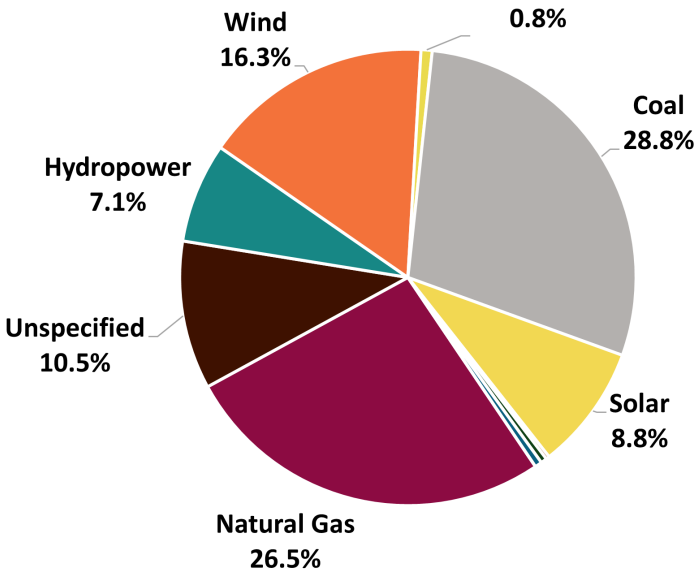
Investor-Owned Utility Resource Mix

The resources utilities use to generate electricity consumed in Oregon vary depending on the utility provider. The electricity resource mixes for Oregon's three investor-owned utilities are shown below. Only 2024 data are shown for each utility; mixes will fluctuate over the years depending on the availability of certain resources like hydro or, increasingly, solar. The dark brown wedge labeled as "unspecified" represents the real-time market purchases to meet demand.[2]

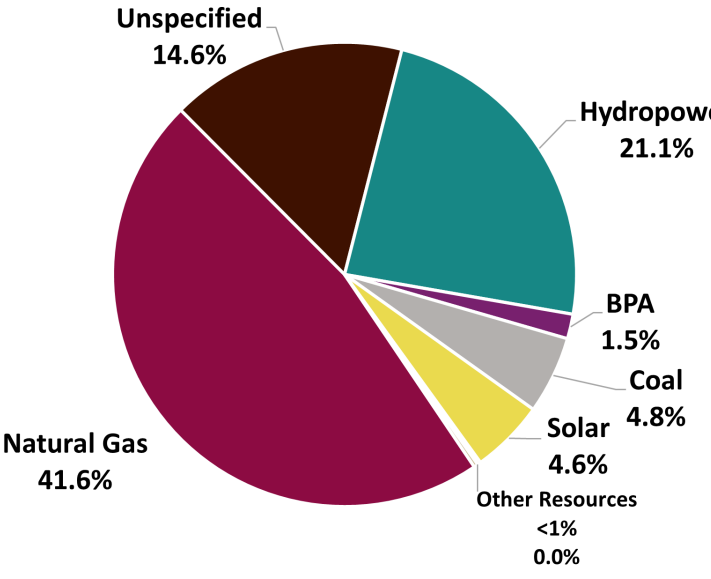
Idaho Power Company 2024



Pacific Power 2024



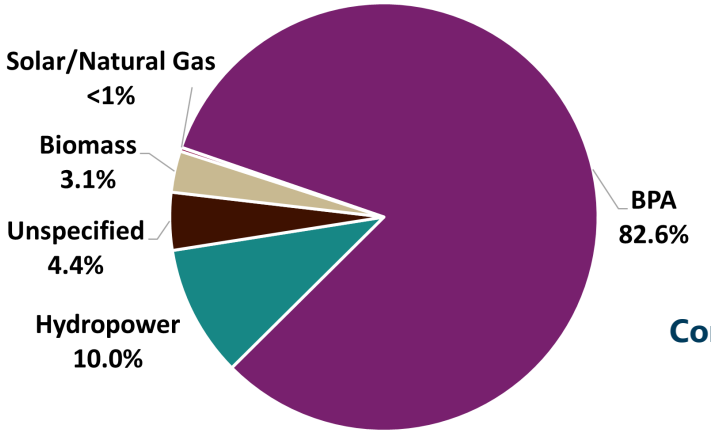
Portland General Electric 2024



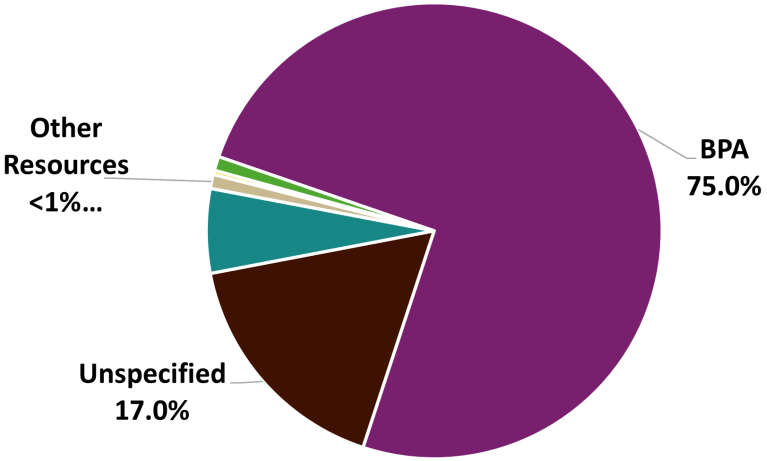
Consumer-Owned Utility Resource Mix

The electricity resource mixes for the Eugene Water & Electric Board (the largest consumer-owned utility by number of customers) and a composite of other COUs operating in Oregon are below. Clatskanie People's Utility District is also included as an example. Only 2024 data are shown for the utilities; COU mixes fluctuate less over the years as many depend on the Bonneville Power Administration to provide their electricity and the BPA mix is typically more consistent year to year.[2]

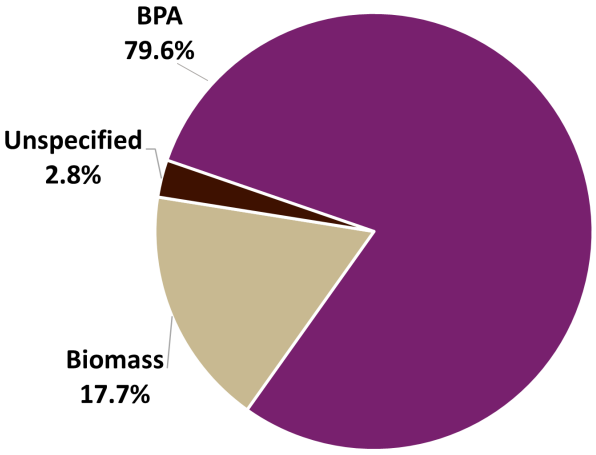
Eugene Water & Electric Board 2024



Composite of Consumer-Owned Utilities (not including EWEB) 2024



Clatskanie People's Utility District 2024



While the majority of power supplied by Oregon's consumer-owned utilities comes from the Bonneville Power Administration, **COUs have also invested in their own energy-generation sources**. For example, Clatskanie PUD supplements the electricity it buys from BPA with purchase agreements for biomass and biogenic facilities.[v] Emerald PUD supplies some of its electricity from solar, biogas, and unspecified purchases from energy markets.

Thanks to the BPA-supplied power – which is mostly from federally owned dams – and their own resources, COU electricity mixes have very low greenhouse gas emissions.

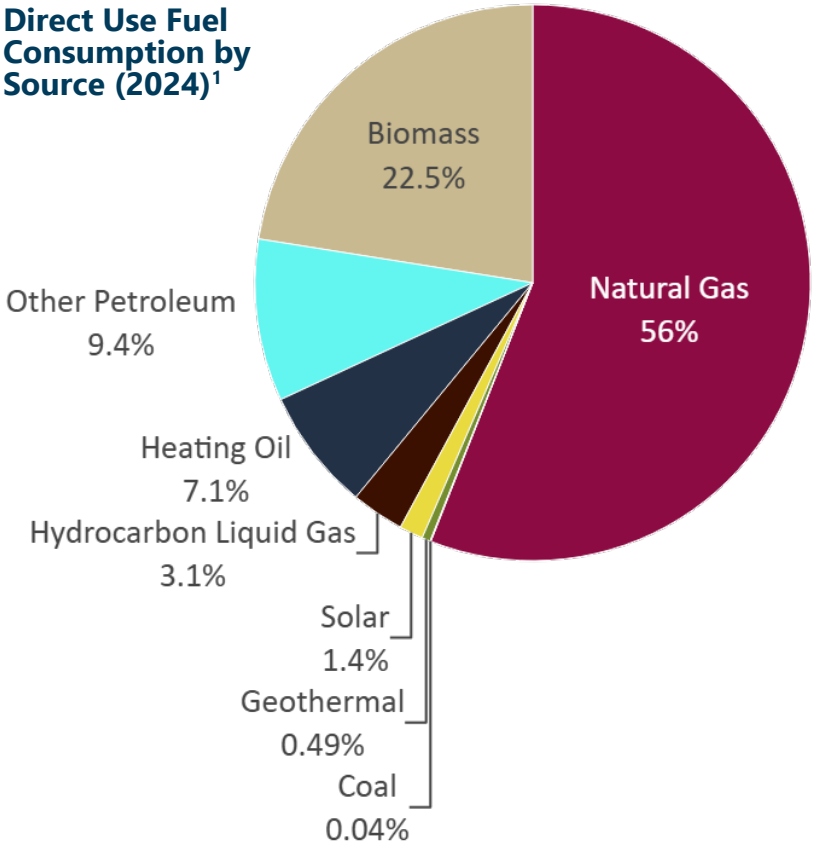
v Biogenic facilities produce energy from waste materials breaking down in a landfill.[10]

Direct Use Fuels

What We Use and Where it Comes From

In 2024, Oregon used 250.5 trillion Btu of direct use fuels to heat buildings, cook food, and support commercial and industrial processes.[1] Direct use fuels make up about 28 percent of the total energy consumption in Oregon.[2] These fuels are used on-site in the residential, commercial, and industrial sectors. They do not include fuels used to generate electricity or support the transportation sector.

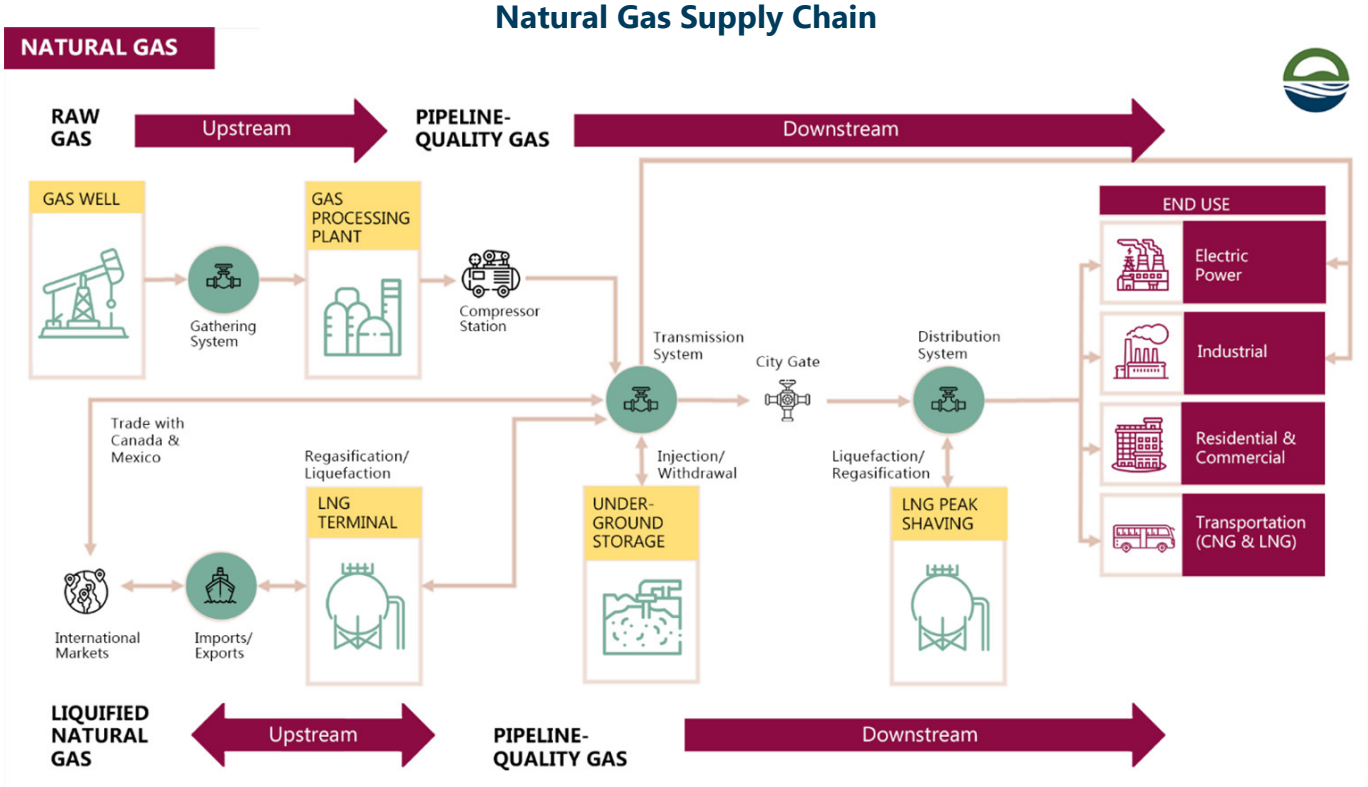
Direct Use Fuel Consumption by Source (2024)[1]





Natural Gas. A gaseous mixture of hydrocarbon compounds (primarily methane), natural gas is a fossil energy source from beneath the earth's surface. The United States is the world's largest producer of natural gas.[3] [4] Production and supply have increased in the last few decades with horizontal drilling and hydraulic fracturing unlocking shale gas reserves.[5] [6] Increased supply, lower costs, and lower greenhouse gas emissions in comparison to other fossil fuels have led to greater consumption in Oregon. Natural gas comes to Oregon by pipeline and is used directly

Natural Gas Supply Chain



for space and water heating, cooking, and many agricultural, commercial, and industrial processes. It can also be efficiently stored and transported by being compressed into high pressure tanks, which is called compressed natural gas or CNG, or it can be cooled to a liquid state, called Liquefied Natural Gas or LNG. LNG is about 600 times smaller in volume than in a gaseous state, which makes it easier to ship.[7] Oregon does not have LNG import or export facilities. Export capacity is expanding in North America, which could lead to interest in developing export facilities in Oregon or other west coast states.[8]

Natural Gas Consumption by Sector[1]

Commercial Sector | 32.5 trillion Btu

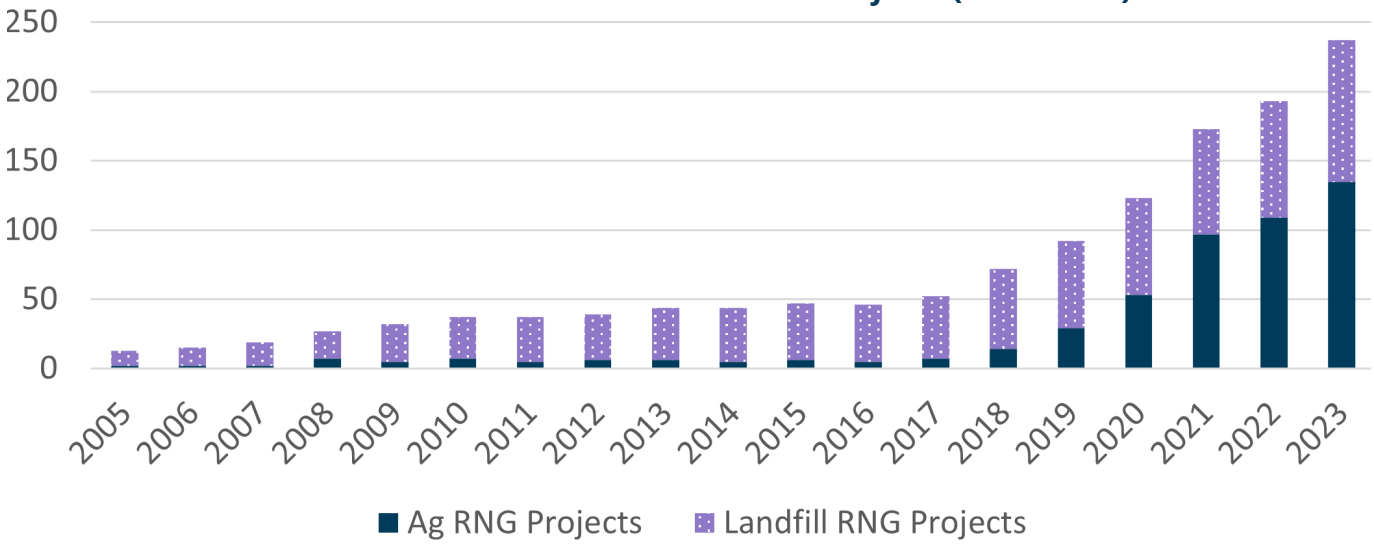
Residential Sector | 48.3 trillion Btu

Industrial Sector | 59.4 trillion Btu

In 2024, Oregon used 140.3 trillion Btu of natural gas for direct uses — nearly all of it imported from Canada and the Rocky Mountain states.[1] The Pacific Northwest's only natural gas extraction facility is located near Mist, Oregon and its resources go to NW Natural, one of three investor-owned gas companies serving the state.[1 9] The Mist field is primarily used for natural gas storage and produced only 0.09 trillion Btu of natural gas in 2024, representing 0.03 percent of Oregon's annual use.[1] Learn more about natural gas in a BER 101 from 2020.

Renewable natural gas, a low carbon-intensity alternative to fossil natural gas, is made by capturing methane biogas emitted from decomposing food waste, agricultural manure, landfills, and wastewater treatment plants.[10] Biogas is collected and processed to remove non-methane elements and then it becomes renewable natural gas. It can then be added to a pipeline or used onsite as natural gas. Oregon natural gas utilities are investing in RNG projects in and outside the state to reduce the greenhouse gas emissions attributed to natural gas combustion.[11 12 13]

Number of U.S. Renewable Natural Gas Projects (2005-2023)[10]



Biomass. Biomass is an organic material that comes from plants and animals that is burned to create energy. Biomass is considered a renewable source of energy, and comes from resources like wood, agricultural crops and waste, food or yard waste, and animal and human waste. Organic waste materials are

Biomass Consumption by Sector [1]

Commercial Sector | 2.7 trillion Btu

Residential Sector | 11.7 trillion Btu

Industrial Sector | 42.0 trillion Btu[1]

collected and combusted to make energy that can be used on site or distributed to a facility instead of filling space in a landfill. Biomass also commonly refers to end-products such as wood chips, wood pellets, and charcoal that are used for thermal energy. Some industrial facilities in Oregon burn woody biomass waste to generate heat for their manufacturing processes or electricity to be used on site or sold to utilities. Biomass is also used as a thermal energy source in commercial buildings, including schools and hospitals. In 2024, Oregon consumed 56.3 trillion Btu of biomass as a direct use fuel.[1]

Heating Oil. Heating oil is a petroleum distillate fuel that is used primarily to heat buildings; some buildings also use it to heat water. Because space heating is the primary use for heating oil, demand is highly seasonal and affected by the weather. Most Oregon heating oil use occurs during the heating season: October through March.

Heating Oil Consumption by Sector [1]

Commercial Sector | 2.5 trillion Btu

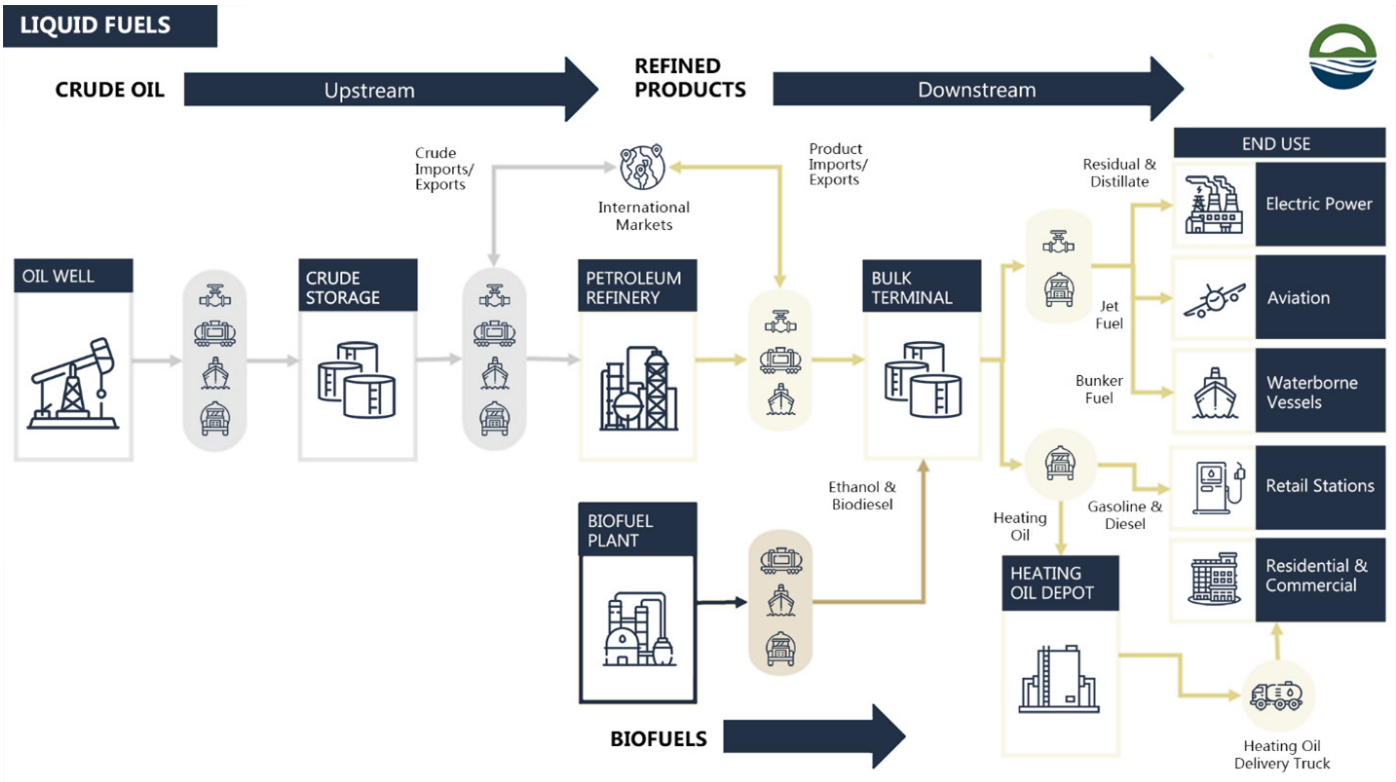
Residential Sector | 1.8 trillion Btu

Industrial Sector | 13.5 trillion Btu[1]

In 2024, Oregon used 17.8 trillion Btu of heating oil for direct uses, and 1.2 percent of Oregon homes use fuel oil for heating.[1] [14] It is also used to heat commercial buildings and for industrial applications. Oregon does not produce any heating oil in the state, so most of Oregon's petroleum supply comes from refineries in Washington.[15]

Biodiesel heating oil is a renewable fuel made from vegetable oils, like soy and canola, and is a lower carbon intensity alternative to petroleum heating oil. Biofuels are mixed with petroleum heating oil to create blends of 5 to 20 percent to create a cleaner burning alternative fuel. The mixes can be used by typical oil furnaces in homes, but increasing the portion of vegetable oils in the blends does require adjustments to home oil furnaces.[16] Policies such as the Oregon Renewable Fuel Standard and Oregon Department of Environmental Quality's Clean Fuels

Liquid Fuels Supply Chain



Program are driving increased demand for biodiesel and other biofuels as they displace petroleum fuels used for transportation and heat.[17] For more information about biofuels powering transportation in Oregon, see the 2022 BER Resource and Technology Review of Transportation Fuels.

Hydrocarbon Gas Liquids and Propane. HGLs are gases at atmospheric pressure and can be liquefied by cooling and pressurizing. Their versatility and high energy density in liquid form make them useful for many purposes, including as feedstock in petrochemical plants, as fuel for home space and water heating or cooking, and as transportation fuels, additives, or as a diluent. Propane is a hydrocarbon gas liquid that can be used to power farm and industrial equipment, backyard barbecues, and Zamboni machines at ice skating rinks. Propane remains a viable fuel over long periods of storage, making it a common backup fuel for essential facilities like hospitals and a potential resource in response to an emergency. Propane is a byproduct of natural gas production and crude oil refining.[18] As U.S. natural gas production has increased, the supply of propane has followed, making it an affordable and attractive option for many Oregonians.[19]

Hydrocarbon Gas Liquids and Propane Consumption by Sector[1]

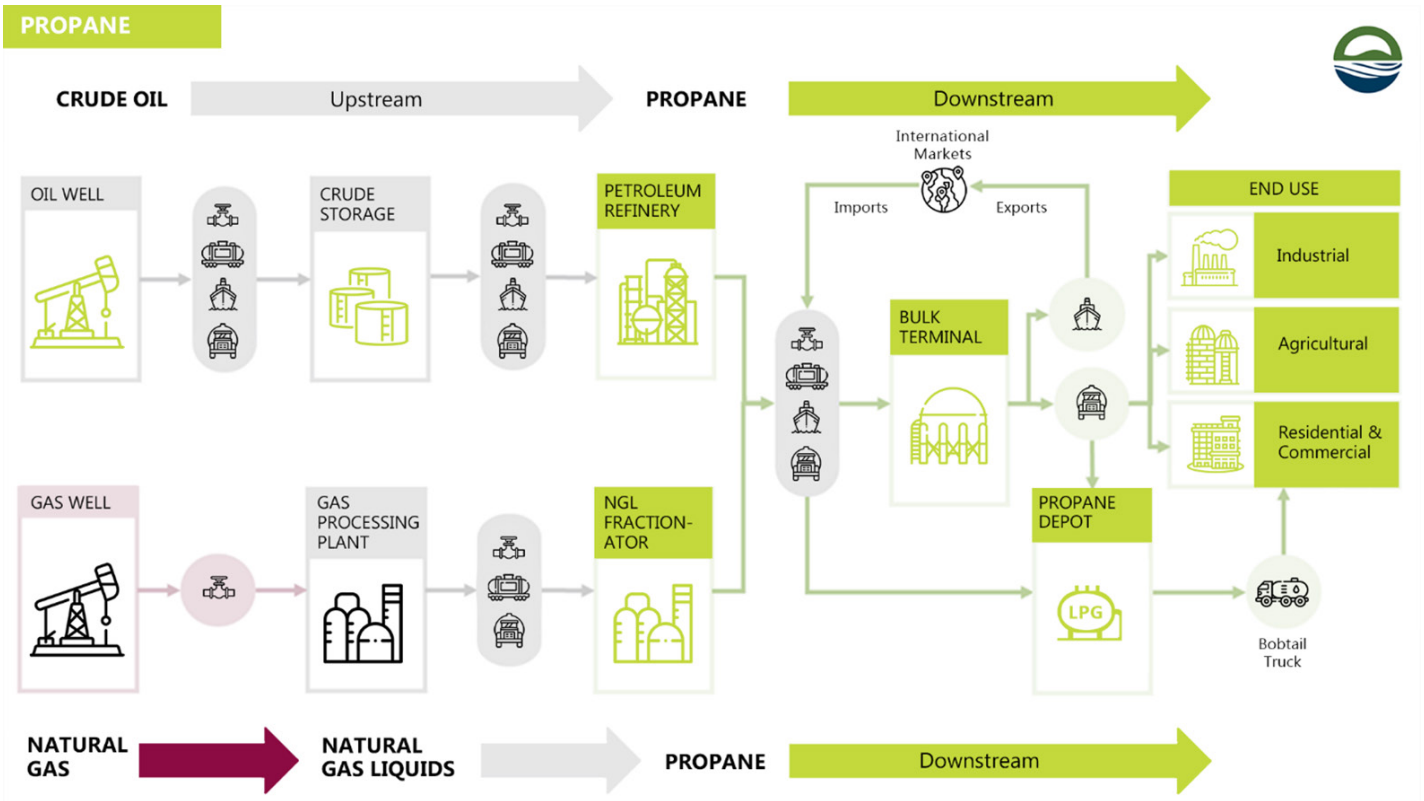
Commercial Sector | 4.2 trillion Btu

Residential Sector | 2.2 trillion Btu

Industrial Sector | 1.3 trillion Btu

Propane consumed in Oregon is imported. Based on the available data on propane production, imports, exports, and transportation, the Pacific Propane Gas Association estimates that more than 95 percent of the propane consumed in Oregon is sourced from natural gas processing plants in Alberta and British Columbia, Canada.[20]

Propane Supply Chain



Renewable propane is a lower carbon form of propane made from a mix of waste residues and sustainably sourced materials, including agricultural waste products, cooking oil, and animal fats.[21] Renewable propane production is in its early stages, with the first commercial production in the United States beginning in 2018. It is most often created as a byproduct of renewable diesel or sustainable aviation fuel production. Other methods for producing renewable propane are being studied and tested. It is currently available only in limited quantities and is typically mixed into existing propane supplies for distribution to propane vehicle fleets.

Oregon consumed 7.7 trillion Btu of propane in 2024 as a direct use fuel.[1] About 1.4 percent of Oregon residents use propane boilers or furnaces to heat their homes; even more use it for cooking.[14]



Other Petroleum. These are petroleum fuels like kerosene or lubricants that are not propane or heating oil, and are used, for the most part, in Oregon's commercial and industrial sectors to fuel machinery and manufacturing processes. In 2024, Oregon consumed about 23.6 trillion Btu of Other Petroleum fuels.[1]

Other Petroleum Consumption by Sector[1]

Commercial Sector 4.9 trillion Btu

Residential Sector 0.2 trillion Btu

Industrial Sector 18.5 trillion Btu



Solar Thermal. While solar is commonly thought of as a resource to generate electricity, Oregon also uses sunlight to produce energy to heat spaces and water in homes and businesses. Over 3.5 trillion Btu of solar thermal energy was consumed in Oregon in 2024.[1] Solar thermal is most used as a direct use fuel in solar water heating systems in buildings. Solar water heating systems collect and transfer thermal energy to preheat water for the building, which reduces natural gas or electricity consumption.

Solar Thermal Consumption by Sector[1]

Commercial Sector | 0.5 trillion Btu

Residential Sector | 2.9 trillion Btu

Industrial Sector | 0.1 trillion Btu



Geothermal. In 2024, Oregonians consumed 1.2 trillion Btu of geothermal energy for heating and cooling residential, commercial, and industrial spaces.[1] Geothermal energy is a renewable fuel that comes from the internal heat of the earth and is produced in Oregon. While geothermal is often used to generate electricity, it can also be used for thermal energy applications such as heating spaces and keeping bridges and sidewalks from icing over.[22]



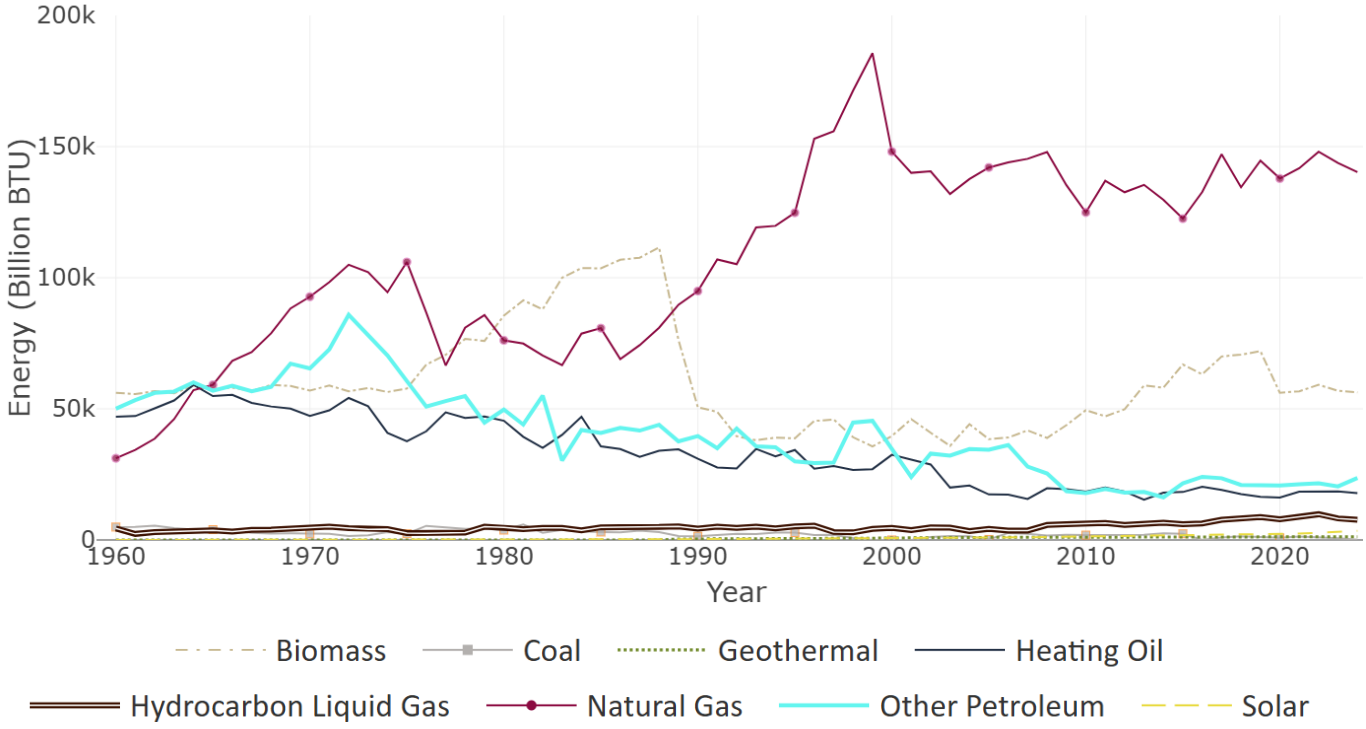
Coal. Coal is imported to Oregon for use as a direct fuel in the industrial sector. Oregon consumed 0.1 trillion btu in 2024. Most applications of coal as a direct use fuel in Oregon have been replaced by other fuels like natural gas, which has led to a general decrease in coal use since the 1990s.[1]

Geothermal and coal represent
less than 1 percent of Oregon's direct use fuels.[1]

Direct Use Fuels Over Time

Oregon's energy consumption has evolved over time. For direct use fuels, that has meant decreasing wood and fuel oil use and an increase in natural gas. The chart below uses data from the U.S. Energy Information Administration to compare total consumption of direct use fuel types in Oregon's residential, commercial, and industrial sectors from 1960 to 2024. The chart does not include transportation fuels or fuels used to generate electricity.

Oregon Direct Use Fuels Consumption: 1960-2024 (Billion Btu)[1]



Natural gas has replaced heating oil and coal use in many Oregon buildings and industrial processes as a cleaner-burning and, in many cases, less expensive fuel. Oregon's natural gas utilities are planning for the blending of lower carbon alternative fuels such as renewable natural gas and hydrogen with fossil natural gas to reduce the GHG emissions from fuel consumption.[11] [12] [13]

Geothermal is one of the smallest direct use fuels consumed in Oregon, but it has the potential to be a greater clean energy resource in the future. Research and pilot projects are spurring more potential for geothermal for electricity generation. Although this is directly related to advancements in the electricity sector, the knowledge gained from these projects could inform more opportunities or technological innovations in geothermal energy as a direct use fuel.

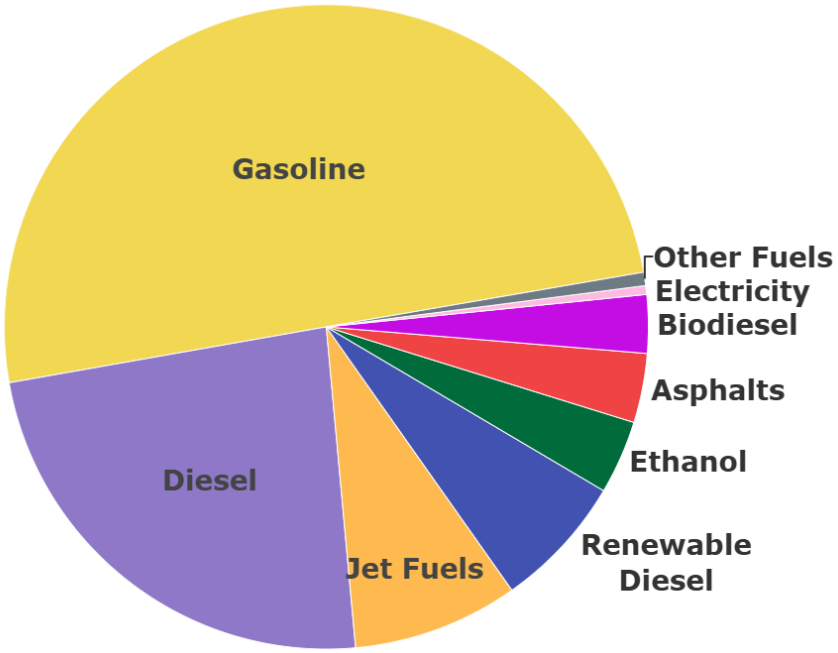
Oregon industry consumes a significant amount of biomass energy from secondary waste products, like lumber mill residue, logging slash, and animal manure. Waste products are burned to provide heat to manufacturing processes or generate electricity or they can be processed to become a commercial energy product like wood pellets or charcoal briquettes.

Transportation Fuels

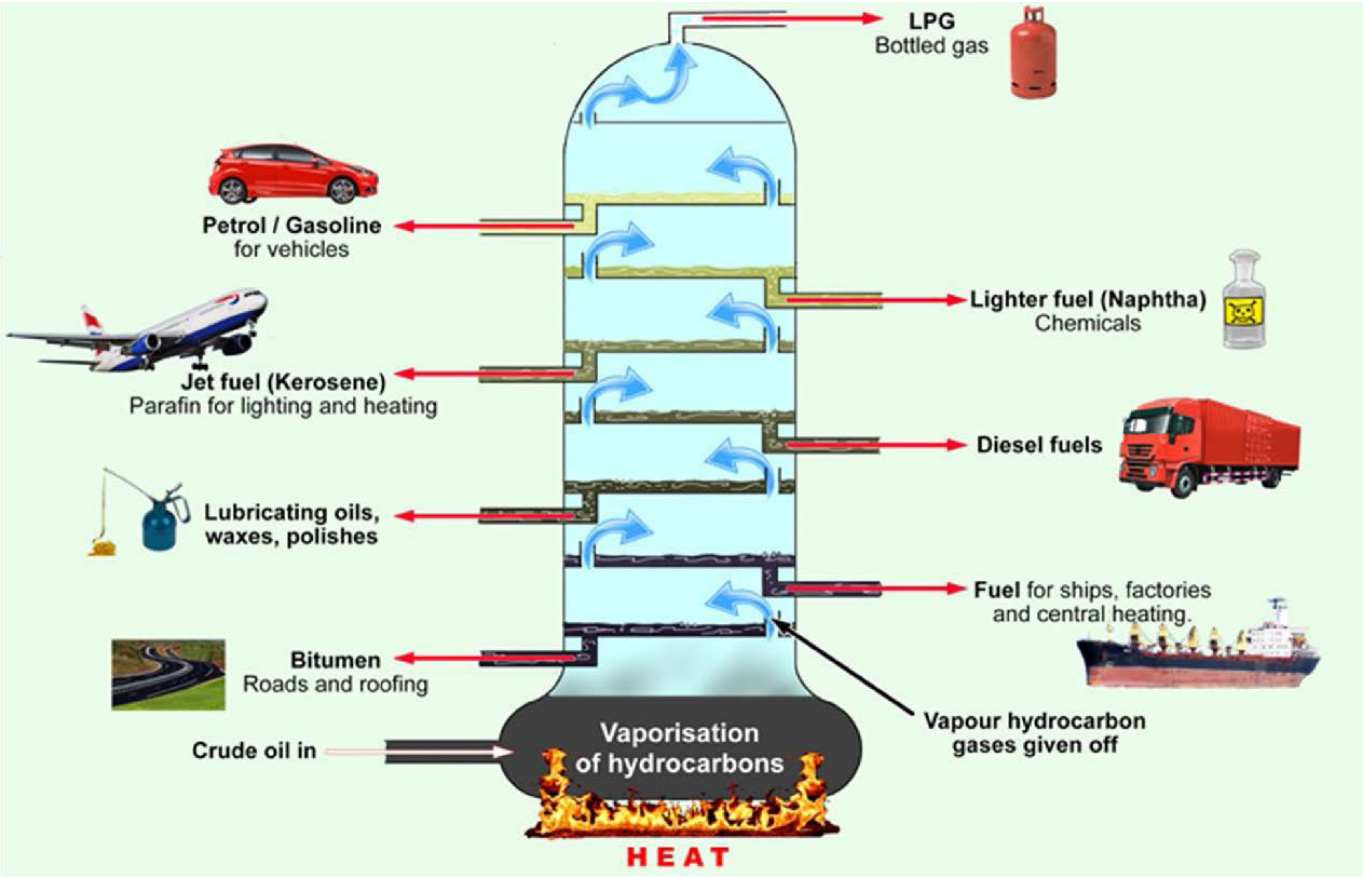
What We Use

In 2024, Oregon's transportation sector accounted for 36.1 percent of the energy consumed in Oregon.[1] Petroleum-based products represent 86 percent of fuel consumed in this sector. Alternative fuels or biofuels like ethanol, biodiesel, and renewable diesel accounted for 13.6 percent, and electricity accounted for 0.4 percent of the fuels consumed.[1]

Oregonians consume many different types of transportation fuels.[3]



Uses for Petroleum Distillates in the Transportation Sector[2]



Petroleum-based products make up 86 percent of Oregon's transportation fuel use.[1] They are processed by heating crude oil and separating components by weight, sometimes referred to as fractionations (of the crude oil).

Gasoline. Lighter distillate of petroleum used by cars, motorcycles, light trucks, airplanes, and boats.

Diesel. Heavier distillate of petroleum used by trucks, buses, trains, boats, and ships.

Propane. A light petroleum hydrocarbon gas liquid fuel used to power cars, buses, trucks, and some non-road vehicles.

Alternative fuels (to petroleum) used in Oregon are produced by various means, usually by collecting and processing crops, byproducts, or waste streams.[4]

Ethanol. Fuel produced from agricultural crops or wood that is blended with gasoline and used by cars and trucks.

Biodiesel. Fuel from organic oils and fats that can be blended with diesel fuel (up to 20 percent) and used by trucks, buses, trains, and boats.

Electricity. Fuel that powers some public mass transit systems, school buses, port equipment, and passenger zero-emission vehicles.

Natural Gas. Compressed and liquefied natural gas used by cars, buses, trucks, and ships.

Renewable Natural Gas. Biogas from agricultural waste, wastewater, or garbage collected and refined to power natural gas cars and trucks.

Renewable Diesel. Fuel from organic oils and fats using a different production process than biodiesel to power diesel vehicles.

Hydrogen's Potential as a Transportation Fuel in Oregon?

A potential emerging resource in Oregon and beyond is renewable and clean hydrogen, which could be used as a replacement for fossil-based hydrogen currently in use, as a direct transportation fuel for medium- or heavy-duty vehicles, as storage for clean electricity generation, for industrial processes and heat, and other uses.

In November 2022, the Oregon Department of Energy published a study on the potential of renewable hydrogen, including opportunities and challenges for using the resource in the state.[5]

Use Over Time

The U.S. Energy Information Administration has tracked national energy consumption and individual state consumption since 1960. In Oregon and nationally, overall transportation fuels consumption increased between 1960 to 2018. In 2020, there was a 16 percent reduction in the use of gasoline and a 37 percent reduction in jet fuel, but a 3 percent uptick in the use of diesel. Analysis indicates this is due to less personal vehicle travel and more delivered goods during the COVID-19 pandemic.[7] [8] Since 2020, energy consumption in Oregon's transportation sector has risen, and in 2023 exceeded pre-pandemic levels. In 2024, Oregonians consumed 322.9 trillion Btu[i] of energy in the transportation sector.[1]

i Energy consumption data are based on data sets from Oregon Departments of Environmental Quality and Transportation. For this reason, actual Btu numbers for the sector and individual fuels may not exactly match U.S. Energy Information Administration values.

Petroleum consumption in Oregon's transportation sector has generally increased over time and continues to comprise the vast majority of transportation fuel use. All petroleum-based transportation fuels consumed in the state are imported, which means most of the $9.5 billion spent in 2024 on transportation fuel is not retained in Oregon's economy. In 2024, in-state production accounted for only 1.6 percent of total transportation fuel consumption, primarily from 4.2 trillion Btu of fuel ethanol. Oregon electric utilities supplied an additional 0.84 trillion Btu of electricity for electric vehicle charging in 2024.[1] Oregon has no crude oil reserves or petroleum refineries. More than 90 percent of the petroleum products delivered to and used in the state originate from four refineries located in Washington.[9] These refineries process crude oil sourced from Alaska, western Canada, and North Dakota.

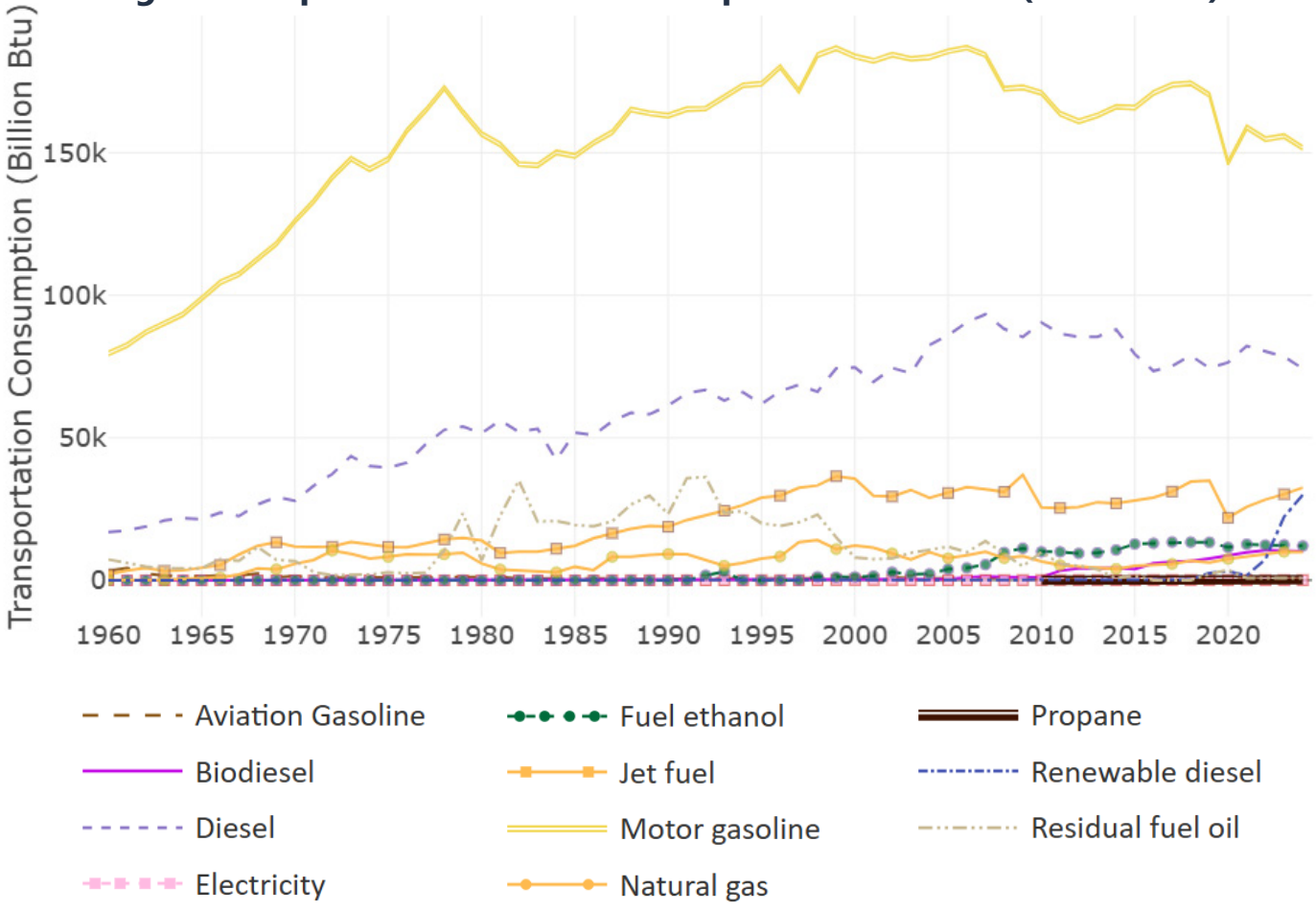
1.6%

Percentage of transportation fuel used in Oregon that was produced in state.[1]

$9.5 billion

The amount of money Oregonians spent on transportation fuels in 2024.

Oregon Transportation Sector Consumption: 1960-2022 (Billion Btu)[10]

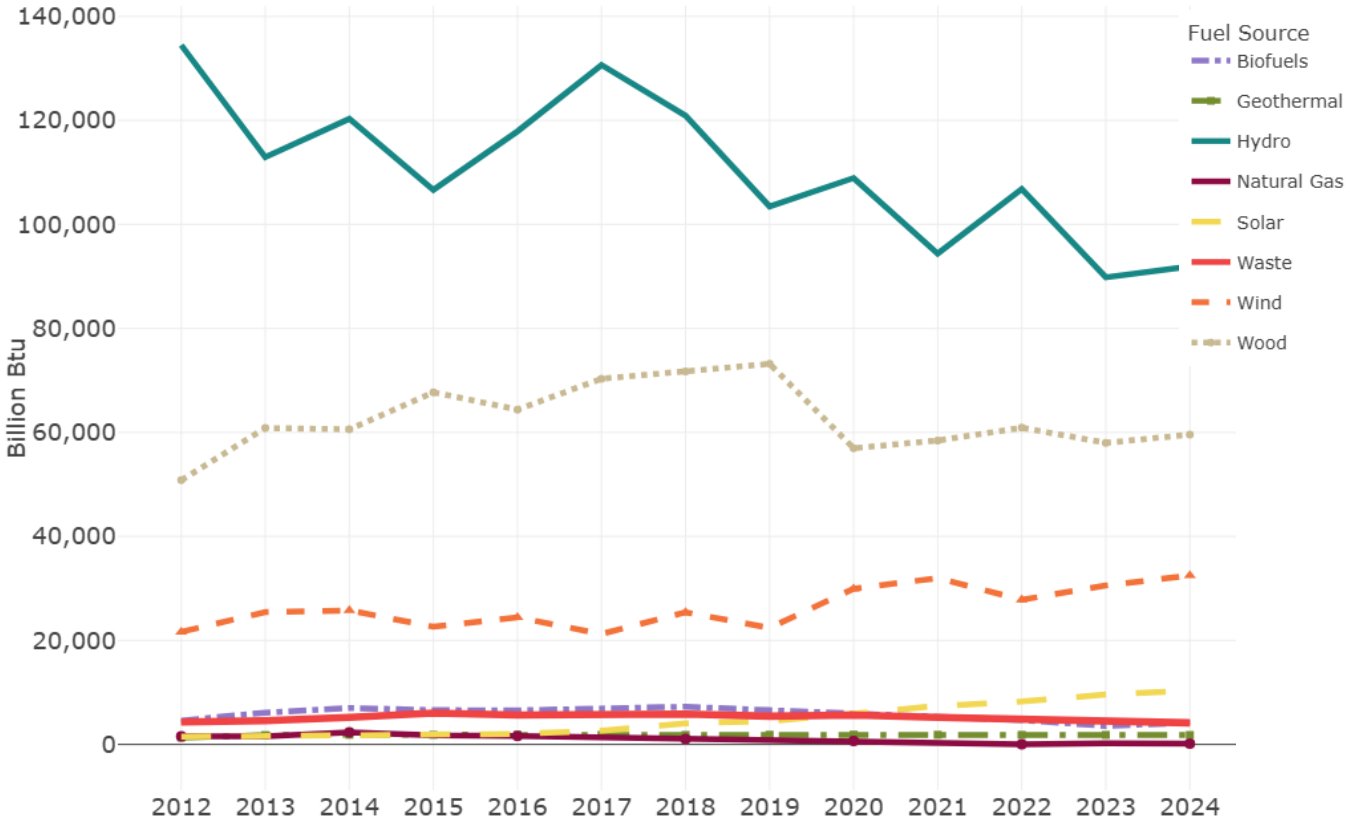


Energy Production

Overview

This section provides energy consumption and energy production data. Energy production focuses on primary and secondary energy produced in Oregon. *Primary* energy represents energy that is collected from Oregon's natural resources — it does not include energy that is imported for consumption or for electricity generation in Oregon. *Secondary* energy is consumed in real time, like electricity, or may be stored for later use, like wood pellets.

Oregon Primary Annual Energy Production Over Time[1]



The chart above shows primary energy produced in Oregon in 2024. Almost all the primary solar, wind, geothermal, and hydro energy is converted to *secondary* energy as electricity. Some of the biomass is used to make a variety of renewable fuels and some is combusted to produce heat and electricity.[1]

Over the last two decades, hydropower has been the largest primary energy source in Oregon. Wood remains the second largest primary energy source. Solar power has been steadily increasing since 2012, with faster growth starting in 2015. Wind power grew at a slower rate and is the third largest energy resource produced in Oregon. Between 2014 and 2021, natural gas production slowly declined, and is currently the smallest primary resource.[1]

Electricity

Oregon generates electricity from a variety of resources — hydropower, natural gas, and wind are the largest. In 2024, Oregon's hydroelectric facilities were responsible for 41.7 percent of the electricity generated in Oregon.[1] The state's four largest electricity generating facilities are federally owned and operated dams on the Columbia River. They account for two-thirds of the generating capacity from the 10 largest power plants in the state.[2] Oregon is the second largest producer of hydroelectric power in the U.S. after Washington.

Oregon's abundance of renewable electricity is used in Oregon and sold to utilities in other states through wholesale electricity markets. In 2024, 21.4 percent of Oregon's hydropower and 48.5 percent of its wind generation were exported.[3] Sixty percent of electricity generated in Oregon in 2024 came from non-greenhouse gas emitting resources.[1]

Natural gas accounted for 38.6 percent of Oregon's 2024 electricity generation. Nearly all the natural gas used to generate electricity in Oregon is imported. There is only one natural gas site in Mist, Oregon, but this facility is used primarily for natural gas storage. Oregon has no coal or petroleum resource extraction facilities.

65.3 Million

Megawatt hours of electricity generated in Oregon in 2024.[1]

62.4 Million

Megawatt hours of electricity consumed in Oregon in 2024.[3]

60%

Percentage of Oregon's electricity generation that comes from non-emitting resources.[3]

77%

Percentage of Oregon's electricity generation that is used in-state.[3]

Utility-Scale Solar in Oregon

The first Energy Facility Siting Council-jurisdictional solar facility constructed was the Wheatridge Renewable Energy Facility. Fifty megawatts of the approved 150 MW solar energy facility became operational in March 2022.

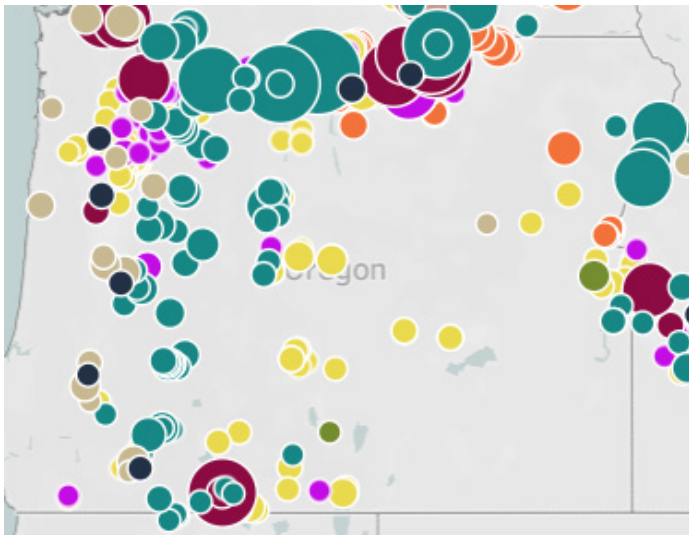
As of September 2026, there are 10 EFSC-jurisdiction solar facilities under review, under construction, or operating in Oregon, which amounts to 412 MW of solar generating facilities in operation with another 296 MW in construction.[4] The largest proposed facility to date is the 1,400 MW Speedway Energy Facility Project in Sherman County.



Construction of the Oregon Trail Solar Facility In Gilliam County.

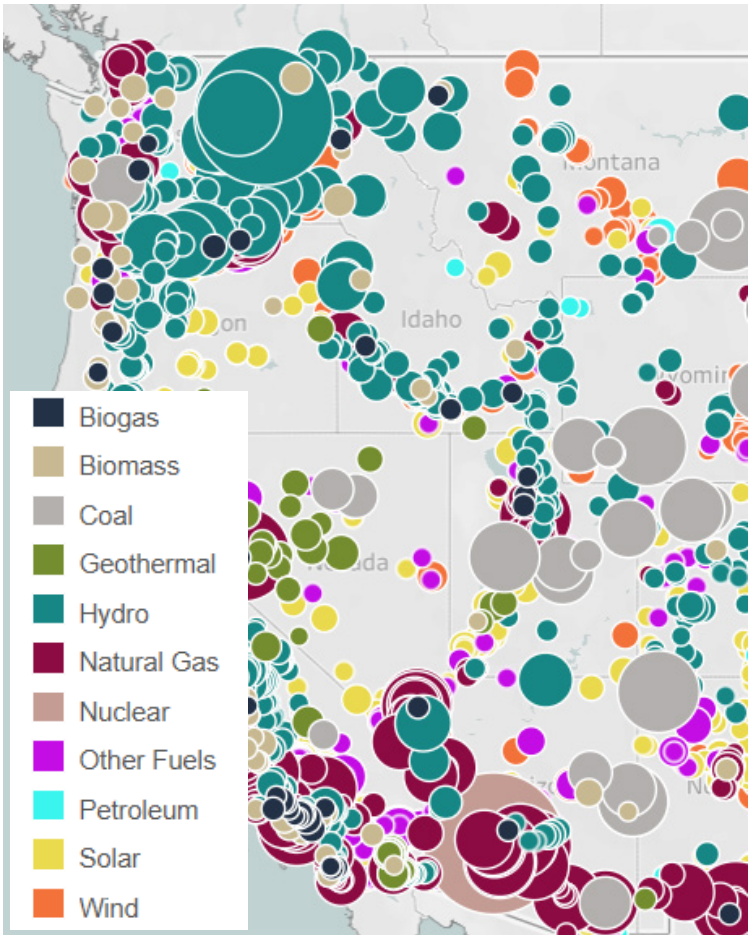
Electric Facilities

The map of Oregon at right shows where electricity generation sites are in the state. The map includes facilities owned by Oregon utilities as well as third-party owned facilities, with which utilities can contract to provide electricity to Oregon consumers. Third parties can also sell their electricity on the open energy market. Note that the color of the circles corresponds to the type of resource used to generate electricity, and the size of the circle is in relation to generation capacity or size of that facility.



Electricity used by Oregonians can come from facilities across the western United States. Oregon relies on hydroelectric power produced on rivers in the Columbia River watershed, nuclear power from the Columbia Generating Station in Washington, wind from turbines along the Columbia River Plateau, and electricity generated at coal-powered facilities located in several western states.[5]

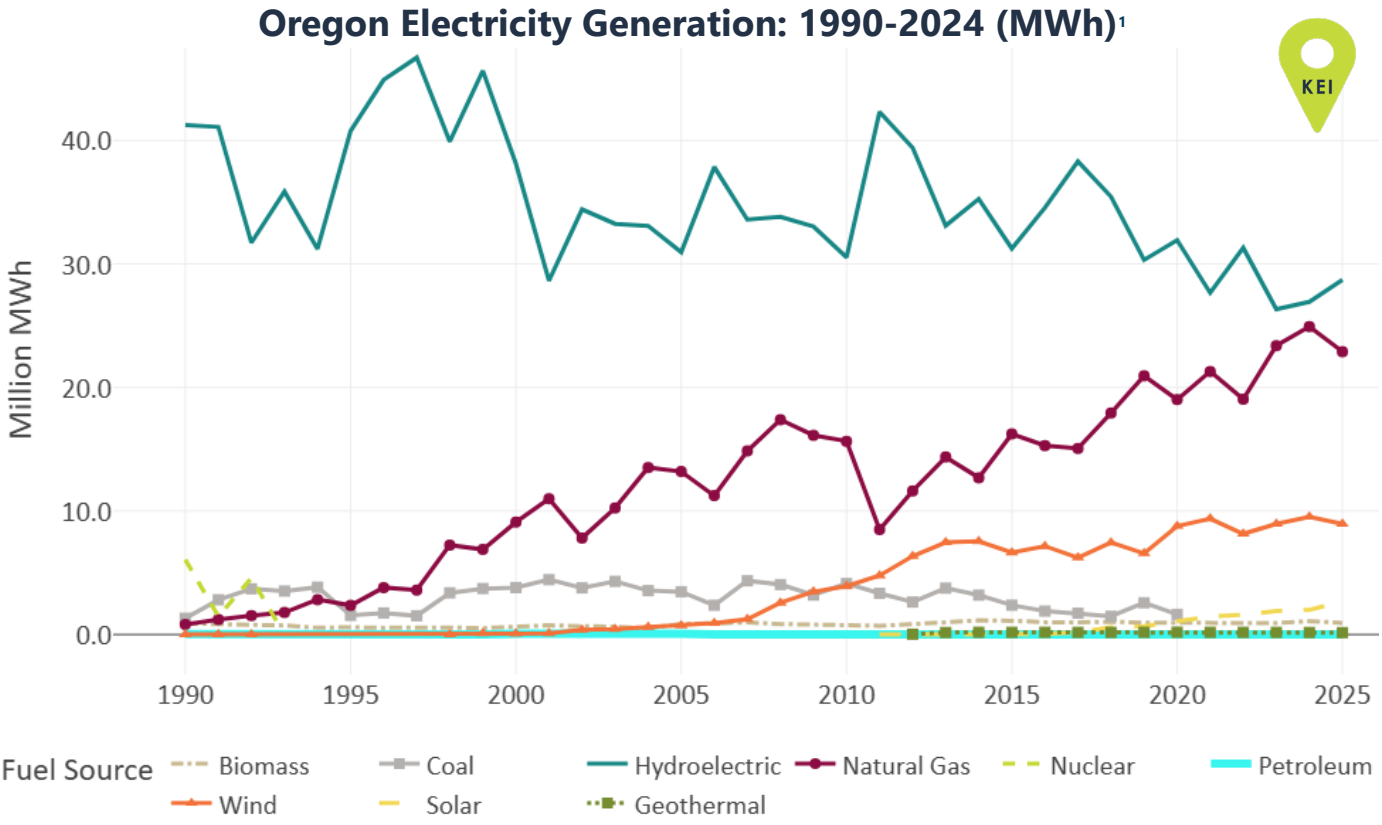
The map below shows the various electricity generation sources in the Western Electricity Coordinating Council.[6] The WECC is a nonprofit organization that focuses on system wide electricity reliability and security across a geographic region known as the Western Interconnection. This diverse region includes Oregon and most of the intermountain west and parts of Canada and Baja Mexico.



The maps of electricity generating resources are created using data from the U.S. Energy Information Administration and include facilities with a nameplate capacity of one megawatt or greater.[5] According to the EIA, nameplate capacity is defined as the maximum rated output of a generator, prime mover, or other electric power production equipment under specific conditions designated by the manufacturer. Installed generator nameplate capacity is commonly expressed in megawatts and is usually indicated on a nameplate physically attached to the generator. Not all resources or facilities shown on the map contribute to Oregon's overall fuel mix, but many are used when Oregon utilities purchase electricity on the open market. Similarly, electricity generated in Oregon may be sold through the energy market to support electricity needs in other states.

Electricity Over Time

Oregon's electricity generation has changed over the years. Hydropower, which is Oregon's largest electricity resource, varies year-to-year based on precipitation. Oregon hydropower reached a generation high of 46.7 million MWh in 1997 as shown in the chart below. Wind and natural gas have both seen a gradual increase in generation over time. In 2024, natural gas was the second largest share of Oregon's electricity generation, at 24.9 million MWh. Coal generation no longer occurs in Oregon, with the last coal generating plant closing in 2020. Solar has increased each year since 2011, and is expected to continue growing with several proposed large facilities in planning and review stages.[7]



Utility-scale Storage

There are several options for storing energy, including batteries and hydroelectric facilities. Many hydroelectric facilities store energy as water in reservoirs that can be released to flow through turbines when needed. When electricity demand is low, some of them can use their on-site electricity generation to pump water back upstream to be stored behind the reservoir until needed. Increasingly, utilities are also storing electricity in batteries, which can be sited alongside variable renewable resources like solar and wind. This helps utilities get more out of these resources by storing generation when demand is low and using them to supplement supply when demand is high. In 2025, Executive Order 25-29 established a goal of 8 GW of battery storage in Oregon by 2045.[8] As of September 2026, there are currently 9.4 GW of battery storage that have been built, are in construction, or being considered for siting approval by EFSC.[7]

Renewable Electricity

Renewable electricity generated in Oregon has grown due to customer demand, dramatic reductions in costs, and clean energy policies, like the Renewable Portfolio Standard and the 100 percent clean electricity by 2040 target set in House Bill 2021 (2021).[9] [10] Demand for clean energy in California also spurred prior wind development in Oregon – contributing to the large share of wind energy Oregon exports.[3]

Solar[11]

KEI

2016 Generation	2020 Generation	2022 Generation	2024 Generation
40,900 MWh	1,077,900 MWh	1,505,400 MWh	2,001,400 MWh



10.7% of Oregon's solar consumption was imported in 2024.[3]

Oregon has 1,150 MW of utility-scale solar facilities and 183 MW[i] of net-metered solar installations on homes and businesses.

Wind[12]

KEI

2016 Generation	2020 Generation	2022 Generation	2024 Generation
7.2 Million MWh	8.8 Million MWh	8.2 Million MWh	9.5 Million MWh[3]



48.5% of Oregon's wind generation was exported in 2024.[3]

Oregon has 3,863 MW of wind facilities in operation.[8]

Hydro[12]

KEI

2016 Generation	2020 Generation	2022 Generation	2024 Generation
34.6 Million MWh	31.9 Million MWh	31.3 Million MWh	26.9 Million MWh



21.4% of Oregon's hydropower generation was exported in 2024.[3]

In some Oregon utility service areas, hydropower provides over 90% of consumers' electricity.[4]

Oregon's hydropower resource fluctuates from year-to-year due to changing precipitation and water conditions.

i Rooftop solar capacity is provided in direct current, or DC megawatts.

Direct Use Fuels

Natural gas is Oregon's most consumed direct use fuel and almost all of it is imported. Biomass is the most produced direct use fuel in Oregon but makes up only 22.5 percent of total consumption in the state; most direct use fuels — consumed by the residential, commercial, and industrial sectors — are imported. In 2024, Oregon used 250.55 trillion Btu of direct use fuels, representing about 28 percent of the total energy consumed in Oregon.[1] While the majority of Oregon's primary energy production comes from energy sources like hydropower, wind, and solar electricity generation, Oregon also produces some direct use fuels.

100%

Percentage of Oregon geothermal energy consumption that is produced in-state.

28%

Percentage of Oregon overall direct use fuels consumption that is produced in-state.[1]

The table below shows a comparison of the direct use fuels produced in Oregon to how much is consumed by the residential, commercial, and industrial sectors. If energy is produced in Oregon and not consumed in state, the Oregon Department of Energy determines that energy was exported to support neighboring states' energy systems. If more of a specific energy resource was consumed than produced, it is assumed that it was imported into the state for consumption.

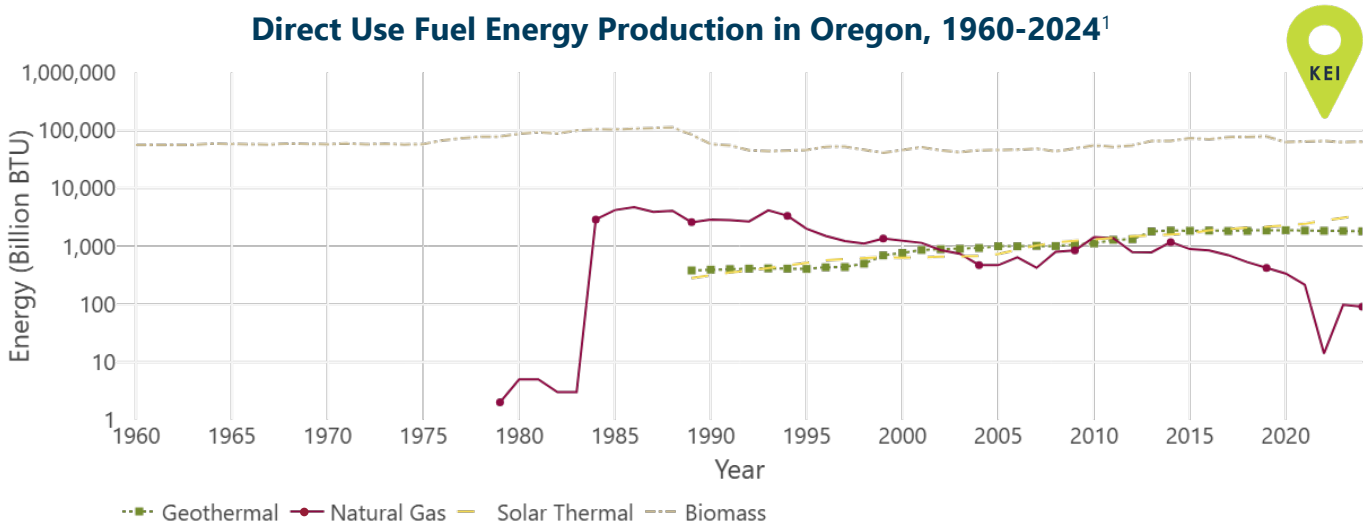
In 2024, Oregon produced approximately 63.72 trillion Btu of direct use fuels energy from biomass.[1] The U.S. Energy Information Administration collects and shares these high-level energy production and consumption estimates to inform Oregon's understanding of state and federal energy systems — but the data do not show where each Btu of energy is consumed. The data do not include agricultural biomass used to produce ethanol in Oregon, because it is typically used only as a transportation fuel.

Production & Consumption of Direct Use Fuels in 2024 (trillion Btu)[1]

Resource	Consumption in Oregon	Oregon Production	Imported	% of Consumption Produced in Oregon
Natural Gas	140.26	0.09	140.17	0%
Biomass	56.32	63.72	-7.4[i]	100%
Other Petroleum	23.61	0	23.61	0%
Heating Oil	17.82	0	17.82	0%
Hydrocarbon Gas & Liquids/ Propane	7.72	0	7.72	0%
Solar Thermal (for heat)	3.48	3.48	0	100%
Geothermal	1.23	1.23	0	100%
Coal	0.11	0	0.11	0%
Totals	**250.55**	**68.52**	**182.03**	**27%**

i Negative values in the imported column indicate that more energy was exported out of the state than imported into the state.

Direct Use Fuel Energy Production in Oregon, 1960-2024[1]



Like the Oregon Primary Annual Energy Production Over Time chart at the beginning of this section, the chart above uses a logarithmic scale to compare direct use energy produced in Oregon so that the natural gas, geothermal, and solar thermal resources can more easily be discerned. Although not an intended effect, this change in scale emphasizes changes in smaller resources like natural gas, solar thermal, and biomass, and deemphasizes changes in resources that constitute a larger proportion of the resources, like biomass.

Natural Gas. The Pacific Northwest's only natural gas production is located outside of Mist, northwest of Portland, and is owned and operated by NW Natural, one of three investor-owned natural gas companies serving Oregon. The Mist field produced about 84 million cubic feet of natural gas or 0.09 trillion Btu of energy in 2024.[1] The facility hit a production peak of 4.6 billion cubic feet in 1986, and since then production has steadily declined.[13]

The Mist facility is used to store natural gas sourced from outside Oregon for electricity generation and for customers served by the natural gas distribution system. NW Natural injects natural gas into underground rock formations for later use during cold weather events to help balance fluctuations in its pipeline system, and to reduce costs for customers by purchasing gas throughout the year when market conditions are favorable.

Renewable Natural Gas. Biogas must be cleaned up to be a substitute for fossil natural gas and often needs to meet stringent specifications required for injection into a natural gas distribution pipeline. Biogas is collected from landfills where it is produced from decaying municipal waste streams like food and garbage, from anaerobic digesters at wastewater treatment plants (waste and food), and at agricultural sites that process waste streams like manure.[14]

There are six RNG projects located in Oregon, and three are currently operational and able to inject RNG into natural gas pipelines.[15] [16] In 2018, the Oregon Department of Energy conducted an inventory of current and potential RNG facilities and estimated 4.5 percent of Oregon's total annual natural gas use could be replaced with RNG produced in the state. Production capacity could reach as high as 17.5 percent of annual use with future technological advancements in collection and processing.[17] In November 2021, the Metropolitan Wastewater Management Commission in Lane County became the first public agency in Oregon to collect and inject RNG into NW Natural's gas line. The biogas is collected and processed from a regional wastewater treatment plant in Eugene, Oregon.[18]



Solar Thermal. Solar thermal energy is a resource used directly to provide heat in Oregon homes and businesses. Solar thermal systems capture energy from the sun to provide water heating and space heating in buildings. Most solar thermal systems installed in Oregon are solar water heating systems that provide supplemental energy to residential water heaters, which can reduce water heating bills. In the last 10 years, residential solar water heating system installations have declined. Instead, more Oregonians are installing solar photovoltaic systems combined with energy efficient heat pump water heating systems as these combined systems have come down in cost.



Geothermal Energy. Direct use geothermal energy uses hot water or steam from reservoirs below the earth's surface piped to end users for water or space heating. Oregon produced 1.8 trillion Btu of geothermal energy in 2024, and 1.2 trillion Btu of it was consumed as a direct use fuel.[1] For decades, the City of Klamath Falls and the Oregon Institute of Technology Klamath Falls Campus have used geothermal heat sources to heat buildings, residences, pools, and sidewalks.[19] [20] Schools and hospitals in Lakeview use a geothermal well system to heat some buildings.[21] The geothermal energy not used as a direct use fuel is used to generate electricity.

Other examples of direct use of geothermal heat in the state include drying agricultural products, aquaculture (raising fish), heating greenhouses, and heating swimming pools. There are more than 2,000 thermal wells and springs delivering direct heat to buildings, communities, and other facilities in Oregon. The U.S. Department of Energy ranked Oregon as the state with the third highest geothermal potential, behind only Nevada and California.[2]



Biomass, Wood Pellets, and Charcoal Briquettes. Biomass energy is from plants and plant-derived materials, including wood, wood waste, wood pellets, and charcoal briquettes. Residual materials or waste from forest harvest and mill operations are converted into useful retail products. Wood and wood waste biomass have been Oregon's largest direct fuel production source since 1960. In 1988, wood and wood waste production hit a high of 113 trillion Btu. Thirty-six years later, Oregon's production was 63.7 trillion Btu — a 44 percent decrease.[1] In Oregon, the industrial sector is the largest producer and consumer of biomass energy. Eleven woody biomass facilities use biomass to generate electricity used onsite and sold to other businesses in Oregon, primarily in the wood-products industry.[22] Wood is also produced and consumed as firewood to heat homes — after industrial, the residential sector is the second largest consumer of wood energy in Oregon.[1]

Wood pellets are manufactured from timber waste and used for residential and commercial heating. Biomass Magazine lists five wood pellet plants in Oregon, with an annual production capacity of 207,500 metric tons per year.[23] Charcoal briquettes and cooking pellets also use timber waste to create a fuel source for cooking; wood waste is burned in the manufacturing process as the products are heated up to remove moisture. Springfield, Oregon, is home to one of Kingsford's five charcoal briquette manufacturing plants in the U.S. The facility has 90 local employees, is on a 40 acre site, and has been in operation for over 50 years.[24] [25]

Transportation Fuels

Only 1.6 percent of the 323 trillion Btu of energy Oregonians consumed for transportation in 2024 was produced in state.[26] Oregon does not produce or refine any petroleum-based transportation fuels, but does produce 36 percent of the ethanol that is blended into the gasoline used.[26] Though still a small fraction of the total transportation fuels, electricity use for transportation is growing in Oregon. The state consumed 1.38 trillion Btu of electricity in 2024 for transportation, or about 0.44 percent of total transportation fuel consumption.

5%

Biodiesel blend is used in most heavy-duty vehicles both on and off the highway.[27]

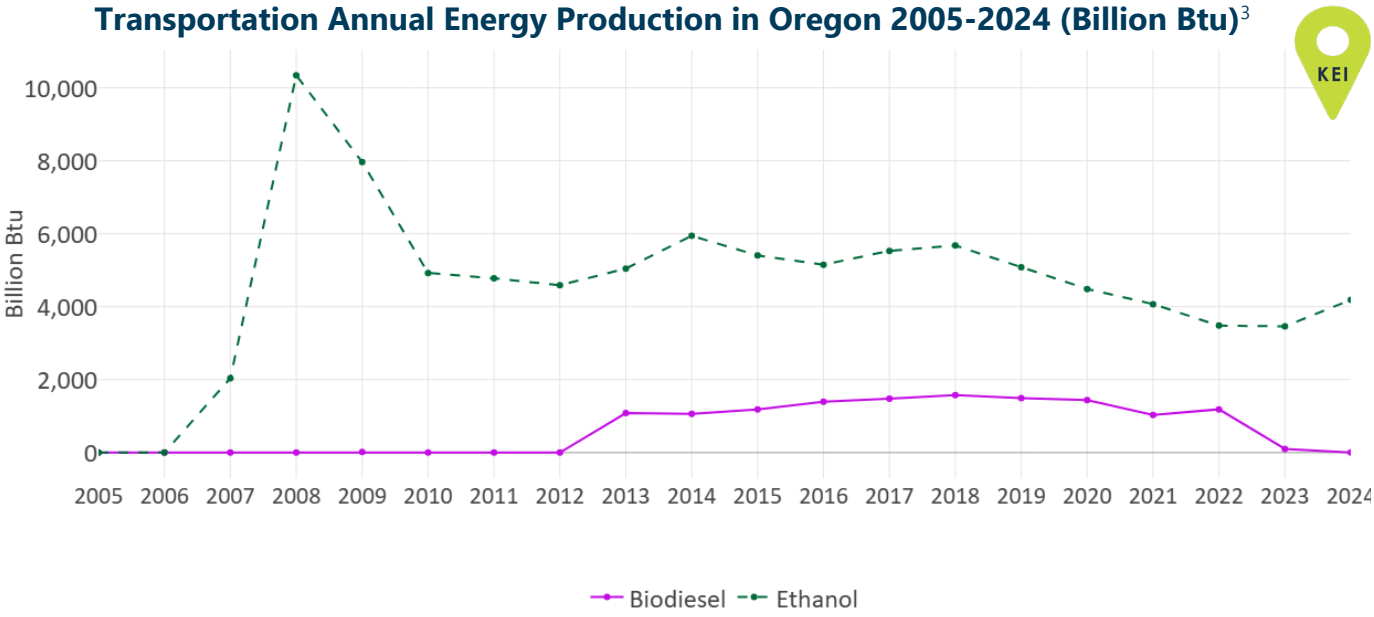
10%

Ethanol blend fuel is used in a majority of light-duty vehicles in Oregon.[27]

Production & Consumption of Transportation Fuels in 2024[26] (Trillion Btu)

Resource	Consumption in Oregon	Oregon Production	Imported	% of Consumption Produced in Oregon
Gasoline	156.8	0	156.8	0%
Diesel	74.16	0	74.16	0%
Jet Fuel	26.1	0	26.1	0%
Renewable Diesel	21.1	0	21.1	0%
Fuel Ethanol	11.6	4.2	7.4	36%
Asphalt & Road Oil	10.88	0	10.88	0%
Biodiesel	9.16	0	9.16	0%
Lubricants	1.04	0	1.04	0%
Electricity	1.38	0.84	0.54	61%
Bio-Compressed Natural Gas	0.5	0	0.5	0%
Aviation Gasoline	0.32	0	0.32	0%
Liquid Propane Gas/ Propane	0.22	0	0.22	0%
Renewable Propane	0.00	0	0.00	0%
Natural Gas	<0.01	0	<0.01	0%
Hydrogen	<0.01	0	<0.01	0%
Totals	**313.26**	**5.04**	**308.22**	**1.6%**

Transportation Annual Energy Production in Oregon 2005-2024 (Billion Btu)[3]



Ethanol. Oregon began producing fuel ethanol in 2007 and had its largest production year in 2008 with 10.3 trillion Btu of energy created. In 2024, Oregon produced 4.2 trillion Btu of ethanol.[1] Oregon has one commercial ethanol producer — Alto Ingredients' Columbia Dry Mill and Distillery in Boardman (previously known as Pacific Ethanol). Carbon dioxide emissions from the plant are captured and used by the food and beverage industry, turning emissions into a beverage-grade liquid used to carbonate soft drinks and make dry ice.[28]

Biodiesel. The U.S. Energy Information Administration began tracking Oregon biodiesel production in 2013. Oregon no longer produces biodiesel in the state. In January 2024, SeQuential Pacific Biodiesel was acquired by Neste Corporation and has been merged with Mahoney Environmental.[29] The company continues to collect used cooking oils in Oregon as a feedstock for renewable diesel produced at a facility in Martinez, California.[30]

Electricity. Increasingly, more zero-emissions vehicles – fully battery electric or plug-in hybrids that can use both electricity and petroleum – are operating in Oregon.[31] Historically, Oregon has imported almost all of the fuel consumed in the transportation sector.[1] As electric vehicle adoption increases, more of the money Oregonians spend on transportation fuels will remain in the state economy because many electricity jobs and investments are located in Oregon.



The State of Oregon and Portland General Electric partnered to host a Fleet Forward Electric Ride and Drive event at Portland International Raceway in September 2026, offering the broader Oregon fleet electrification community the opportunity to get behind the wheel of the latest electric trucks and vans on the market.

Energy Facility Siting in Oregon

Oregon's Energy Facility Siting Council is a governor-appointed body that oversees the siting of energy facilities in the state and is staffed by the Oregon Department of Energy. The types and sizes of energy projects subject to EFSC jurisdiction have changed over time. While the bulk of applications have been for electric generation projects, EFSC has also reviewed site certificate applications for electrical energy transmission, pipelines, nuclear research reactors, ethanol production, liquified natural gas storage, and many others. More recently, EFSC has reviewed battery storage as part of other energy projects. EFSC also has ongoing responsibility for approved sites, including monitoring projects going into construction and operation, and reviewing site certificate amendment requests.

65

Total number of site certificates issued by EFSC — **45** are for facilities that are either operating, under construction, or have the appropriate state approvals to begin construction.[1]

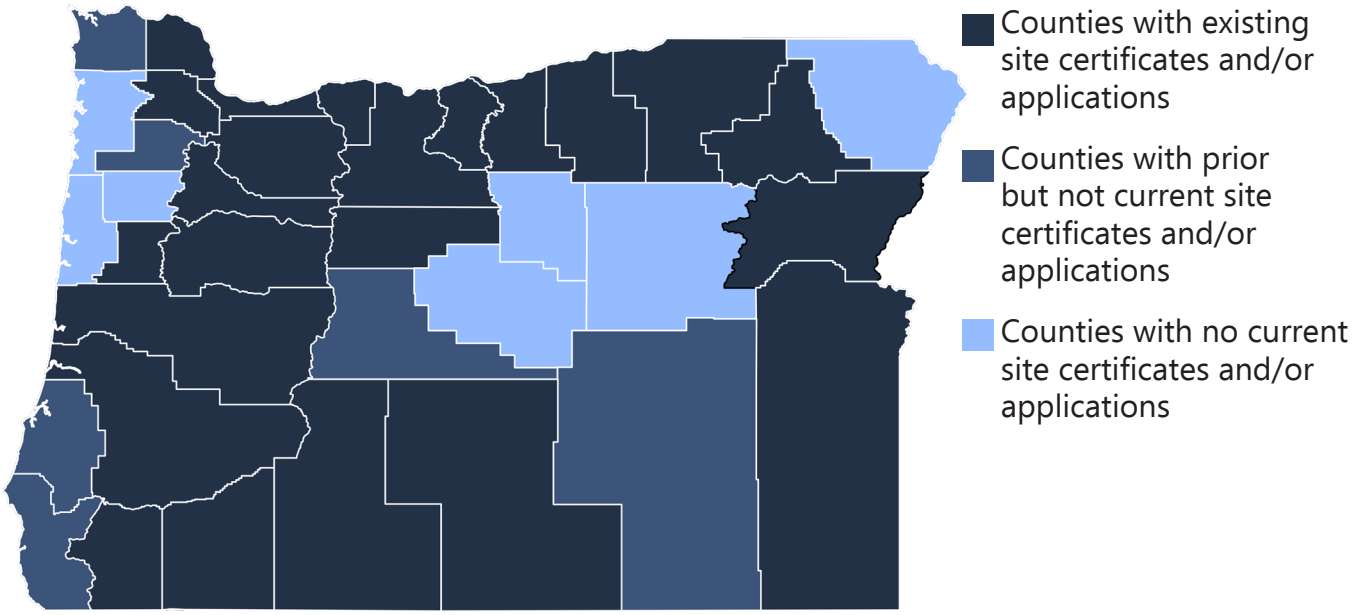
30 Gigawatts

Total capacity of electricity energy generation facilities that have been approved by EFSC.[1]

14.7 Gigawatts

Total capacity of renewable electricity generation under EFSC review, approved to begin construction, under construction, or operating.[1]

Oregon Counties with State Jurisdictional Energy Projects



Site Certificate — under ORS 469.300(26) — means the binding agreement between the State of Oregon and the applicant, authorizing the applicant to construct and operate a facility on an approved site, incorporating all conditions imposed by EFSC on the applicant.

EFSC Jurisdiction Renewable Electricity Projects (Megawatts) [2]

Active

Status	Wind	Solar	Geothermal	Hydro	Battery*	Total MW*
Operational	2,919	412	-	-	56	3,331
In Construction	0	296	-	-	185	296
Approved	440	3,396	-	-	2,983	3,836
Under Review	1,578	5,634	-	-	6,143	7,212
Subtotal	**4,937**	**9,738**	**-**	**-**	**9,367**	**14,675**

Inactive

Status	Wind	Solar	Geothermal	Hydro	Battery*	Total MW*
Approval Expired	1,034	120	35	-	70	1,189
Decommissioned	-	-	-	-	-	-
Denied	-	-	-	80	-	80
Withdrawn	2,646	2,460	180	200	2,701	5,486
Subtotal	**3,680**	**2,580**	**215**	**280**	**2,771**	**6,755**

Total MW	**8,617**	**12,318**	**215**	**280**	**12,138**	**21,430**

**Standalone battery energy storage system projects are not state jurisdictional. Storage values provided above include storage approved by EFSC that was part of a larger site approval but are not included in the Total MW reported. ORS 469.320(8)(a)(C) allows developers to opt in to EFSC siting approval, but no projects have yet to opt into state jurisdiction.*

Klondike III Wind Project operating in Sherman County



EFSC Jurisdiction Non-Renewable Electricity Projects (Megawatts)[1 2]

Active

Status	Coal	Nuclear	Natural Gas	Other	Total MW
Operational	-	-	3,237	51	3,288
In Construction	-	-	-	-	-
Approved	-	-	-	-	-
Under Review	-	-	-	-	-
Subtotal	**-**	**-**	**3,237**	**51**	**3,288**

Inactive

Status	Coal	Nuclear	Natural Gas	Other	Total MW
Approval Expired	109	5,040	3,636	38	8,823
Decommissioned	550	1,130	415	-	2,095
Denied	-	-	-	-	-
Withdrawn	431	-	5,147	109	5,687
Subtotal	**1,090**	**6,170**	**9,198**	**147**	**16,605**

TOTAL MW	**1,090**	**6,170**	**12,435**	**198**	**19,893**

EFSC Jurisdiction Non-Electricity Generation Projects (Number) — Part 1[1 2]

Active

Status	Research Reactors & ISFSI*	Electric Transmission Line	Natural Gas Storage	Liquefied NG Storage	Total Projects
Operational	3	1	1	-	5
Under Construction	-	1	-	-	1
Approved	-	0	-	-	-
Under Review	-	2	-	-	2
Subtotal	**3**	**4**	**1**	**-**	**8**

Inactive

Status	Research Reactors & ISFSI*	Electric Transmission Line	Natural Gas Storage	Liquefied NG Storage	Total Projects
Withdrawn	-	1	-	2	3
Subtotal	**-**	**1**	**-**	**2**	**3**
Total	**3**	**5**	**1**	**2**	**11**

**Portland General Electric's Independent Spent Fuel Storage Installation Facility at decommissioned Trojan Power Plant.*

Non-Electricity Generation EFSC Projects Summary (Number) — Part 2[1 2]

Active

Status	Natural Gas Pipeline	Ethanol Production	Total Projects
Operational	2	1	3
Approved	-	-	-
Under Review	-	-	-
Subtotal	**2**	**1**	**3**
Total MW	**2**	**2**	**4**

Inactive

Status	Natural Gas Pipeline	Ethanol Production	Total Projects
Withdrawn	-	1	1
Subtotal	**-**	**1**	**1**
Total MW	**2**	**2**	**4**

Energy Costs & Economy

What We Spend

In 2024, Oregon spent $18.9 billion on energy. This is less than the $19.4 billion spent in 2022, primarily due to reductions in transportation fuel costs which had risen sharply during the COVID-19 pandemic. Despite this, energy costs have largely increased in the last decade as Oregon's population and economy have grown.[1] Oregon's per capita energy expenditures rose from an estimated annual consumer cost of $3,736 in 2014 to $4,439 in 2024, an increase of $703.[i] Energy expenditures include electricity and fuel for homes and businesses, industrial energy uses, and petroleum used in the transportation sector.

Since 2014, Oregon is spending $2.5 billion more on electricity and $1.3 billion more on petroleum fuels annually. Transportation accounts for about half of our state's energy expenditures and sees the largest swings in price due to volatile global and regional petroleum fuel markets. This variability in transportation fuel costs is the primary driver for fluctuations in Oregon's total energy expenditures. In 2024, Oregonians spent over $9.5 billion on transportation fuels and most of it went to other states and countries where extraction, processing, and refining of transportation fuels occurs.[1]

$18.9 billion

Amount Oregonians spent on energy in 2024, over 57 percent more than the amount in 2020.[1]

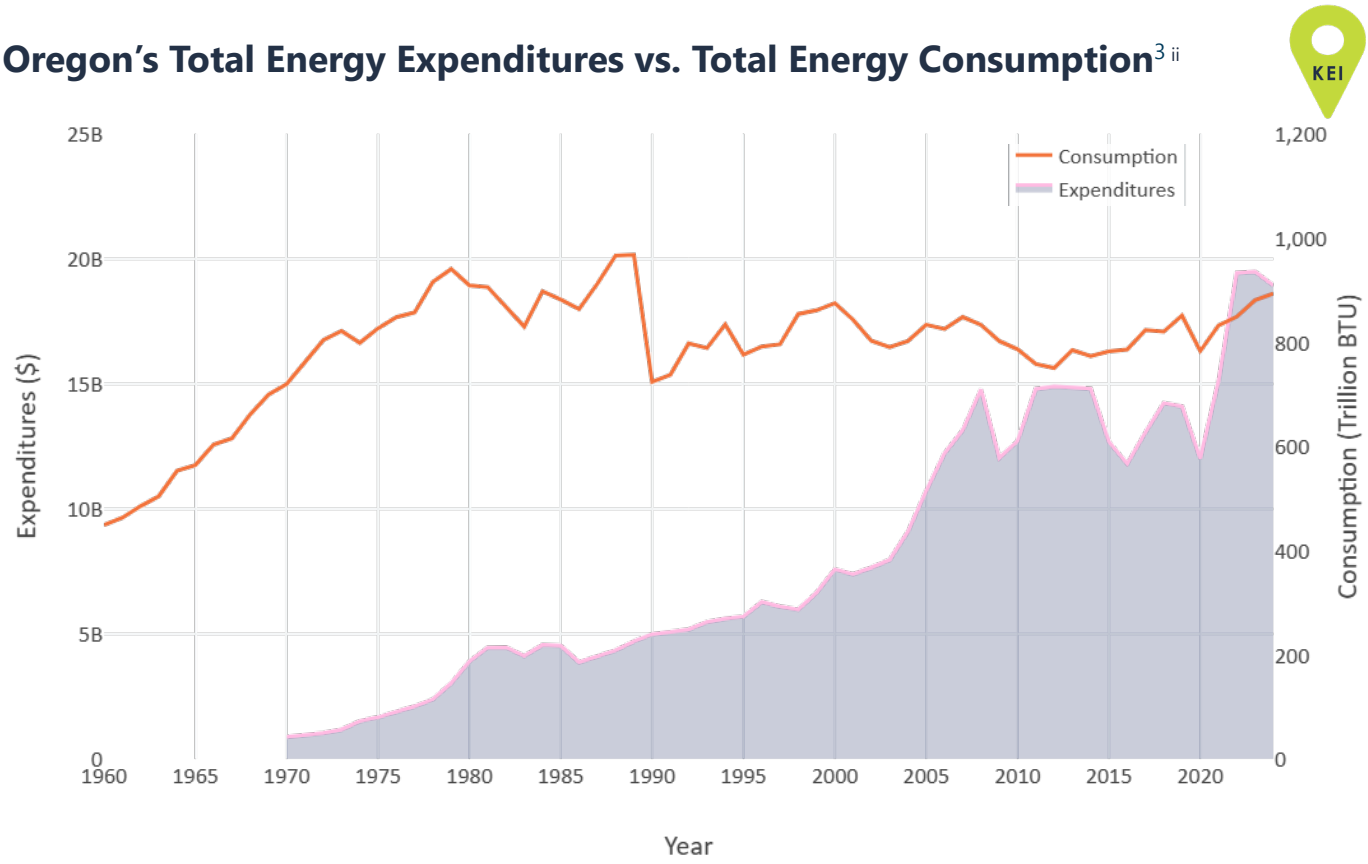
14.86 cents

Oregon's average residential retail price per kilowatt hour of electricity for 2022.[2]

5.73%

Percentage of Oregon's GDP spent on energy in 2024.[1]

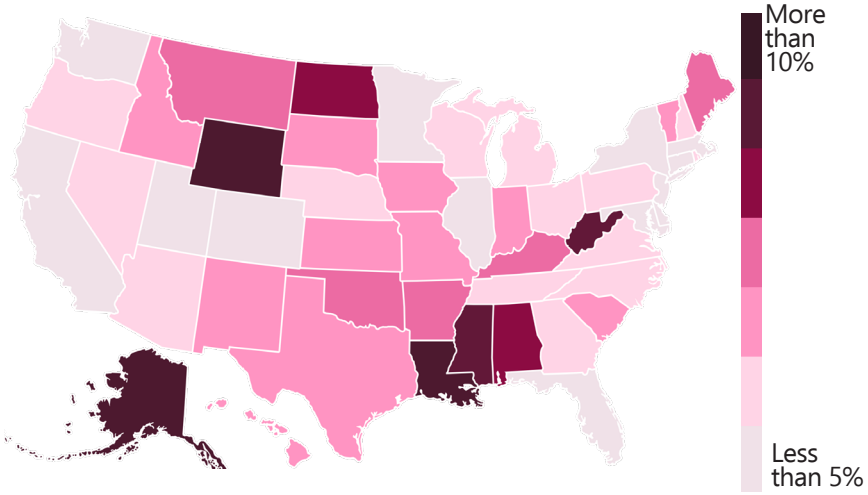
Oregon's Total Energy Expenditures vs. Total Energy Consumption[3] [ii]



i Estimates are in 2026 dollars and not adjusted for inflation over time.
ii Figures show expenditures in nominal dollars, which are not adjusted for inflation.

Oregon's energy expenditures as a percentage of the state's gross domestic product was 5.73 percent in 2024, which is above the 5.15 percent national average.[1]

State Total Energy Expenditures as a Percentage of State Gross Domestic Product (2024)[1]

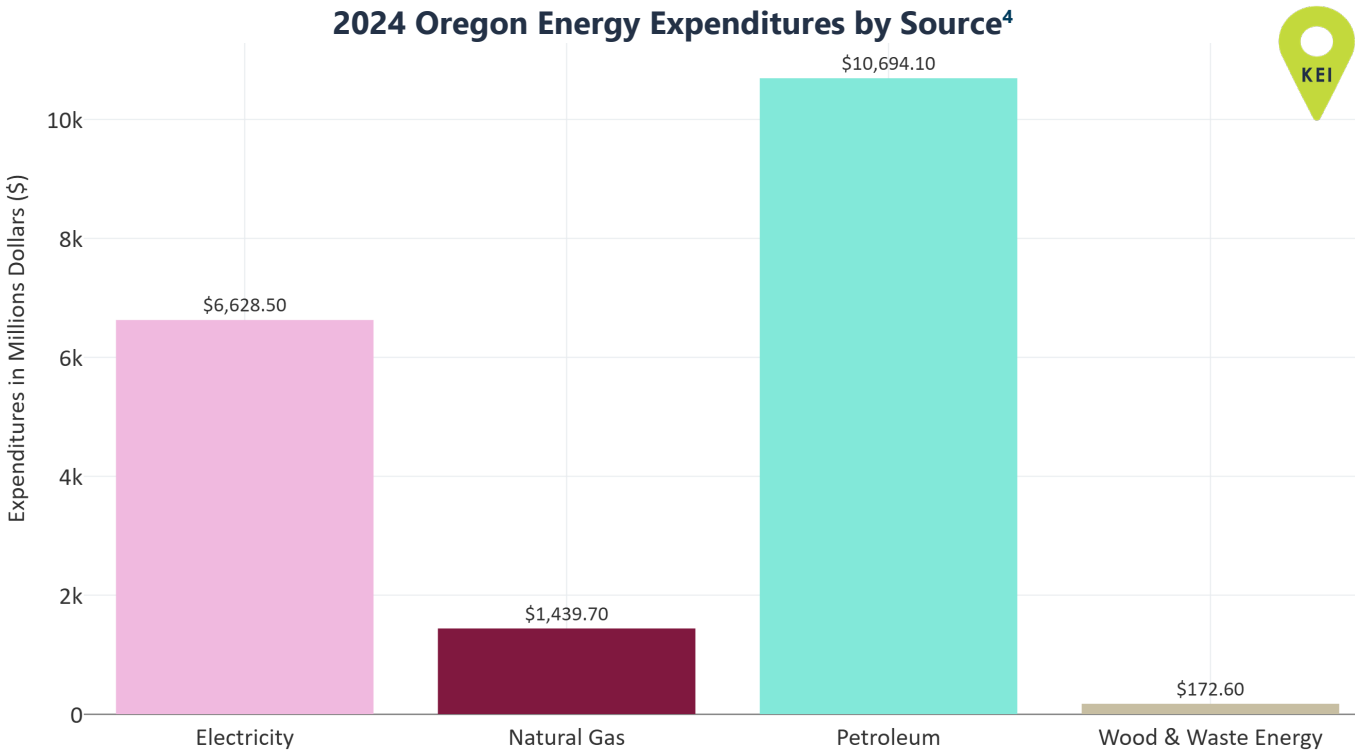


Oregon Energy Expenditures by Source

Oregon's industrial, commercial, residential, and transportation sectors spent over $18.9 billion on energy from petroleum, electricity, natural gas, wood, waste, and some coal in 2024.[1]

The petroleum category is dominated by transportation fuels. The transportation sector accounts for over half of all energy expenditures mainly for petroleum products, though it also includes some natural gas and electricity expenditures. Unlike these energy commodities, which are subject to regulation by the Oregon Public Utility Commission, petroleum product prices are unregulated and experience a high level of price volatility. The price per unit of energy of petroleum products may rise and fall over the short periods of time, but Oregonians are spending more on transportation fuels over the long term. In 2024, Oregon spent $1.3 billion more on petroleum products than in 2014.[1] This trend is expected to continue, and with elevated gas and diesel prices throughout much of 2026, it is likely overall energy expenditures in Oregon will rise over the next two years.

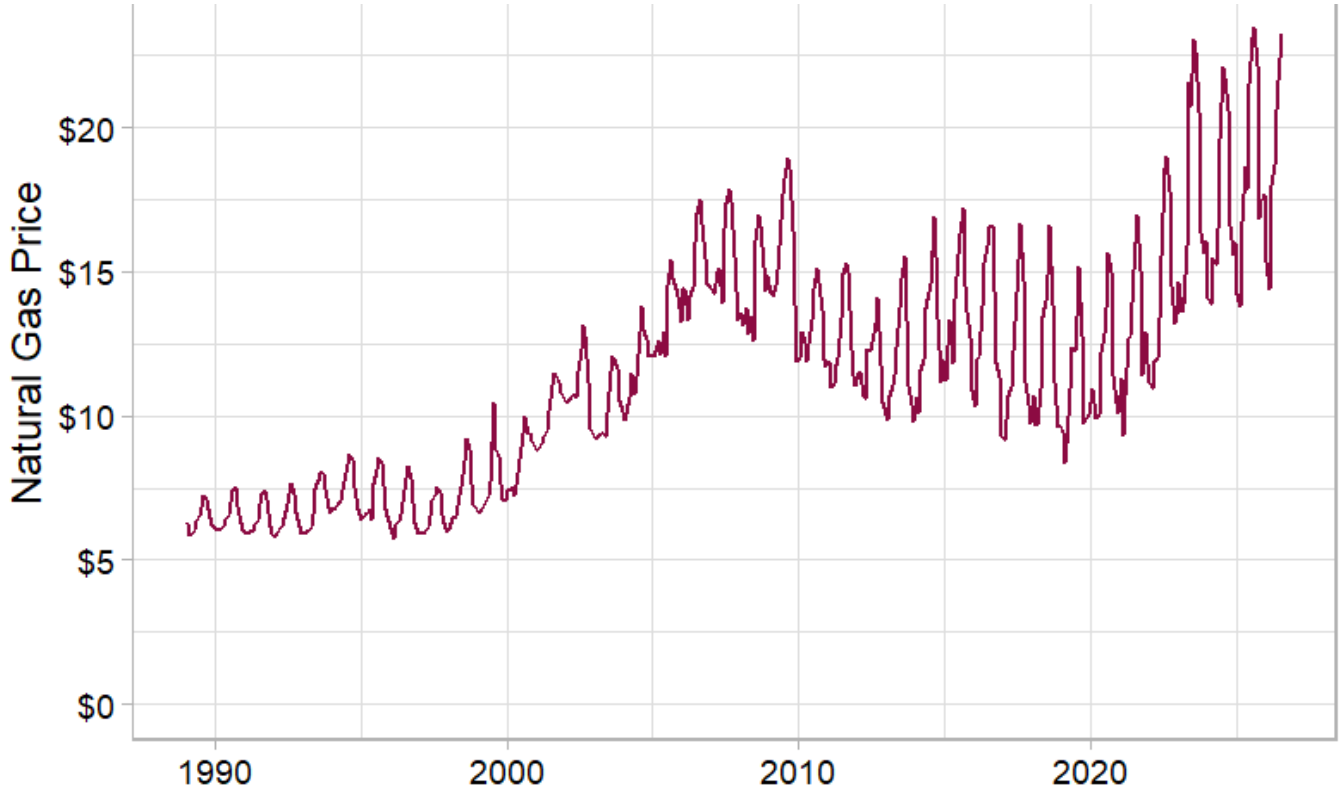
2024 Oregon Energy Expenditures by Source[4]



The average price of electricity increased slowly from 2020 through 2024, but regulation of retail rates by the OPUC and local governing boards of consumer-owned utilities keeps retail electricity prices from being as volatile as transportation fuel costs. Since 2022, many electric utility customers have seen rate increases, with the highest increases for investor-owned utility customers.[5]

Natural gas expenditures constitute a smaller portion of total consumer energy expenditures in Oregon, primarily because not all people and businesses use natural gas. Natural gas retail prices are also regulated by the OPUC, and like electricity prices, have increased since 2020.[2] Customers have faced higher retail prices due to a variety of factors, including higher natural gas supply costs.[6] Investments in energy efficiency, low-carbon alternative fuels, and other options to decarbonize Oregon's existing natural gas system could increase the cost of doing business for utilities and contribute to future retail rate increases.[7] [8]

Oregon Price of Natural Gas Delivered to Residential Consumers over time[9]



Home Energy Burden

The Oregon Energy Wallet

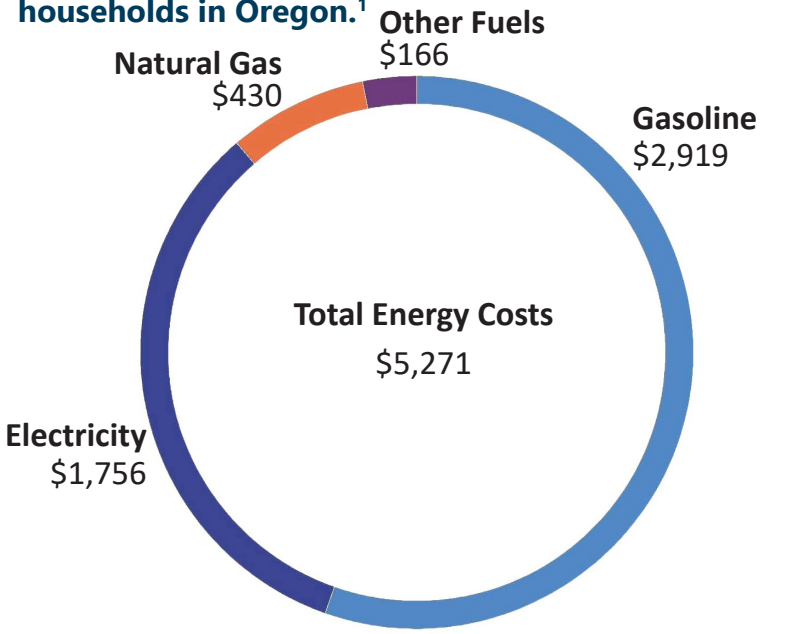
An energy wallet provides a high-level view of what the average household is spending on energy sources in a year. These expenditure averages consist of utility bills for electricity and gasoline for transportation (including electricity used for charging electric vehicles at home), the purchase and delivery of propane and natural gas, and costs associated with solar installation and operation. These average costs create a picture of what Oregonians spend on energy and provide insight into how changes in energy costs affects household budgets.

In 2024, Oregon residents spent an average of $5,271 per year on energy-related expenses. Of those costs, electricity accounted for an average of $1,756 per year, natural gas an additional $430, and other fuels (propane, fuel oil, solar etc.) accounting for $166. However,

the largest energy-related expense for Oregonians is gasoline sales for transportation purposes, accounting for approximately $2,919 per year across households in the state, or 55 percent of all energy costs.[1]

The Oregon Energy Wallet data provide insight into the percentage of income dedicated to energy costs and how that may affect Oregonians' budgets. However, to better understand the effect of energy expenditures on household finances, average household energy expenditures are compared against average income, which provides the commonly used metric of energy burden.[iii]

2024 Average annual energy costs for single family households in Oregon.[1]



Effects of global energy market conditions on Oregon's economy

The costs of transportation fuels influence the costs for goods and services that rely on those fuels. Gasoline and diesel are important energy sources for the transportation of goods and commodities, as well as people. Fuel prices rose in 2026, and if they remain elevated, Oregon residents can expect to pay more for fuel in 2026. Stanford University estimates that the average U.S. household will pay an additional $857 in 2027, but since Oregon fuel prices are higher than the national average, Oregonians are likely to pay more. Jet fuel prices have increased by approximately 75 percent. Fuel costs account for roughly 30 percent of total airline operating costs, which are likely to translate into higher prices for travelers. Higher diesel prices raise costs for agricultural production and transportation, which affect prices for food and goods. This volatility in the fuel energy market presents an ever-growing challenge for Oregonians and Oregon businesses and industry. It is particularly challenging for lower-income families, who must dedicate an ever-increasing portion of their total income to energy expenditures.[8]

Oregon households earning the median income ($83,011 per year in 2024 based on an average household size of 2.42) spend 6.34 percent of their total income on energy expenditures.

This increases dramatically to 13.19 percent for households living at or below the poverty line ($39,950 per year), though energy use for these households may be substantially different from the average.[1 2] A household is considered energy burdened if 6 percent or more of their income was dedicated to energy expenses and severely burdened at 10 percent.[3]

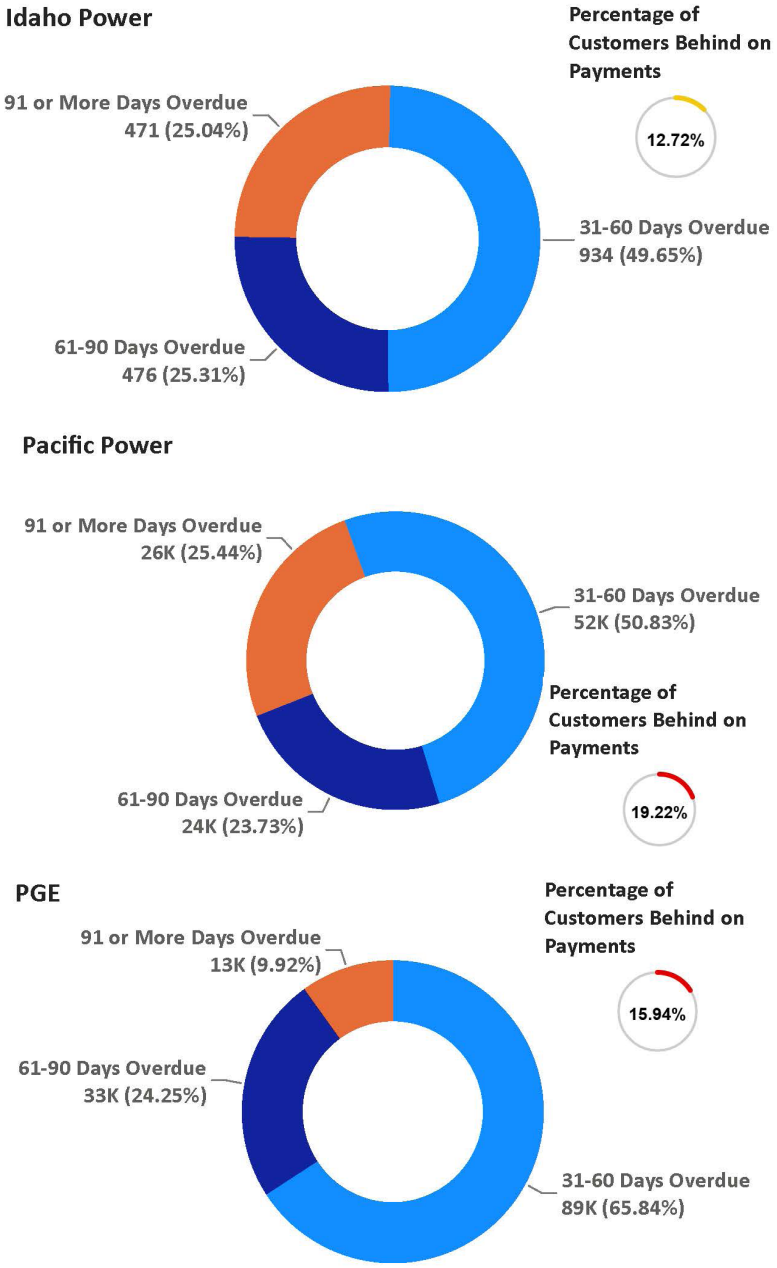
iii The energy wallet used for this discussion estimates average household energy expenditures by calculating total energy costs across all types of energy used in the state and normalizing that value to the level of the household. It does not examine the average energy use of a representative household, which varies significantly in the amounts and types of energy used. See https://energywallet.epri.com/en/current.html for a more thorough discussion of the metric.

Analysis of current data finds that all Oregonians at or below median income would be classified as "energy burdened." While it should be noted that previous energy burden analysis did not include transportation fuels, including these costs allows for a more complete picture of total household energy expenditures. These energy burden statistics demonstrate the disproportionate effect of energy costs on lower income households and highlight the increasing need for affordable efficiency and energy solutions for those who need them most. Additionally, for those residents unable to afford these high energy costs, many face falling behind on payments or the threat of disconnection due to non-payment. High energy costs can also lead to residents choosing between paying energy bills or purchasing everyday necessities like food, childcare, medical expenses, clothing, etc.

Investor-owned utility data submitted to the Oregon Public Utility Commission provide greater insight into the challenges emerging from high energy costs. In March and April 2026, 15.96 percent of reporting electric utility customers and 8.08 percent of reporting natural gas utility customers were declared in arrears and behind on payments (300,363 customers in total). Of those customers, 7,123 experienced utility disconnection due to non-payment, and 110,443 received disconnection notices. Additionally, some Oregon households take part in utility discount programs, and 253,070 customers were reported to have received a discount on their bills.[7]

Taken with the Oregon Energy Wallet, the number of Oregonians reliant on bill discount programs and facing either arrears or disconnection suggests energy affordability remains a significant challenge for Oregon residents, especially those at or below the federal poverty line.

March and April 2026 IOU Electric Utility Energy Burden Data[7]



The Oregon Energy Strategy identified energy efficiency as one of the cheapest and best energy resources available. By identifying households with high energy burdens and prioritizing them for investment, energy efficiency can be an effective solution in reducing overall home energy consumption.

Water, sewage, and waste removal are additional costs often associated with utility/energy expenses. On average, a household in 2026 can expect to pay $1,735 per year in non-energy related, basic utility costs.[4–6]

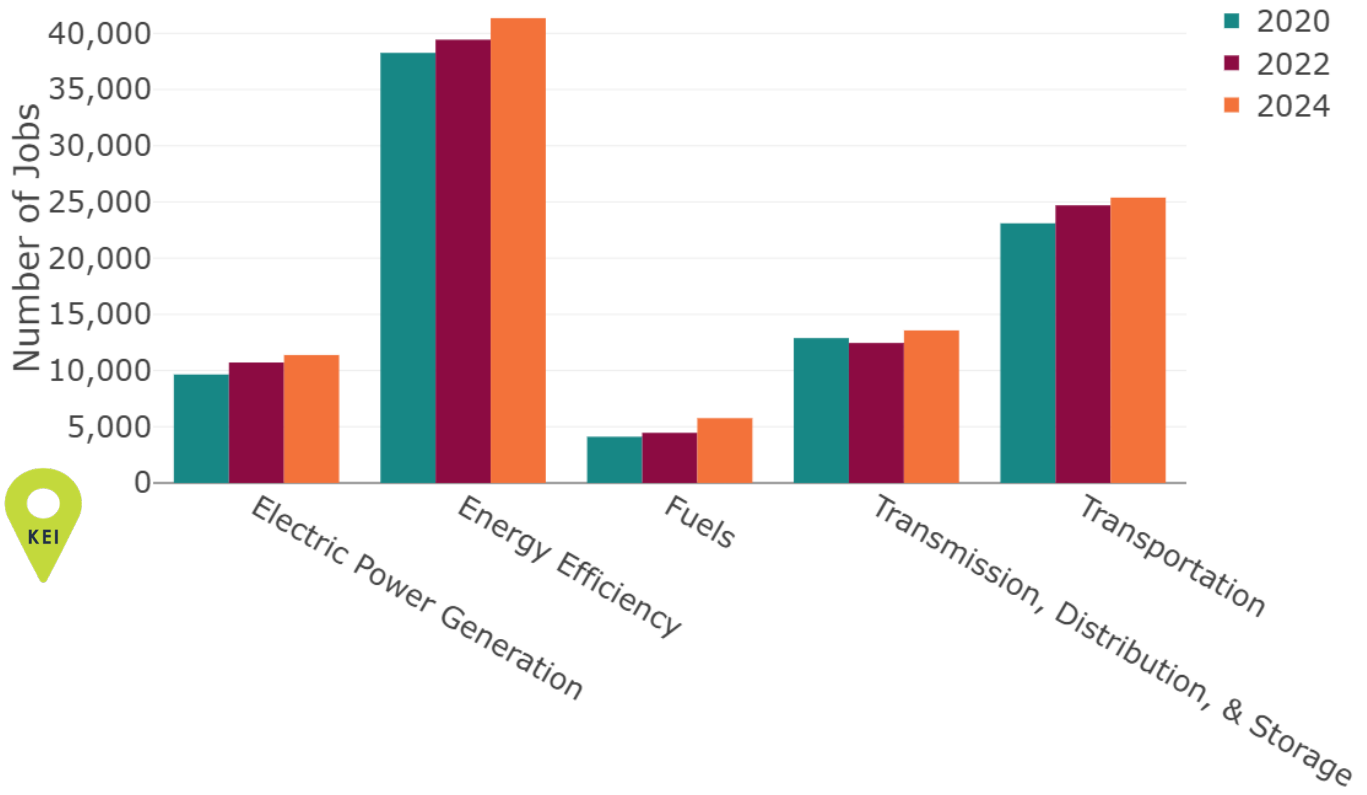
Energy Jobs

Oregonians hold many different types of jobs in the energy industry — from energy utility workers to wind turbine technicians to HVAC[iv] installers.

Energy employment is often sorted into energy efficiency, traditional energy, and transportation sector jobs. In Oregon, most energy-industry employees work in energy efficiency, including high-efficiency and traditional HVAC, and renewable heating and cooling firms, in addition to other specialized areas. Traditional energy jobs include power generation, transmission, distribution, and storage as well as jobs related to the extraction, processing, production, and distribution of fuels. Transportation jobs include the manufacturing and distribution of parts for gasoline as well as plug-in hybrid, battery electric, and hydrogen fuel cell vehicles for all industries from large scale industrial vehicles to small recreational vehicles such as golf carts.

There were 97,466 Oregonians employed in the energy industry in 2024.

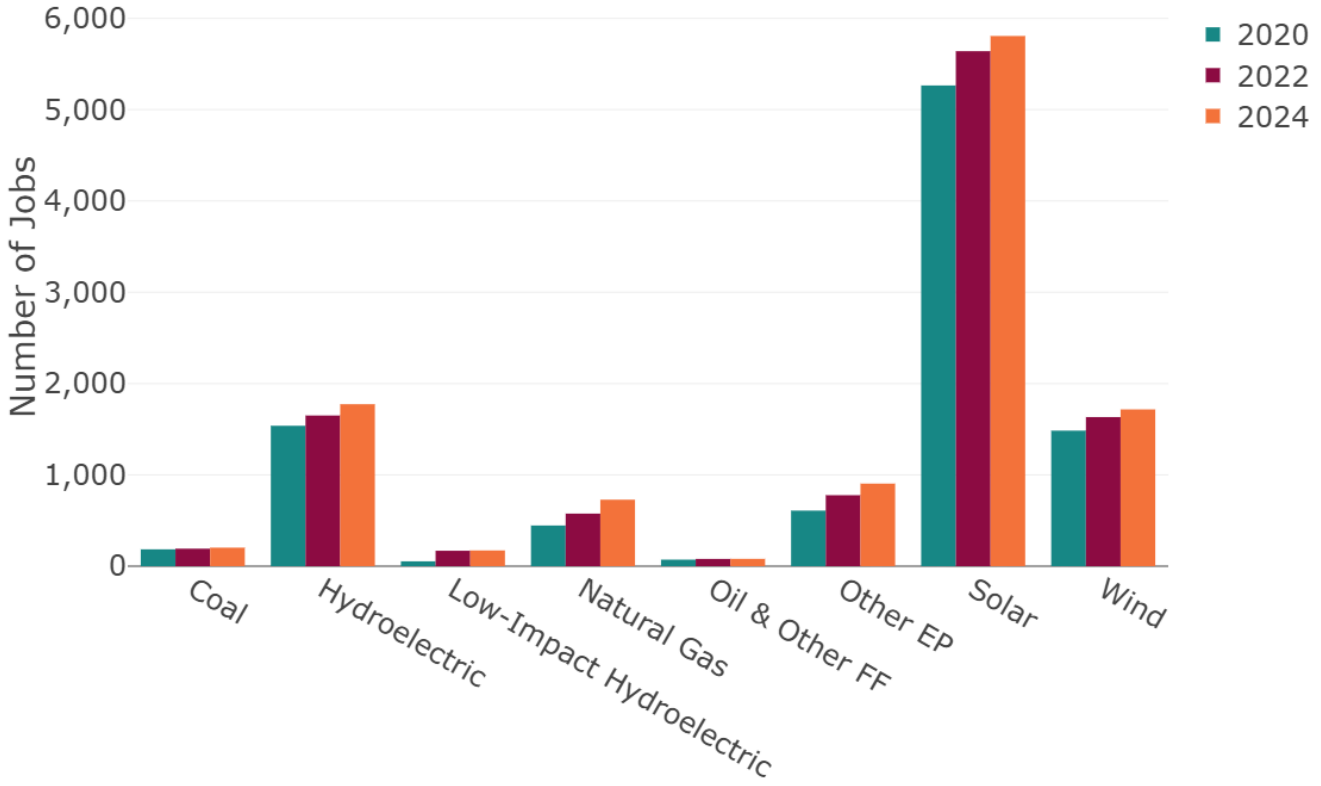
Number of Energy Jobs in Oregon by Type (2020, 2022, 2024)[10 11]



The electric power generation sector in Oregon employed 11,917 workers in 2024, an increase of 1,200 jobs from 2022.[10 11] In 2024, there were 5,807 Solar jobs in Oregon – 167 more than 2022. In Oregon, the solar industry has rapidly expanded since the early 2000s due to many factors, including solar potential, previous incentive programs, and clean energy policies in the state. In 2024, hydroelectric generation and wind energy provided 1,774 and 1,717 jobs, representing gains of 124 and 84 jobs from 2022, respectively.

iv HVAC stands for heating, ventilation, and air conditioning.

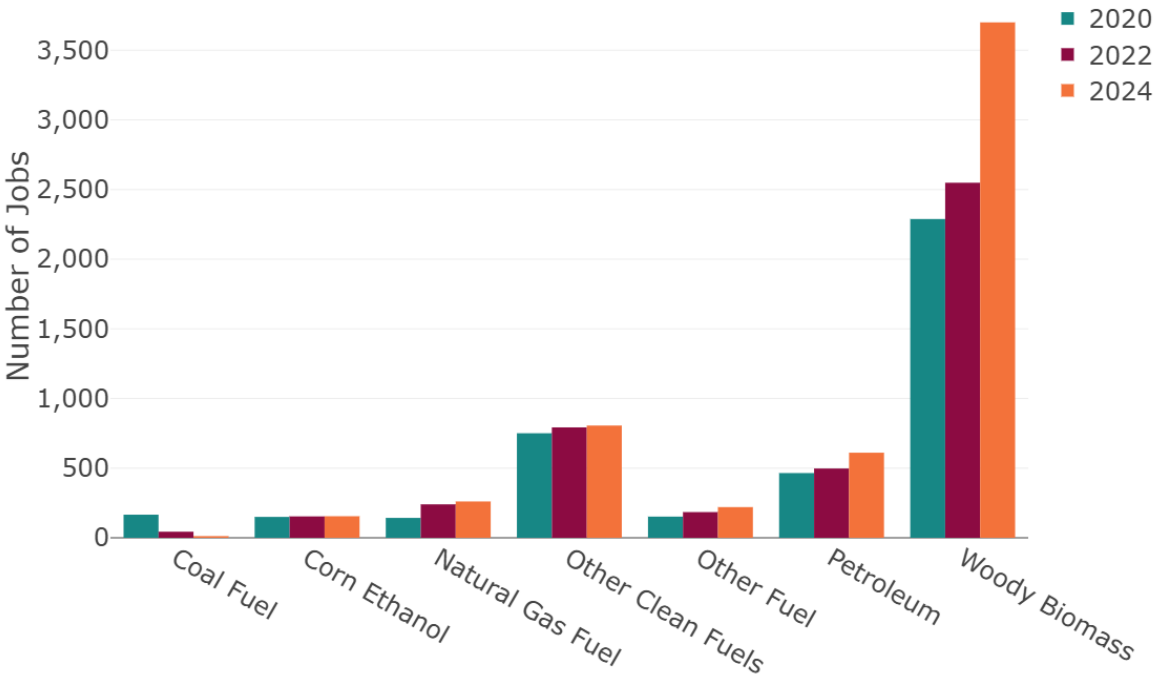
Electric Power Generation Jobs in Oregon by Technology (2020, 2022, 2024)[10 11]



The fuels sector in Oregon employed 5,234 workers in 2024, 773 more than 2022.[10 11] Fuel jobs are positions involved in the extraction, processing, production, or distribution of specific energy sources that are combusted or spent to generate electricity, produce heat, and power transportation. For example, natural gas jobs include all work associated with extracting and preparing it for use, generating fuel products from it, and transporting it to end users.

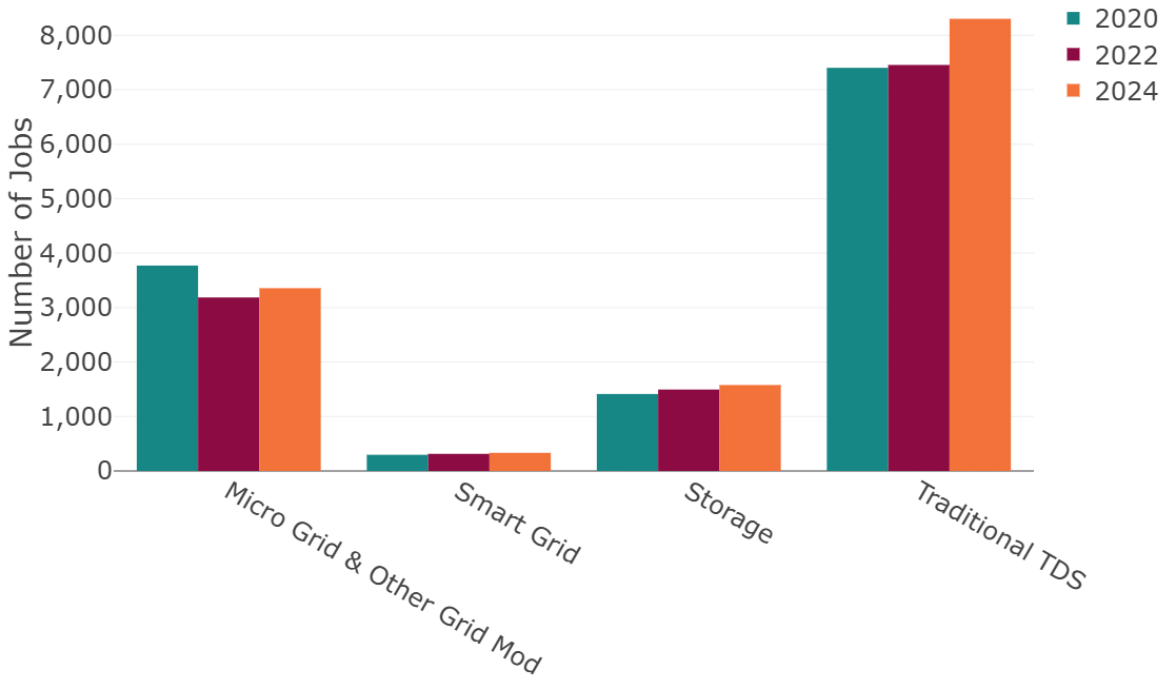
More than half, or 3,700, of the fuel jobs in Oregon are related to woody biomass.

Fuels Jobs in Oregon by Resource (2020, 2022, 2024)[10 11]



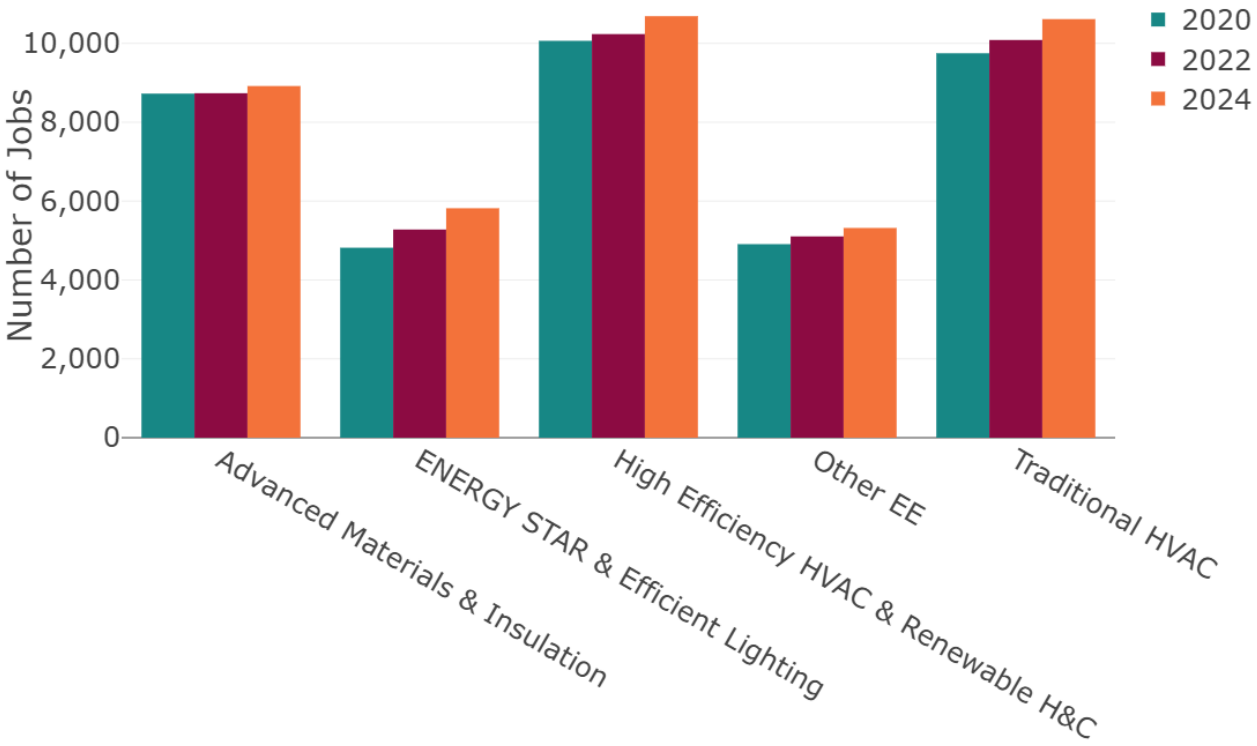
The transmission, distribution, and storage sector in Oregon employed 13,572 workers in 2024, an increase of 1,120 jobs from 2022.[10] [11]

Transmission, Distribution, and Storage Jobs in Oregon (2020, 2022, 2024)[10] [11]



The energy efficiency sector in Oregon employed 41,357 workers in 2024, up 1,920 jobs from 2022.[10] [11] Employment in the categories of High Efficiency & Renewable Heating & Cooling and Traditional HVAC both grew from 2022 and account for more than half of the energy efficiency sector jobs in Oregon in 2024. Traditional HVAC companies are companies where more than 50 percent of installations are not considered high efficiency. High Efficiency & Renewable Heating

Energy Efficiency Jobs in Oregon by Technology (2020, 2022, 2024)[10] [11]



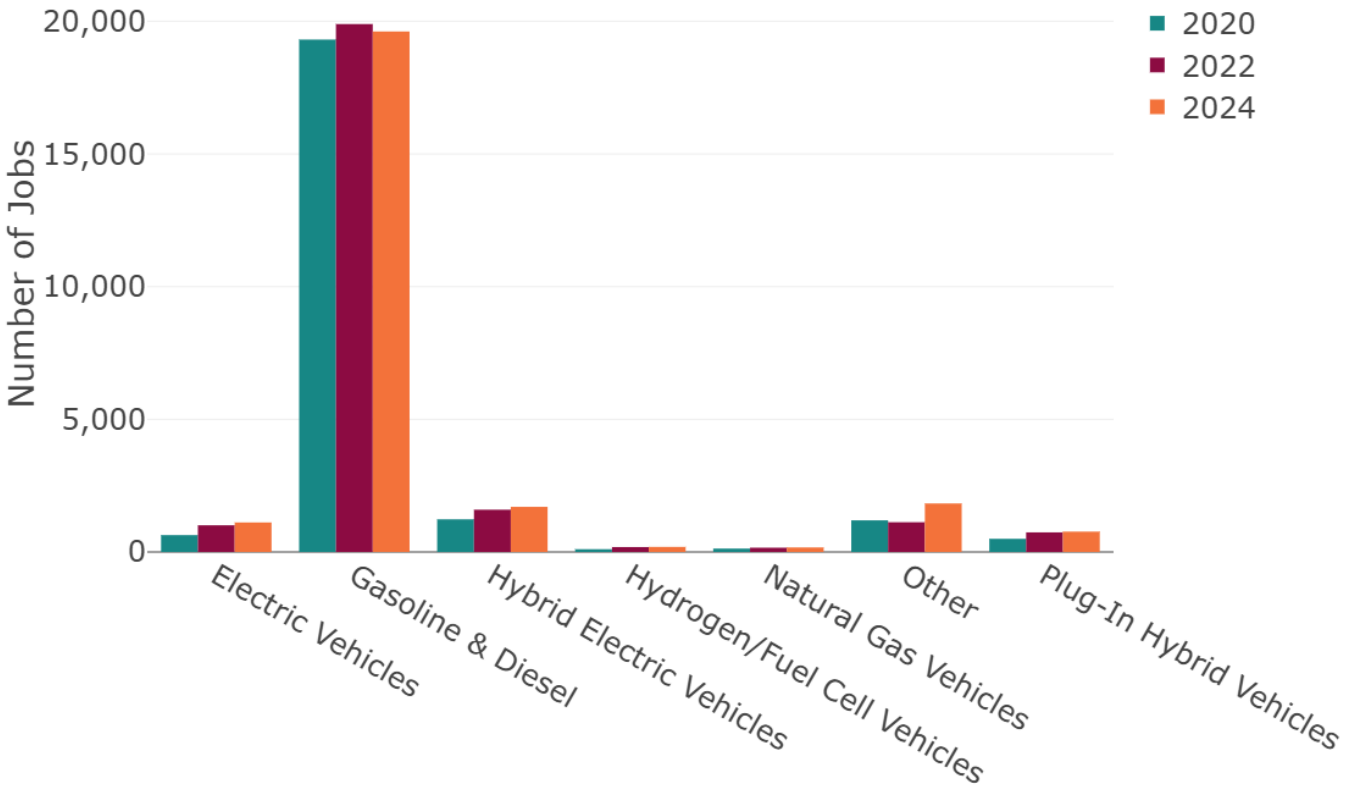


Heat pump installation supported by the Oregon Rental Home Heat Pump Program

& Cooling indicates businesses where more than 50 percent of installations performed are considered high efficiency, such as heat pumps. The transportation sector in Oregon employed 25,386 workers in 2024, an increase of 684 jobs from 2022.[10] [11]

The majority of jobs in the transportation sector remain in the gasoline and diesel sectors. In 2024, the motor vehicle commodity flows, which are jobs related to the transportation of motor vehicles, were added to the dataset. The commodity flows contributed 707 jobs to the "other" category in 2024.

Transportation Jobs in Oregon by Technology (2020, 2022, 2024)[10] [11]



Oregon Energy Strategy Jobs Analysis

The Oregon Energy Strategy is a comprehensive, first-of-its-kind report developed by the Oregon Department of Energy under House Bill 3630 (2023) that outlines pathways, policies, and recommended actions to help the state meet clean energy goals while supporting affordability and reliability. Created through extensive collaboration with Tribes, agencies, energy partners, and the public, the strategy evaluates five key pathways — energy efficiency, clean electricity, electrification, low-carbon fuels, and resilience — and examines their impacts on household energy costs, air quality, public health, jobs, and the economy. The energy strategy offers policy recommendations and near-term legislative actions focused on program support, agency coordination, energy burden reduction, and environmental justice. Its development relied on broad engagement over two years, including an interagency steering group, advisory groups, working groups, public sessions, and feedback.[12]

To support the pathways and actions identified in the Oregon Energy Strategy, ODOE worked with the Clean Energy Transition Institute and BW Research to conduct a jobs analysis. The jobs analysis indicates that Oregon's clean energy transition is likely to generate substantial net employment gains, with total energy sector jobs projected to grow 7 to 12 percent by 2035 and 11 to 19 percent by 2050. Most new jobs stem from major growth in the electricity and building sectors, driven by expanded grid infrastructure, utility-scale renewable development, and investments in energy efficiency and electrification. The fuels sector sees modest net gains, primarily from hydrogen, while transportation experiences job displacement as electric vehicles reduce demand for fuel stations and maintenance. These shifts highlight both the need for strategies to support affected workers and the importance of developing robust training pipelines to ensure Oregon has the skilled workforce required to meet its clean energy goals.[13]

In addition, ODOE is partnering with the University of Oregon's Institute for Policy Research and Engagement to conduct a workforce needs assessment that will give the state information needed to understand strengths and weaknesses in Oregon's clean energy workforce and training pipelines.





Energy Efficiency

Oregon's Second Largest Resource

9th

Oregon's 2025 rank among U.S. states for energy efficiency by the American Council for an Energy Efficient Economy.[6]

Energy efficiency, the use of less energy to perform the same task or produce the same result, plays a critical role in Oregon. It remains the second largest resource in the state after hydropower, and Oregon has consistently met increased demand for electricity by implementing energy efficiency strategies.[1] The Northwest Power & Conservation Council reports that since 1978, the Pacific Northwest has provided about 8,247 average megawatts of savings through efficiency programs and improvements.[2] That's more electricity than the whole state of Oregon uses in a year.

In 2010, Oregon's per capita energy use was 204.9 million Btu, and by 2024 it was 209.5 million Btu, despite the state's population growing a half a million people to 4.3 million people from 3.8 million.[3] [4] One reason for this slowed increase is energy efficiency.[5] Oregon's gains in energy efficiency have been helped by federal appliance standards, state policies and programs, natural gas and electric utility programs, Energy Trust of Oregon utility programs, and other non-governmental organizations. Energy efficiency gains are cumulative and continue paying dividends for the region over time. Of the region's cumulative energy savings, 59 percent comes from utility and Bonneville Power Administration programs.[2]

While Oregon has long remained in the American Council for an Energy Efficient Economy's (ACEEE) top ten ranking, the state fell to eleventh place in 2022.[7] The latest ranking puts Oregon back into the top ten, largely due to the adoption of statewide commercial Building Performance Standards.

Heat Pump Purchase Program

The Oregon Heat Pump Purchase Program represents a major investment in decarbonizing Oregon's homes; backed by a $24 million EPA Climate Pollution Reduction Grant and administered by ODOE. The program began in June 2025 offering 12,000 incentives of $2,000 each, spanning owner-occupied homes (2,000 units), rental properties (6,000 units), and new residential construction (4,000 units).[8]

The Heat Pump Purchase Program builds on Oregon's success with earlier programs like the Oregon Rental Home Heat Pump and Community Heat Pump Deployment Programs but streamlines the process with a simplified one-step incentive via contractors.[9]



Heat pump installations supported by ODOE incentives.

Oregon Electricity Savings

8,247
Average megawatts of regional electricity savings from energy efficiency (1978-2024).[2]

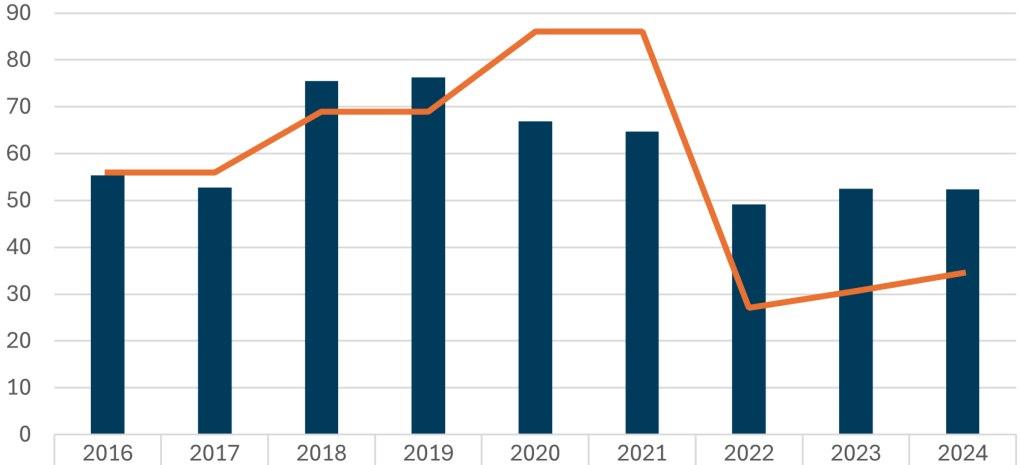
2,412
Average megawatts of Oregon electricity savings from energy efficiency (1978-2024).[14]

The Northwest Power & Conservation Council tracks energy savings in the region against goals set forth in the Northwest Regional Power Plan.[10] The Council publishes a power plan about every five years. The most recent is the 2021 Power Plan, which set a regional conservation target of 750 – 1,000 average megawatts by 2027.[11] In 2026, the Council published the draft 9th Northwest Power Plan, which proposes a new regional conservation target of 1,060 aMW by 2032.[12] The Council further proposed a demand response goal of 590 MW. As of the time of publication of this article, the Council was reviewing comments submitted on the draft 9th Power Plan, including comments from the Oregon Department of Energy. A key innovation in development of the 9th Power Plan has been modeling the region as 17 zones, which provides more granular data on the avoided cost of energy efficiency and marginal cost of resources across the zones. The final energy efficiency, demand response, and other goals will be published in the final 9th Northwest Power Plan, following the Council's review and consideration of comments to the draft plan.

The Regional Conservation Progress Report to the Northwest Power & Conservation Council in September 2024 evaluated progress toward the targets set in the 2021 Plan and noted that the region achieved 160 average megawatts of energy savings from conservation measures in 2024, maintaining the trajectory set in the first plan to meet or exceed the savings achievement targets set.[13]

Bonneville Power Administration and individual utilities set goals for energy efficiency based on the most recent Council power plan goal, but to assess progress as a state, ODOE calculated a goal for Oregon based on the regional goal. This analysis illustrates Oregon's progress within the regional context but does not indicate whether or not BPA and Oregon utilities met their individual targets. ODOE determines this energy efficiency goal by assuming Oregon will meet a percent share of the Northwest Power & Conservation Council energy efficiency goal equivalent to its percent share of electricity consumption compared to the region. The average megawatts shown in the figure below reflect that percentage.

Oregon Electricity Savings & Estimated Share of the 2021 Power Plan Goal (aMW)[14]

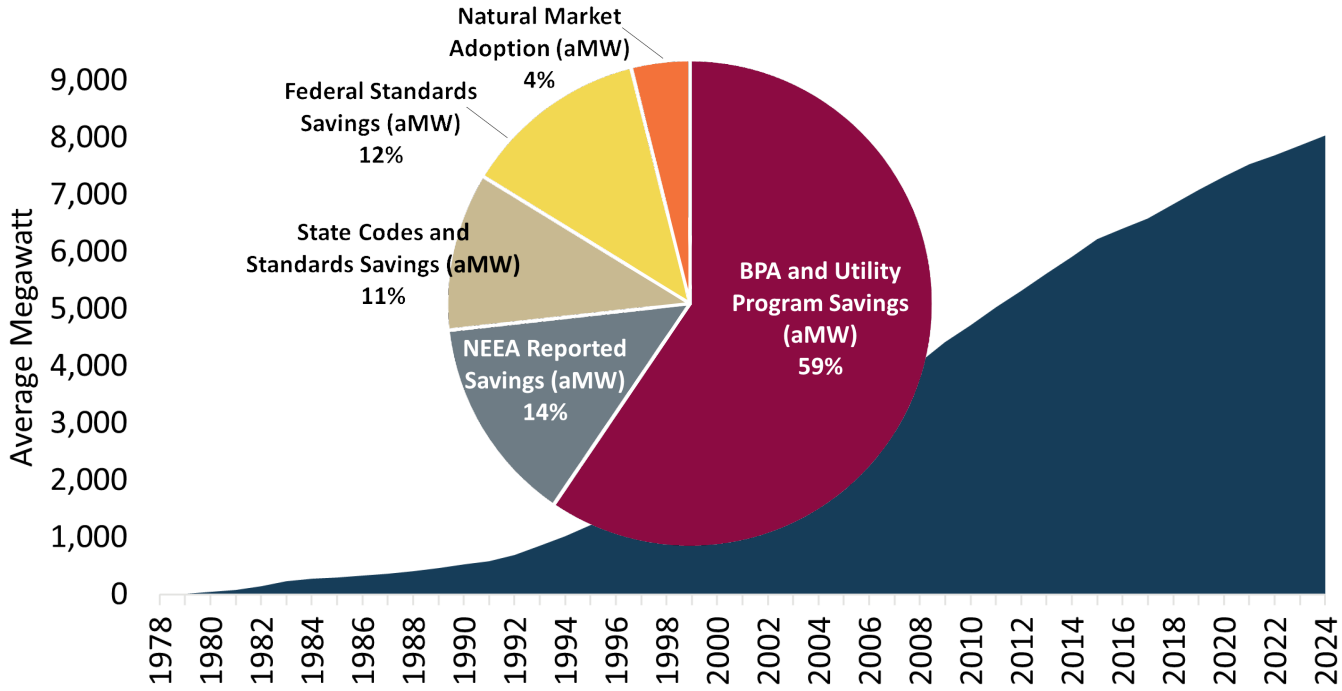


	2016	2017	2018	2019	2020	2021	2022	2023	2024
Total Oregon Savings	55.3	52.8	75.5	76.2	66.9	64.7	49.1	52.5	52.4
Estimated Oregon Share of Goal	56.0	56.0	69.0	69.0	86.0	86.0	27.0	30.6	34.5

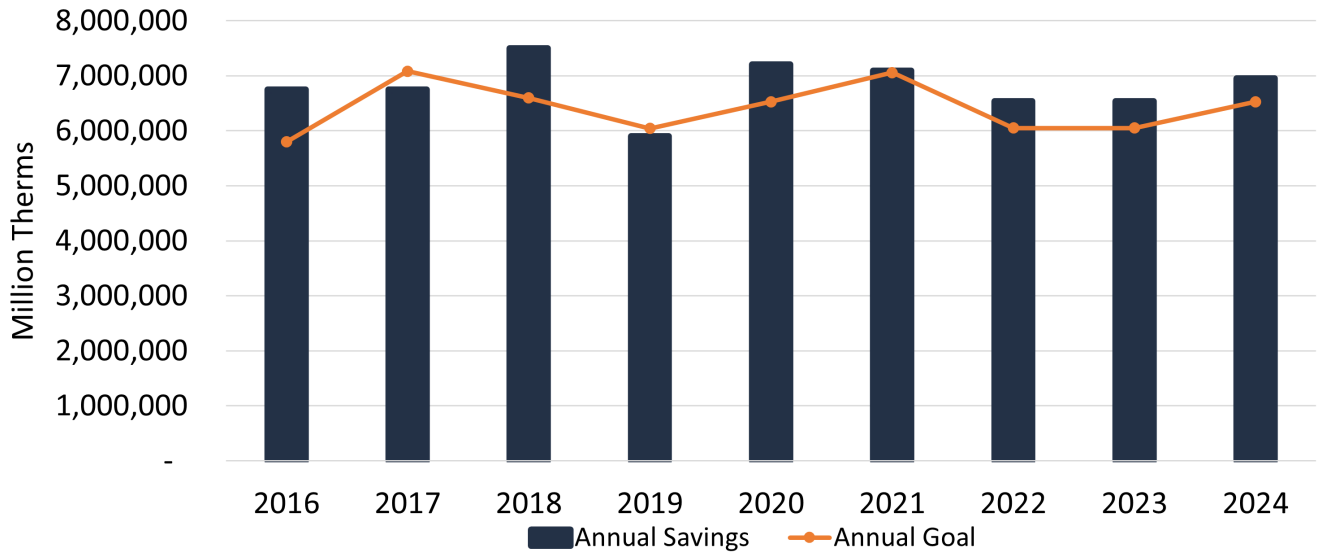
i ODOE used 750 aMW as the target, based on the 2021 Power Plan goal range of 700 to 1,000 aMW.[13]

Oregon energy efficiency achievement has varied over the last nine years, as shown in the varying heights of the bars in the chart. The annual goal shown as the line on the chart also varies, depending on the amount of energy consumed during the year and updates to the regional energy efficiency goals. Oregon has largely achieved its proportional share of the regional goal since 2016. Several factors contributed to underperforming in 2020 and 2021, including increasing costs for energy efficiency measures without subsequent increases in energy efficiency investments. Energy efficiency targets were updated in the 2021 Power Plan, and Oregon has achieved the proportional goal since then.

NWPCC Cumulative Regional Energy Efficiency Savings and Share of Cumulative Savings by Mechanism[15]



The figure above shows cumulative regional energy efficiency savings since 1978. Savings are shown cumulatively because each measure continues to provide efficiency savings over the life of the equipment. The pie chart indicates how each program or mechanism contributed to the savings over the entire time frame from 1978 through 2024. Federal standards include federal appliance and equipment efficiency standard programs such as Energy Star. States in the region set building codes, efficiency codes and may set additional standards for appliances and equipment that are not included in the Federal standards. The Northwest Energy Efficiency Alliance supports building code and energy efficiency standard work in the region and implements market transformation programs that seek to remove market barriers to energy efficiency and drive permanent change through the supply chain.[16] Market momentum is an estimate of additional energy savings attributed to the changing market. The largest slice of energy saving contributions is the utility programs shown in red, this is inclusive of all local utility programs and the regional Bonneville Power Administration programs that some local utilities participate in.



Oregon Natural Gas Savings

Natural gas efficiency goals are developed in each natural gas utility's Integrated Resource Plan submitted to the Oregon Public Utility Commission. The utilities' savings exceeded goals from 2016 and 2018 with a slight decline in 2019, then continued to exceed goals in 2020 through 2024.[7] Energy Trust of Oregon implements energy efficiency programs for the state's natural gas utilities. Programs are funded by customer rates, and cost effectiveness tests of natural gas measures ensure that efficiency investments cost less than building new natural gas infrastructure.

Building Performance Standard Program

Oregon's Building Performance Standard program requires owners of large buildings to dedicate resources for energy management and in some cases to implement energy efficiency projects. These efforts will lead to installation of cost-effective energy efficiency measures that will create operational savings for the building owners, lower energy use, and reduce greenhouse gas emissions. For utilities, these reductions can translate to real demand-side reductions to support meeting their energy efficiency goals.

i A therm is a unit of measurement describing the amount of heat, or energy content, in a unit of natural gas.

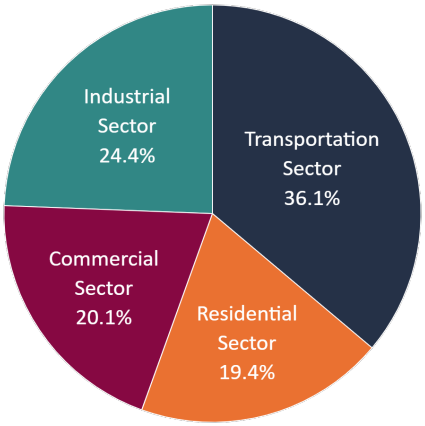
Energy End Use Sectors

Consumption

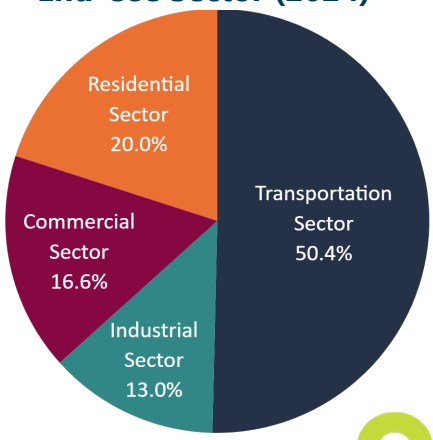
As noted earlier in this section, energy metrics are commonly divided into four end-use sectors: residential, commercial, industrial, and transportation. Consumption and cost of energy vary across the sectors. In 2024, transportation accounted for 36.1 percent of energy consumption and 50.4 percent of expenditures due to the higher per-unit cost of transportation fuels.[1 2 3] The industrial sector used 24.4 percent of the total energy but accounted for only 13 percent of expenditures due to lower per-unit costs relative to the other sectors. Industrial users can buy some types of energy in bulk or are large users and in some cases have different (lower) rates.

Energy consumption across all sectors has remained relatively steady over the last two decades. Increased population, GDP, and more vehicle miles traveled — which all affect energy use — have been offset by efficiency gains and a shift toward less energy-intensive industries, demonstrated in the relatively flat energy use since the early 2000s, as shown in the figure below. However, in the last few years energy consumption has trended upward, particularly in the commercial and transportation sectors. Industrial energy use slightly increased over this time frame, while residential energy use has decreased.

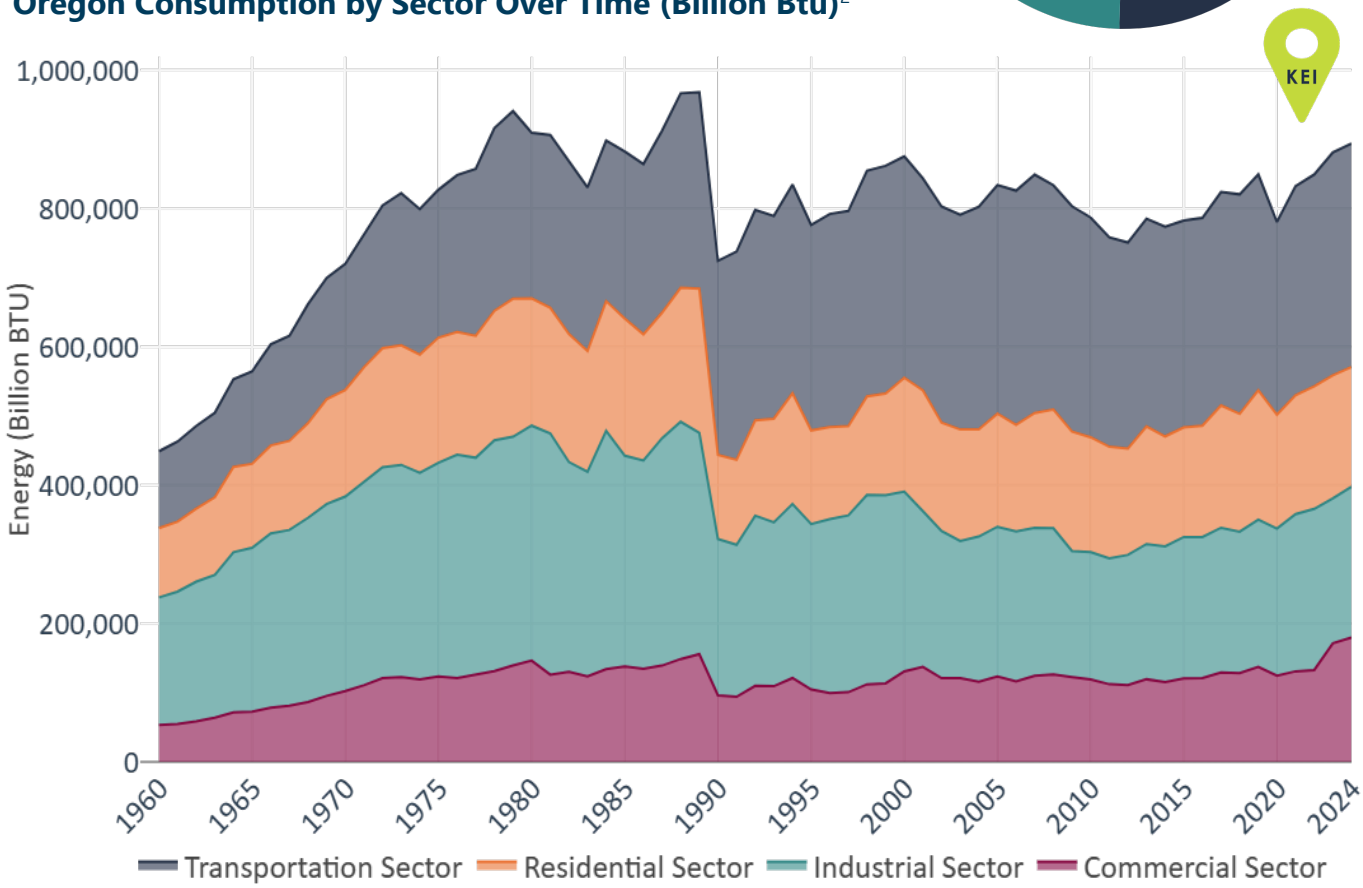
Oregon Consumption by End-Use Sector (2024)[1]



Oregon Expenditures by End-Use Sector (2024)[2 3]



Oregon Consumption by Sector Over Time (Billion Btu)[2]



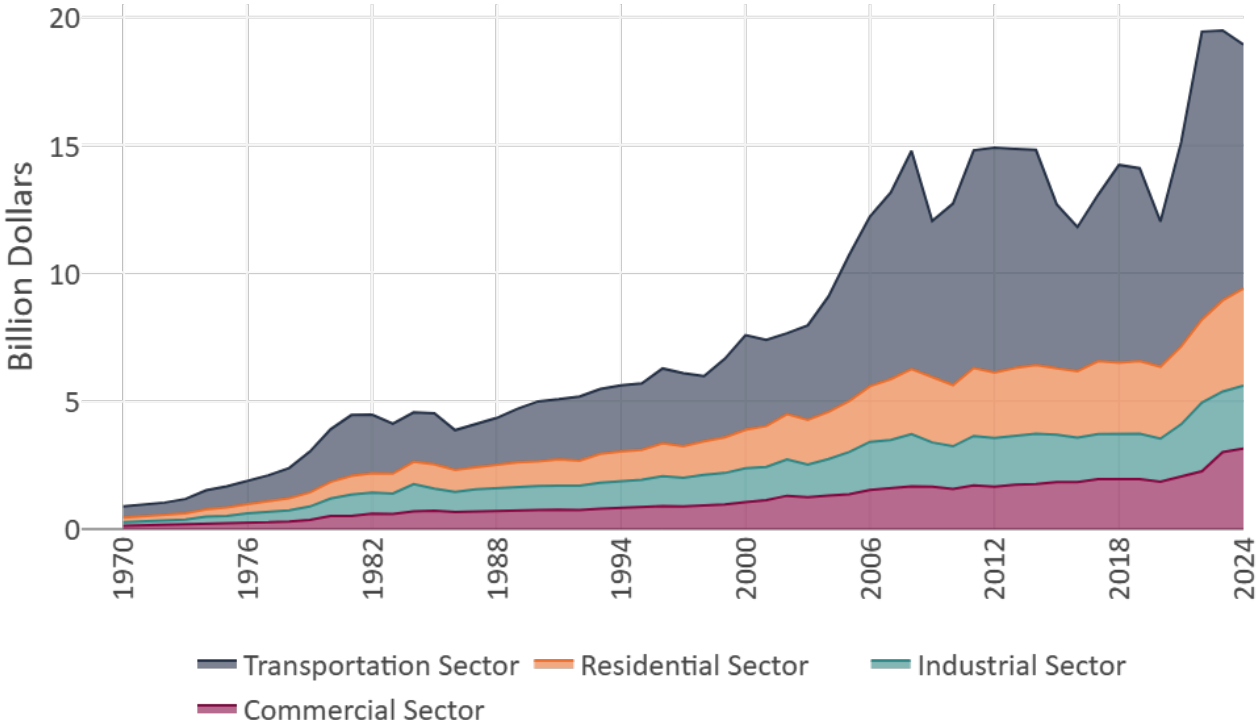
Expenditures

Oregonians' 2024 energy expenditures can be separated by sector. The transportation sector accounts for about half of all expenditures.[1] The large variances in transportation sector expenditures reflect greater price volatility in transportation fuels. Oregon does not have any petroleum resources or fuel refineries, so most transportation expenditures exit Oregon's economy.[3]

The variability in what Oregonians spend on energy is driven primarily by transportation fuel costs. The data show lower expenditures across all sectors for 2019 and 2020 — a sharp drop in transportation and slight decreases in each of the other sectors. This coincides with the start of the COVID-19 pandemic, which affected energy use and prices during this time frame. Initially the pandemic reduced demand for all transportation fuels, resulting in the sharp decrease, but as more people turned to shipping goods to their home, demand for fuel increased sharply.[1] This led to rising expenditures in transportation fuel costs. Since 2022, energy expenditures for the transportation and industrial sectors have been declining while residential and commercial expenditures have been rising in Oregon, largely due to increases in electricity and direct use fuel costs and growing energy demand.

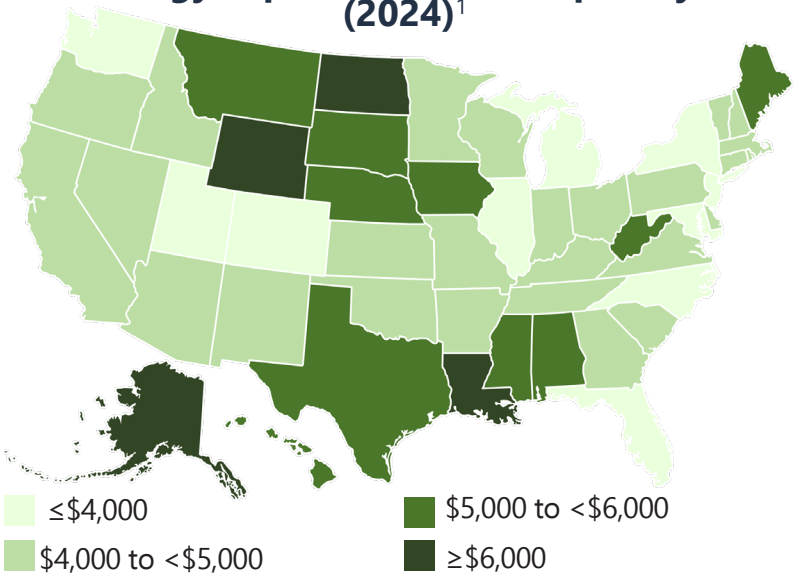
Although the pandemic drove changes in transportation fuels consumption that led to higher costs, expenditures are also rose due to increasing passenger vehicle use. As the economy recovered in post-pandemic years, individuals began driving more. Even with the brief dip during the early pandemic, total vehicle miles traveled in Oregon increased by 15.8 percent between 2020 and 2024.[4] At the same time, crude oil prices – the primary driver of the price of gasoline and diesel – increased from an average closing price of $41.96 per barrel in 2020 to an average of $82.25 in June 2024, with a peak of $127.40 in June 2022.[5] [6] From 2023 to 2024, lower fuel prices led to a reduction in transportation expenditures even as VMT rose. With fuel prices rising considerably in 2025 along with increases in prices for electricity and direct use fuels, it is almost certain that Oregon's total current energy expenditures are higher than in 2024.

Oregon's Total Energy Expenditures by Sector Over Time[1]



The U.S. EIA reports prices in current dollars per million Btu and expenditures in current dollars — the chart is not adjusted for inflation. Learn more: https://www.eia.gov/state/seds/

U.S. Energy Expenditures Per Capita by State (2024)[1]



$4,440

Per capita energy expenditures in Oregon in 2024. The amount has increased by 57 percent since 2020.[7]

38th

Oregon's rank in the U.S. for per capita energy expenditures, meaning 37 states spend more per capita.[3]

Greenhouse Gas Emissions

Most of Oregon's greenhouse gas emissions come from the energy we use every day. These GHG emissions contribute to climate change.

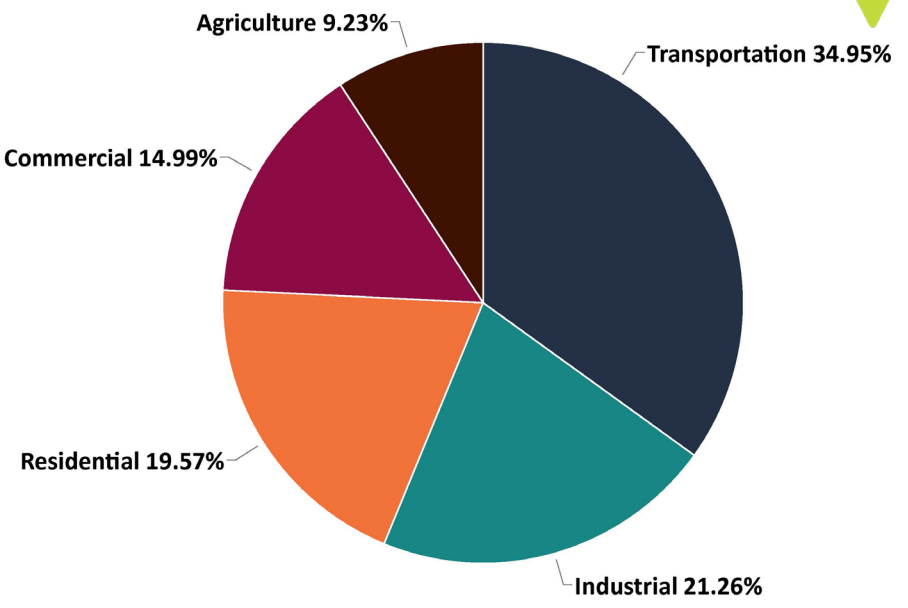
The Oregon Department of Environmental Quality collects data on GHG emissions in Oregon. DEQ publishes the data and uses it to create a sector-based GHG emissions inventory, which is updated annually. The data presented are based on the DEQ sector-based emissions inventory for 2023.[8]

Greenhouse gas emissions can be categorized in multiple ways: by the end-use – for example, heating or lighting – that creates emissions, by end-use within a sector, and by the source of the emissions. DEQ provides a mixture of these data categories. As a result, when analyzing the data, various methods of categorization can reveal new insights. In this section, the data are first presented based on end-use sector, then by source, and then by a mixture of sector and source – presenting DEQ's usual sector-based inventory depiction and an expanded depiction based on further analysis of the data.

GHG Emissions by Sector[8]

A majority of Oregon's greenhouse gas emissions come from the production or use of energy. The state categorizes and reports GHG emissions for five end-use sectors — transportation, residential, commercial, industrial, and agriculture. Note that in other sections of this report, agriculture is included in the industrial sector. Oregon's sector-based GHG inventory reports

Oregon Greenhouse Gas Emissions by Sector[8]



annual emissions from each of these sectors.

This chart summarizes emissions by sector for 2023. The transportation sector is the largest source of sector emissions, contributing over a third of Oregon's total GHG emissions. The residential and industrial sectors each contribute approximately 20 percent of state emissions, and the commercial sector contributes 15 percent. Together, energy consumption makes up nearly 90 percent of Oregon's greenhouse gas emissions.

Transportation GHGs. Transportation is the state's largest source of sector-based GHG emissions, primarily from the direct combustion of petroleum products in on- and non-road vehicles (such as construction equipment, agricultural vehicles, and off-road recreational vehicles). About 57 percent of Oregon's transportation emissions are from gasoline combustion in passenger cars and other gas-powered vehicles, and about 27 percent are from medium- and heavy-duty diesel vehicles.

Commercial & Residential GHGs. The largest sources of GHG emissions from the residential and commercial sectors include electricity generation, natural gas direct use, municipal landfills, commercial petroleum combustion, and wastewater treatment.

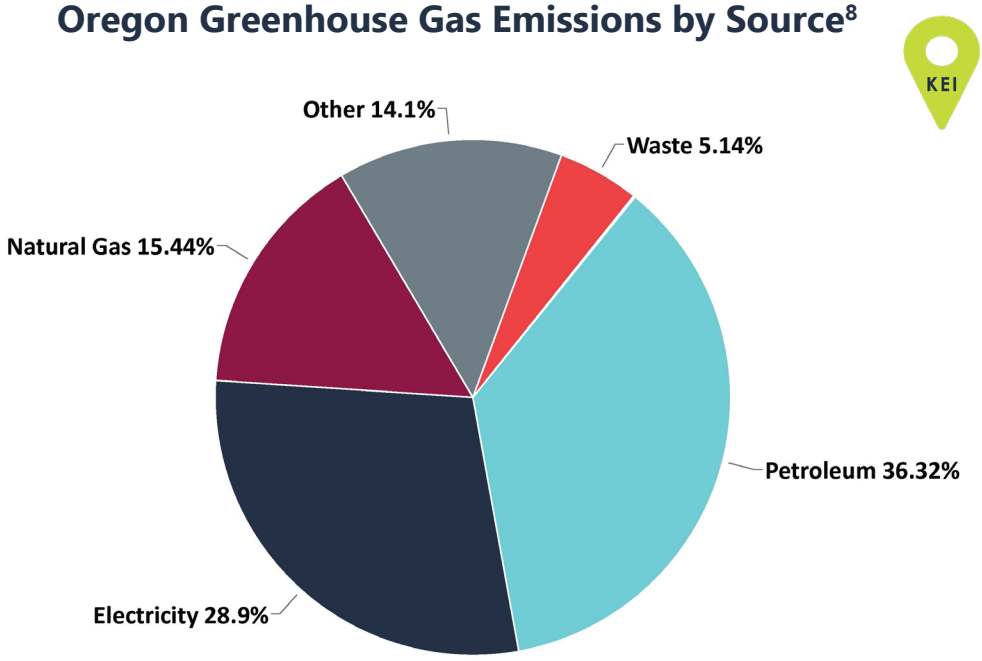
Industrial GHGs. The largest sources of industrial GHG emissions in Oregon are semiconductor manufacturing, natural gas distribution and production, and cement manufacturing. The sector-based inventory includes industrial emissions from electricity generation, natural gas direct use, and petroleum combustion, in addition to GHG emissions from industrial processes unrelated to energy use.

Agricultural GHGs. Oregon's sector-based GHG inventory tracks emissions from certain agricultural processes and waste products, including manure and other organic wastes, fertilizer application and soil management, and agricultural residue burning.[i]

GHGs by Source[8]

GHG emissions data can also be categorized by the direct source of emissions, which relates to energy production and consumption processes that directly emit greenhouse gases. This includes petroleum combustion, electricity generation, and natural gas combustion, as well as emissions from waste production and treatment.

Oregon Greenhouse Gas Emissions by Source[8]



i The sector-based inventory exclusively tracks anthropogenic (i.e., human-caused) emissions for the agricultural sector, which are primarily methane and nitrous oxide emissions from agricultural processes. Energy consumption, such as electricity and fuels used in this sector are included in the transportation and industrial sectors.[8]

The combustion of petroleum products is the largest source of emissions at 36 percent, followed by emissions resulting from generating electricity then natural gas use.

Petroleum. Petroleum-derived fuels, including diesel, gasoline, and jet fuel, are primarily consumed by the transportation sector. Emissions from petroleum-fueled equipment used by the residential, commercial, and industrial sectors are also included.

Electricity. This accounts for electricity used in all sectors, which includes emissions from the generation of electricity used in the state, regardless of where it is generated. Emissions from electricity generated in Oregon but used out of state are not included.

Natural Gas. This includes direct use of natural gas in all sectors, plus fugitive emissions from distribution. It does not include emissions associated with natural gas-fired power plants.

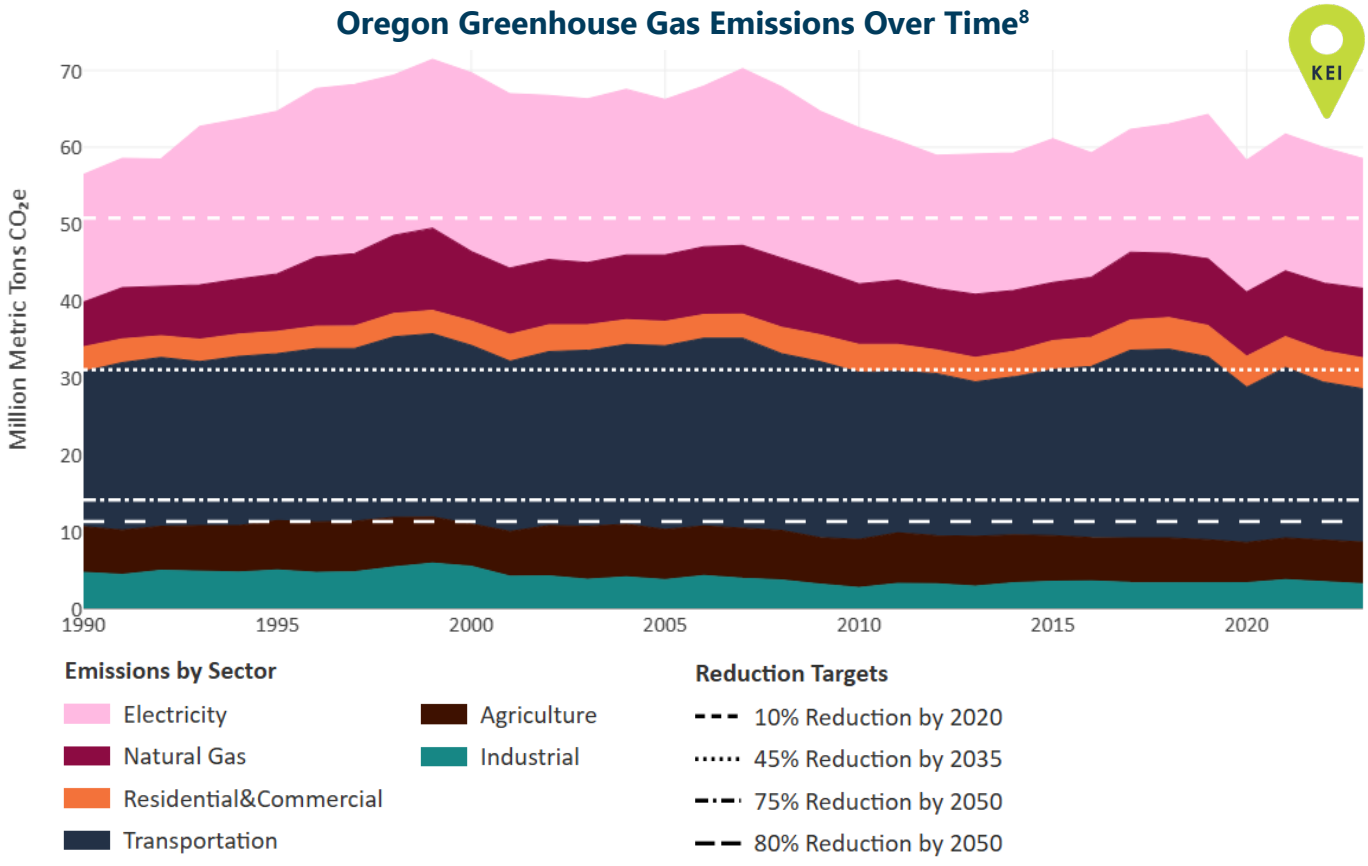
Other. This category includes uses specific to a sector's activity, such as fertilizer, cement and soda ash production and consumption, semiconductor manufacturing, and use of refrigerants and solvents.

Waste. This includes treatment of waste products from the various sectors, including landfill waste and agricultural waste. Some of these emissions result from the combustion of waste.

GHGs by Sector and Source[8]

Whether something is classified as a sector or a source can sometimes be blurred in GHG emissions data. For example, electricity can sometimes be considered a sector or source, depending on what is being assessed.

This chart reflects emissions across six categories, including for each of the sectors, as well as for electricity and natural gas. The residential and commercial sectors have been combined.



Electricity and natural gas reflect source emissions, while the remaining categories are sector specific. As a result, the residential and commercial, and industrial source emissions in this chart do not include emissions associated with electricity or natural gas use on site.

Assessing progress toward meeting Oregon's GHG emission reduction goals requires looking at recent and historical emissions as compared with the state's targets. The Oregon Climate Action Commission and others use DEQ's inventory to track progress toward the state's GHG emissions reduction goals, including goals established in legislation and by executive order. The different goals are indicated by horizontal lines on the chart. Although emissions are declining, Oregon did not achieve its goal of 10 percent below 1990 levels by 2020 (top line), nor has the state yet met this goal.

In 2020, Executive Order 20-04 established an updated 2050 goal, going from 75 percent (dashed and dotted line) to at least 80 percent below 1990 levels by 2050 (dashed line at the bottom) and a near-term goal of at least 45 percent below 1990 levels by 2035 (dotted line).[9] The most recent GHG emissions forecast for the Oregon Climate Action Commission found that Oregon is not on track to achieve its 2035 goal even if all currently adopted climate policies and programs are fully implemented.[10] The single largest contributor to Oregon no longer being on track to meet its sector-based climate goals is the forecasted load growth from new data centers. The projected load growth accounts for 34 percent of all forecasted emissions by 2050. However, these emissions could be greatly reduced if these facilities can meet their energy needs with clean energy sources.

Oregon's Greenhouse Gas Emissions Forecast

The Oregon Department of Energy prepares the Transformational Integrated Greenhouse Gas Emissions Reduction (TIGHGER) analysis to evaluate the emissions reductions anticipated from existing state laws, programs, and regulations, and to identify additional actions to further reduce emissions while continuing to grow Oregon's economy. The most recent TIGHGER analysis in 2026 will present a series of gap measures, or potential actions to inform state climate actions and help put Oregon on track to meet its GHG emissions reduction goals.[ii]

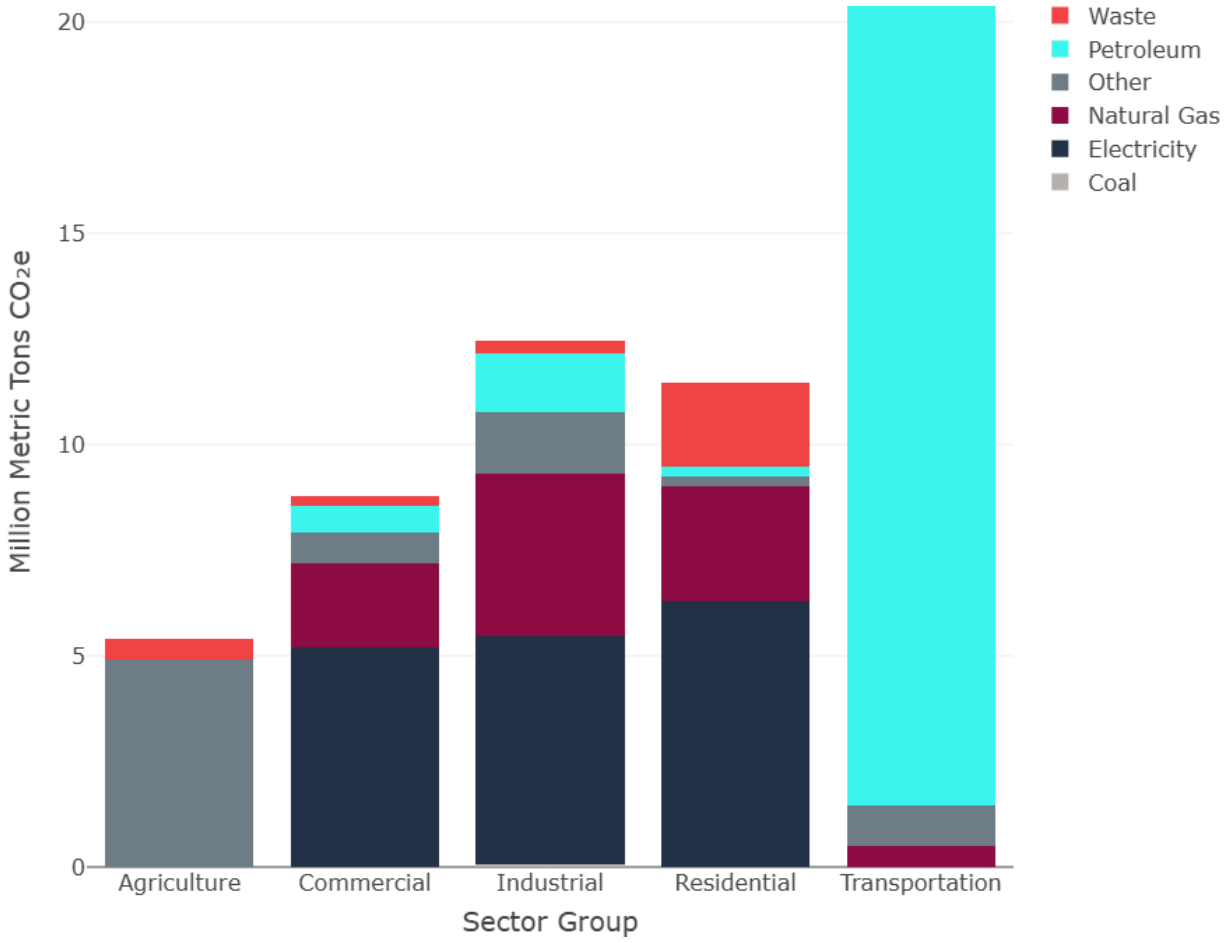
The following chart shows Oregon's 2023 emissions from the five GHG sectors, broken out into emissions by source within each sector.[10] The color fields within the bars reflect energy-related emissions and their source. The chart shows transportation emissions as largely driven by petroleum combustion, while the residential, commercial, and industrial sector emissions largely come from electricity generation followed by natural gas use. The chart shows that energy use is the primary source of GHG emissions in Oregon.

Viewing these data over time shows the variety of emissions sources in Oregon and emissions trends from these sources over time. This level of analysis informs policy makers about what potential programs or policies will most effectively reduce emissions and meet state goals.

This chart groups emissions by sector, with emissions by source illustrated using similar colors within each sector.

ii The 2026 TIGHGER 2.0 analysis has not been published at the time of this report, but the draft final report will be available on the Oregon Climate Action website in late 2026.

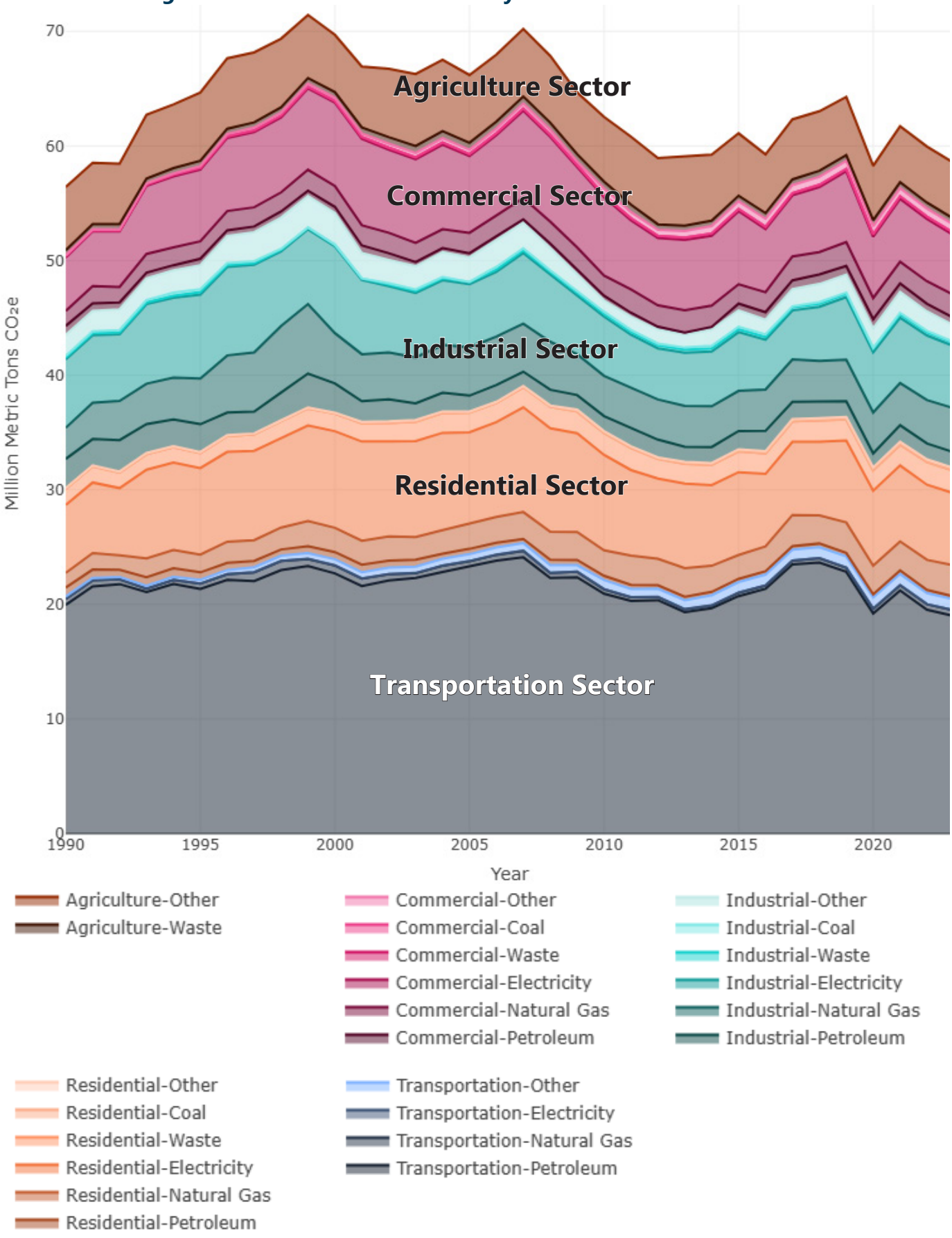
Oregon Greenhouse Gas Emissions By Sector and Source[8]



The chart above shows that electricity consumption is the largest source of emissions in the commercial, residential, and industrial sectors. This means policies like those incorporated into HB 2021, which requires a 100 percent reduction in emissions from electricity sold to investor-owned electric utility customers by 2040, will have the greatest effect on emissions across these sectors.[11]

Almost all emissions in the transportation sector come from petroleum use. State greenhouse gas policies, such as DEQ's Climate Protection Program, Clean Fuels Program, Advanced Clean Cars II (ACC II) rule, and Advanced Clean Trucks (ACT) rule, would, if fully funded and implemented as planned, drive electrification of vehicles and, in conjunction with decarbonization of the electricity sector, address much of the emissions in this sector. However, in 2025 Congress created uncertainty about the future of these policies; this action is currently in litigation.[12] [13] Due to this uncertainty, Oregon could see a short-term slowdown in the rate of electric vehicle adoption across the state.

Oregon Greenhouse Gas Emissions By Sector and Source Over Time[8]



Sector Profiles

Residential

The residential sector consists of both single- and multi-family occupancies. Common uses of energy associated with this sector include space heating, water heating, air conditioning, lighting, refrigeration, cooking, and appliances. Residential energy use is closely tied to weather, housing size and vintage (the decade a home is built), and type of housing.

19.4%

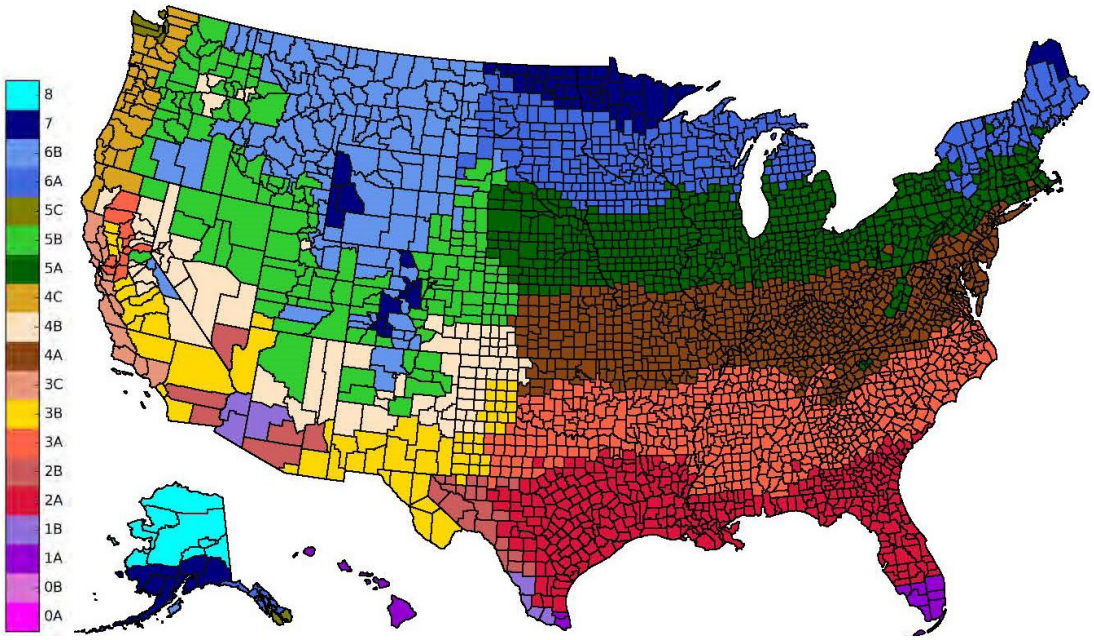
Residential sector's share of Oregon's energy use in 2024.[1]

1.72 Million

Number of occupied housing units in Oregon in 2024.[2]

Weather

Oregon is divided by two climate zones with different energy needs and weather patterns. The map below demonstrates the climates zones in the U.S.[3] In Oregon, west of the Cascade mountain range is a temperate mixed marine – or more humid – climate zone. East of the Cascade Mountain range is a cool, dry climate with more heating and cooling days that require more energy use. Buildings in Eastern Oregon have a higher average energy use index, meaning they typically use more energy per square foot.

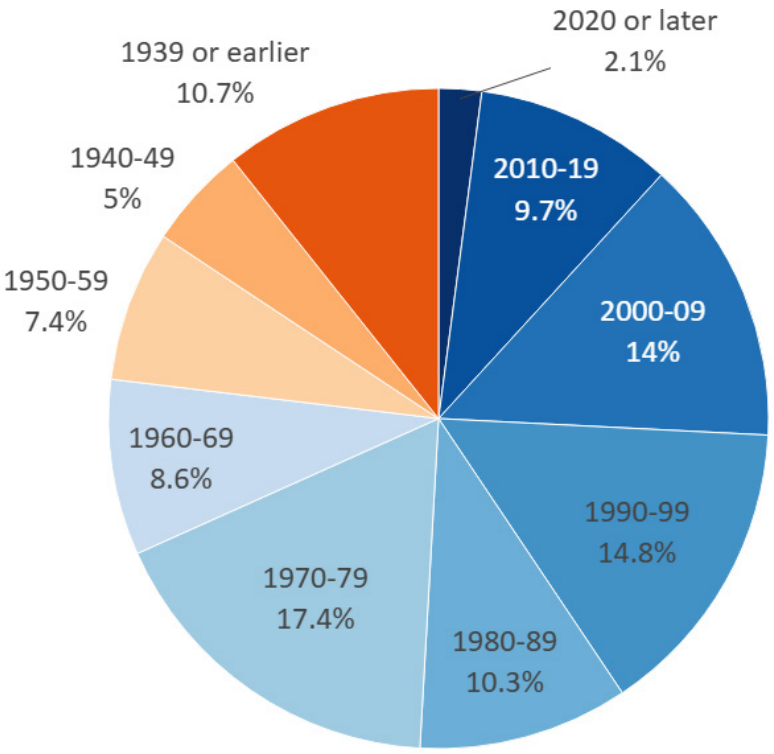


Home Vintage

The residential sector includes new construction and existing construction — and energy use can be very different between them, especially when comparing a newly built home to a decades-old home. Oregon's residential energy code has made significant performance increases since Oregon's first energy code in 1974.

Older homes with less insulation and older equipment use more energy for heating and cooling than newer, more efficient homes. Home vintage can indicate opportunities for updating heating and cooling equipment, water heating, insulation, windows, and house weatherization. About 61 percent of all homes in Oregon were built before 1990.[4]

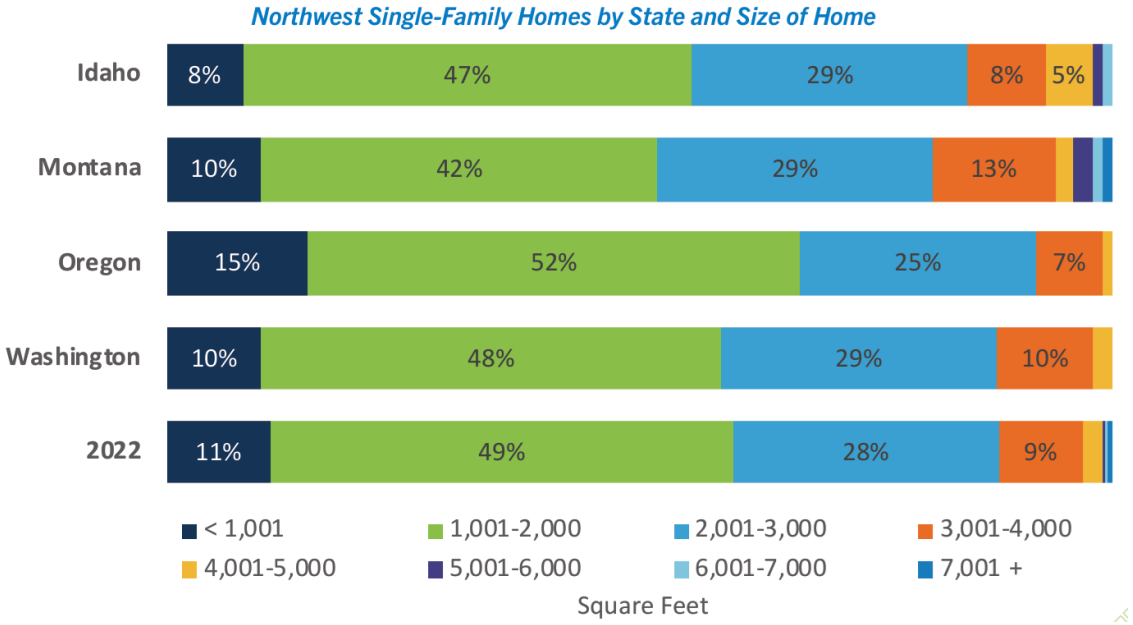
Oregon Homes by Vintage[4]



Size of Housing

The size of a home affects energy use. Typically, larger homes use more energy, since there is a greater volume of air to heat or condition. Since 2015, the size of new single-family homes has become smaller as homes have become less affordable.[5] One exception is in 2021, when home sizes grew as interest rates were very low, creating the opportunity for homebuyers to afford more.[6] However, as interest rates increased in 2022 and 2023, homes became harder to afford again, resulting in consumers choosing smaller homes. New single-family homes became smaller from 2023 into 2024, then largely stabilized in 2025 as builders continued to respond to housing-affordability pressures. The visual below shows the size distribution of single-family homes by state in the region.

Northwest Single-Family Homes by State and Size of Home[7]



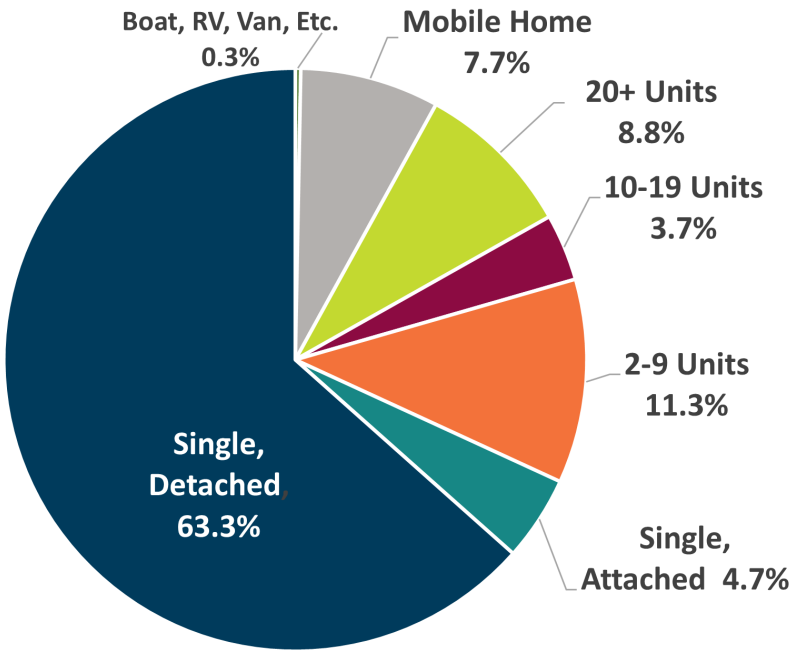
Type of Housing

Most housing in Oregon (63 percent) is detached, single-family. Multifamily complexes with 20 or more units represent 8.8 percent of all housing, followed by mobile/ manufactured homes at 7.7 percent. Other multifamily units (like those with fewer than 20 units) comprise the remainder.[8]

Ownership and Home Vintage

Another way to look at housing stock in Oregon is by ownership and home vintage across the region. Northwest Oregon has the most housing units, as well as the highest percentage of rental units.[9] The distribution also shows over 60 percent of housing units were built prior to 1990.

Oregon Housing Types[8]



Oregon Housing Characteristics by Region[9]

Region	Total Occupied Housing Units	Average Share of Units That Are Renter Occupied	Average Share of Units Built Before 1980
East Oregon	221,493	30%	55%
NW Oregon	1,280,770	34%	49%
SW Oregon	216,159	29%	52%
All of Oregon	1,718,422	32%	52%

Residential Energy Efficiency

Oregon's energy efficiency programs and policies continue to help residential customers save energy and money while improving home comfort. According to the Northwest Power and Conservation Council, the region is actively tracking progress toward the conservation goals set in the 2021 Power Plan, which call for acquiring 750-1,000 average megawatts of cost-effective energy efficiency by 2027.[10] Recent Regional Conservation Progress Reports show that the region achieved 182 aMW of savings in 2025, with the residential sector contributing nearly 15

percent of those savings. The report finds that the region continues to make progress toward the 2021 Power Plan goals and recommended pursuing all cost-effective energy efficiency first. The report acknowledged that the region may need to also consider non cost-effective measures to achieve energy efficiency goals, including improvements in weatherization, ensuring access to energy efficiency programs in small and rural markets, and encouraging jurisdictions pursuing decarbonization goals to include energy efficiency options.

Oregon's energy efficiency programs and policies save residential customers energy and money while increasing household comfort. In their 2021 Power Plan, the Northwest Power and Conservation Council estimated the total technical energy efficiency potential of the residential sector in the Pacific Northwest would meet about 27 percent of the projected load in 2041.[11] The Northwest Power and Conservation Council outlines several opportunities for increased efficiency in residential buildings:

Heating, Ventilation and Air Conditioning. Nearly half the residential achievable technical potential is in this sector.[11] For example, upgrading an electric furnace to a heat pump can cut heating electricity use in half.[12]

Water Heating. More efficient water heating technologies could achieve up to 31 percent of the region's residential energy efficiency potential.[11] Heat pump water heater market share in the Northwest remains low, but still makes up a meaningful portion of the market at 18.6 percent.[13] A heat pump water heater that earns the ENERGY STAR label uses about one quarter of the energy of a standard model, providing consumer savings and helping the region achieve efficiency targets.[14]

Electronics. Homes have a lot of electronic devices, and many are plugged in most of the time. Simple controls that turn off equipment when nobody is in the room can significantly reduce energy use.[10]

Lighting. Lighting has historically been a significant energy efficiency opportunity, and the region has made great progress. However, much of this has been captured and is expected to play a smaller role going forward.[9]

Residential Heating and Cooling

More than half of Oregon homes heat with electricity.[15] Cooling types vary among Oregon homes, and the percentage of homes in the region using air conditioning increased from 57 to 66 percent between 2017 and 2022.[16] [i]

Average electricity use in Oregon decreased slightly from 11,323 in 2022 to 10,560 kWh in 2024.[17] [18] Average residential electricity use in consumer-owned utility territory is typically higher than in investor-owned territory. In 2024, the average annual COU customer use was 12,588 kWh, while for IOUs it was 9,859 kWh. This may be partially due to higher prevalence of electric resistance heating – which is less efficient than natural gas – in more rural COU territories, and more homes that use gas as a heat source in urban IOU areas.

10,560 kWh[17]

KEI

Average annual residential electricity use in Oregon in 2024

600 therms[17] [18]

KEI

Average annual residential natural gas use in Oregon in 2024

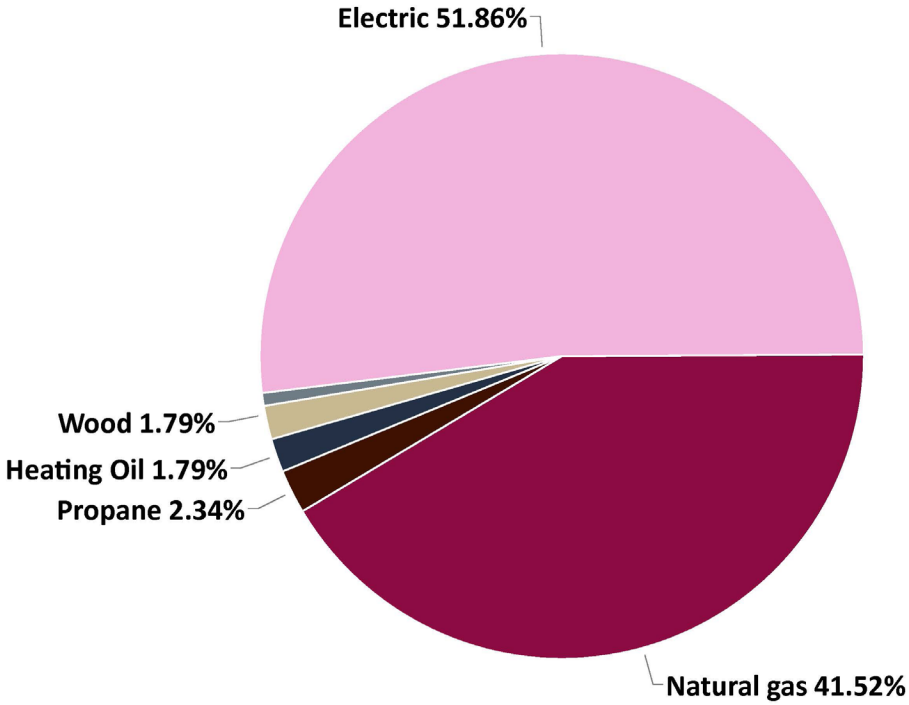
i ODOE uses the Northwest Energy Efficiency Alliance's 2022 Residential Building Stock Assessment to provide heating and cooling data for Oregon homes. NEEA is beginning work on preparing the next RBSA, which is expected in 2027.

Oregon County Profiles

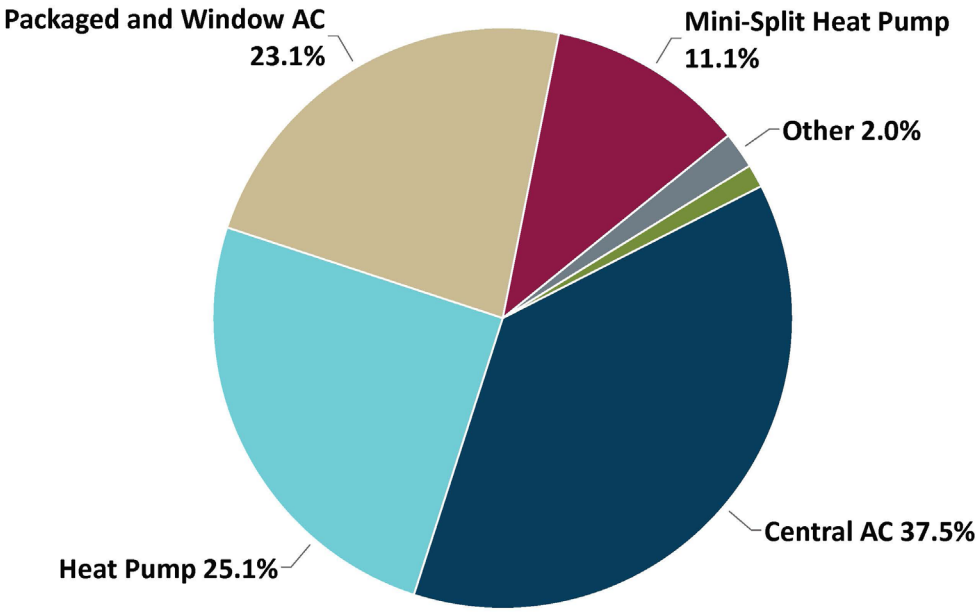
Data used to populate the county profiles have been updated and remain helpful for understanding how Oregon county energy use differs, including energy and transportation burden. View the county profiles online:

energyinfo.oregon.gov/ber

Average Heating Types Across Oregon Homes[15]



Average Cooling Types Across Oregon Homes[16]



The bottom figure shows the types of cooling equipment in Oregon homes as a percentage of the homes that have cooling equipment. In Oregon, many homes do not have cooling equipment. Historically, weather patterns have kept much of the state's population in a moderate climate where passive cooling strategies – such as shading, reflective surfaces, and night ventilation – were often sufficient to maintain comfortable indoor conditions. Recent extended high heat weather events have motivated many homeowners to install new cooling equipment and state programs have incentivized heat pump installations to provide cooling.

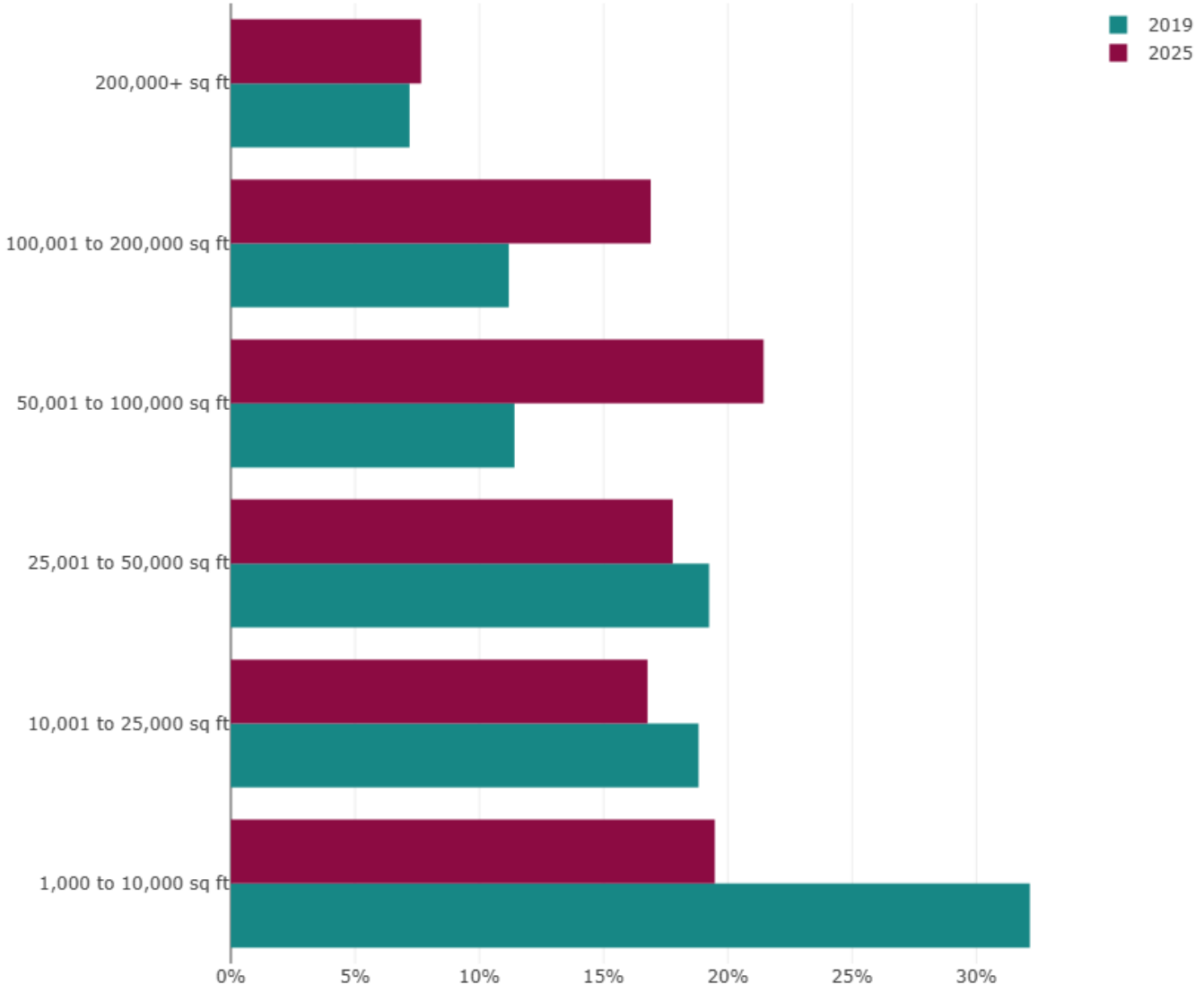
Commercial

The commercial sector includes buildings that support community needs and economic life, from small local storefronts and schools to hospitals, restaurants, and industrial facilities.

In recent years, this sector has become an increasingly significant part of Oregon's energy landscape: commercial energy use grew approximately 35 percent between 2022 and 2024, rising from 16 percent to 20 percent of statewide consumption, its highest share in the historical record. This rapid growth reflects not only the expansion of energy-intensive uses such as data centers, but also broader shifts in how Oregon's commercial buildings are developed, occupied, and used.

To better understand the makeup of the region's commercial sector, the Northwest Energy Efficiency Alliance conducts a Commercial Building Stock Assessment[ii] every five years.

Distribution of Regional Floor Space by Building Size in the Northwest[22]



ii The 2025 Commercial Building Stock Assessment, the fifth CBSA conducted on behalf of NEEA and its funders since 2003, collects, analyzes, and publishes data on the characteristics, installed equipment, and energy consumption of commercial and muti-family residential buildings in four states in the Northwest region of the United States: Idaho, Montana, Oregon, and Washington. Data from the study are intended to inform energy savings potential, load flexibility, load forecasting, and other regional data needs for the commercial and multi-family residential sectors.

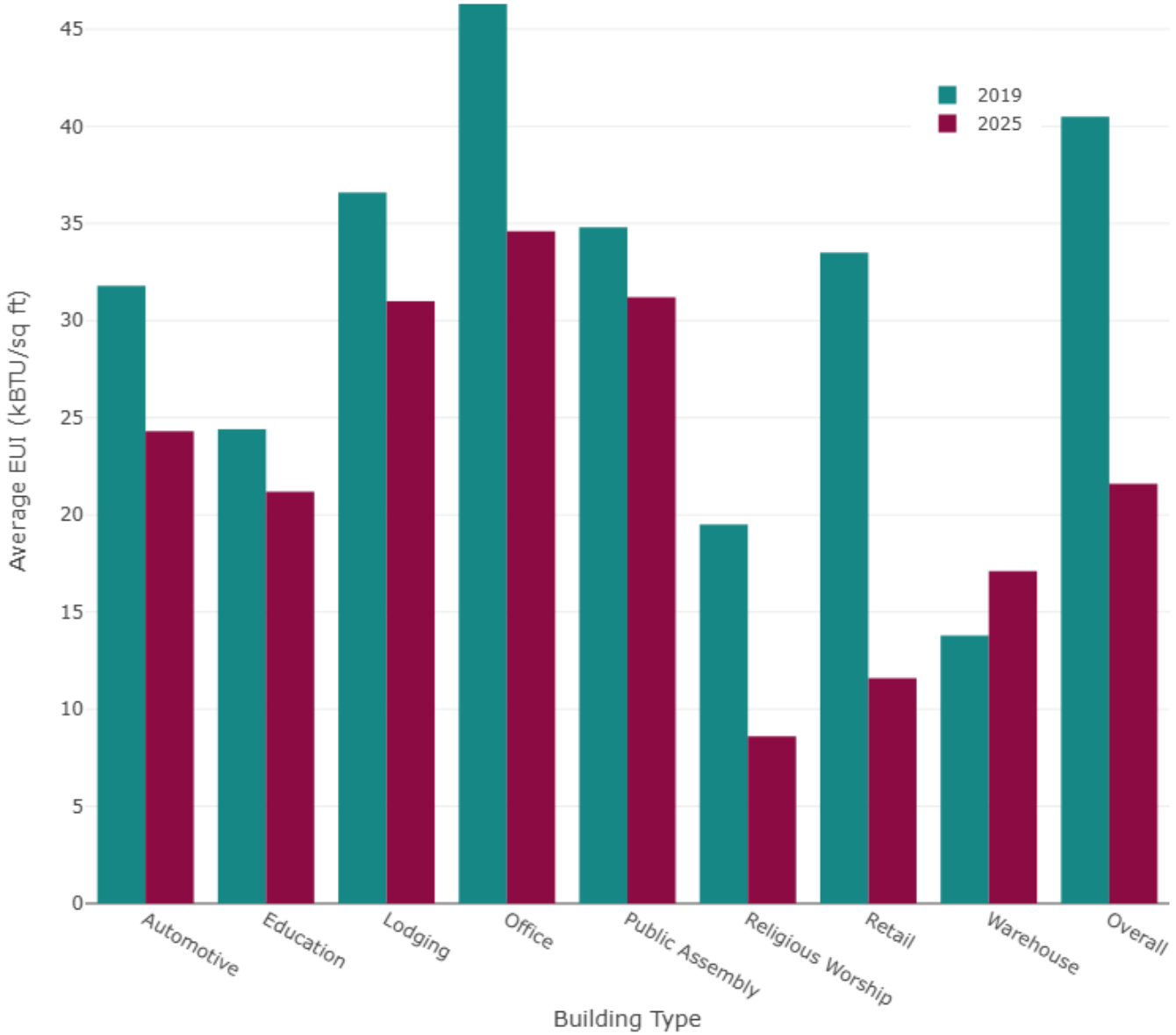
The previous assessment was completed in 2019, and results from the 2025 study were recently published.[19] Findings show an increase in the total floor space of mid-sized buildings (50,000 – 200,000 square feet) alongside a decrease in the largest buildings (200,000 square feet and greater). This pattern reflects post-pandemic redevelopment across the commercial real estate market. Research indicates that many large office buildings are being demolished or removed, confirming the reduction in inventory of buildings over 200,000 square feet.[20] Additionally, there is evidence that large buildings are being repurposed into smaller commercial footprints due to hybrid and remote work trends, persistent vacancy, and the underuse of older office assets.[21]

Energy Performance

Energy performance in commercial buildings is commonly measured using a building's Energy Use Intensity, which compares annual energy consumption to building size. EUI brings all energy sources, such as electricity and natural gas, into a common unit of thousands of Btu per square foot per year. This metric reflects how factors such as construction practices, equipment efficiency, operational patterns, and climate influence a building's total energy use.

In 2023, Oregon adopted a Building Performance Standard aimed at improving energy performance in large commercial and multifamily buildings.[23] Modeled after ANSI/ASHRAE/IES Standard 100-2024, the BPS requires covered buildings to benchmark their energy use and meet

Energy Use Intensity by Building Type[22]

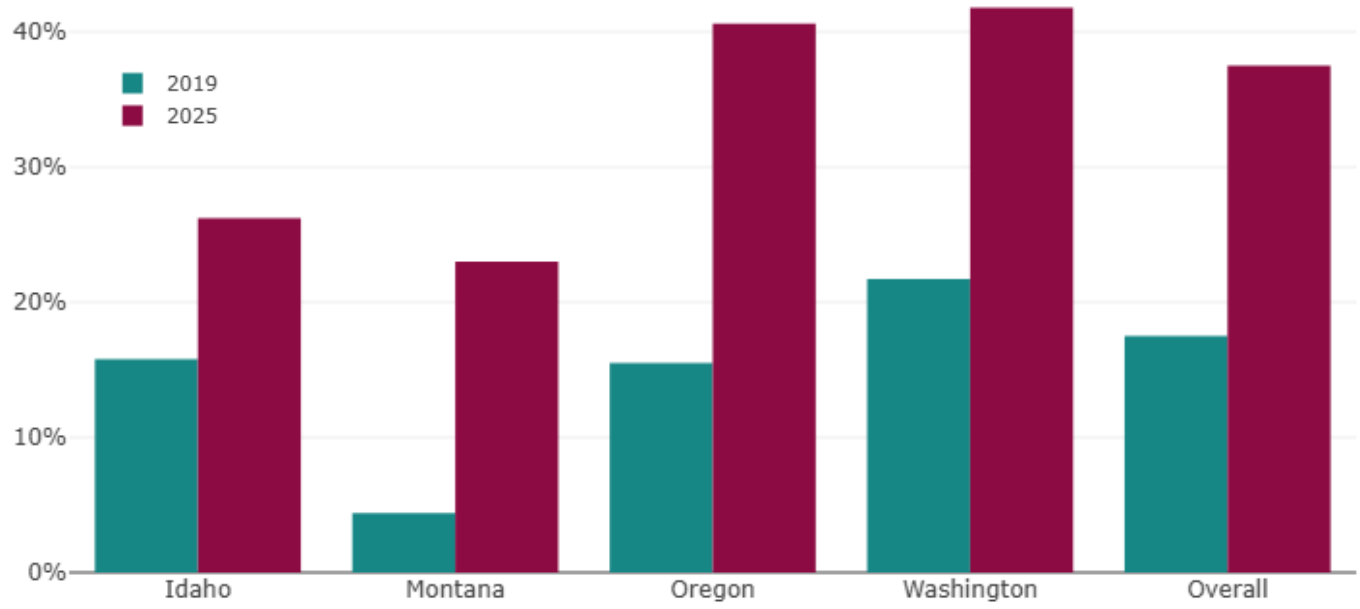


EUI targets over time. Compliance will phase in based on building size, with initial reporting beginning in 2028. The standard is designed to reduce statewide energy consumption, support climate goals, and strengthen the local energy-efficiency workforce.

Recent trends in the Commercial Building Stock Assessment report reveal that efficiency improvements over the past five years in the Pacific Northwest have not been evenly distributed across fuel types.[19] Electricity EUIs decreased significantly due to sustained reductions in lighting energy use. Natural gas EUIs, however, remained comparatively stable, reflecting both the persistence of combustion-based heating systems and the slower pace of upgrades to major heating equipment.

While many buildings continue to rely on combustion-based heating systems, the share of commercial buildings in Oregon using heat pumps for at least one portion of heating increased from 15 percent in 2019 to 41 percent in 2025, marking one of the most significant changes identified in the Commercial Building Stock Assessment. Similar growth is evident in neighboring states, with Washington showing the highest adoption rate in 2025.

Share of Heat Pumps in Commercial Buildings[19]



Industrial

The industrial sector includes all facilities and equipment used for producing, processing, or assembling goods. The U.S. Energy Information Administration defines the industrial sector to include manufacturing, agriculture (including fishing and forestry), construction, and mining (which includes oil and natural gas extraction).[24]

Nationally, manufacturing was about 80 percent of industrial energy consumption in 2022,[iii] by far the largest share of any of the industrial subsectors.[25] The largest industrial energy consumer of the manufacturing segment is the bulk chemical industry (followed by petroleum refining and paper production). Oregon's industrial manufacturing subsector includes paper and food processing, along with wood products, and computers and electronics.

The industrial sector uses electricity to operate machine drives (motors), lights, computers and office equipment, and equipment for facility heating, cooling, and ventilation. Machine drives are the largest use of electricity by U.S. manufacturers.[26] Industry uses fossil fuels and renewable energy sources for heat in industrial processes and space heating in buildings, boiler

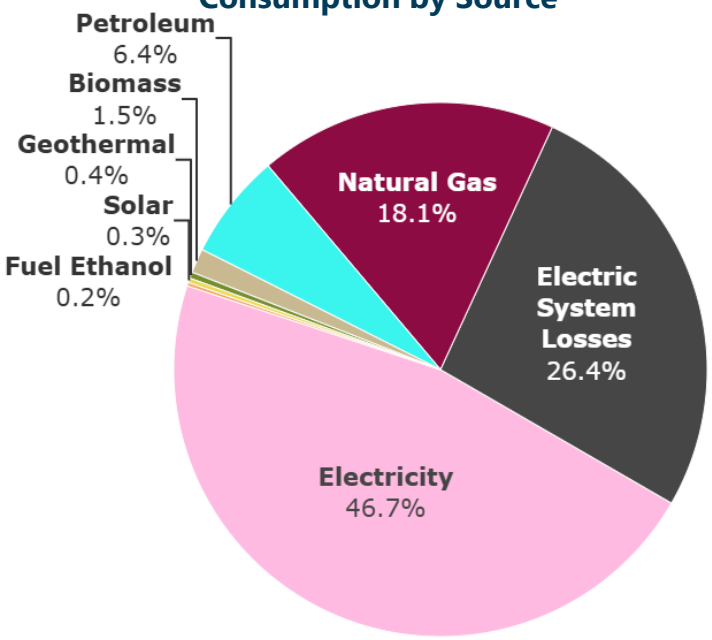
iii 2022 is the most recent year for which manufacturing data is available from the MECS.

fuel to generate steam or hot water for process heating and generating electricity, and feedstocks (raw materials) to make products like plastics and chemicals.[25]

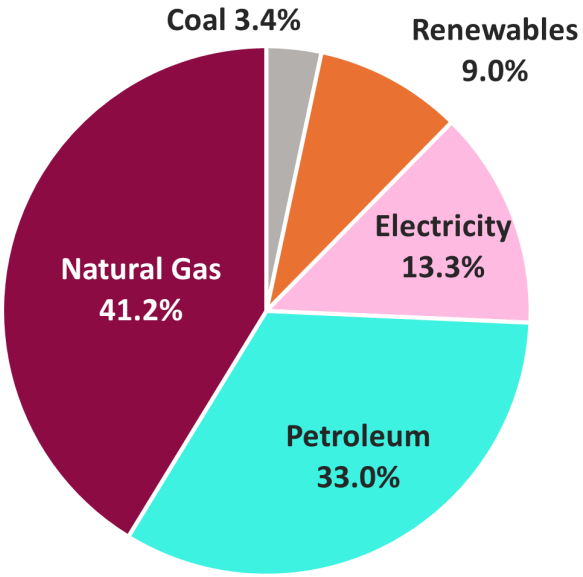
24.4%
Industrial sector's share of Oregon's energy use in 2024.[1]

According to the U.S. Energy Information Administration, most of Oregon's Gross Domestic Product comes from "non-energy-intensive, service-providing businesses," though the energy-intensive subsectors of agriculture, food processing, and forest products manufacturing are important to Oregon. Computers and electronic products (not including data centers, which are included in the commercial sector) accounted for about 40 percent of Oregon's manufacturing GDP. Relative to other states, Oregon's industrial sector energy use is lower per capita — about 60 percent of other states.[27] Computer and electronic manufacturing overall have low energy intensity relative to their high dollar value contribution to GDP.[27] Many forest products and paper operations in Oregon offset natural gas for heat and electricity from the grid by using residual woody biomass and black liquor,[iv] respectively, for cogeneration of electricity and steam for process heat.

2024 Oregon Industrial Energy Consumption by Source[1]



2024 U.S. Industrial Sector Energy Use by Source[25]



Transportation

The transportation sector covers the movement of goods, services, and people — including passenger and commercial vehicles, trains, aircraft, boats, barges, and ships. Fuel, mostly in the form of petroleum products, is used directly for transportation vehicles and to fuel equipment.[24]

Transportation fuel costs tend to be higher in Oregon than many other states because of the region's distance from fuel supplies and refineries, state taxes, and clean fuel policies.[29–32] Although passenger vehicles have improved their efficiency due to fuel economy standards, motor gasoline consumption is the largest portion of Oregon's transportation sector energy use.[33 34] Oregonians tend to keep their vehicles longer with an average age of 14.5 years, compared to the national average of 12.2.[35] Also, SUVs and pickup trucks make up more than half (31 and 24 percent respectively) of passenger vehicles registered in Oregon.[36]

iv Black liquor is produced as a byproduct of creating paper from wood pulp. It can be combusted to produce electricity for on-site generation.[28]

Of the transportation fuels used in Oregon, gasoline creates the largest amount of greenhouse gas emissions — about 17.0 million metric tons of carbon dioxide equivalent[v] in 2024.[38] Diesel is the second largest contributor of emissions at just over 9.9 million metric tons of carbon dioxide equivalent. Increased consumption of lower-emitting and renewable fuel sources such as electricity, biodiesel, renewable natural gas, and renewable diesel helps reduce emissions from the transportation sector.

Greenhouse gas emissions per light-duty passenger vehicle decreased in the early parts of the century primarily due to federal fuel efficiency standards.[39] Emissions per vehicle have held steady since 2012 but dipped in 2020 because although the total number of vehicles remained the same, gas consumption dropped during the COVID-19 pandemic. As gasoline consumption increased, emissions per vehicle rebounded in 2021 and 2022, but not to pre-COVID levels.

36.1%

Transportation sector's share of Oregon's energy use in 2024.[1]

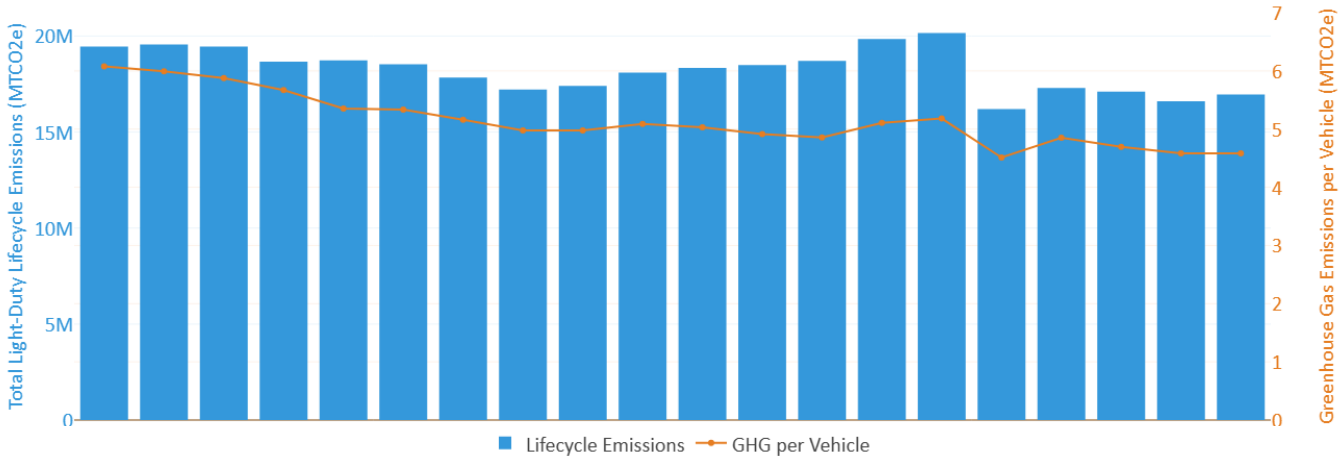
25 miles per gallon

Average fuel efficiency of a registered passenger vehicle in Oregon.[36]

400 grams per mile

Amount of CO2 emitted per mile by the average passenger vehicle in the U.S. This adds up to about 4.6 metric tons of CO2 per year.[37]

Metric Tons of CO2 produced by all Light-Duty Vehicles and Metric Tons of CO2 per vehicle[38]



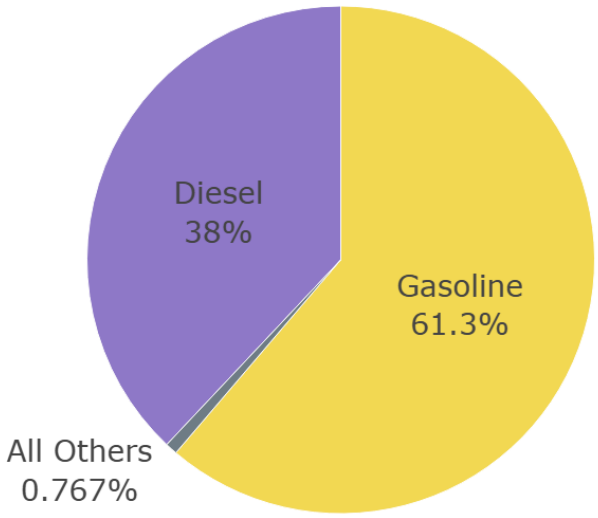
Transportation Fast Facts

- **In 2024, just over 1.35 billion gallons of gasoline powered vehicles on Oregon roads.**[38]
- **That's over 318 gallons per Oregonian.**
- **The typical Oregon household has at least two cars.**[40]
- **For electric vehicles, no matter where a car is fueled in Oregon, drivers reduce their greenhouse gas emissions by 50 to 95 percent[vi] by fueling with electricity.**[41]

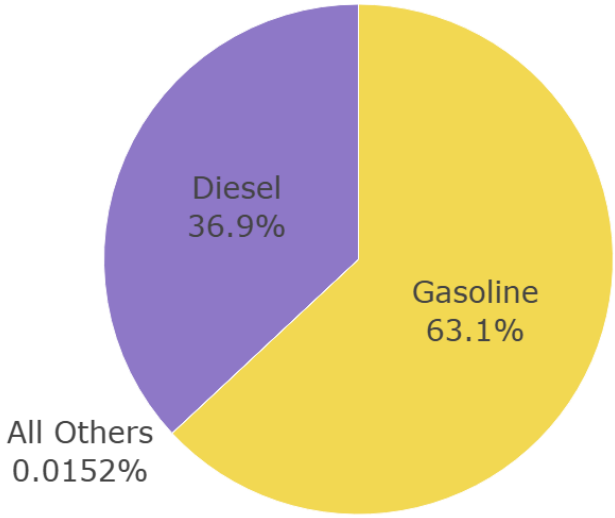
v Oregon Department of Environmental Quality's Clean Fuels Program calculates emissions for the program using carbon dioxide equivalent, which includes additional greenhouse gas emissions beyond carbon dioxide alone. This differs from the U.S. Environmental Protection Agency data, which provides data on transportations sector emissions as CO2 emissions only. According to the EPA, CO2 comprises 95-99 percent of CO2e.[48]

vi Assuming the vehicle is operating only using electricity.

Percent of On-Highway Transportation Fuel Consumption in Oregon (2024)[22]



Percent of On-Highway GHG Emissions of Transportation Fuel Types (2024)[22]



Other fuels include different small amounts of renewable natural gas, propane, and hydrogen. It does not include jet fuel, aviation gasoline, road oil, or asphalt because these are not used for on-highway vehicles.

Electric Vehicles

January 2015: 6,861 registered EVs[42]

KEI

May 2022: 52,108 registered EVs - More than 45,000 EVs added in just over seven years[42]

May 2026: 140,297 registered EVs - More than 85,000 EVs added in four years[42]

Oregon's Zero Emission Vehicle Targets (Senate Bill 1044 and the Advanced Clean Cars II Rules)[43] [44] [45]

- At least 250,000 registered ZEVs on Oregon roads by 2025
- At least 25 percent of registered vehicles and at least half of the new vehicles sold annually are ZEVs by 2030
- 100 percent of new vehicle sales are ZEVs beginning in 2035.

Oregon EVs by the Numbers (through May 2026)[46]

3,743,463 registered passenger vehicles

140,297 registered electric vehicles

3.75% of registered vehicles are EVs

102,036 are battery EVs

38,261 are plug-in hybrid EVs

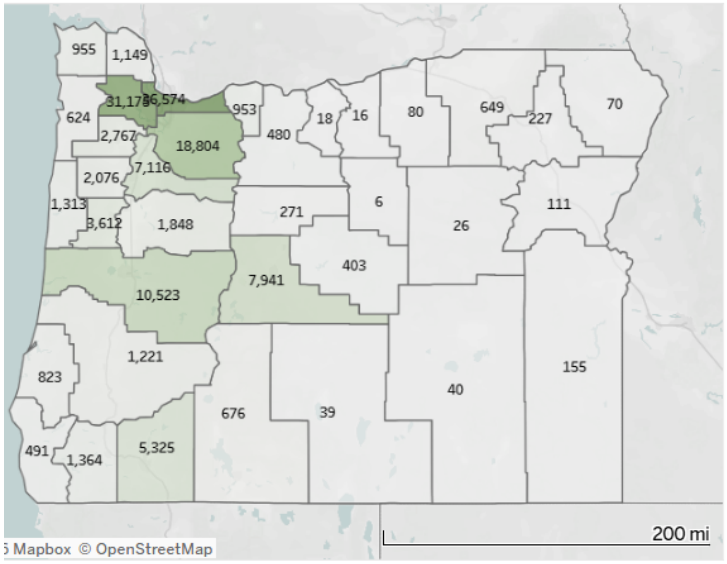
Oregon's EV Charging (through July 2026)[47]

4,313 public EV charging ports

1,662 public charging locations

Oregon Electric Vehicle Dashboard[41]

ZEVs by County as of May 2026



ut-of-state vehicles registered in Oregon are excluded from the map and scatter plot.

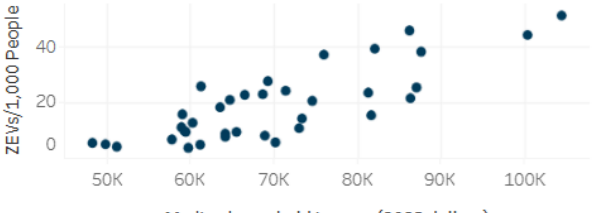
ZEVs by Type as of May 2026

BEV	PHEV
102,036	38,261

Total ZEVs

140,297

ZEVs/1,000 People vs. Income by County as of May 2026



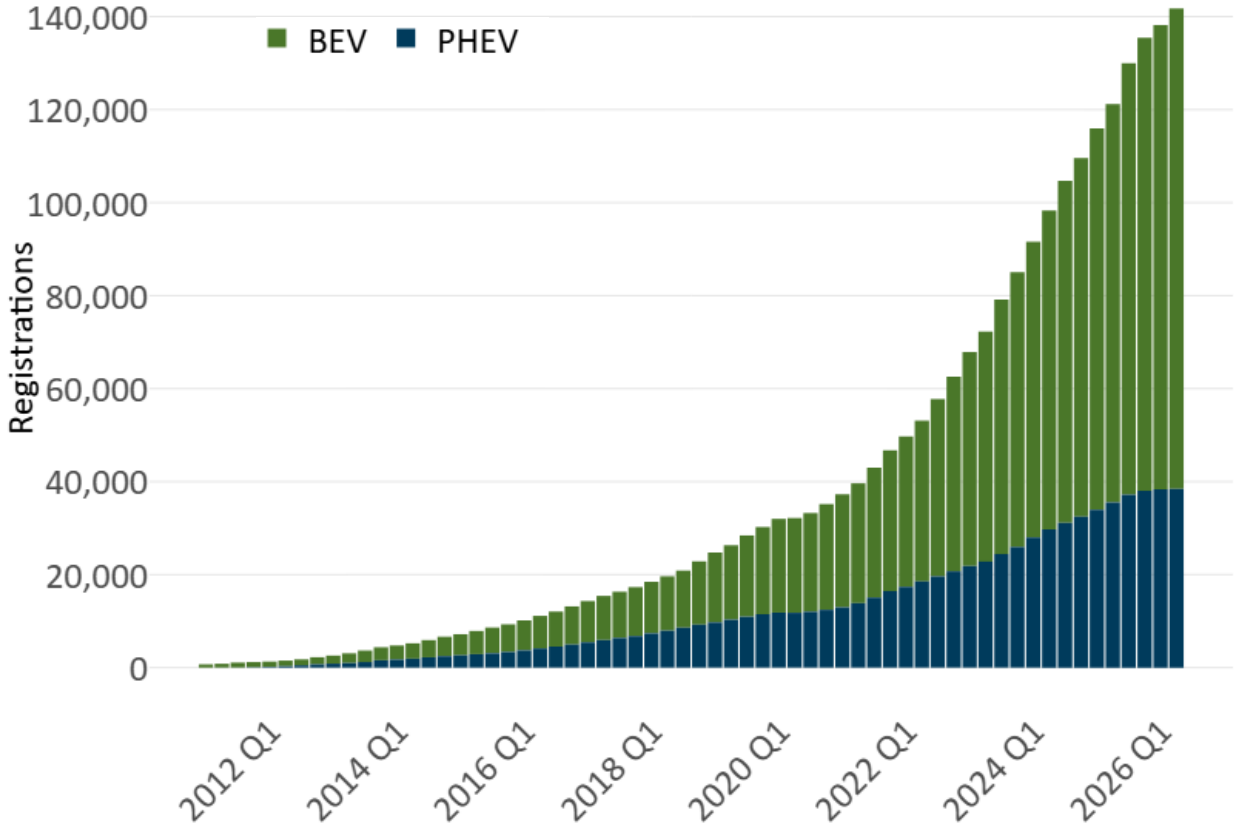
The Oregon Department of Energy's interactive Electric Vehicle Dashboard shows county-by-county EV adoption information, popular EV models, and other data. The dashboard also includes a calculator to calculate estimated fuel and greenhouse gas savings by making the switch to an EV.

www.tinyurl.com/OregonEVDashboard

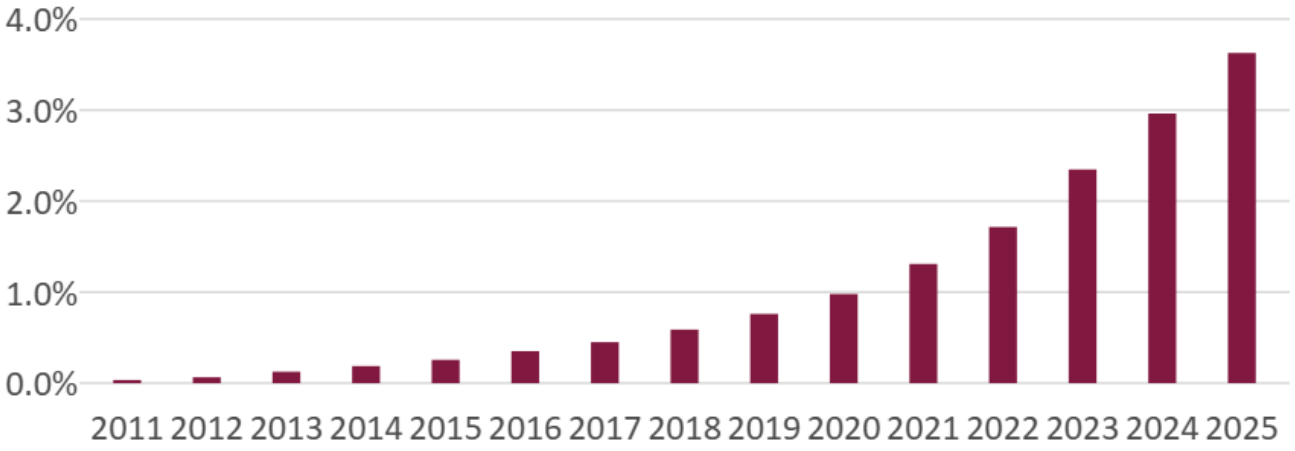
SCAN OR CLICK



Cumulative Oregon Electric Vehicle Registrations by Quarter Year (Q1 2013 – Q1 2026)[41]



BEVs and PHEVs as a Percent of Total Fleet by Year[41]



County Profiles

Oregon county profiles are a compilation of demographic, economic, and geographical datasets representing Oregon's 36 counties. The profiles aim to highlight aspects of each county's economic status and provide a focused perspective on the diverse communities within our state.

The profiles have been updated with the most currently available data from 2024 and include the following categories: County Seat, Poverty & Energy Burden, Homes, Energy, Home Primary Heating, and Travel. The following describes these categories and how they provide information about energy use and costs in different Oregon counties.

County Demographics[1] [2]

Demographic characteristics play a role in county-level energy consumption. Accounting for factors such as county area (total acreage), population, number of households, regional average annual household income, and diversity index[i] assist with understanding population, demographics, and cultural factors affecting energy consumption.

Homes[1]

The residential sector contains new, existing, and vintage constructions, with home energy use varying significantly depending on the type and size of the home under consideration. Accounting for factors such as the age of residences, type and size of residences, and type of ownership, aids in understanding the energy needs of state residents.

Energy[2] [3]

Energy use represents the direct use of energy resources within each county. These data demonstrate the amount of energy consumed by county residents and include the average annual residential electricity use and cost, average annual residential natural gas use and cost, and the average cost of these as a percentage of a typical income for that county. Ranges are provided where more than one utility serves a county.

Home Primary Heating[1]

Home heating evaluates the primary heating resources used by residents within the county. Heating systems vary depending on the energy source and the mechanical device that produces the heat. Heating systems used by residents can vary depending on their needs and the energy resources available. In the county profiles, heating systems are categorized as natural gas, electricity, propane, or wood fueled systems.

Travel[4]

The transportation and travel section accounts for the transportation burden of county residents. Information in this section includes average vehicle miles traveled per household, the fuel, maintenance, and repair costs associated with that VMT, VMT costs as a percent of typical income, and VMT as a percentage of 200 percent the federal poverty level income.[5] ODOE uses the U.S. Department of Health and Human Services federal poverty guidelines and assumes an average household size of three. This is $25,820 per year, so costs for 200% poverty level are compared to a $51,640 income.

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i The diversity index is a measurement that describes how diverse a population is by calculating the probability that two people chosen at random will be from different rae and ethnicity groups. The metric considers all of the race and ethnicity data selection options collected in the U.S. Census and is updated every 10 years.

Profiles

Below are three county profiles that provide a view of the different demographic, economic, and geographic factors that affect the state. A comprehensive set of county profiles can be found on the Oregon Department of Energy website.

County #1 Multnomah

County Seat: Portland

Characteristic	Amount
Area (Total Land Acres)[6]	275,848
Population (2024)[7]	803,343
Diversity Index[8]	53.9%
Number of Households[9]	349,803
Median Household Income (2024)[10]	$88,766

Homes



Characteristic	Amount
Homes Built Before 1990[11]	68%
Owner-Occupied Homes[12]	53%
Renter-Occupied Homes[12]	47%

Energy



Characteristic	Amount
Average Annual Residential Electricity (kWh)[13]	9,318 – 10,592
Average Annual Electricity Cost[13]	$1,562 - $1,695
Average Annual Residential Natural Gas Therms[13]	517
Average Annual Natural Gas Cost[13]	$887
Electricity and Natural Gas Average Costs (percent of typical income)[ii]	2.8 – 2.9%

Home Primary Heating



Characteristic	Amount
Electricity[14]	49%
Natural Gas[14]	46%
Propane[14]	1.1%
Wood[14]	0.6%
Other[14]	2.9%

Travel



Characteristic	Amount
Average Annual Vehicle Miles Traveled (VMT) Per Household[15]	13,311
Annual VMT Cost (Fuel, Maintenance, Repairs)[15]	$3,001
VMT Cost as Percent of Regional Typical Income[iii]	3.4%
VMT as Percent of 200% Federal Poverty Level Income[iv]	5.8%

ii Calculation of total average costs for electricity and natural gas divided by median income.
iii Calculation of total annual VMT cost divided by median county income.
iv Calculation of total annual VMT cost divided by the 200% poverty level for a 3-person household in Oregon in 2024 ($51,640).

County #2 Grant

County Seat: Canyon City

Characteristic	Amount
Area (Total Land Acres)[6]	2,897,787
Population (2024)[7]	7,225
Diversity Index[8]	20.5%
Number of Households[9]	3,444
Median Household Income (2024)[10]	$59,450

Homes



Characteristic	Amount
Homes Built Before 1990[11]	76%
Owner-Occupied Homes[12]	77%
Renter-Occupied Homes[12]	23%

Energy



Characteristic	Amount
Average Annual Residential Electricity (kWh)[13]	10,237 – 16,509
Average Annual Electricity Cost[13]	$1,212 - $1,610
Average Annual Residential Natural Gas Therms[13]	NA[v]
Average Annual Natural Gas Cost[13]	NA[ii]
Electricity and Natural Gas Average Costs (percent of typical income)[vi]	2.0 – 2.7%

Home Primary Heating



Characteristic	Amount
Electricity[14]	39%
Natural Gas[14]	0.4%[ii]
Propane[14]	6.3%
Wood[14]	39%
Other[14]	15%

Travel



Characteristic	Amount
Average Annual Vehicle Miles Traveled (VMT) Per Household[15]	27,551
Annual VMT Cost (Fuel, Maintenance, Repairs)[15]	$6,209
VMT Cost as Percent of Regional Typical Income[vii]	11%
VMT as Percent of 200% Federal Poverty Level Income[viii]	12%

v ODOE is unaware of any Natural Gas utilities serving Grant County. The U.S. Census Bureau data indicates 0.7 percent of Grant County residents use natural gas, but Oregon Public Utility Commission data do not indicate any natural gas use in Grant County.
vi Calculation of total average costs for electricity divided by median income.
vii Calculation of total annual VMT cost divided by median county income.
viii Calculation of total annual VMT cost divided by the 200% poverty level for a 3-person household in Oregon in 2024 ($51,640).

County #3 Klamath

County Seat: Klamath Falls

Characteristic	Amount
Area (Total Land Acres)[6]	3,807,934
Population (2024)[7]	69,474
Diversity Index[8]	41.9%
Number of Households[9]	28,999
Median Household Income (2024)[10]	$58,830

Homes



Characteristic	Amount
Homes Built Before 1990[11]	70%
Owner-Occupied Homes[12]	69%
Renter-Occupied Homes[12]	31%

Energy



Characteristic	Amount
Average Annual Residential Electricity (kWh)[13]	10,592 – 15,496
Average Annual Electricity Cost[13]	$1,562 - $1,872
Average Annual Residential Natural Gas Therms[13]	517 - 697
Average Annual Natural Gas Cost[13]	$772 - $885
Electricity and Natural Gas Average Costs (percent of typical income)[ix]	4.0 – 4.7%

Home Primary Heating



Characteristic	Amount
Electricity[14]	34%
Natural Gas[14]	43%
Propane[14]	3.4%
Wood[14]	11%
Other[14]	9.0%

Travel



Characteristic	Amount
Average Annual Vehicle Miles Traveled (VMT) Per Household[17]	21,558
Annual VMT Cost (Fuel, Maintenance, Repairs)[17]	$4,858
VMT cost as Percent of Regional Typical Income[x]	8.3%
VMT as Percent of 200% Federal Poverty Level Income[xi]	9.4%

ix Calculation of total average costs for electricity and natural gas divided by median income.
x Calculation of total annual VMT cost divided by median county income.
xi Calculation of total annual VMT cost divided by the 200% poverty level for a 3-person household in Oregon in 2024 ($51,640).

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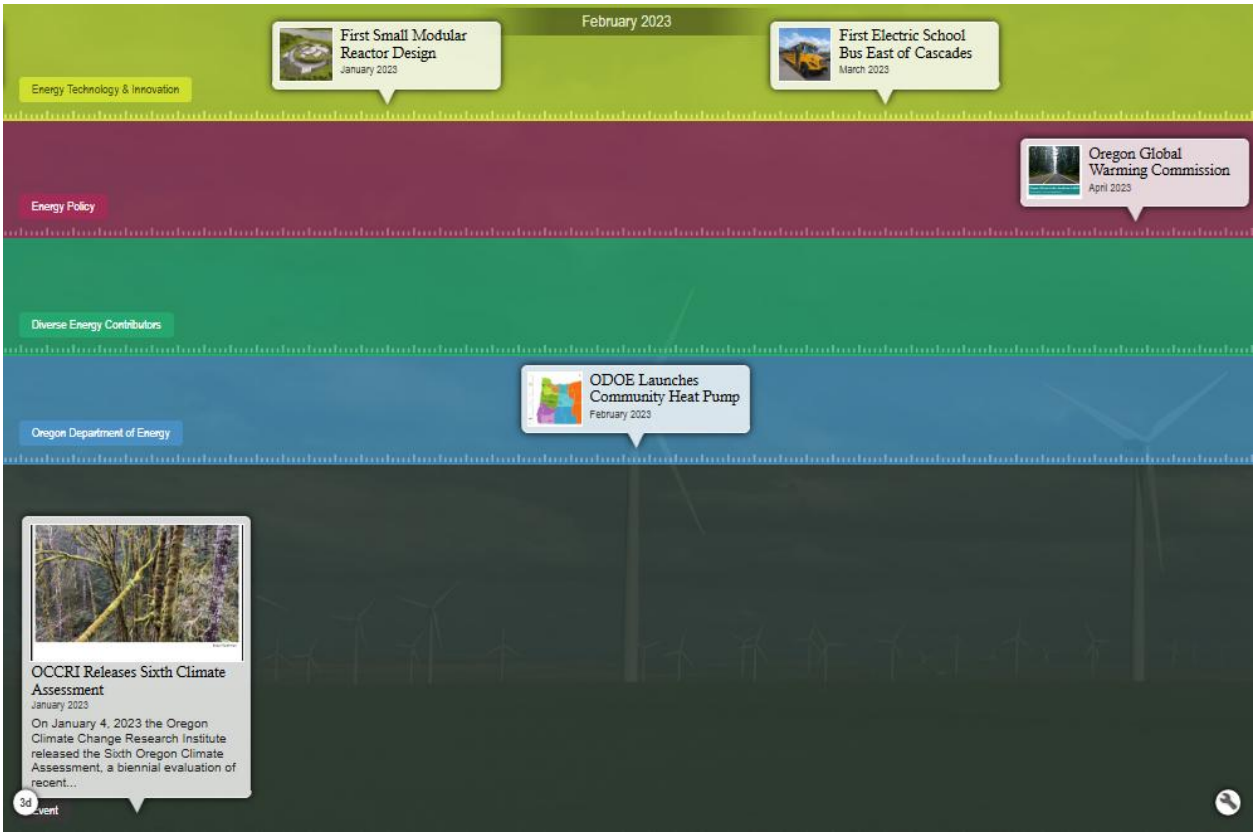
Energy History Timeline

The Oregon Department of Energy first introduced an Energy History Timeline in the 2020 edition of this *Biennial Energy Report*. It aimed to show how Oregon's energy systems have evolved over time, from harnessing the state's various natural resources to human events like technology development and energy crises. The timeline also shared events that significantly affected Oregon's Tribes – the original inhabitants of this state. Among the many events along the timeline are actions and policy choices that Oregon's leaders and citizens have made in response to changing times, like stronger clean energy policies or a focus on electric vehicle adoption.

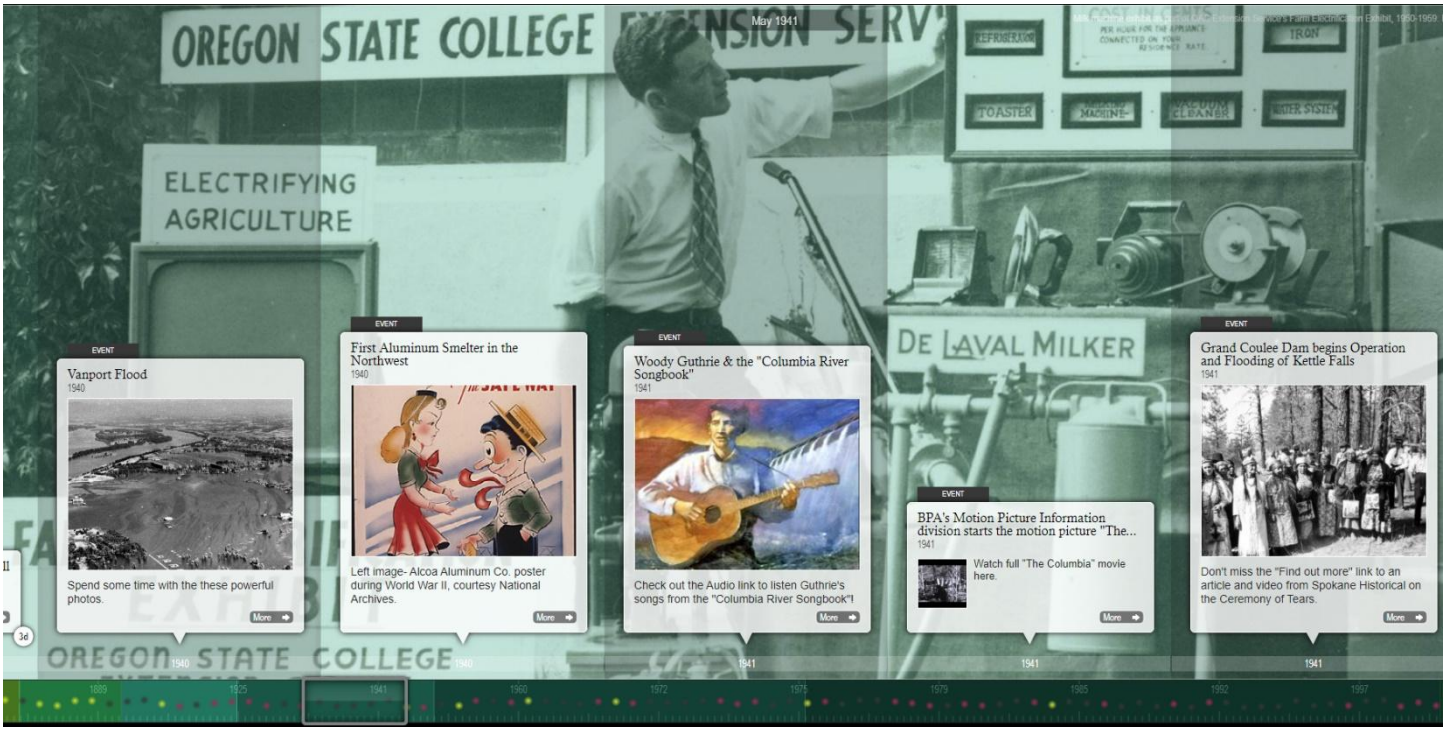
In 2022, the agency evolved the timeline to create an interactive online tool and experience. The ODOE team collected dozens of photographs, stories, videos, and more to create an insightful and informative journey through Oregon's energy history and present. The interactive tool is composed of five layered timelines: Energy Technology & Innovation, Energy Policy, Diverse Energy Contributors, Oregon Department of Energy history, and a main events timeline. Each one showcases points in time that have shaped Oregon's energy landscape and the way we live today.

ODOE has added additional milestones from the last two years, including new ODOE work like the Oregon Energy Strategy, policies like a natural and working lands carbon sequestration goal, and new legislation, like the FAIR (Fairness & Affordability in Residential Energy) Act.

Explore the online tool: https://energyinfo.oregon.gov/timeline



Timeline Tool Tips





As you explore events, be sure to check for multimedia and links. Notice the left side of the Grand Coulee Dam event. There are multiple images to view.



Events may have video or audio features, like this entry that will play Woody Guthrie's love song to the Columbia River.

More user experience tips and instructions are available: https://energyinfo.oregon.gov/timeline

Energy Resource and Technology Reviews

Rapid advancements in resources and technology have responded to and pioneered changes in our state and across the world.

Often these resources and technologies are critical to the function of our society while also helping us work better and faster. This year, we updated information on electricity generation, clean vehicle technologies, and fuels. This includes technologies that people are familiar with, like hydro, solar, and natural gas electricity generation, but also ones that are less well known, like conduit hydro and biogas. Gasoline and diesel fuels remain the primary transportation fuels in Oregon, but renewable diesel and electricity are growing, fundamentally changing the mix of fuels that underpins the state's economy. The growth in electric vehicles is also changing Oregon's energy landscape, with EV charging becoming increasingly prevalent across the state.

Innovation is a cornerstone of fundamental change, and new and improved technologies are certain to play an important role in Oregon's energy future. Another purpose of this section is to provide information on energy technologies that people might be hearing about in the news, talking to their family and friends, or in energy-related discussions. In the 2026 report, we included overviews of up-and-coming grid technologies that could play a role in Oregon's energy future, focusing on those highlighted in the Oregon Energy Strategy. This new section was developed in response to Executive Order 25-29, which directed ODOE to report on up-and-coming technologies that can help the state achieve its energy and climate goals.

Previous Biennial Energy Reports have also included resource and technology reviews that cover more energy innovations. You can find information on other resources and technologies — such as hydropower generation, carbon capture and sequestration, electricity storage, zero emission vehicles, and more — in previous reports.

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143 Clean Vehicle Technologies

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Electricity Generation Technologies

Hydroelectricity Generation

Total capacity in Oregon	**9,026.85 MW**
Number of utility-scale facilities	**91**[i]
Resource share of electricity consumption	**33.91%**
Total generation	**26.93 million MWh**
In-state consumption	**21.17 million MWh**
Exports	**5.77 million MWh**

Technology Overview



Hydropower converts the energy of moving water into electricity using turbines connected to generators.[1] This includes generators at large dams in the region, but also smaller dams along tributary rivers. Hydropower is also generated by water flowing through pipes, which is described in the Conduit Hydropower Energy Resource and Technology Review. As the largest source of electricity generation in Oregon and the broader Pacific Northwest, hydropower is renewable and can be a dispatchable energy resource that allows operators to increase or decrease electricity generation to meet changing electricity demand by directing more or less water though the turbines. This attribute helps balance the ebb and flow of electricity from variable resources like solar and wind, and respond to fluctuations in electricity demand. Most hydropower facilities operate either as water storage reservoirs behind a dam that can be released as needed, or as run-of-river systems that use the natural flow of rivers. Dams can also be designed with pumps that can move water to a higher elevation when water is plentiful to serve as storage for times when more electricity generation may be needed. Hydropower operations must be balanced with the other uses that rivers serve, including fish habitat, irrigation, recreation, and navigation.

Hydropower has been foundational to the Pacific Northwest economy since the early 1900s, providing power to rural areas, navigable waterways for goods, support for agricultural activities in arid parts of the region, and a source of low-cost electricity. Like other electricity generation resources, dams have also had an impact on the region's cultural and ecological health. Many were built on Tribal lands and affected Tribal resources without permission or compensation for damages.[2–4] For example, construction of The Dalles dam flooded Celilo Falls, important Tribal fishing grounds that served as an economic center of Columbia River Tribal economies.[5] The dams have also disrupted the ecology of the region's rivers, leading to diminishing numbers of salmon and other fish species that are

[i] This does not include conduit hydropower facilities.

traditional First Foods for Tribes and contribute to the regional economy. Significant investments through Bonneville Power Administration, state, and Tribal governments have and are being made to mitigate these effects.

Trends in Oregon

Figure 1: Share of Hydro Electricity Consumed in Oregon

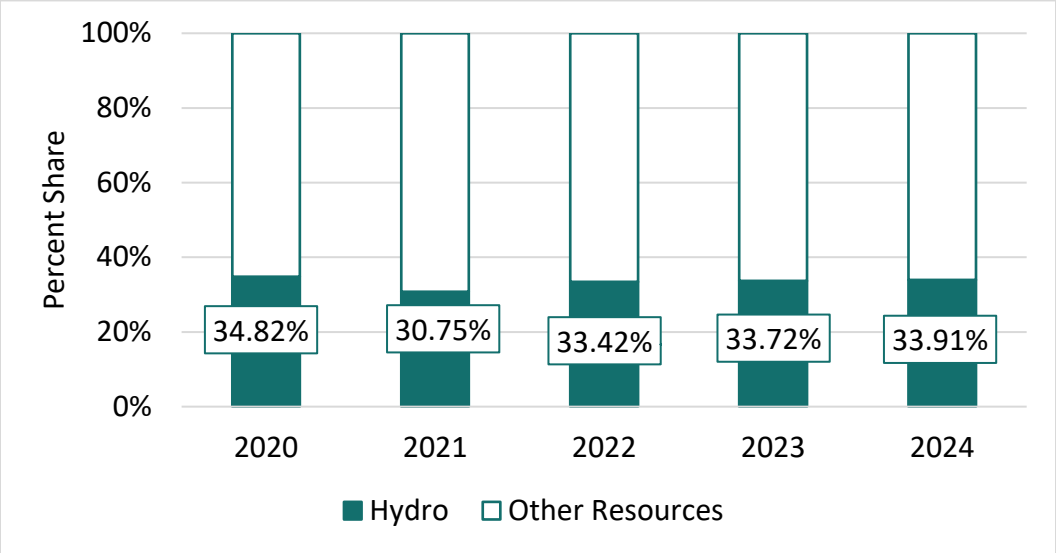
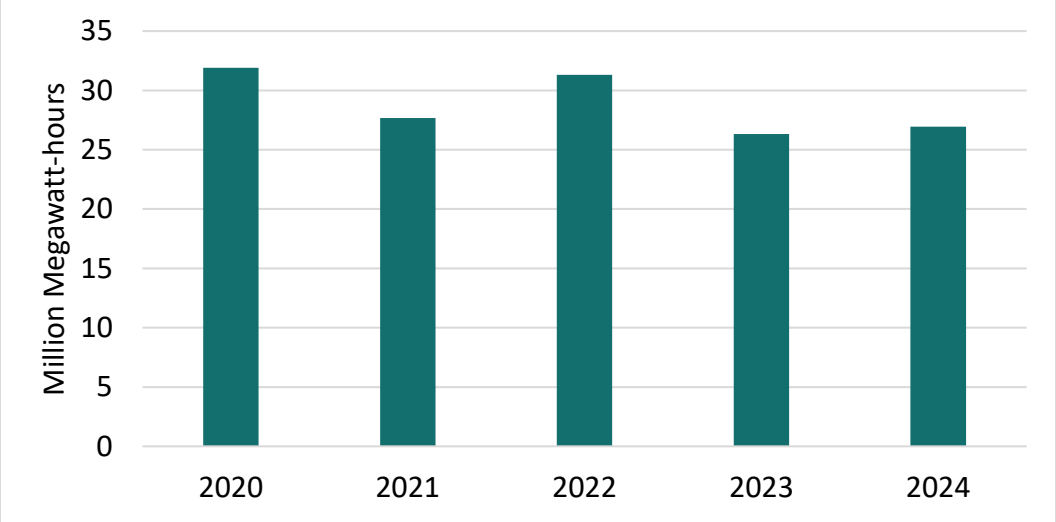


Figure 2: Amount of Hydro Electricity Generated in Oregon



Hydropower provides about a third of the electricity Oregonians use, though consumption fluctuates between seasons and from year-to-year. It comprises over 50 percent of the electricity generated in the state. Most of Oregon's hydropower is generated by federal and utility-owned facilities, and annual generation varies primarily with precipitation and mountain snowpack. Hydropower is an important resource for achieving Oregon's clean electricity goals, because it is non-emitting and can help support increasing amounts of variable renewable resources. The development of new large dams is unlikely given the high up-front cost, environmental risk and mitigation measure expenses, and land use needs. However, improving and modernizing existing facilities continues to occur. Ongoing dynamics between NW Tribes, the States of Oregon and Washington, and the federal

government regarding the Columbia River dams and fish passage are also leading to changes in the operation of dams.[6]

Climate change is affecting hydro electricity generation outputs. The warming climate reduces average annual snowpack amounts, which the system relies on as storage that is slowly released during the drier months of summer. Climate change is also affecting rainfall patterns, which in addition to affecting snowpack, is changing water levels across the year. At the same time, climate change is also creating more heatwaves in the summer months, creating higher electricity demand from cooling at a time when hydro resources are often at seasonal lows. These changes are expected to continue, affecting the future level of hydropower availability in Oregon and the region.

Additional Resources

- U.S. Energy Information Administration: Hydropower explained
- Bonneville Power Administration: Hydropower 101
- 2026 Biennial Energy Report: Energy by the Numbers – Electricity
- U.S. Department of Energy: Hydropower Basics
- U.S. Energy Information Administration: Hydropower and the environment

Natural Gas Electricity Generation

Total capacity in Oregon	**4,483 MW**
Number of utility-scale facilities	**13**[ii]
Resource share of electricity consumption	**20.4%**
Total generation	**24.9 million MWh**
In-state consumption	**12.7 million MWh**
Exports	**12.2 million MWh**

Technology Overview



Natural gas facilities combust fuel to propel turbines and engines that in turn generate electricity.[7] Natural gas facilities can increase or decrease production to reliably meet power demand, but the production efficiency and flexibility are determined by how they are designed to operate and their age. There are many types of natural gas generation technologies, but essentially they fall into two categories: combined cycle or peaker plants. Combined cycle units are designed to provide efficient, low-cost, and consistent

[ii] Includes combined heat and power facilities, campus generation, and other facilities using natural gas to produce electricity onsite and to be distributed by a utility.

baseload power over long periods. Peaker plants[iii] are capable of rapidly ramping up output to meet peak demand but are generally less efficient and therefore cost more to operate. While all natural gas plants play a role in meeting demand and complementing production from variable renewable generation resources, peaker plants are operated less frequently because of their higher operational costs. Over time, technological innovations have led to efficiency improvements in natural gas generation technologies, which means older plants tend to be less efficient, and thus more expensive to operate.

Natural gas is the second largest generating resource in Oregon behind hydropower. In 2024, generation from in-state and out-of-state facilities supplied 12.7 million megawatt-hours of electricity to Oregonians, a little more than 20 percent of Oregon's total electricity consumption. Facilities located in Oregon produced over 24 million MWh in 2024, helping meet state and regional demand. Oregon exports more electricity from natural gas than it imports. Because they are available to operate most of the time, natural gas generators can be a go-to resource whenever more power is needed. However, natural gas production and combustion both emit greenhouse gases. Emissions from natural gas generation are growing and now account for about 35 percent of emissions from electricity generation serving Oregon. If this trend continues, natural gas may surpass coal, which is currently the largest emitter of greenhouse gases resulting from Oregon electricity consumption, but is declining.

Natural gas is comprised of methane, a greenhouse gas that is more potent than carbon dioxide. Methane emissions that occur during the extraction, transport, and combustion of natural gas directly affect land, water, and air quality and contribute to climate change. Natural gas extraction and distribution pipelines require clearing land and drilling into the earth, producing air pollutants from equipment and flaring. Extraction also produces large volumes of contaminated wastewater that must be treated and disposed of appropriately to minimize polluting nearby lands and waters.[8] Natural gas combustion in Oregon and the region also releases nitrogen and sulfur oxides, particulates, and other pollutants, though power plants are required to have controls to reduce emissions.[iv] They generally require less land than wind or solar developments, depending on the type and size of the facility. Plant operations typically require water for cooling purposes. Most of the water is discharged back into the environment, but this can raise temperatures in local waters, which may negatively affect local ecosystems.[9] [10]

[iii] Peaker plants include simple-cycle turbines, steam turbines, and internal combustion engine forms of power generation, all of which are often referred to as "peaker" plants.

[iv] Electricity generating facilities must report greenhouse gas emissions to the Oregon Department of Environmental Quality. DEQ's Cleaner Air Oregon regulates emissions of toxic air contaminants from facilities based on risk to nearby communities. Cleaner Air Oregon requires facilities to report toxic air contaminant emissions, assess potential health risks to people nearby and install emissions controls to reduce toxic air contaminant risk if it exceeds legal limits.

Trends in Oregon

Figure 3: Share of Natural Gas Electricity Consumed in Oregon

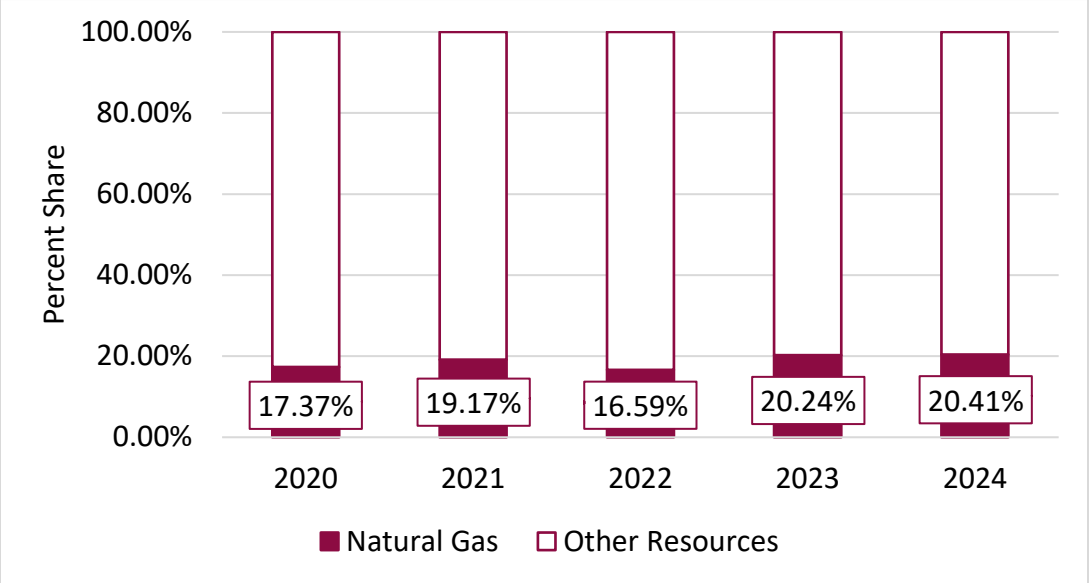
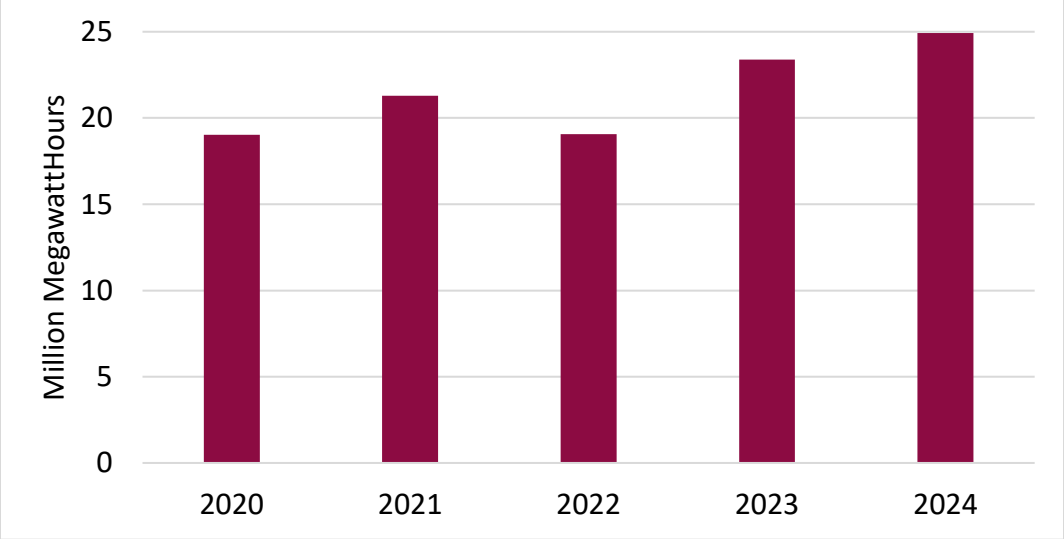


Figure 4: Amount of Natural Gas Electricity Generated in Oregon



Natural gas consumption has been steadily growing in Oregon, but whether that growth continues in the near-term is uncertain. Growth is driven by declining coal generation in Oregon's electricity mix, rapidly rising electricity demand, and the need to balance variable renewable energy resources. At some point, however, natural gas consumption will likely begin to decline. Utilities are testing and adopting many different technologies that can provide reliable electricity while also reducing greenhouse gas emissions. These will help the state's two largest utilities meet Oregon's clean electricity targets, which necessitates reductions in natural gas generation. At the same time, changes to Oregon's electricity system to achieve state targets need to be balanced with the need to maintain grid reliability, resilience, and affordability.

The future of natural gas electricity use in Oregon depends on many factors, including load growth, technological advancements in grid technologies and operations, energy costs, and state and federal policies. The proliferation of data centers in Oregon and across the Pacific Northwest is creating a

need for additional round-the-clock electricity supply, but how much demand and by when is highly uncertain. More or less natural gas may be needed depending on how quickly demand grows, where the load is located on the grid, how much of the expected load growth materializes, and whether new clean energy technologies can compete with natural gas to reliably serve load. All of these factors will affect the amount of natural gas in Oregon's electricity resource mix.

It is unlikely that new large-scale natural gas electricity generation resources will be built in Oregon in the near-term. Several states in the West, including Oregon, have established clean energy policies and targets that discourage natural gas development and use. Oregon statute prohibits the state's Energy Facility Siting Council from approving new natural gas permits, which applies to any natural gas facility to be located in Oregon that has a capacity of 25 megawatts or larger. However, natural gas plants can and are being developed across the broader Pacific Northwest, and these may contribute power to regional wholesale markets.

Additional Resources

- U.S. Energy Information Administration: Natural gas explained
- 2020 Biennial Energy Report Natural Gas Energy 101
- 2026 Biennial Energy Report: Energy by the Numbers – Electricity
- American Gas Association: Back to Basics Natural Gas 101
- U.S. Energy Information Administration: Natural gas and the environment

Coal Electricity Generation

Total capacity in Oregon	**0 MW**
Number of utility-scale facilities	**0**
Resource share of electricity consumption	**8.29%**
Total generation	**0 MWh**
In-state consumption	**5.17 million MWh**
Exports	**0 MWh**

Technology Overview

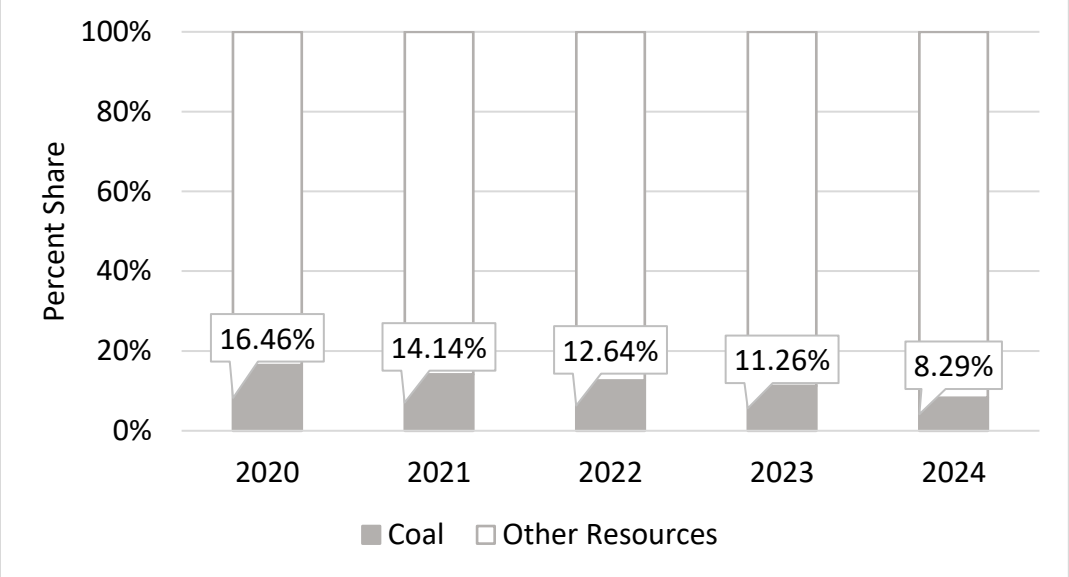
Coal-fired power plants generate electricity by combusting coal to produce high-pressure steam that drives electricity-generating turbines.[11] They can provide consistent power throughout the year but are not engineered to meet hourly changes in demand. Coal accounts for approximately 8.29 percent of Oregon's electricity consumption. All coal-generated electricity consumed in Oregon is imported. Coal generators likely contribute to Oregon's electricity mix from purchases made through wholesale electricity markets, which is not included in the above percentage. Oregon has no active coal mining, processing operations, or generating facilities.

Coal is a non-renewable fossil fuel that is abundantly available in the United States. It is also a carbon-intensive resource, producing higher greenhouse gas emissions per megawatt-hour than any other form of electricity generation. More efficient coal generators, known as supercritical coal, produce fewer emissions but still more than a typical natural gas plant. Significant greenhouse gas emission

reductions can be attained with carbon capture and storage technologies, but these reduce the plant's overall efficiency and significantly add to its capital and operating costs.

Trends in Oregon

Figure 5: Share of Coal Electricity Consumed in Oregon



Coal's contribution to Oregon's electricity supply has continued to decline over the last five years, reflecting a longer-term national trend driven by cost, technological innovations, and federal and state policy. Beginning in the 1990s, natural gas increasingly displaced coal as the lower cost generation resource, and technological innovations have reduced the cost to develop solar and wind, increasing competitive market pressures. At the same time, federal and state air and water quality mitigation requirements have increased operational expenses for coal plants, making them less economically viable. In 2016, the Oregon legislature passed SB 1547, which restricts Oregon's investor-owned utilities from recovering costs for coal generation beginning in 2030.[v]

Particularly in areas of the country without significant hydropower resources, coal generation was foundational to the early decades of the grid, providing a low-cost, reliable resource to meet electricity demand. Coal mines and power plants served as key drivers for economic development in the communities they operated in, providing jobs, tax revenue, and supporting local economies. However, coal also has well-documented environmental and public health drawbacks. Mining and combustion activities contribute to degraded air and water quality, with associated respiratory and ecological impacts in surrounding communities. Coal combustion is a major source of greenhouse gases and other pollutants, making it a significant driver of climate change. As these environmental and health costs have become clearer, and as cleaner, lower-cost alternatives have matured, the role of coal in Oregon's energy mix has diminished and will continue to do so under current policy and market conditions.

[v] SB 1547 included an exception allowing five additional years for a coal plant which has no more than four generating units and in which the IOU owns a minority share.

Additional Resources

- U.S. Energy Information Administration: Coal Explained
- U.S. Department of Energy: Coal Fact Sheet
- 2026 Biennial Energy Report: Energy by the Numbers – Electricity
- U.S. Energy Information Administration: Coal and the environment

Wind Electricity Generation

Total capacity in Oregon	**3,863 MW**
Number of utility-scale facilities	**48**
Resource share of electricity consumption	**7.85%**
Total generation	**9.5 million MWh**
In-state consumption	**4.9 Million MWh**
Exports	**4.6 Million MWh**

Technology Overview



Wind energy facilities produce electricity by capturing the kinetic energy (movement) of wind, which is a renewable resource.[12] Wind power is considered a variable energy resource because power production depends on wind conditions. Most of Oregon's existing wind energy facilities were built along the Columbia River Plateau. Facilities in this area produce more electricity at night than during the day, and more electricity during the spring and early summer than fall or winter.[13] Some Oregon utilities import wind power from Montana, which has different wind conditions and produces more electricity during the winter than the summer. There is some interest in developing wind facilities offshore where the wind tends to be stronger and more constant.

Wind energy facilities are economical to build and low cost to operate since the resource (wind) is free. Their operations also do not affect local air quality and do not emit greenhouse gases. However, wind energy facilities can negatively affect wildlife, particularly birds and bats that may collide with the turbine blades. Wind facilities also have a large footprint, but most of the land can still be used for other purposes, such as farming around and between each wind turbine tower. There is significant interest in expanding recycling opportunities for used facility components, which otherwise would substantially contribute to landfill volumes.

Trends in Oregon

Figure 6: Share of Wind Electricity Consumed in Oregon

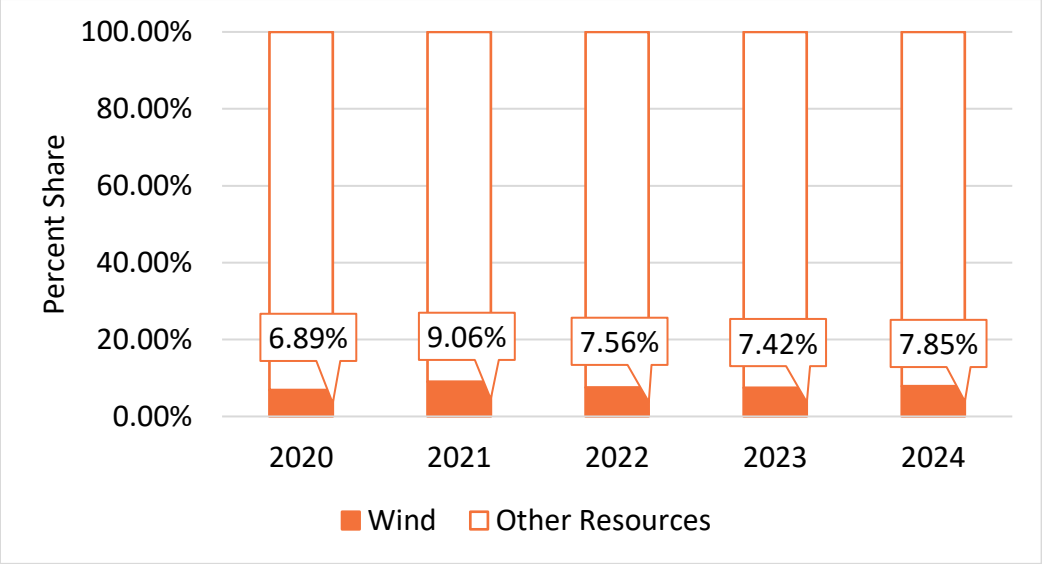
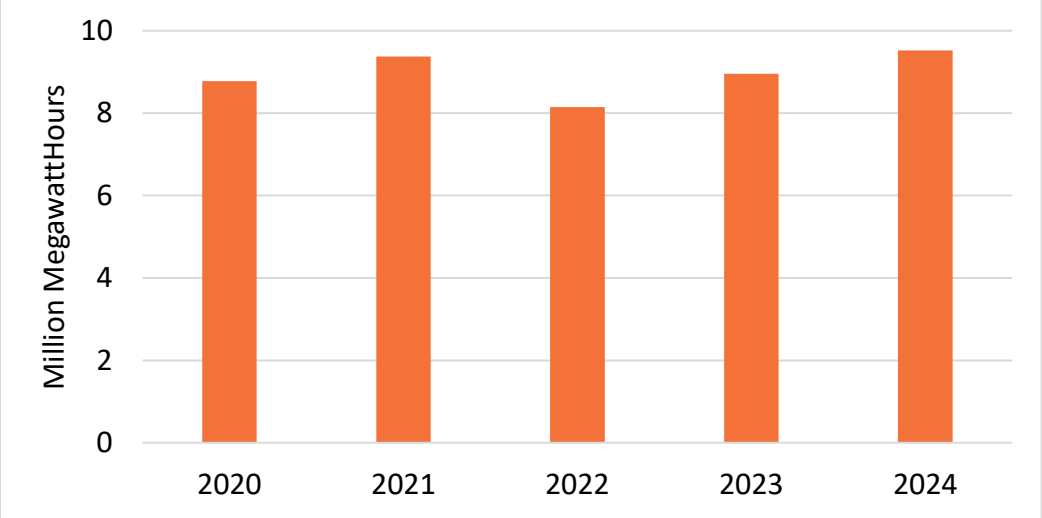


Figure 7: Amount of Wind Electricity Generated in Oregon



Wind energy is commercially available and cost competitive to deploy. The technology continues to advance, making more areas potentially viable for wind energy development, including offshore, and offering increased output at older sites if they are repowered with more modern and efficient equipment. Growing electricity demand from data centers, electrification, and other sources provides a likely market for new wind energy facilities. However, federal policies and incentives for wind and solar have fluctuated significantly in recent years, which may deter or delay new development.

Additional Resources

- U.S. Energy Information Administration: Wind explained
- U.S. Energy Information Administration: Renewable energy explained
- 2026 Biennial Energy Report: Energy by the Numbers – Electricity

- U.S. Energy Information Administration: Wind energy and the environment
- U.S. Department of Energy: Wind Turbine Recycling
- Tethys: Enabling Coexistence Options for Wind Energy and Wildlife

Solar Electricity Generation

Total capacity in Oregon	**1,369.02 MW**
Number of utility-scale facilities	**164**
Total (DC) capacity of residential/commercial units	**182.99 MW**
Resource share of electricity consumption	**3.9%**[vi]
Total generation	**2.16 million MWh**
Utility-scale generation	**2.00 million MWh**
In-state consumption	**2.44 million MWh**[vii]
Exports	**0 MWh**

Technology Overview



Ground mounted solar at the Gresham wastewater treatment plant.

Solar energy is radiant light and heat from the sun that can be collected and used to generate electricity.[14] Solar photovoltaic panels are the most common technology for generating electricity from solar energy. Cells in the panel capture solar photons, which are used to produce electrons that flow along wires embedded in the panel. Panels may be placed on residential or commercial rooftops for energy use or ground mounted for large utility-scale electricity generation. Solar panels produce energy during daylight hours, and the amount of energy they produce varies depending on location, time of day, season, and weather conditions. This means solar is a renewable but also a variable generation resource because it produces electricity only when there is sunlight. Increasingly, solar facilities are using batteries to store solar energy generation before use in the evening or other times when it is most needed.

Solar electricity production does not generate air pollutants, including greenhouse gas emissions, particulate matter, or pollutants that lead to smog. Like most technologies, there are air pollutants generated in the production of the panels and other materials needed for solar facilities. Most utility-scale solar facilities are built on large land parcels close to a utility substation or distribution lines. Siting these facilities may compete with agricultural and industrial interests, which has led to concerns

[vi] Solar's Resource Share of Oregon's Electricity Mix only includes consumption of utility-scale solar power generation, not residential and commercial solar such as rooftop generation.

[vii] Consumption data for Solar power use in Oregon refers only to utility-scale solar.

about land use needs, especially for land designated for agricultural use. Utility-scale solar facilities typically require 5 to 7 acres per MW of capacity. Rooftop solar can help offset some of the electricity needs for the buildings they reside upon and some agricultural uses can be co-located with solar panels.

Trends in Oregon

Figure 8: Share of Solar Electricity Consumed in Oregon

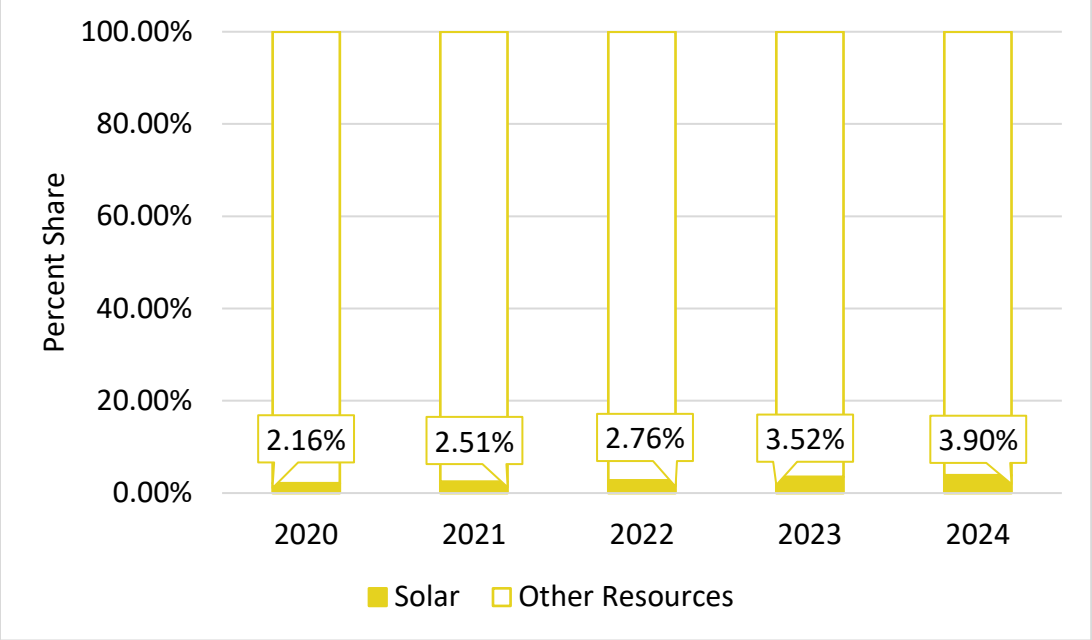
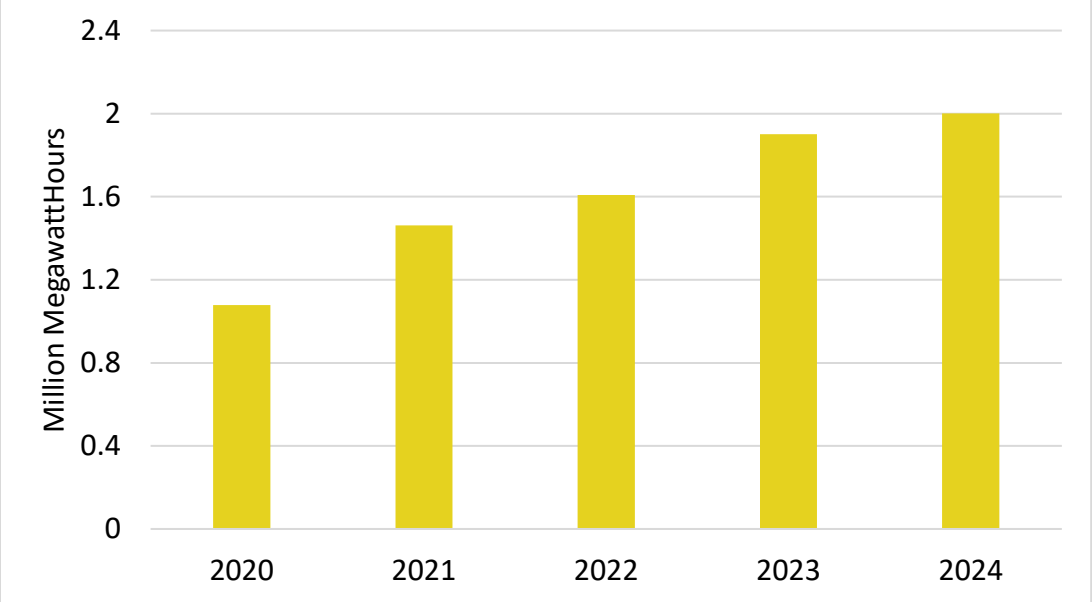


Figure 9: Amount of Solar Electricity Generated in Oregon



Solar generation is the fastest growing electricity resource in Oregon, more than doubling since 2019 with 3.375 megawatts of new capacity installed in 2025. This increase is largely due to the low cost of building and operating solar facilities compared to other types of generation, bolstered by federal tax credits.[15] Utility-scale and other large commercial solar projects are expected to increase in 2026 as

developers race to complete construction by the end of 2027 to qualify for expiring federal tax credits. However, even without tax credits, utility-scale solar is likely to continue to grow in Oregon because it is often the electricity generation resource option with the lowest construction and operating costs, and it contributes to compliance with Oregon's clean electricity targets.

Future adoption trends for rooftop solar are less certain. Installing rooftop solar requires a large up-front investment, which may take more than a decade to pay for itself in reduced electricity bills. The federal residential energy tax credit that helped address some of these costs was eliminated by H.R. 1 in 2025. The Oregon Solar + Storage Rebate Program that supported nearly 7,000 solar and battery installations since 2020, including more than 1,300 on low- and moderate-income households, ran out of funds in 2026. Energy Trust of Oregon and some consumer-owned electric utilities continue to offer financial incentives for solar installations. Rising costs for electricity and growing interest in energy resilience may bolster the residential rooftop solar market in the near future. Higher electricity costs reduce the payback period for rooftop solar investments, making them more appealing for consumers. Climate change may also bolster the market for rooftop solar and battery installations, as wildfires and extreme weather events are driving interest in backup power systems.

Additional Resources

- U.S. Energy Information Administration: Solar explained
- U.S. Energy Information Administration: Renewable energy explained
- 2026 Biennial Energy Report: Energy by the Numbers – Electricity
- U.S. Energy Information Administration: Solar and the environment
- Oregon Department of Energy: Oregon Solar Dashboard

Nuclear Electricity Generation

Total capacity in Oregon	**0 MW**
Number of utility-scale facilities	**0**[viii]
Resource share of electricity consumption	**3.79%**
Total generation	**0 MWh**
In-state consumption	**2.37 million MWh**
Exports	**0 MWh**

Technology Overview

Nuclear fission energy comes from splitting atoms in reactors containing radioactive fuel to heat water into steam, which turns a turbine to generate electricity.[16] In 2024, nuclear power facilities provided about 19 percent of the electricity consumed in the U.S., second only to natural gas.[17] [18] Nuclear provided close to 4 percent of the electricity Oregonians consumed in 2024, behind hydro,

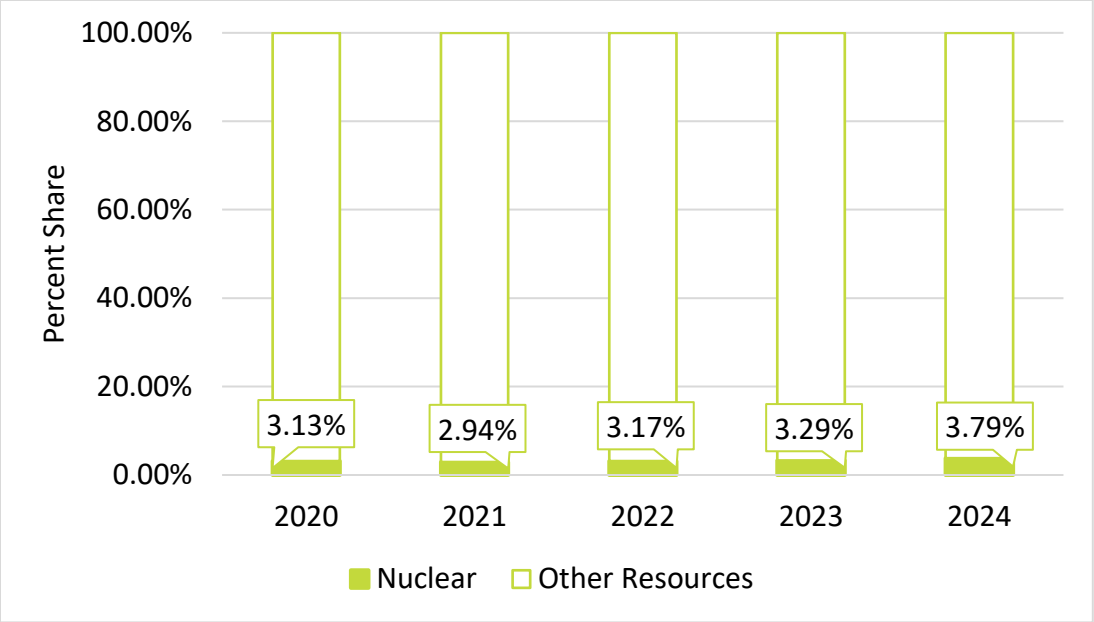
[viii] There are two research reactors in Oregon, located at Reed College and Oregon State University, but these do not produce electricity and are only used for research and training.

natural gas, coal, wind, and solar. Nuclear facilities typically operate more than 90 percent of the time, providing a consistent output of electricity. Existing reactors are not designed to ramp up or down. They are also typically large generators, with most existing reactors rated between 1,000 and 1,600 megawatts of capacity. For reference, the rated capacity of Bonneville Dam is 1,162 MW.[19] There are no nuclear power facilities operating in Oregon since the closure of the Trojan plant in the early 1990s. The Bonneville Power Administration markets power from the Columbia Generating Station nuclear plant in Washington to its customers, including many Oregon utilities.

Nuclear energy does not emit greenhouse gas emissions, but it can affect the environment and communities. Reactors generate radioactive waste that remains hazardous for tens of thousands of years, and most waste is stored on site.[20] For example, spent fuel from Trojan's operations is stored on site in dry casks, pending availability of a federal disposal facility. Site operators must handle and store waste according to federal guidelines to avoid contaminating local water and land resources. Because reactors create hot water for steam, they not only consume water for cooling but also discharge water back into the local environment. This could stress water resources in arid areas. Discharged water can raise temperatures in local waters, which may negatively affect local ecosystems.[9]

Trends in Oregon

Figure 10: Share of Nuclear Electricity Consumed in Oregon



Nuclear generation has provided a share of Oregon's electricity mix for many decades, serving about 2-4 percent of Oregon's electricity load since 2020. The high up-front capital costs of nuclear power plants when compared to solar, wind, energy efficiency, or even procuring additional power through wholesale markets has limited the options for the further development of nuclear energy in the Pacific Northwest. In addition, legal restrictions make nuclear power development in Oregon less likely in the near future. State law prohibits siting new nuclear plants in Oregon unless the federal government opens a permanent geologic repository for used nuclear fuel and voters approve a site certificate issued by the Energy Facility Siting Council for a facility. There is momentum at the federal level to site

one or more used nuclear fuel disposal facilities, but it will take many years before such a facility could be sited and begin operating.[21] The need for more electricity supply is spurring some data center developers to push for reopening previously shuttered nuclear power plants, including in Pennsylvania, Michigan, and Iowa, but there are no viable decommissioned plants in the Pacific Northwest that could be reopened.[21]

Utilities operating in Oregon could still build plants in or purchase nuclear power from other states. While conventional nuclear power is often too expensive to be considered a competitive energy resource to build, interest is growing in the development of advanced nuclear power. This is inclusive of a variety of new technologies that can produce electricity, potentially at lower costs and with more operational flexibility than traditional nuclear power. In its 2025 Integrated Resource Plan update, PacifiCorp included nuclear power from Kemmerer Unit 1, an advanced nuclear plant being constructed in Wyoming, in its preferred portfolio.[22] PacifiCorp is intending to allocate some of that power to Oregon customers through its subsidiary, Pacific Power, beginning in 2032. In addition, advanced nuclear power plants are under development in Washington and Idaho, all of which could potentially provide power for Oregon consumers.

Additional Resources

- U.S. Energy Information Administration: Nuclear explained
- U.S. Department of Energy: Nuclear Energy
- 2026 Biennial Energy Report: Energy by the Numbers – Electricity
- U.S. Energy Information Administration: Nuclear power and the environment

Biomass Electricity Generation

Total capacity in Oregon	**297.8 MW**
Number of utility-scale facilities	**14**
Resource share of electricity consumption	**0.7%**
Total generation	**1.09 million MWh**
In-state consumption	**446,895 MWh**
Exports	**372,200 MWh**

Technology Overview



Biomass, such as agricultural and forestry residuals, animal and food waste, and the organic portion of municipal solid waste, can be burned to generate electricity.[23] The biomass is burned in boilers to create steam that drives turbines, or it can be converted into a synthetic gas to fuel generators. In 2024, about 0.7 percent of the electricity consumed in Oregon came from combusting biomass. Biomass is considered a renewable resource because the feedstocks are replenishable. Oregon has an abundance of wood

waste that can be used to provide electricity, largely from the forest sector, including logging residues, mill waste, and material removed from forests to improve their health and resilience.

Biomass generators provide consistent generation when in operation, like coal and natural gas plants, though they don't produce as much energy per ton of fuel. Biomass combustion produces more air pollutants and greenhouse gas emissions than other renewable resources like hydropower, wind, and solar, and it is subject to state and federal air quality requirements. However, biomass generation facilities with particulate and emissions controls emit fewer pollutants than would otherwise be released if the biomass decayed or burned in the open.

Trends in Oregon

Figure 11: Share of Biomass Electricity Consumed in Oregon

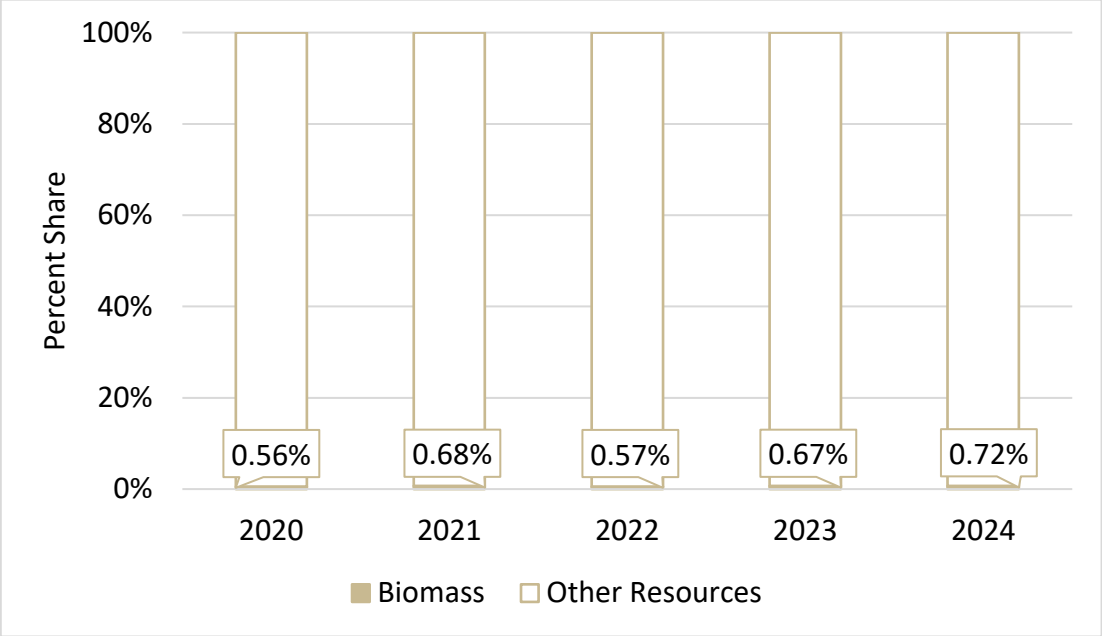
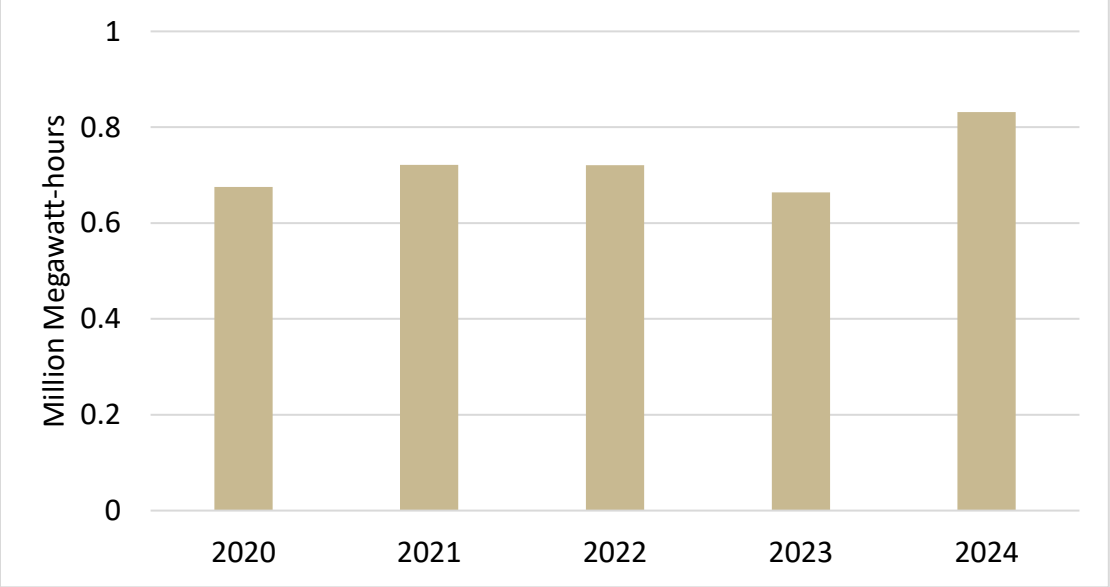


Figure 12: Amount of Biomass Electricity Generated in Oregon



Biomass contributes less than 1 percent of the electricity Oregonians use, though the relative percentage varies from year-to-year. Some biomass facilities in Oregon also supply electricity for use at the facility where it is generated, with any remaining power sent to the grid. The relative availability of the specific biomass feedstock used at the site also affects the amount of electricity that can be generated. Biomass electricity is typically more expensive to produce than many other electricity generation resources. For this reason, it is often used at times when biomass feedstocks are readily available and when other wholesale electricity costs are high.

The future of biomass electricity generation is uncertain. There is interest in the benefits biomass generation can provide, including lowering wildfire risk and providing jobs and support for local economies in rural communities. However, biomass electricity must compete with typically lower-cost wind, solar, and natural gas generation. and additional costs for biomass fuel collection, transportation, and processing often make it a higher cost resource. More expensive resources are typically operated when the cost of electricity is high, such as peak demand times, but biomass generators usually provide only consistent, baseload power, and are not designed to be ramped up or down quickly. Because biomass generation releases air pollutants, investments in air pollution mitigation technologies can also increase the costs for producing electricity. Clean and renewable energy policies that incentivize biomass electricity generation and access to broader regional wholesale electricity markets could help offset some of the costs, but the relative costs of other renewable resources, evolving energy and climate policies, and the speed and degree of electricity load growth will affect the amount of biomass generation in Oregon's future.

Additional Resources

- U.S. Energy Information Administration: Biomass explained
- U.S. Energy Information Administration: Renewable energy explained
- 2026 Biennial Energy Report: Energy by the Numbers – Electricity
- U.S. Department of Energy: Biomass: An Energy Resource
- U.S. Energy Information Administration: Biomass and the environment

Geothermal Electricity Generation

Total capacity in Oregon	**35.03 MW**
Number of utility-scale facilities	**2**
Resource share of electricity consumption	**0.11%**
Total generation	**168,873 MWh**
In-state consumption	**70,561 MWh**
Exports	**99,644 MWh**

Technology Overview

Conventional geothermal power plants use hot water resources from below the earth's surface to generate electricity.[24] Plants are built over wells that tap into these resources and capture the hot water or steam that in turn spins turbines at the site. Newer enhanced geothermal systems require

only hot rocks (>300°C), not water. EGS plants pump water down to the hot rocks where it is heated and then brought back to the surface to generate electricity.

Oregon has two operational geothermal power plants. The first, completed in 2010, is the 1.75 MW Oregon Institute of Technology plant in Klamath Falls that generates heat and electricity used on the Oregon Tech campus. The second, completed in 2012, is the Neal Hot Springs geothermal power plant near Vale, Oregon. This plant has a capacity of 22 MW and provides electricity to Idaho Power.



Neal Hot Springs Geothermal Plant in Vale, OR.

Geothermal electricity generation is a clean and renewable resource that can benefit the grid and help Oregon achieve its clean energy targets. It continuously generates electricity, providing a consistent resource for grid operations. It has a relatively small land use footprint compared with other renewable resources like solar, wind, and hydro, and fewer environmental concerns than fossil fuel resources. It generates near-zero greenhouse gas emissions, and the water it needs can be injected back into the earth to be reheated and reused. The process-water may pick up contaminants including small amounts of radioactive compounds which are naturally occurring in underground water resources.

Trends in Oregon

Figure 13: Share of Geothermal Electricity Consumed in Oregon

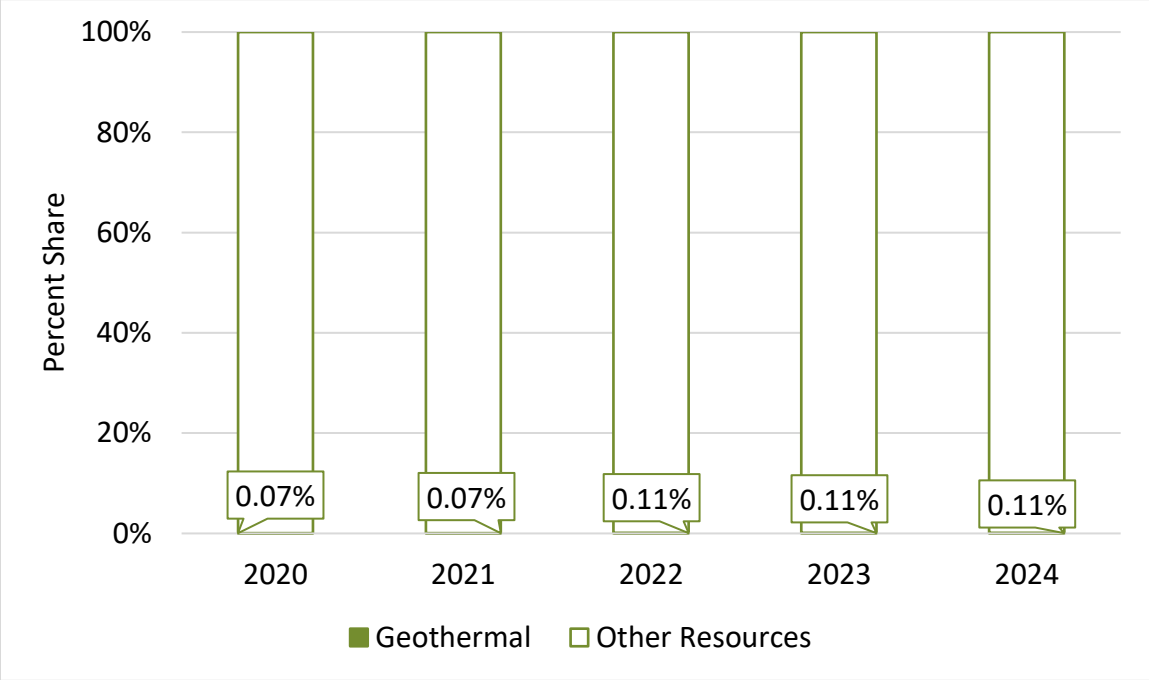
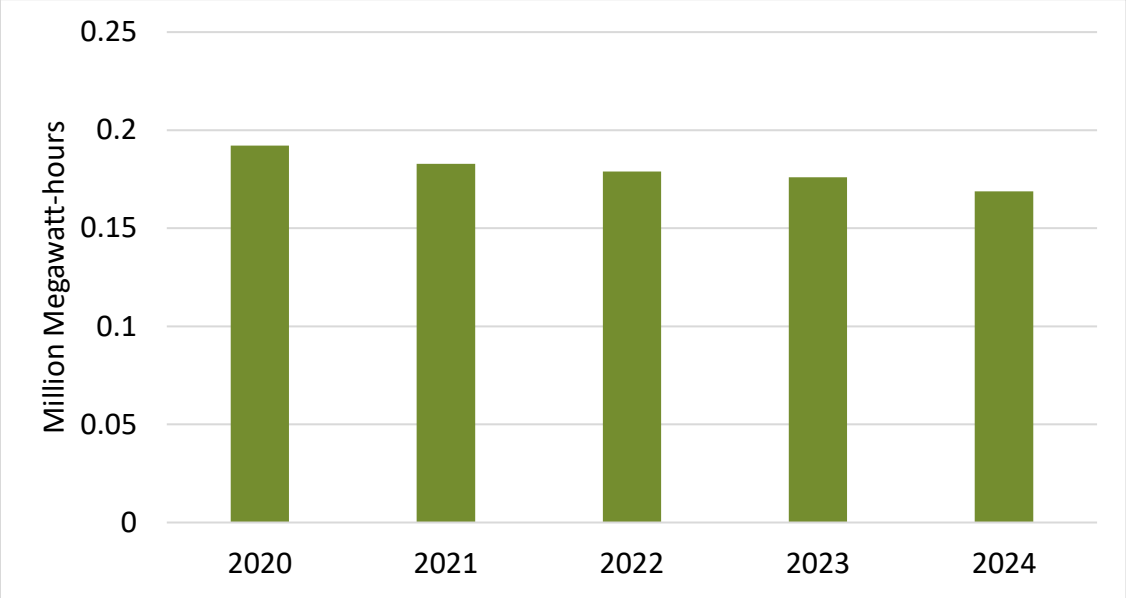


Figure 14: Amount of Geothermal Electricity Generated in Oregon



Advancements in geothermal electricity generation are creating more opportunities for development. For example, new technological innovations reduce drilling timelines by months which reduces costs to test subsurface conditions for geothermal, and significantly changes the project risk considerations. Constructing geothermal plants is expensive and financially risky, even for the large geothermal energy resources present in Oregon. The viability of a traditional geothermal plant depends on water well performance, which can be uncertain, leading to higher upfront costs for development. Emerging enhanced geothermal technologies do not rely on these difficult-to-assess hot water reservoirs; instead, they use heat from abundant hot, dry rock deep beneath the surface. U.S. DOE-funded pilot projects are providing data and insights that could help lower costs for geothermal in the future. Two of these enhanced geothermal projects are currently under construction at the Newberry volcano in Central Oregon, making Oregon a national leader in geothermal energy research.

Additional Resources

- U.S. Energy Information Administration: Geothermal explained
- 2026 Biennial Energy Report: Energy by the Numbers – Electricity
- 2026 Biennial Energy Report: Emergency Technology Review – Enhanced Geothermal
- U.S. Department of Energy: Geothermal Electricity Generation Plants
- U.S. Energy Information Administration: Geothermal and the environment
- Mazama Energy: Newberry Project
- Quaise: Project Obsidian

Biogas

Total capacity in Oregon	**57.4 MW**
Number of utility-scale facilities	**47**
Resource share of electricity consumption	**0.06%**
Total generation	**235,306 MWh**
In-state consumption	**36,670 MWh**
Exports	**199,288 MWh**

Technology Overview

Biogas is a lower-carbon fuel alternative to fossil natural gas and is produced in Oregon by capturing methane and other gases emitted from decomposing food waste, agricultural manure, and municipal waste.[25] When this gas is captured for use, it is referred to as biogas. Oregon's major biogas sources include landfills, municipal wastewater treatment facilities, dairy and livestock operations, and industrial food processors. Once collected and processed to remove moisture and impurities, biogas becomes renewable natural gas, which can be injected into existing natural gas pipelines, used as transportation fuel, or combusted onsite to make electricity.



JC-Biomethane in Junction City, OR transforms food waste into 1.5 MW of renewable electricity.

Biogas generators in Oregon typically provide power for use at the site where the biogas is produced. Biogas collection sites commonly have heat and power systems that use biogas to generate both electricity and useful heat at the same time. The electricity produced onsite can power the facility and any excess can be sold to the local electric utility. Produced heat can be used for space heating or other facility operations, reducing the need for other fuels. Because biogas would otherwise be emitted into the environment, collecting and using biogas reduces on-site methane emissions. It also reduces odors emitted from organic waste. While biogas collection reduces methane emissions, it still emits other greenhouse gases during combustion.

Trends in Oregon

Figure 15: Share of Biogas Electricity Consumed in Oregon

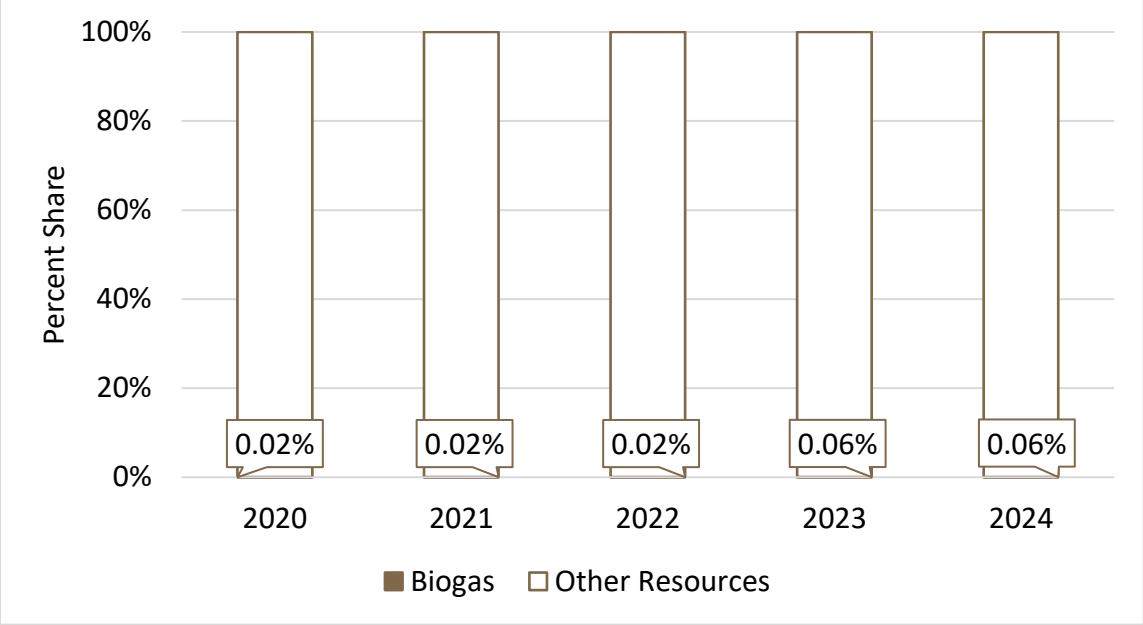
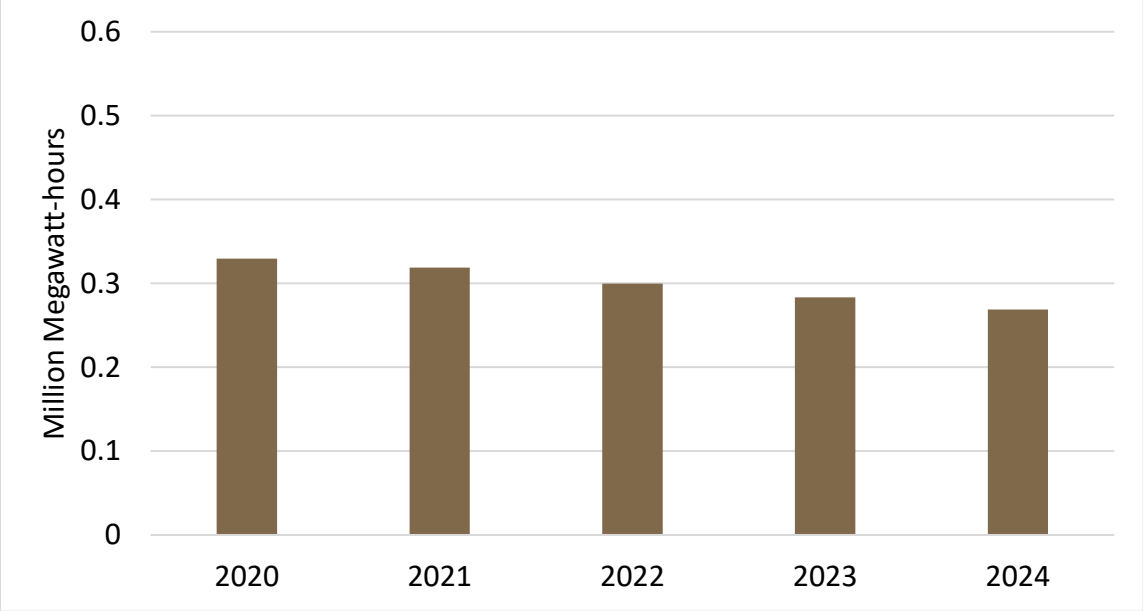


Figure 16: Amount of Biogas Electricity Generated in Oregon



The rising costs of energy coupled with rising electricity demand and state clean energy targets may spur more interest in biogas collection and use. In 2018, the Oregon Department of Energy produced a Biogas and Renewable Natural Gas Inventory that calculated the potential for biogas and renewable natural gas production in Oregon. The report found that state resources could potentially displace up to 17.5 percent of Oregon's total annual natural gas consumption, but several barriers would need to be overcome to achieve this, including high costs, interconnection and gas pipeline access constraints, and evolving regulatory structures for air emissions.

Low-carbon fuels like biogas are needed to meet Oregon's energy and climate goals. Biogas could be used to generate lower carbon electricity, but it could also serve as a low-carbon fuel for Oregon's

hardest-to-electrify transportation and industrial process heating needs.[26] At the same time, increasing electrification of fleets and buildings may create more interest in on-site electricity generation using biogas to offset costs to purchase power from a utility. On-site electricity generation could also provide backup power for facilities, improving overall energy resilience on site and potentially serving as a power source for emergency response activities in communities.

Additional Resources

- U.S. Energy Information Administration: Landfill gas and biogas
- Oregon Department of Energy: Biogas and Renewable Natural Gas Inventory

Conduit Hydropower Electricity Generation

Total capacity in Oregon	**12.84 MW**
Number of utility-scale facilities	**13**
Resource share of electricity consumption	**Data not available**
Total generation	**26,220 MWh**
In-state consumption	**Data not available**
Exports	**Data not available**

Technology Overview

Conduit hydropower refers to electricity generated by installing turbines within pressurized human-made water conveyance systems used for agricultural, municipal, or industrial water delivery. These turbines operate by converting excess water pressure into mechanical energy, moderating flow conditions while producing usable power. Similar to rooftop solar, conduit hydro systems provide power on the customer side of the meter. The electricity generated can be used on site or delivered to the grid, depending on system design and power needs. When generating, conduit hydropower does not emit greenhouse gases and is a renewable energy source that does not require ongoing fuel purchases.

Conduit hydropower installations can be a cost-effective option for municipal projects. They typically have low capital and operating costs because they leverage existing water infrastructure with excess water pressure. For example, the City of Hillsboro's conduit hydropower system generates a little over 200,000 kWh of electricity per year, offsetting the power needs of the Gordon-Faber Recreational Complex. This project lowered the complex's energy costs by $11,000 in 2021, and accrued $83,000 in cumulative cost savings through Fiscal Year 2026.[27] [28] While these benefits accrue over the lifetime of the project, there are technical and financial challenges for in-conduit hydro that can be an initial hurdle. Project development can be complicated by variable water system conditions, limited municipal staffing capacity, and complex permitting and utility interconnection requirements.[29] In addition, some installations, such as agricultural projects that need irrigation system modifications, may have high upfront costs.

Trends in Oregon



The City of Hood River installed conduit hydropower in 2026 with the help of an ODOE Community Renewable Energy Grant. Over its first 30 years, the project will generate roughly 16 million kilowatt hours of electricity.

Nationwide, more than 350 conduit hydropower projects have been permitted or completed.[30] In Oregon, cities such as Hillsboro and Beaverton have already integrated conduit hydropower into their municipal water systems.[31] Hood River and Tualatin both brought new systems online in the summer of 2026, and Bend is moving forward with a project to incorporate conduit hydropower into its planned water system expansion by 2030, signaling expanding municipal interest across the state.[32–35] Agricultural applications are also growing, supported by the collaboration between the Farmer Conservation Alliance and the Energy Trust of Oregon; however, publicly available data do not yet indicate how many of these agricultural systems are currently operating or in development beyond the known project at Siebe Ranch.[36,37] The Three Sisters Irrigation District's final canal-to-pipe modernization continues to demonstrate the broader potential of this approach by restoring year-round flows to Whychus Creek, improving fish habitat, and delivering pressurized water that cuts farm energy use by about 9 million kWh annually.[38] The fully modernized system now includes three in-pipe hydropower facilities producing up to 700,000 kWh per year, demonstrating how irrigation modernization can simultaneously support farms, ecosystems, and renewable energy. Together, these efforts illustrate how conduit hydropower is becoming an increasingly valuable and low-impact energy resource in Oregon's energy infrastructure.

Additional Resources

- National Hydropower Association: Conduit Hydropower
- Hood River harnesses hydropower with ODOE grant
- Oak Ridge National Laboratory: Assessment of Hydropower Potential at National Conduits

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Fuels

Gasoline Fuel

Total annual consumption	**156.8 trillion Btu**
End-use sector(s)	**Transportation**
Percent of total transportation fuels	**50.1%**
Produced in Oregon	**0**
Imported	**156.8 trillion Btu**
Carbon intensity	**98.06 gCO2e/MJ[i]**
Total annual greenhouse gas emissions	**16.6 million MTCO2e**

Fuel Overview



Puget Sound Refinery in Anacortes, WA (photo courtesy of Wikipedia)

Gasoline is a petroleum-based liquid fuel made by refining crude oil, a naturally occurring fossil fuel extracted from underground reservoirs through a process called fractional distillation.[1] In Oregon, gasoline is primarily used as a transportation fuel for light-duty passenger vehicles, though it also powers motorcycles, recreational boats, and some small aircraft and equipment. Gasoline is Oregon's dominant transportation fuel, accounting for more than half of all transportation energy consumption and fueling the majority of the state's approximately 3.7 million registered light-duty vehicles. Oregon does not produce crude oil or refine gasoline; about 90 percent of the gasoline sold in the state is produced at petroleum refineries and blending facilities in Washington and delivered via pipelines, marine terminals, rail, and tanker trucks. Gasoline may sometimes be used as a direct use fuel, such as in a gasoline generator for heating, but these uses are not explored here.

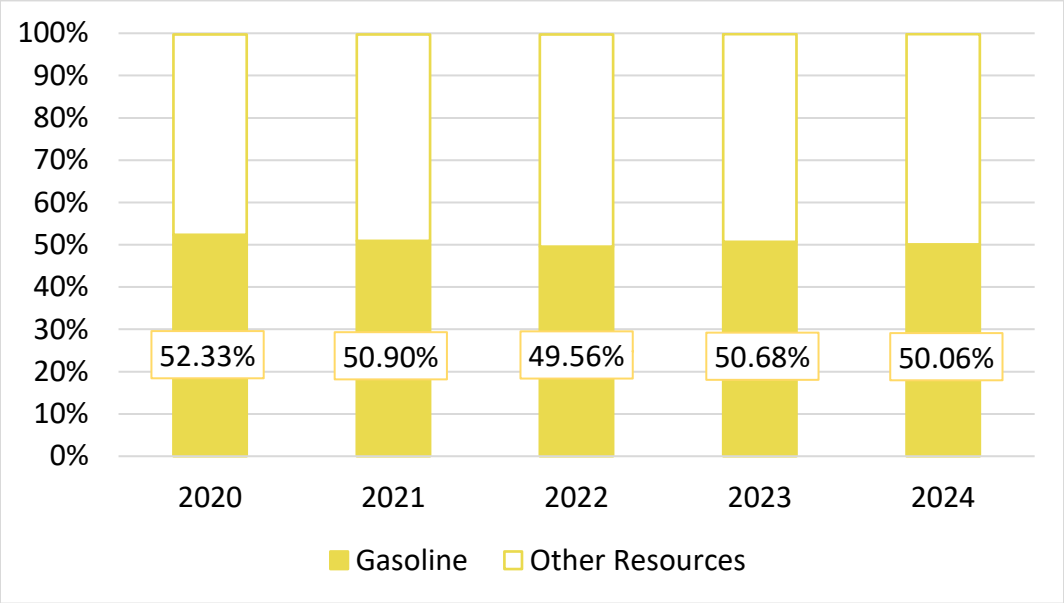
While gasoline is a critical resource for many Oregonians, enabling people to travel for work and pleasure and supporting local economies, it also negatively affects Oregonians' health and wallets. It is the largest source of greenhouse gas emissions in Oregon, contributing to climate change. It also emits carbon monoxide, nitrogen oxides, and particulate matter, which contribute to smog formation and worsen chronic respiratory and cardiovascular diseases. Oil extraction, transportation, and refining also pose environmental risks, including habitat disruption, water contamination, and potential spills. Fuel affordability varies frequently because Oregon imports all of the gasoline it consumes, and prices are highly sensitive to global crude oil market shifts. Supply disruptions and geopolitical events affect the price for crude oil, and refinery outages affect fuel prices, all of which

[i] Oregon's Renewable Fuel Standard requires nearly all gasoline sold for on-road use to contain 10 percent ethanol (E10). As a result, the carbon intensity commonly reported for gasoline under Oregon's Clean Fuel Program reflects the blended fuel rather than pure petroleum gasoline. Without the ethanol blending requirement, gasoline's lifecycle carbon intensity would be modestly higher because ethanol displaces a portion of the more carbon-intensive petroleum fuel.

are reflected at the pump and in household transportation costs. This can be particularly challenging for Oregonians who live in rural areas and live in low-income households, who often travel longer distances and have fewer alternatives to gasoline-powered vehicles.

Trends in Oregon

Figure 1: Gasoline Share of Transportation Fuels Consumed in Oregon



Gasoline consumption in Oregon generally increased until 2020, alongside population growth, economic expansion, and increases in vehicle miles traveled, before declining sharply during the COVID-19 pandemic. Consumption has since stabilized at somewhat lower levels than before the pandemic. Long-term gasoline demand is expected to decline further as vehicle fuel economy improves, electric vehicle adoption increases, and travel shifts to other transportation modes.

Gasoline has been the dominant fuel for passenger vehicles for over a century because it is a high-energy density fossil fuel with an extensive distribution network. However, several state policies are expected to reduce gasoline consumption over time in order to address greenhouse gas emissions. The state Renewable Fuel Standard requires a 10 percent blend of ethanol in most commercially available gasoline, which reduces emissions in the fuel consumed. The Clean Fuels Program requires progressively lower-carbon transportation fuels, as well as investments and policies that support electric vehicles and reductions in vehicle-miles-traveled. At the same time, recent federal policy changes, including the expiration of federal EV tax credits, ongoing legal uncertainty surrounding Oregon's ability to adopt and implement California's emissions standards and programs, and changes to federal vehicle efficiency and emissions requirements, may slow the rate at which gasoline demand declines, making the pace of this transition increasingly uncertain.

Additional Resources

- U.S. Energy Information Administration: Gasoline Explained
- U.S. Energy Information Administration: Oil and Petroleum Products Explained
- ODOE 2026 Biennial Energy Report: Energy by the Numbers – Transportation Fuels
- ODOE 2020 Biennial Energy Report: Where Oregon Gets its Transportation Fuels
- U.S. Environmental Protection Agency: GHG Emissions from a Typical Passenger Vehicle

Natural Gas Fuel

Total consumption[ii]	**140.26 trillion Btu**
Percent of total transportation fuels	**<0.01%**
Percent of total direct use fuels	**55.98%**
Carbon intensity	**79.98 gCO2e/MJ**
End-use sector(s)	**Residential, commercial, industrial, transportation**
Produced in Oregon	**0.17 trillion Btu**
Imported	**140.09 trillion Btu**
Total annual greenhouse gas emissions[iii]	**7.84 million MTCO2e**

Fuel Overview

Natural gas is a fossil energy resource produced from underground reservoirs and shale formations, delivered to Oregonians through interstate pipelines or delivery trucks.[2] It is used for space and water heating, cooking, industrial processes, and transportation. Natural gas is also important to electricity generation in Oregon. Natural gas provides high and controllable heat output, supporting on-demand energy needs across sectors. In areas with distribution pipeline systems, natural gas can be supplied directly to homes and businesses; in other areas, deliveries occur via tanker trucks for onsite storage and use. Approximately 37 percent of Oregon households rely on natural gas for home heating.[3] While less common, compressed and liquefied forms of natural gas are used in Oregon to fuel certain vehicle fleets, including transit buses, refuse trucks, and other heavy-duty vehicles. Almost all the natural gas Oregonians use is imported from Canada. The Pacific Northwest's only natural gas extraction field is located near Mist, Oregon, and it produced 0.09 trillion Btu in 2024, or roughly 0.03 percent of Oregon's annual consumption.[4]

In 2023, natural gas consumption outside the electricity generation sector accounted for roughly 15 percent of Oregon's total greenhouse gas emissions. Methane leaks released from natural gas infrastructure and emissions from fuel combustion contribute to statewide greenhouse gas levels. While natural gas has a lower carbon intensity and produces fewer greenhouse gas and air pollutant emissions than some fossil fuels, it remains a significant source of emissions in Oregon's energy system.

In 2024, Oregon households spent almost $708 million on natural gas, or about $874 per household.[5]

[ii] Includes natural gas consumed in Oregon as a fuel in the residential, commercial, industrial, and transportation sectors. This total does not include natural gas used to generate electricity.

[iii] Emissions data are from US Department of Energy's Energy Information Administration's State Energy Database. Oregon Department of Environmental Quality's Greenhouse Gas Sector-Based Inventory Data for 2024 was not yet available at publishing. This emissions total does not include emissions from electricity generation or the non-carbon dioxide emissions of methane and nitrous oxide from combustion of natural gas.

Trends in Oregon

Figure 2: Natural Gas Share of Direct Use Fuels Consumed in Oregon

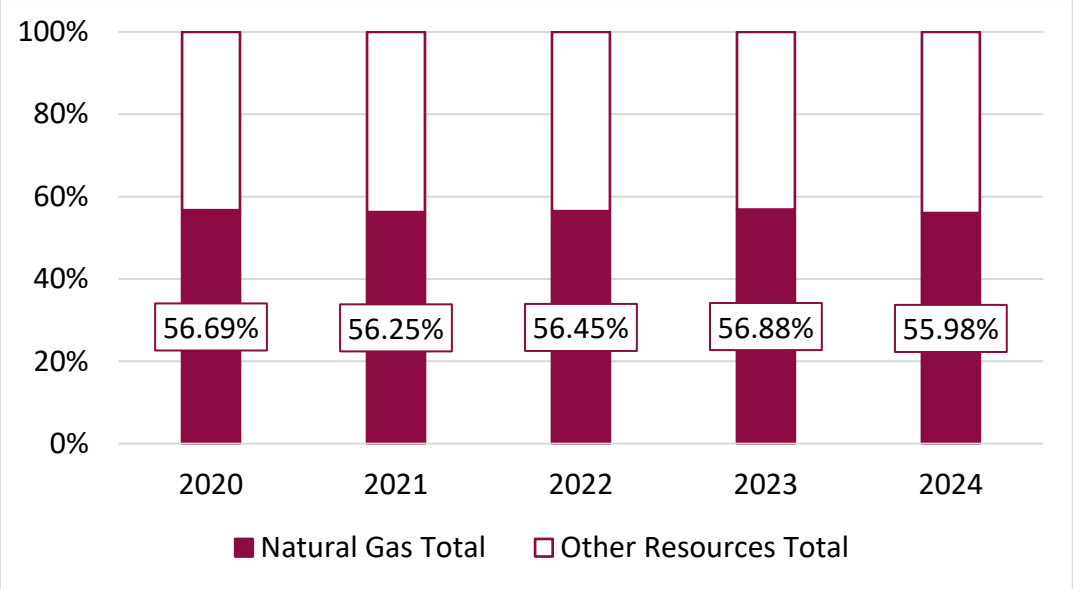
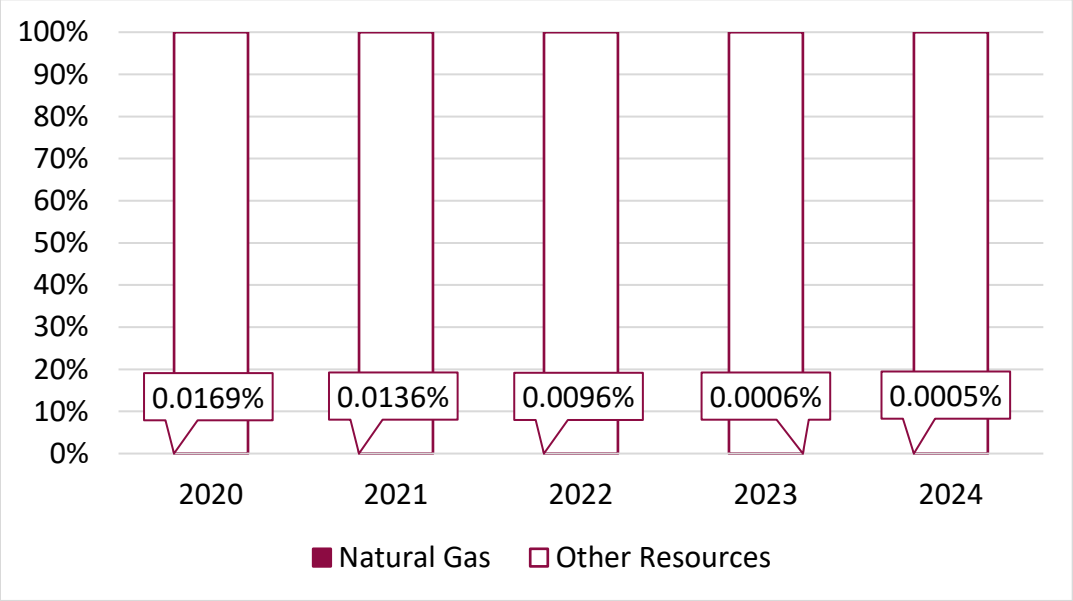


Figure 3: Natural Gas Share of Transportation Fuels Consumed in Oregon



Overall natural gas consumption in Oregon has grown, though trends vary by sector. Natural gas consumption has increased the most in the electricity generation sector. Consumption in buildings and industry has remained relatively stable, as economic and customer growth has been offset by energy efficiency improvements and electrification in some applications. Natural gas continues to provide reliable, high efficiency heating and often remains less costly than electric alternatives, particularly for large commercial and industrial loads. Direct combustion also avoids some energy losses associated with electricity generation, making natural gas a practical option for high-temperature industrial processes. Use of natural gas as a transportation fuel in Oregon has declined as fleets transition to renewable natural gas.

Natural gas is expected to remain an important part of Oregon's energy mix, although its best application and consumption volumes are uncertain. State policies that encourage a transition to lower-carbon fuels, including the Oregon Department of Environmental Quality's Climate Protection Program, are likely to increase adoption of renewable natural gas or biogas alternatives with lower emissions. Many state incentives prioritize electric technologies, such as electric heat pumps. At the same time, some end uses, like high heat applications in the industrial sector, have no cost-effective substitute for natural gas and will continue to rely on this fuel until a low-carbon fuel is more commercially available.

Economic factors and public sentiment are also shaping demand for natural gas in Oregon. Between 2020 and 2025, the price of natural gas delivered to residential customers increased by 53 percent, driven by post-pandemic inflation, higher fuel and operational costs, and capital investments needed to modernize aging infrastructure.[6] Although natural gas has historically been a lower-cost option for space heating compared to electricity, evolving state policies and broader market trends are influencing its relative economics. Growing global demand and the expansion of liquefied natural gas infrastructure are enabling greater international trade, which may contribute to higher market prices that could eventually affect Oregon customers. Public scrutiny of new gas utility infrastructure has also increased in recent years, and some decisionmakers are considering policies that emphasize electrification, which could reduce future natural gas demand.

Additional Resources

- U.S. Energy Information Administration: Natural Gas Explained
- 2020 Biennial Energy Report Natural Gas Energy 101
- ODOE 2026 Biennial Energy Report: Energy by the Numbers – Direct Use and Transportation Fuels
- American Gas Association: Back to Basics Natural Gas 101

Diesel Fuel

Total annual consumption	**74.16 trillion Btu**
End use sector(s)	**Transportation**
Percent of total transportation fuels	**23.68%**
Produced in Oregon	**0**
Imported	**76.66 trillion Btu**
Carbon intensity	**100.74 gCO2e/MJ**
Total annual greenhouse gas emissions	**8.65 million MTCO2e**

Fuel Overview

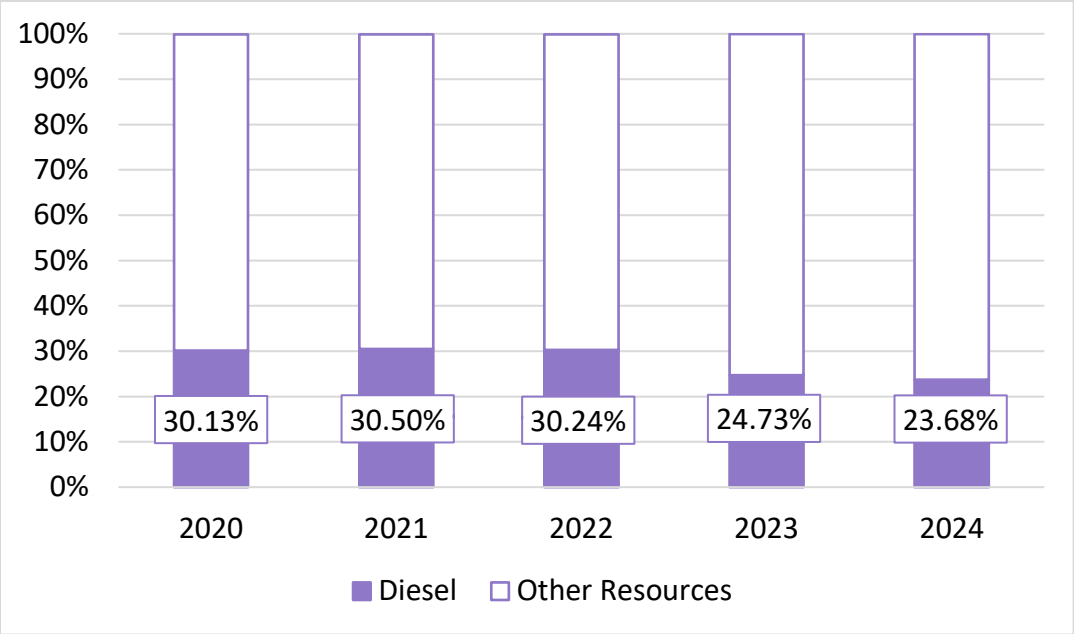
Diesel is a petroleum-based transportation fuel made by refining crude oil into a heavier distillate fuel that contains more energy per gallon than gasoline. Oregonians use diesel primarily to power trucks, buses, trains, ships, farm equipment, construction equipment, and some passenger vehicles. Diesel is widely used across Oregon's freight and commercial transportation sectors. Oregon does not produce or refine petroleum-based diesel, so all petroleum diesel consumed in the state is imported, with

more than 90 percent of diesel sold at Oregon service stations coming from refineries in Washington. Diesel is energy-dense and well-suited for high-power applications, especially in the transportation sector. It can be used for heating or industrial purposes, but the amount used for this purpose in Oregon is very small compared to transportation fuel use and is not discussed here.

Diesel combustion produces particulate matter, which is linked to asthma, respiratory illness, heart disease, and premature mortality. Diesel exhaust disproportionately affects communities located near highways, freight corridors, ports, rail yards, warehouses, and other high-traffic areas, which are often low-income and environmental justice communities. Diesel comprises the second-largest transportation fuel consumed in Oregon, after gasoline, generating 27.83 percent of Oregon's total greenhouse gas emissions, which continue to rise. Oil extraction, transportation, and refining also pose environmental risks, including habitat disruption, water contamination, and potential spills. Diesel is a combustion hazard, and spills can contaminate soil and waterways, although it is generally less flammable than gasoline.

Trends in Oregon

Figure 4: Diesel Share of Transportation Fuels Consumed in Oregon



Diesel consumption in Oregon has declined over the last few years as renewable diesel has grown rapidly and accounted for a larger share of consumption. Consumption remains closely tied to freight movement, construction, agriculture, and goods delivery. Unlike gasoline, diesel demand is less influenced by personal travel patterns and more closely reflects broader economic activity and movement of goods. Consumption remained relatively stable during the COVID-19 pandemic as increased freight activity and e-commerce offset declines in other sectors of the economy. Because Oregon imports nearly all transportation fuels, diesel prices remain highly sensitive to global oil markets and regional refinery supply. Supply disruptions, geopolitical events, refinery outages, and fluctuations in crude oil prices can significantly affect diesel prices and freight movement costs.

Several Oregon policies are expected to reduce diesel consumption over time, including the state's Renewable Fuel Standard, which requires diesel sold or distributed in Oregon to contain at least a 5

percent blend of biodiesel or renewable diesel, and the Clean Fuels Program, which incentivizes lower-carbon transportation fuels. Portland also has its own Renewable Fuel Standard and beginning in July 2026, all diesel fuel sold in the city must contain at least 50 percent biofuel.[7] Diesel is also affected by broader clean transportation policies that support zero-emission trucks, buses, and equipment. However, recent federal policy changes, including ongoing legal uncertainty surrounding Oregon's ability to implement the Advanced Clean Trucks regulation and changes to federal vehicle efficiency and emissions requirements, may slow the pace of diesel displacement and create additional uncertainty around long-term consumption trends.

Additional Resources

- U.S. Energy Information Administration: Diesel Fuel Explained
- U.S. Energy Information Administration: Diesel and the Environment
- ODOE 2026 Biennial Energy Report: Energy by the Numbers – Transportation Fuels
- ODOE 2020 Biennial Energy Report: Where Oregon Gets its Transportation Fuels
- U.S. Environmental Protection Agency: Particulate Matter (PM) Pollution
- Oregon Department of Environmental Quality: Diesel Emissions Program

Renewable Diesel Fuel

Total annual consumption	**21.09 trillion Btu**
End use sector(s)	**Transportation**
Percent of total transportation fuels	**6.73%**
Percent of total direct use fuels	**0%**
Produced in Oregon	**0**
Imported	**21.09 trillion Btu**
Carbon intensity	**16.22-66.00 gCO2e/MJ**
Total annual greenhouse gas emissions	**0.84 million MTCO2e**

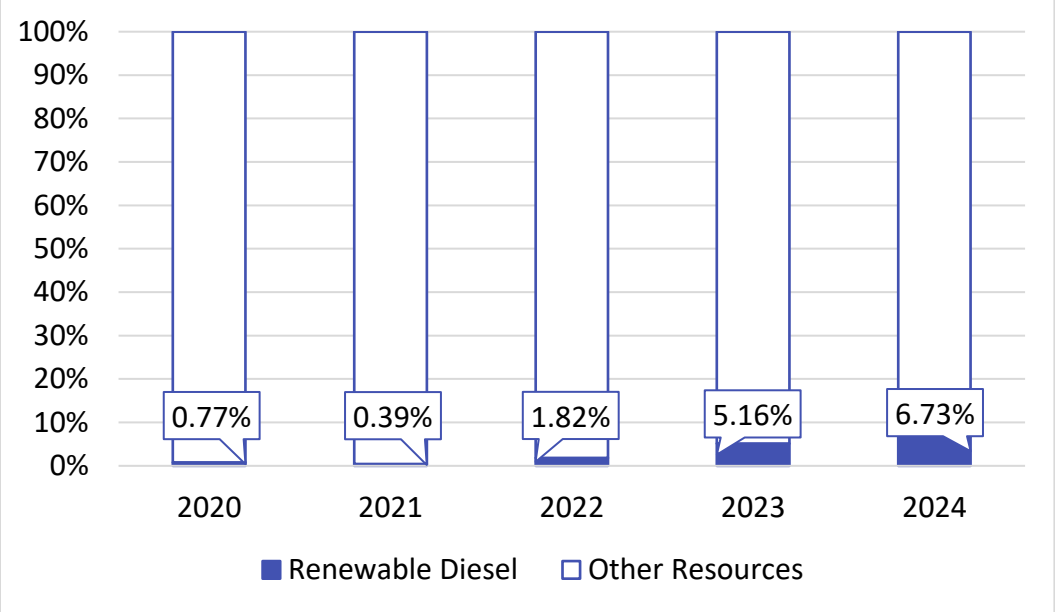
Fuel Overview

Renewable diesel is a drop-in fuel, meaning it can replace or be blended with fossil diesel and biodiesel at any ratio without requiring changes to vehicles or fueling infrastructure.[8] The key difference between renewable diesel and biodiesel is that renewable diesel is chemically similar to fossil diesel and can be used as a full replacement fuel, while biodiesel is chemically different and is typically used as a blend with fossil diesel or renewable diesel. In Oregon, state law requires that diesel sold or distributed contain at least a 5 percent blend of biodiesel or renewable diesel, so most diesel users consume some biodiesel regardless of the fuel they purchase. Renewable diesel is made by refining renewable biomass feedstocks, such as plant- and animal-based fats and oils. Using renewable diesel reduces greenhouse gas emissions 55-65 percent compared to fossil diesel and produces fewer particulate emissions because it burns cleaner.[8] [9] Oregonians use renewable diesel for transportation fuel in on-road vehicles and other uses, such as the Port of Portland's dredging vessel used in the Columbia River. It can also be used to power backup generators. In Oregon, almost 102 million gallons of renewable diesel were consumed in 2025.

All renewable diesel is currently imported into Oregon, primarily from Washington, California, and Louisiana, in addition to international providers. In 2024, Oregon imported approximately 171.6 million gallons of renewable diesel. The only in-state production project under active development is the proposed NXTClean Fuels facility at Port Westward, which is still awaiting final federal approval from the U.S. Army Corps of Engineers. If permitted and constructed, NXTClean would aim to begin refining in 2028.[10] [11] The facility is expected to produce up to 750 million gallons per year of renewable diesel and sustainable aviation fuel with the ability to switch which fuels being produced based on demand. While Oregon's renewable diesel supply will continue to depend on imports for the foreseeable future, an operational in-state facility would significantly increase local production capacity and reduce some reliance on imports. Like the fuel itself, the refining process for renewable diesel produces fewer greenhouse gas and particulate emissions than fossil diesel, resulting in a reduced, but not entirely eliminated, environmental impact.[8]

Trends in Oregon

Figure 5: Renewable Diesel Share of Transportation Fuels Consumed in Oregon



Renewable diesel consumption has been steadily rising in Oregon, with demand exceeding supply, especially in the Willamette Valley where most of the fuel is sold. This is primarily because it offers several advantages over fossil diesel. It has fewer contaminants, which lowers operational costs for vehicle owners by reducing wear and tear on engines. It also performs better in cold weather. With fewer contaminants, renewable diesel also has fewer particulate emissions, mitigating some negative health effects in communities near busy roadways or places where diesel is regularly combusted. Since it was made available in Oregon, renewable diesel has been more expensive than regular diesel, but since May 2025, wholesale prices for renewable diesel (R99) have been trending lower than prices for the two most-used types of fossil diesel fuel (B5 and B20).[12]

State and federal policies encourage renewable diesel uptake. The Federal Renewable Fuels Standard and Oregon's Clean Fuels Program provide systems that enable renewable diesel sellers to monetize credits or certificates for the sale of the fuel. Oregon's Climate Protection Program sets an annual cap on emissions from fuels, and renewable diesel is one option for regulated parties to meet that CPP

requirement. Bills have been proposed but not passed in the Legislature to set adoption goals, including SB 803 (2023), which would have established a phased-in statewide renewable diesel standard, and HB 3308 (2025), which would have set state fleet R99 targets. Renewable diesel is also an eligible fuel to support Portland's Renewable Fuel Standard, which currently has a 50 percent biofuel requirement.

Additional Resources

- U.S. Department of Energy Alternative Fuels Data Center: Renewable Diesel
- U.S. Department of Energy: Biofuels Explained
- ODOE 2026 Biennial Energy Report: Energy by the Numbers – Transportation Fuels
- NXTClean Fuels: Port Westward renewable diesel refinery
- American Chemical Society: *Life Cycle Greenhouse Gas Emissions of Biodiesel and Renewable Diesel Production in the United States*

Ethanol Fuel

Total annual consumption	**11.58 trillion Btu**
End use sector(s)	**Transportation**
Percent of total transportation fuels	**3.7%**
Produced in Oregon	**4.19 trillion Btu**
Imported	**7.4 trillion Btu**
Carbon intensity	**21.91-87.34 gCO2e/MJ**
Total annual greenhouse gas emissions	**0.4 million MTCO2e**

Fuel Overview



Ethanol Production Plant in Clatskanie, OR.

Ethanol is a renewable alcohol-based transportation fuel produced by fermenting and distilling plant-based feedstocks such as corn, sugarcane, wheat, sorghum, and increasingly, agricultural and forestry waste materials.[13] It is most commonly blended with gasoline rather than used as a standalone fuel. Oregonians primarily use ethanol as a gasoline additive, with most gasoline sold for on-road vehicles containing a 10 percent ethanol blend (E10). Ethanol increases the oxygen content of gasoline, promoting more complete combustion and reducing air pollutants and greenhouse gas emissions. Higher blends, including E15 and E85, are available in limited markets and, in the case of E85, can only be used in flex-fuel vehicles.[iv] Most ethanol consumed in Oregon is imported from large production

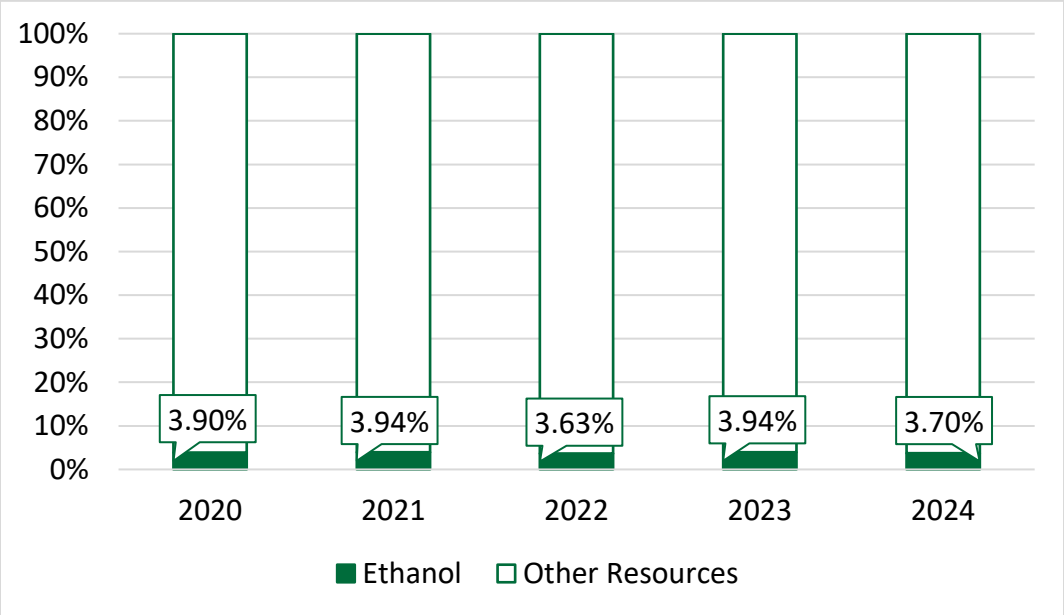
[iv] A flex-fuel vehicle is a type of vehicle designed to run on more than one kind of fuel – typically gasoline or gasoline blended with ethanol, most commonly E85 (a fuel containing up to 85 percent ethanol). Flex-fuel vehicles look and operate like conventional gasoline vehicles but offer drivers the option to use a higher-ethanol, lower-carbon fuel when available.

facilities in the Midwest and transported by rail and truck. There is limited in-state production, including a facility in Boardman.

Blending ethanol reduces greenhouse gases that would otherwise be emitted from fossil gasoline combustion. It also helps reduce criteria air pollutants,[v] including carbon monoxide and volatile organic carbon compounds (VOCs). Using ethanol can reduce negative health outcomes, mitigate climate change, and lower Oregon's exposure to volatile global crude oil markets. Environmental benefits vary substantially depending on feedstock, agricultural practices, transportation distances, and production methods. Corn-based ethanol can contribute to changes in land use, fertilizer runoff, and increased water use. However, lower-carbon pathways that utilize agricultural residues, renewable energy, or carbon capture technologies can significantly improve environmental performance. Ethanol may sometimes be used as a direct use fuel, such as in a gasoline generator for heating, but these uses are not explored here.

Trends in Oregon

Figure 6: Ethanol Share of Transportation Fuels Consumed in Oregon



Ethanol consumption in Oregon has remained relatively stable over the past five years because it is closely tied to gasoline demand. Oregon's Renewable Fuel Standard effectively guarantees statewide E10 adoption, which ensures every gasoline-powered vehicle in the state uses some amount of ethanol. Higher blends like E15 or E85 remain niche fuels and are unlikely to substantially influence statewide fuel consumption in the near term. Use of ethanol is bolstered by Oregon's Clean Fuels Program, which incentivizes lower-carbon fuels. Ethanol will likely remain an important component of Oregon's transportation fuel mix for decades, but consumption is expected to gradually decline over time as increasing electric vehicle adoption reduces demand for gasoline.

[v] Criteria air pollutants are a group of six widespread outdoor pollutants regulated under the U.S. Clean Air Act due to their harmful effects on health, the environment, and property. For each, the EPA has established National Ambient Air Quality Standards to protect public health and welfare. They include ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, nitrogen dioxide, and lead.

Ethanol can modestly reduce gasoline prices by increasing fuel supply and diversifying fuel sources. Ethanol prices may also behave differently than petroleum prices; for example, from June 2025 to June 2026, ethanol prices increased by about 10 percent, roughly one-quarter as much as the approximately 40 percent increase in crude oil prices over the same time period.[14] [15] Ethanol is also the only liquid transportation fuel currently produced at commercial scale in Oregon. Increased demand could support expanded in-state production, while existing production capacity and feedstock supply chains may also provide opportunities to transition toward other low-carbon fuels in the future. However, ethanol contains approximately 30 percent less energy than gasoline, meaning higher ethanol blends can reduce vehicle fuel economy unless engines are specifically designed or optimized to use them.

Additional Resources

- U.S. Department of Energy Alternative Fuels Data Center: Ethanol Fuel Basics
- U.S. Energy Information Administration: Ethanol Explained
- U.S. Department of Energy Alternative Fuels Data Center: Flexible Fuel Vehicles
- ODOE 2026 Biennial Energy Report: Energy by the Numbers – Transportation Fuels

Biodiesel Fuel

Total annual consumption	**9.16 trillion Btu**
End use sector(s)	**Transportation**
Percent of total transportation fuels	**2.9%**
Produced in Oregon	**0**
Imported	**9.16 trillion Btu**
Carbon intensity	**11.68-57.26 gCO2e/MJ**
Total annual greenhouse gas emissions	**0.4 million MTCO2e**

Fuel Overview



A biodiesel fuel pump offering multiple blends. Source: Flickr | United Soybean Board

Biodiesel is a renewable transportation fuel produced by chemically converting vegetable oils, animal fats, used cooking oils, and other organic feedstocks into fatty acid methyl esters[vi] that can be blended with conventional petroleum diesel.[16] In Oregon, biodiesel is used primarily as a blend component in diesel fuel to power trucks, buses, agricultural equipment, construction equipment, and other diesel-powered vehicles and equipment. Unlike electricity or hydrogen, biodiesel can often be used in existing diesel vehicles with little or no modification, making it a near-term option for reducing emissions from medium- and heavy-duty transportation applications. Higher blends may require manufacturer approval and additional fuel management considerations

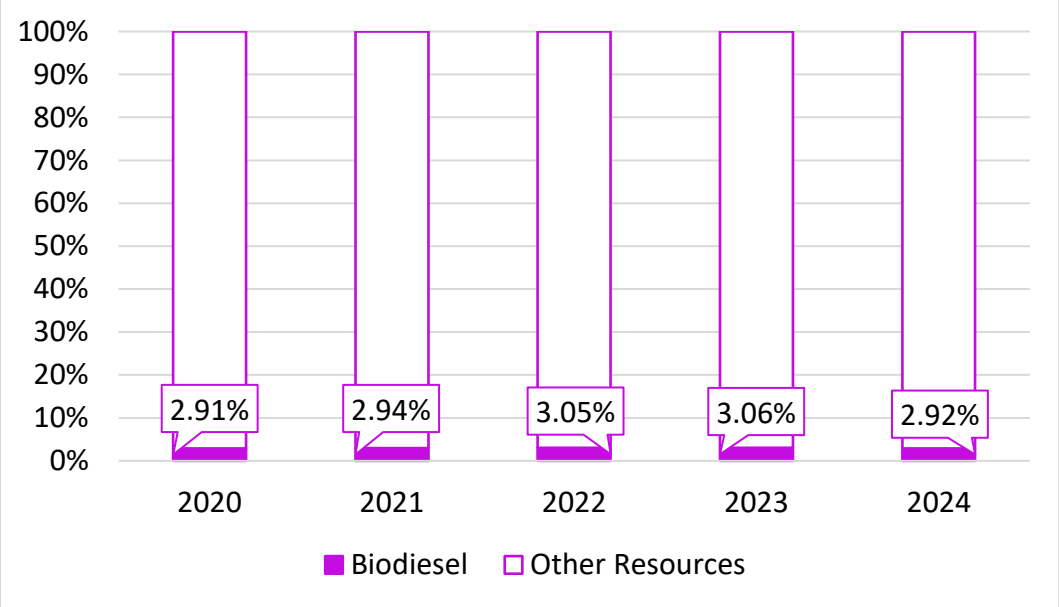
[vi] Fatty acid methyl esters (FAME) are a class of chemical compounds produced by reacting fats or oils, such as vegetable oils, used cooking oil, or animal fats, with methanol. They are the primary chemical components of conventional biodiesel.

because biodiesel's physical properties can affect engine performance and fuel storage, particularly in colder temperatures. Many vehicle manufacturers approve blends up to 20 percent biodiesel (referred to as B20) for certain applications, though higher blends are not universally compatible across all engines and equipment. Biodiesel can also be used for heating or industrial use, but this amount is very small compared to transportation fuel use and is not discussed here.

Oregon has no in-state biodiesel production, so all the biodiesel consumed in the state is imported from producers in other western states and the Midwest, and distributed through Oregon's existing diesel fuel infrastructure. Compared to petroleum diesel, biodiesel can substantially reduce lifecycle greenhouse gas emissions and decrease emissions of particulate matter and other pollutants. However, like other low-carbon fuels, environmental benefits vary depending on the feedstock and production methods. Producing biodiesel from waste oils and fats generally results in lower emissions than crop-based feedstocks. Crop-based feedstocks can contribute to changes in land use, increased water consumption, and fertilizer runoff. Biodiesel is biodegradable and less toxic than petroleum diesel, reducing some spill risks, although improper handling and storage can affect fuel quality.

Trends in Oregon

Figure 7: Biodiesel Share of Transportation Fuels Consumed in Oregon



Biodiesel consumption in Oregon has declined in recent years as renewable diesel has gained a larger share of the diesel fuel market. Biodiesel remains a component of Oregon's transportation fuel supply, driven in part by state fuel policies rather than direct consumer choice because biodiesel is typically sold blended with petroleum diesel rather than as a standalone fuel. Oregon's Renewable Fuel Standard requires most diesel sold or distributed in the state to contain at least a 5 percent blend of biodiesel or renewable diesel,[vii] with exemptions for certain uses including rail, marine, home heating, and emergency power generation. Renewable diesel, unlike biodiesel, can be used at high blend levels or as a direct replacement for petroleum diesel. As renewable diesel availability and

[vii] Biodiesel and renewable diesel are distinct fuels that can be produced from similar feedstocks, including used cooking oil, animal fats, or vegetable oils. They are produced using different processes.

consumption have increased in Oregon, biodiesel has accounted for a smaller portion of the state's diesel fuel supply. Oregon's Clean Fuels Program also incentivizes both biodiesel and renewable diesel based on their lifecycle carbon intensity relative to conventional petroleum diesel.

Most diesel users consume some amount of biodiesel, although the exact amount varies over time based on market conditions and fuel availability. Biodiesel prices in Oregon remain influenced by petroleum diesel prices, feedstock availability, and broader energy market conditions. Supply disruptions, geopolitical events, fluctuations in crude oil prices, and changes in agricultural commodity markets can all affect biodiesel cost and availability.

Additional Resources

- U.S. Department of Energy Alternative Fuels Data Center: Biodiesel
- U.S. Energy Information Agency: Biodiesel Explained
- U.S. Department of Energy: Biofuels Explained
- ODOE 2026 Biennial Energy Report: Energy by the Numbers – Transportation Fuels
- U.S. Department of Energy Alternative Fuels Data Center: Biodiesel Handling and Use Guide

Propane Fuel (Fossil and Renewable)

Fossil Propane

Total annual consumption	**7.95 trillion Btu**
End use sector(s)	**Residential, Commercial, Transportation, Industrial**
Percent of total transportation fuels	**0.07%**
Percent of total direct use fuels	**3.08%**
Produced in Oregon	**0**
Imported	**7.95 trillion Btu**
Carbon intensity	**80.88 gCO2e/MJ**
Total annual greenhouse gas emissions	**0.014 million MTCO2e**

Renewable Propane

Total annual consumption	**Data not available**[viii]
End use sector(s)	**Transportation**
Percent of total transportation fuels	**Data not available**
Percent of total direct use fuels	**Data not available**
Produced in Oregon	**0**
Imported	**0**
Carbon intensity	**17.39-35.34 gCO2e/MJ**
Total annual greenhouse gas emissions	**0.001 million MTCO2e**

[viii] Renewable propane was blended into petroleum propane, distributed, and consumed in state but not tracked in 2024.

Fuel Overview

In 2024, propane, also known as liquefied petroleum gas or LPG, represented approximately 3.1 percent of the direct-use fuels consumed in Oregon. Produced as a byproduct of natural gas processing and crude oil refining, propane is stored and transported in liquid form under moderate pressure, usually in tanks or cylinders. Oregon does not produce propane and relies predominantly on imports from natural gas processing facilities in Alberta and British Columbia.[17] An estimated 33,550 Oregon households, or about 2 percent of homes, use propane for space heating, and it is also commonly used for water heating and cooking.[18] Propane's high energy density, clean-burning characteristics and ease of storage make it a practical fuel option for Oregon's rural communities and areas outside the state's natural gas pipeline network.[19] Beyond residential uses, propane supports commercial and industrial heating loads, agricultural activities such as grain drying and greenhouse heating, backup power generation, and some transportation needs.

Renewable propane is an emerging lower-carbon fuel alternative produced as a coproduct of renewable diesel from waste residues and sustainably sourced materials, including agricultural byproducts, used cooking oils, and animal fats. Because it is chemically identical to conventional propane, renewable propane is fully compatible with existing appliances, vehicles, and storage infrastructure, allowing customers to adopt the fuel without modification. Growing demand for renewable diesel is prompting investment in new production facilities that will also expand renewable propane supply. Currently, only a portion of renewable propane reaches the commercial market because much of it is used on site to power production facilities. Commercial production in the United States began in 2018, but market supply remains limited, with most imports to Oregon coming from Louisiana and California.[20] In Oregon, renewable propane is gaining relevance in applications that are difficult or costly to electrify, such as rural heating, agricultural operations, and some transportation uses, and its adoption is supported by credit generation opportunities under the Oregon Clean Fuels Program, which incentivizes the use of lower-carbon fuels.[21]

Trends in Oregon

Figure 8: Fossil Propane Share of Transportation Fuels Consumed in Oregon

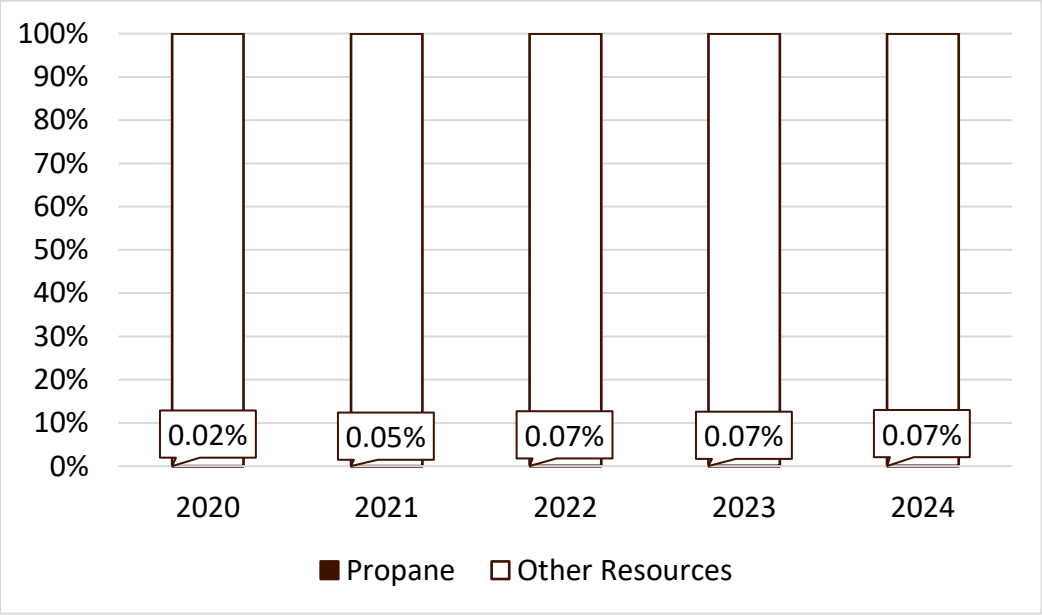


Figure 9: Fossil Propane Share of Direct Use Fuels Consumed in Oregon

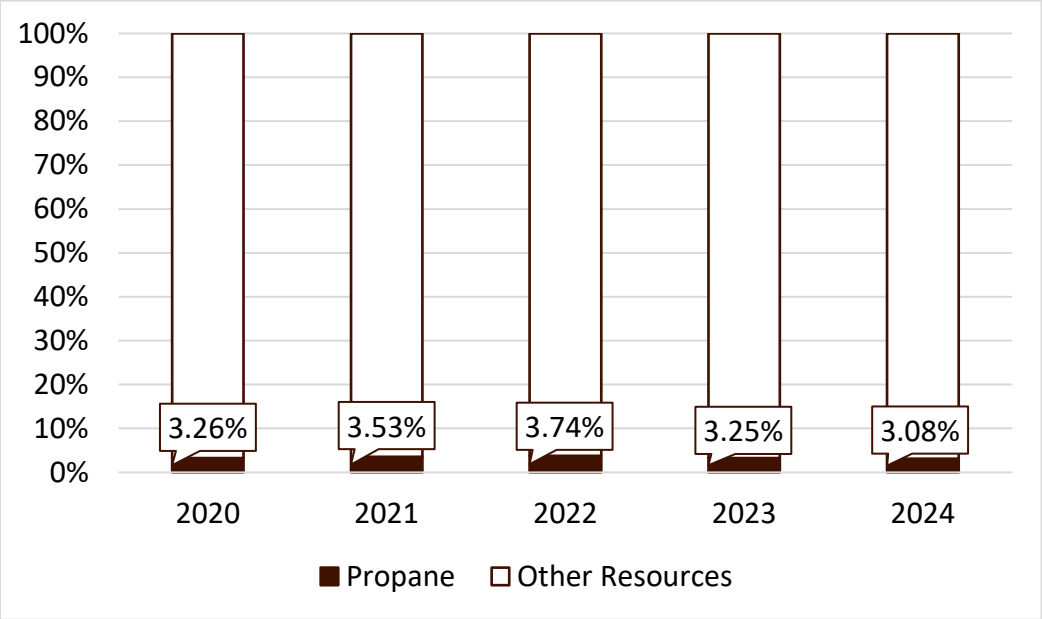
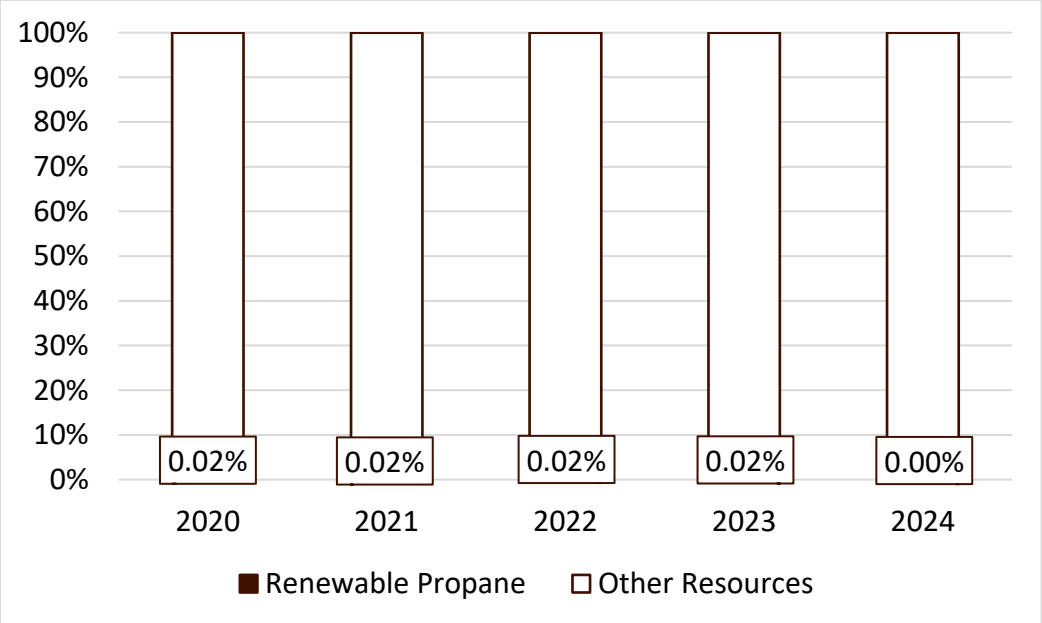


Figure 10: Renewable Propane Share of Transportation Fuels Consumed in Oregon



Propane consumption in Oregon has remained relatively steady due to its affordability, low emissions profile, and energy resilience benefits, such as its ability to be stored for long periods of time. Total consumption fluctuated slightly over recent years, totaling 7.9 trillion Btu in 2020 and 7.7 trillion Btu in 2024, a decrease of about 2.4 percent over this period. Supply has expanded in parallel with growing U.S. natural gas production, which may spur more use especially in the residential sector where propane is delivered and stored on site, providing a reliable energy resource in rural areas and during power outages. State and federal low-carbon fuel programs have also created financial incentives for the purchase and use of both conventional and renewable propane, especially in transportation fuel markets.

While renewable propane offers value across all consuming sectors, it carries higher market value when sold as a low-carbon transportation fuel and is used primarily by medium- and heavy-duty fleets. In 2025, Oregon consumed slightly more than 27.74 billion Btu, or 238,982 gasoline-gallon equivalents, of renewable propane in the transportation sector, representing about 0.01 percent of annual fuel consumption.[21] The fuel is imported from production facilities in Los Angeles and is currently blended into existing propane supplies for distribution to vehicle fleets.

Oregonians used over 1.9 million gasoline-gallon equivalents of propane in vehicles in 2024, accounting for roughly 0.07 percent of statewide transportation fuel consumption, an increase of 50 percent compared with 2021.[21] Propane-fueled vehicles typically cost less to operate, emit less pollution, perform better in cold weather, and operate more quietly compared to diesel. Many Oregon school districts operate propane school buses.[22] Adoption of propane vehicles remains modest and is supported by small fleets and 39 public fueling stations statewide.[23] State clean energy policies are also strengthening demand for low-carbon fuels, including renewable propane. These programs aim to reduce lifecycle emissions from fuels over time; however, the long-term effects on conventional propane availability remain uncertain.

Additional Resources

- U.S. Department of Energy Alternative Fuels Data Center: Propane Basics
- U.S. Energy Information Administration: Hydrocarbon gas liquids explained
- ODOE 2026 Biennial Energy Report: Energy by the Numbers – Transportation Fuels

Renewable Natural Gas Fuel

Total annual consumption	**2.53 trillion Btu**
End use sector(s)	**Transportation, Residential, Commercial, Industrial**
Percent of total transportation fuels	**0.16%**
Percent of total direct use fuels	**Data not available**
Produced in Oregon	**2.03 trillion Btu**
Imported	**0.5 trillion Btu**
Carbon intensity	**-420.3 to 84.16 gCO2e/MJ**
Total annual greenhouse gas emissions	**0.02 million MTCO2e**

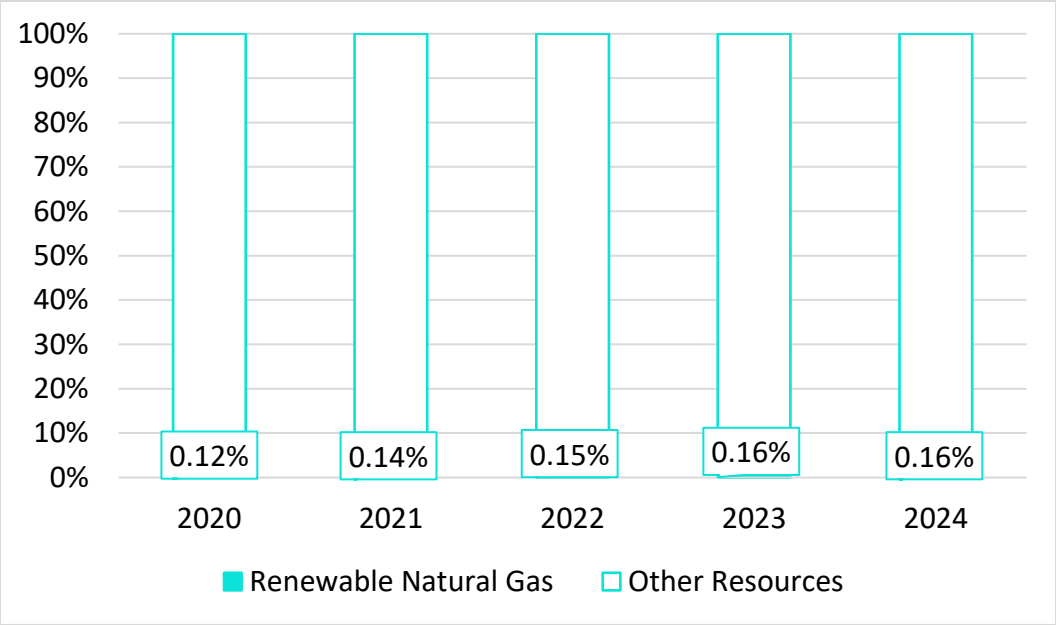
Fuel Overview

Renewable natural gas is pipeline-quality methane produced by upgrading biogas from such feedstocks as manure, food waste, wastewater sludge, and landfill material through anaerobic decomposition, and then refining it to 90-98 percent methane by reducing/removing CO2, water, and other impurities.[24] Oregonians use RNG through existing natural gas infrastructure for heating, industrial processes, electricity generation, and as a transportation fuel in natural-gas vehicles.[25] Because RNG is often mixed with natural gas, Oregonians who use natural gas are likely consuming a small amount of RNG.

Renewable natural gas reduces greenhouse gas emissions by capturing methane that would otherwise be released into the atmosphere at landfills, wastewater treatment plants, and manure-producing agricultural operations. This is a critical benefit because methane is a far more potent climate pollutant than CO2. Reduction benefits depend on how the RNG is made and how effectively operations capture methane and minimize leaks, which has led to a wide range of potential emissions reduction values. Some RNG production pathways reduce emissions more than three times the level that would otherwise occur if methane had not been released. Collecting biogas at these sites also helps manage waste and can improve local air and water quality. Like fossil natural gas, RNG produces emissions when combusted, but those emissions are far less harmful than the methane that would have escaped into the atmosphere without capture.

Trends in Oregon

Figure 11: Renewable Natural Gas Share of Transportation Fuels Consumed in Oregon



Recent trends show Oregon's RNG use is steadily increasing, largely driven by procurement efforts to achieve utility and state decarbonization requirements, primarily in the transportation sector. Although some RNG may be used as a direct use fuel for the residential, commercial, or industrial sectors, data are not available on actual amounts consumed. Natural gas utility customer interest has remained low for voluntary RNG purchase programs.[26] RNG is delivered through the existing natural gas network by Oregon's three major utilities—NW Natural, Cascade Natural Gas, and Avista—which procure RNG to help meet these emissions-reduction goals. Improved technologies for capturing and upgrading biogas into pipeline-quality fuel are expanding procurement options for utilities. NW Natural reported that it supplied 3.35 percent of its total gas mix as RNG to its customers in 2025 and anticipates as much as 4 percent in 2026.[27] In 2019, the Oregon Legislature passed SB 98, which authorized regulated natural gas utilities to procure increasing amounts of RNG. The Oregon Public Utility Commission oversees procurement decisions and cost allocations across utility customers.

The cost difference between fossil and renewable natural gas is a major challenge for greater RNG uptake. RNG is more expensive to produce than conventional natural gas because it must be conditioned to remove contaminants, compressed, and interconnected to a pipeline. For example,

landfill gas projects are estimated to produce RNG at a cost of $10-20 per million British thermal unit (MMBtu), and dairy manure projects may reach costs closer to $40 per MMBtu.[28] In comparison, the price of natural gas the 2026 Henry Hub[ix] price for natural gas averaged $3.44 per MMBtu.[29] Developers and suppliers can monetize federal and state renewable and clean fuels programs to help offset some of these costs. For example, RNG use can generate credits from the Oregon Clean Fuels Program that can be sold on the market, often making environmental credits a key source of revenue.[21] [30] RNG is also an option for utilities to comply with the Oregon Climate Protection Program that sets a decreasing cap on greenhouse gas emissions. In addition to utility procurement, RNG is already being used in Oregon's transportation sector, including fleets like Weyerhaeuser's RNG-powered log trucks and in some Cherriots' buses.[31] [32]

Additional Resources

- U.S. Environmental Protection Agency: An Introduction to Renewable Natural Gas
- U.S. Energy Information Administration: What is biogas?
- ODOE 2026 Biennial Energy Report: Energy by the Numbers – Transportation Fuels
- Oregon Department of Energy: 2018 Biogas and Renewable Natural Gas Inventory
- 2020 Biennial Energy Report: Renewable Natural Gas Policy Brief

Hydrogen Fuel

Total annual consumption	**0.002 trillion Btu**
End use sector(s)	**Transportation, Industrial**
Percent of total transportation fuels	**<0.01%**
Percent of total direct use fuels	**0**
Produced in Oregon	**0**
Imported	**0.002 trillion Btu**
Carbon intensity	**13.11 - 157.62 gCO2e/MJ[x]**
Total annual greenhouse gas emissions	**16.8 million MTCO2e**

Fuel Overview

Hydrogen is an energy carrier, meaning it can be used to store and deliver energy produced by other sources. Because hydrogen rarely occurs naturally in pure form, it must be produced from other resources. Today, most hydrogen is produced from natural gas through steam methane reformation, but it can also be produced through electrolysis, which uses electricity to split water into hydrogen and oxygen. Renewable hydrogen is hydrogen produced using renewable energy sources, such as

[ix] Henry Hub is used as the benchmark for U.S. natural gas prices.

[x] Hydrogen carbon intensity varies significantly depending on the production method and energy source. For example, hydrogen produced through electrolysis using renewable electricity can have a relatively low carbon intensity, while hydrogen produced using grid electricity or fossil fuels can have a substantially higher carbon intensity. The range shown reflect the different hydrogen production pathways recognized under Oregon's Clean Fuels Program.

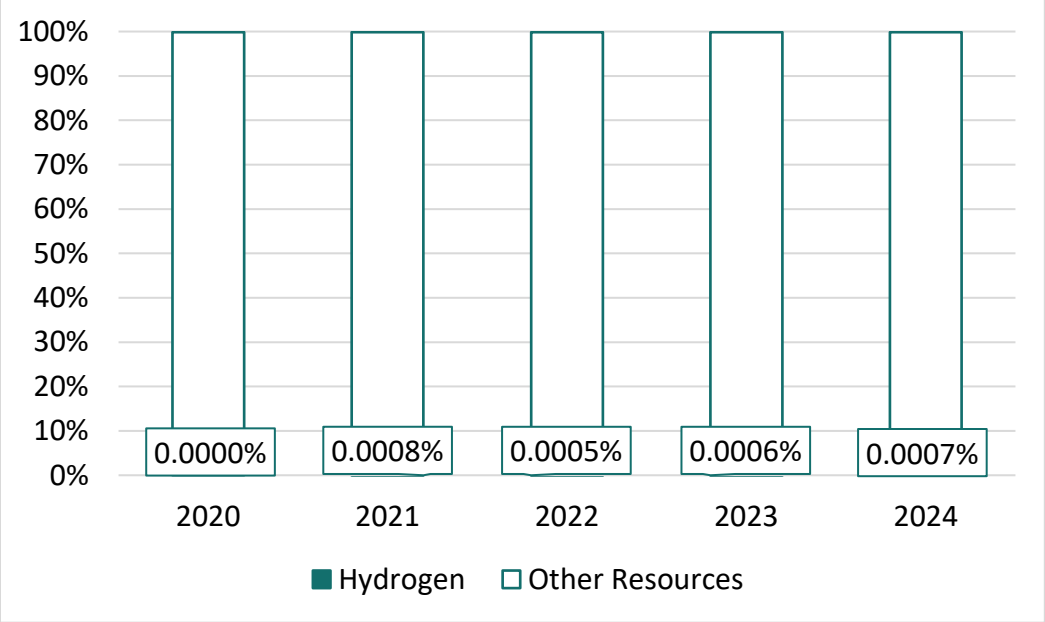
renewable electricity, and can have substantially lower greenhouse gas emissions than conventional hydrogen.

In Oregon, hydrogen use for energy production is currently limited, but it could be used as a transportation fuel in hydrogen fuel cell vehicles, as a substitute for fossil-based hydrogen in industrial processes, and for high-temperature industrial heat, energy storage, backup power, electricity generation, and production of chemicals and fuels. Hydrogen is generally less efficient and more expensive than direct use of electricity for many applications, including light-duty vehicle and building energy use. However, it may offer advantages where direct electrification is difficult or where long range, fast refueling, high equipment utilization, or high-temperature heat are important. ODOE's *2022 Renewable Hydrogen Report* similarly found that hydrogen is likely to be most valuable in Oregon for specific applications where electrification or other alternatives are less practical or cost-efficient, such as heavy-duty transportation like long-haul trucking or transit, industrial heat, backup power, and long-duration energy storage.[33]

Hydrogen can reduce local air pollution when used in fuel cell vehicles because the vehicle tailpipe emits only water vapor rather than greenhouse gases or criteria pollutants. However, the lifecycle emissions associated with hydrogen depend on how it is produced. Hydrogen also presents safety and infrastructure considerations because it is highly flammable, must be compressed or liquified for many uses, can leak more easily than other fuels, and requires specialized storage, handling, and emergency response practices.

Trends in Oregon

Figure 12: Hydrogen Share of Transportation Fuels Consumed in Oregon



Oregon does not have large-scale hydrogen production, distribution, or fueling networks. Since hydrogen is not readily used for energy in Oregon, recent trends are characterized by emerging project development and policy support. In October 2025, InEnTec completed installation of a waste-to-hydrogen facility at the Columbia Ridge Landfill in Arlington.[34] This pilot project is expected to produce about 600 to 1,100 kg of renewable hydrogen per day to be sold in the Pacific Northwest,

some of which may be used to fuel TriMet's pilot hydrogen bus expected to begin operating as early as 2027. This location is anticipated to be the source of hydrogen for the full fleet of hydrogen buses to be deployed on 82nd Avenue in 2029.[35] Beyond this project, there is interest in developing a hydrogen economy in the region. The Pacific Northwest Hydrogen Association was formed to apply for federal funding to support an association of public and private partners interested in developing a new clean hydrogen production and infrastructure in the region. While the association was successful in winning an award, the federal government terminated the funding before construction of projects could begin. The association remains, although project timelines and deployment levels remain subject to uncertain funding, market conditions, and policy decisions.

Hydrogen use is likely to grow first in targeted industrial, fleet, and heavy-duty applications rather than as a broadly available consumer transportation fuel. State and federal policies support hydrogen availability. Clean transportation policies like the Oregon Department of Environmental Quality's Clean Fuels Program and Climate Protection Program encourage hydrogen use as a means to address climate change. House Bill 2530 passed in 2023, directing ODOE to support the development of a renewable hydrogen economy.[36] The Oregon Energy Strategy identified low-carbon fuels like hydrogen as a critical pathway needed to meet state climate goals and energy objectives.[37] The federal Inflation Reduction Act created a clean hydrogen production tax credit of $3/kg, though the passage of H.R.1 in 2025 moved up the sunset date on that credit from 2032 to 2027. Hydrogen costs remain high compared to conventional fuels and other low-carbon technologies, and Oregon's lack of infrastructure remains a major barrier to adoption.

Additional Resources

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- Oregon Department of Energy: Hydrogen
- Oregon Department of Energy: Renewable Hydrogen Study
- Pacific Northwest Hydrogen Hub
- Renewable Hydrogen Alliance: Hydrogen Education

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Clean Vehicle Technologies

Electric Vehicles

Total number of light-duty EVs registered in Oregon:	**141,715**
Number of plug-in hybrid electric vehicles:	**38,409**
Number of battery electric vehicles:	**103,306**
Percentage of EVs in total registered light-duty fleet	**3.78%**
Percentage of light-duty sales that are ZEVs (2026 Q2)	**12%**
State target by 2030[1]	**25% of registered vehicles**
Total number of medium- and heavy-duty EVs registered	**1,051**
Percentage of EVs in total registered MHD	**0.8%**

Technology Overview



Electric vehicles use electric motors powered by onboard batteries rather than internal combustion engines.[1] The two primary types are battery electric vehicles, which operate entirely on electricity, and plug-in hybrid electric vehicles, which combine a battery-powered drivetrain with a conventional gasoline or diesel engine. EVs are refueled by charging their batteries from the electric grid. They generally cost less to fuel and maintain, are more energy efficient, and reduce exposure to fuel price volatility, though they often have higher upfront costs. Electric vehicles are more efficient than internal combustion engine vehicles because electric motors convert a much larger share of energy into moving the vehicle, lose less energy as heat, and can recover energy through regenerative braking that would otherwise be wasted when slowing down.

Full battery electric vehicles produce no tailpipe emissions, and their use can improve local air quality and reduce exposure to pollutants linked to respiratory and cardiovascular illness. They also have fewer lifecycle greenhouse gas emissions than comparable internal combustion vehicles, and these emissions continue to decline as the electric grid becomes cleaner.[2] There are environmental impacts associated with EV battery material extraction, manufacturing, recycling, and end-of-life disposal. These environmental impacts are typically outweighed by long-term emissions reductions. There are also safety concerns associated with the lithium-ion batteries used in the cars. While battery fires are relatively rare, they can be more difficult to extinguish than conventional vehicle fires due to the potential for thermal runaway and re-ignition. Available evidence suggests that overall vehicle fire risk remains lower than that of conventional gasoline vehicles.[3]

[1] DEQ's Advanced Clean Cars II regulations established minimum sales requirements for light-duty zero emission vehicles.

Trends in Oregon

Figure 1: Cumulative Light-Duty Electric Vehicle Registrations in Oregon (2021-2025)

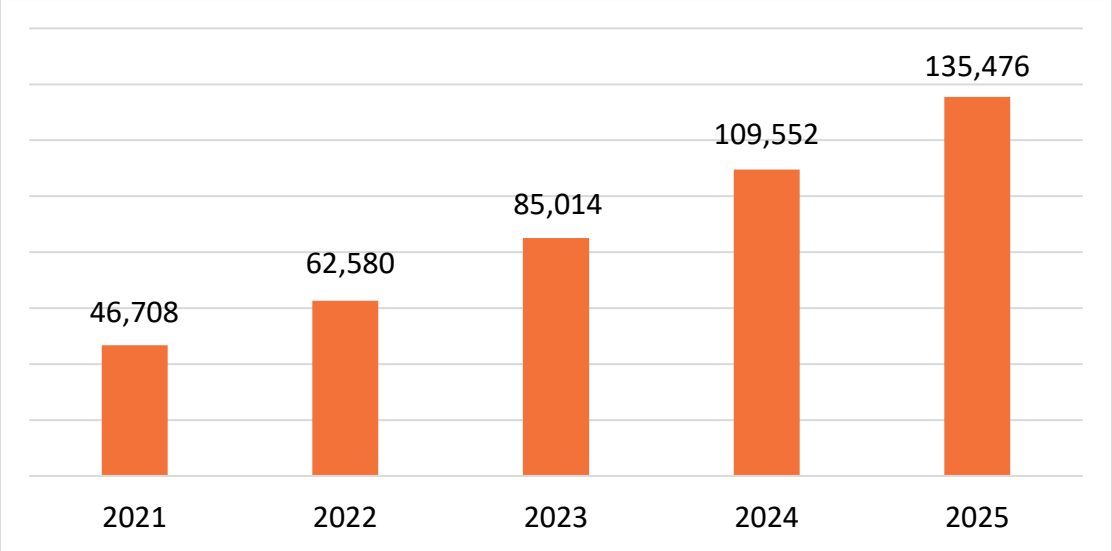
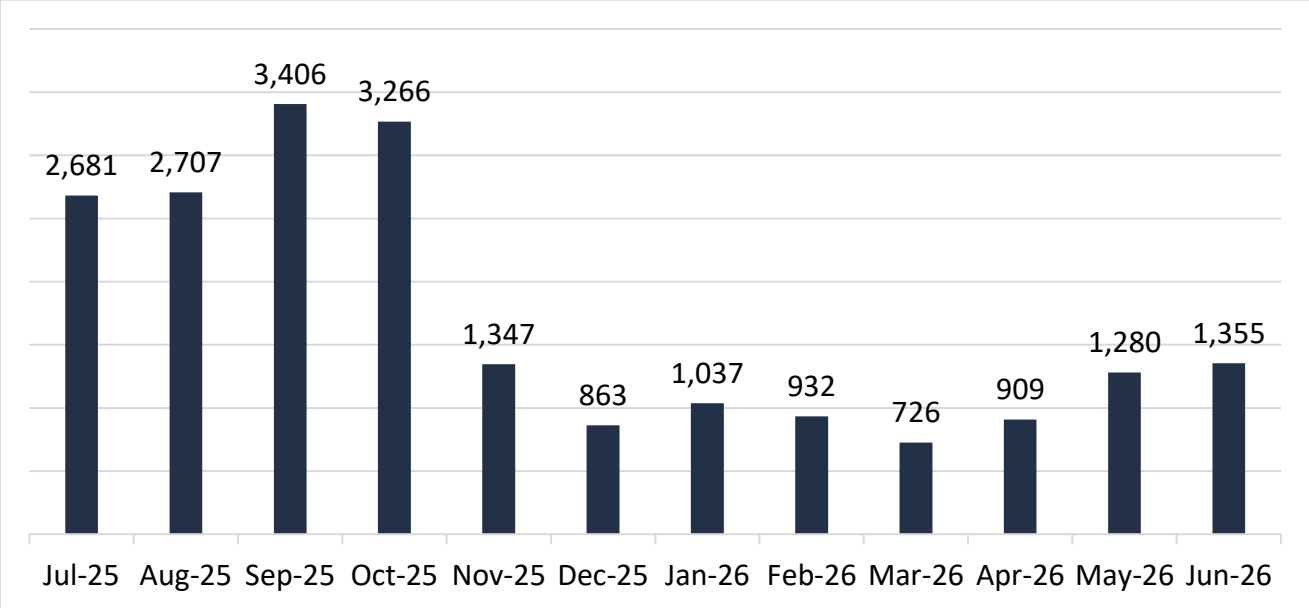


Figure 2: New Light-Duty Electric Vehicle Registrations in Oregon by Month (2025-2026)



Oregon has experienced substantial growth in EV adoption over the past decade, increasing from just over 3,000 registered EVs in 2015 to more than 130,000 by 2026.[4] EV adoption in Oregon has grown as battery costs have declined, vehicle model availability has expanded, consumers have become more familiar with EVs, and state and federal policies have supported the transition. While many of these factors have contributed to EV adoption nationwide, Oregon's adoption has generally outpaced national trends, reflecting additional state-level policies, incentives, and other market conditions that have supported EV uptake. Adoption has been concentrated in the passenger vehicle market, but registrations of medium- and heavy-duty EVs are also growing and have more than tripled since 2023. EVs are now registered in every Oregon county, though adoption remains highest in urban areas and among higher-income households.

Despite overall growth, adoption rates remain below the levels needed to achieve the state's transportation, air quality, and climate objectives. Recent federal policy changes have dampened growth by removing key incentives and regulations[2] that supported EV uptake.[5] Following expiration of the federal EV tax credit in September 2025, EV registrations in Oregon declined significantly through early 2026. While sales have since shown signs of recovery, driven potentially by rising gasoline prices and growth in the used EV market, continued progress will likely depend on expanding the several state policies and utility programs in place that help expand vehicle availability, reduce ownership costs, and build the infrastructure needed to support transportation electrification.

Oregon's EV market appears to be transitioning from early adopters toward broader consumer adoption. EV affordability is improving, which is expanding ownership potential for more households. However, higher upfront costs for new vehicles, limited charging access for renters and rural communities, and concerns about driving range and charging convenience continue to be barriers for some Oregonians. More economical used EVs are approaching price parity with used gasoline vehicles,[6] [7] and EVs continue to offer substantial operating cost savings. On a per-mile basis, an EV charged at home can cost less than half as much to operate as a comparable gasoline vehicle, especially when those fuel prices rise.

Additional Resources

- ODOE: 2025 Biennial Zero Emission Vehicle Report
- ODOE: EV Dashboard
- U.S. DOE Alternative Fuel Data Center: Electric Vehicles
- U.S. EPA: Electric & Plug-in Hybrid Electric Vehicles

Fuel Cell Electric Vehicles

Total number of FCEVs registered in Oregon	**0**
Number of hydrogen fueling stations in Oregon	**0**



An Xcelsior CHARGE FC 60-foot fuel cell electric bus to be used at TriMet's 82nd Avenue Facility. Image courtesy of TriMet.

[2] In June 2025, the Trump Administration and Congress used the Congressional Review Act to purportedly disapprove of EPA waivers authorizing California's Advanced Clean Cars II and Advanced Clean Trucks regulations, creating uncertainty for states like Oregon that have adopted CA's vehicle emissions standards. Oregon joined a multi-state legal challenge to the action. If upheld, the purported disapproval would prevent Oregon from enforcing these regulations and is likely to significantly slow EV adoption in the state.

Technology Overview

Fuel cell electric vehicles, sometimes called hydrogen vehicles, use electric motors for propulsion but store energy as hydrogen rather than in a large battery pack.[8] Hydrogen stored onboard the vehicle is converted into electricity through a fuel cell, which combines hydrogen and oxygen to produce electricity that powers the drivetrain. Like battery electric vehicles, FCEVs are classified as zero-emission vehicles because they produce no tailpipe emissions; the only by-products of the fuel cell reaction are water and heat. FCEVs are refueled at dedicated hydrogen fueling stations, which can provide refueling times comparable to gasoline vehicles but require specialized hydrogen production, delivery, storage, and dispensing infrastructure. Compared with battery electric vehicles, FCEVs are generally lighter and offer faster refueling, making them well suited for applications requiring long range, high utilization, heavy payloads, or centralized fleet fueling. However, vehicle availability remains limited, fueling infrastructure is sparse, and vehicle and fuel costs are higher than competing technologies.

FCEVs have fewer greenhouse gas emissions when fueled with low-carbon hydrogen. Because they are most likely to be deployed in medium- and heavy-duty applications, they could also eliminate diesel emissions contributing to local air pollution, which improves health outcomes for environmental justice communities located close to busy roadways and thoroughfares. However, broader environmental benefits depend largely on how the hydrogen is produced, with most hydrogen production today creating greenhouse gases and local air pollutant emissions. Hydrogen safety is also a common concern because hydrogen is a highly flammable gas that must be stored at very high pressures. Like gasoline and diesel vehicles, fuel cell EVs use an energy source that can ignite under certain conditions, but the risks differ. Unlike liquid fuels that can pool on the ground and continue burning, hydrogen disperses rapidly when released.[9] Modern fuel cell vehicles and fueling stations are engineered with multiple safety systems to manage these risks and are subject to rigorous testing and safety standards.[10]

Trends in Oregon

Fuel cell electric vehicles remain a niche transportation technology in Oregon, with adoption significantly lagging battery electric and conventional vehicles. While a small number of passenger FCEVs are available in the United States, deployment has been concentrated almost entirely in California where the nation's most extensive hydrogen fueling network exists.[11] Oregon currently has little to no FCEV adoption and no public hydrogen fueling stations. Unlike the rapid growth seen in Oregon's light-duty battery EV market, hydrogen vehicle deployment is expected to remain limited in the near term and concentrated in demonstration projects and fleet applications.

Interest in hydrogen transportation has increased in recent years as transit agencies, ports, and freight operators explore hydrogen's potential role in decarbonizing difficult-to-electrify transportation applications. For example, TriMet is actively developing one of the Pacific Northwest's largest transit hydrogen projects. The agency secured federal funding for 14 hydrogen fuel-cell buses and associated fueling infrastructure, is constructing facility upgrades and a hydrogen fueling station, and plans to deploy buses along the 82nd Avenue corridor beginning in 2029.[12] The project remains in the implementation phase, with infrastructure construction, fuel procurement, and workforce training underway. The Oregon Department of Transportation also secured funding through the Charging and

Fueling Infrastructure Grant Program to develop one hydrogen fueling station along the I-5 corridor in Oregon.[13]

Additional Resources

- U.S. Department of Energy: Hydrogen
- National Lab of the Rockies: Hydrogen and Fuel Cells
- U.S. Department of Energy: Alternative Fuels and Feedstocks Office
- Hydrogen Fuel Cell Partnership

Electric Vehicle Charging

Public Level 2 and fast-charging stations in Oregon	**1,651 locations**
Total public Level 2 ports	**2,938**
Total public fast-charging ports	**1,324**

Technology Overview



Electric vehicle chargers supply electricity to battery electric and plug-in hybrid electric vehicles.[14] Charging technologies vary by vehicle type and how the vehicle is used. Charging generally falls into three categories: Level 1 charging using a standard 120-volt outlet, Level 2 charging using 240-volt power, and DC fast charging, which delivers much higher power levels and is commonly used for rapid charging during long-distance travel, public charging for those without access to charging at home, and medium- and heavy-duty zero emissions vehicles. A new charging standard, the Megawatt Charging System, is emerging to support larger vehicle classes, such as freight trucks, delivering up to 10 times more power than today's fastest car chargers.[15] Not all electric vehicles are compatible with every charger due to varying connector standards, though the industry is increasingly converging around J3400 (formerly known as the North American Charging Standard, or NACS), and adapters are becoming widely available.

Most passenger EV charging occurs at home, but public charging plays a critical role in supporting long-distance travel, drivers without access to home charging, and commercial and fleet operations. Charging technology varies in cost, charging speed, and infrastructure requirements. Slower Level 1 and Level 2 chargers are generally less expensive to install and well suited for locations where vehicles remain parked for several hours, such as homes, workplaces, and overnight fleet depots. DC fast chargers and megawatt charging systems recharge vehicles much more quickly but require substantially more electrical capacity and often costly utility upgrades.

Trends in Oregon

Figure 3: Total Cumulative Electric Vehicle Charging Ports in Oregon

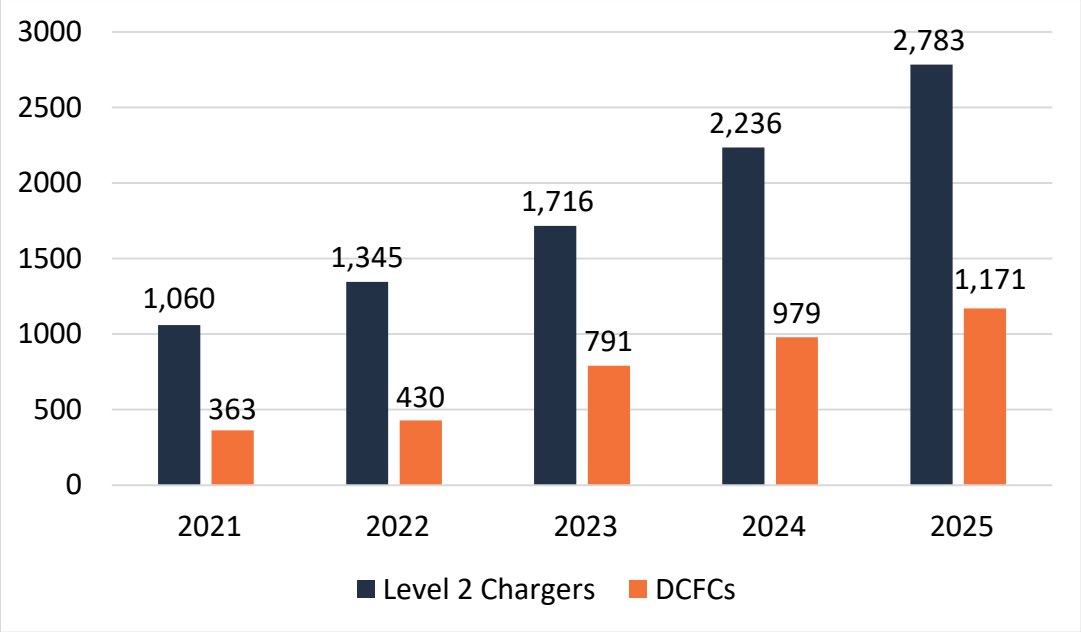
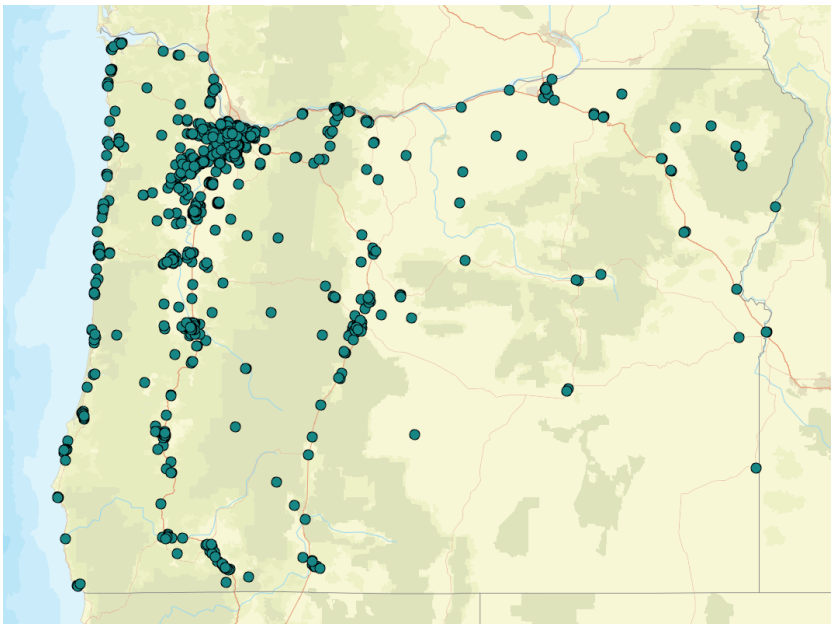


Figure 4: Map of EV Charging Station Locations in Oregon



Oregon's EV charging infrastructure has expanded rapidly over the past decade alongside increasing EV adoption and growing public and private investment. Public chargers are largely concentrated around population centers, major travel corridors, workplaces, and key destinations; however, utilities and public entities continue investing in expanding access to underserved and rural communities. Although Level 2 charging remains the most common charger type in Oregon, deployment of DC fast chargers is accelerating. State and federal investments, including the National Electric Vehicle Infrastructure program, utility transportation electrification programs, Clean Fuels Program credit revenues, and other funding sources have helped accelerate deployment statewide.

Charging infrastructure for medium- and heavy-duty vehicles has significantly lagged light-duty deployment. While many medium-duty electric vehicles can use existing higher-powered public fast chargers, heavy-duty vehicles often require specialized infrastructure, including pull-through station designs, overnight truck parking, and megawatt charging systems. As a result, most medium- and heavy-duty charging infrastructure in Oregon has been privately developed depot charging. There is currently only one publicly accessible charging station in Oregon specifically designed for heavy-duty vehicles: Electric Island in Portland.[16] [17] The site was designed to support up to 5 megawatts of charging capacity, currently includes 15 fast-charging ports, and plans to add megawatt charging capability in 2026. Over the next several years, federal and state funding administered by DEQ and ODOT will add dozens of additional medium- and heavy-duty public charging ports along Interstate 5, Interstate 84, and elsewhere.[13] [18] [19]

Charging station deployment remains well below the levels identified to support Oregon's EV adoption goals. Key barriers include installation costs, electrical service upgrades, utility interconnection timelines, and limited availability for renters, multifamily residents, and those living in rural and underserved areas. Recent federal policy changes have also created uncertainty for EV charging station deployment by reducing incentives for both charging infrastructure and EV adoption. Charger reliability also remains a persistent challenge, with EV drivers frequently encountering broken or nonfunctional chargers that can lead to unexpected delays and undermining confidence in EVs. Recent improvements to reliability standards, maintenance requirements, and interoperability across charging networks are expected to improve the user experience over the next several years.

Additional Resources

- Oregon Department of Energy: 2025 Biennial Zero Emission Vehicle Report
- U.S. Department of Energy: Electric Vehicle Charging Stations
- GreenCars.com: How EV Charging Works: A Beginner's Guide

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Emerging Technology Reviews



New clean energy technologies are under development that could one day help meet Oregonians' energy needs. The Oregon Energy Strategy found that emerging technologies are likely needed to complement new traditional renewable energy resources to meet state energy objectives and climate goals.[1] In early stages of development, it is uncertain if or when different emerging technologies might become cost-competitive options for Oregon. Monitoring advancements can help policymakers, grid operators, and regulators support the development and deployment of technologies that increase access to affordable, safe, and reliable clean energy. The Oregon Energy Strategy included an action for ODOE to report on developments in emerging technologies, identify the role they can play in meeting the state's electricity needs, and explore opportunities for pilot programs in the near term.

In November 2025, Governor Kotek directed the Oregon Department of Energy and other state agencies through Executive Order 25-29 to identify and evaluate emerging clean energy technologies that could play a role in Oregon's energy future, and to publish findings in the *Biennial Energy Report*.[2] The emerging technologies presented in this edition of the report include those indicated in the energy strategy, which incorporated the views and input of hundreds of experts and members of the public who informed that process. The technologies include enhanced geothermal, floating offshore wind, marine hydrokinetic energy, advanced nuclear, and long-duration energy storage. While these are primarily focused on the electricity sector, future reports may include emerging technologies and resources in transportation, heating, or industrial fuels.

Carbon capture technologies, critical mineral resources, and mining technologies are also important pieces of the clean energy transition. The Oregon Department of Geology and Mineral Industries follows emerging technologies such as the minerals (elements) needed to produce batteries, lithium, cobalt, nickel, among others, and the growing interest in geological hydrogen that could someday be used for electricity production. The department also focuses on geologic carbon sequestration and associated capture technologies that could play an important role in decarbonization.

Evaluating emerging clean energy technologies requires understanding how they work as well as projected costs and barriers to development. The information provided below describes how costs and barriers will be compared across all the emerging technologies in this report, with more detailed information provided in the individual emerging technology reviews. Projected costs are taken from multiple publicly available sources to enable objective side-by-side comparisons. Barriers to development are followed by recommendations to improve processes, including cross-agency frameworks that may better serve project developers and Oregon communities.

Key Takeaways

Emerging clean energy technologies have the potential to help build a resilient clean energy economy in Oregon but still face considerable barriers to commercial development. Technology improvements, cost reductions, economies of scale, and local community involvement will all be necessary for emerging technologies to become commercially viable resources in future energy markets. Oregon is rich in renewable energy resources and has been selected by many developers as their preferred location to test and demonstrate emerging technologies. Marine energy research, long-duration

battery storage, enhanced geothermal and other emerging technologies are all under development in Oregon.

A few of the key findings regarding opportunities for emerging technologies that could play a role in Oregon's energy future include:

1. **Long-duration storage can stretch low-cost renewables.** Solar and wind facilities provide some of the lowest cost energy on the grid but require flexible, dispatchable resources to balance their intermittent generation. To date, Oregon's hydro and natural gas generators have provided balancing services. In the future, long-duration storage technologies have the potential to further complement variable renewables by capturing low-cost energy during periods of surplus production and delivering it during periods of peak demand. Some technologies, such as iron-based batteries, utilize more common and lower cost materials than lithium-ion batteries and have the potential to dramatically reduce storage costs. If long-duration storage can reach the $0.05 per kWh target set by the U.S. Department of Energy, it may reduce the amount of other dispatchable energy resources needed to balance wind and solar. Utility-scale solar and wind are projected to be about $25 per MWh by 2035. Adding $5/MWh would make long-duration storage plus wind and solar cheaper than the projected costs for enhanced geothermal and nuclear.

   Next Steps:

   - Coordinate with BPA, utilities, and other energy suppliers to determine the scale and timing of curtailed renewables in the Northwest. This will enable utilities and developers to consider energy storage solutions for the surplus energy.
   - Conduct a review of codes, product standards, and operational standards that apply to battery energy storage systems. This will enable counties, or other permitting entities, to establish eligibility criteria and safety requirements for emerging battery storage facilities.
   - Implement recommendations in the *Accelerating Clean Energy Deployment Through Oregon's Land Use Planning Framework* developed by the Department of Land Conservation and Development. This study provides best practices for policy makers and local jurisdictions to consider when siting battery energy storage systems.

2. **Emerging baseload resources can provide critical grid services and enhanced geothermal is projected to be the lowest cost emerging resource for Oregon.** Enhanced geothermal and advanced nuclear have the potential to provide similar grid services though nuclear is projected to be higher cost. Both have a resource potential that could supply a significant share of the energy needed in Oregon through 2050, and both are baseload resources that may be operated to support grid stability. The differences between the two will emerge with siting, permitting, and cost. Advanced nuclear facilities can be placed anywhere fuel can be delivered but face development limitations in Oregon and may face public scrutiny due to their dangerous radioactive waste streams. Absent a change in state law, nuclear energy needs to be imported from other states. Enhanced geothermal systems have no fuel requirements but are best sited in central and eastern Oregon where geothermal resources are strongest — but

access to transmission is limited. Development will affect communities in these areas and other parts of central and eastern Oregon where transmission lines may need to be developed. Enhanced geothermal has lower cost projections than nuclear but actual costs will depend on technological advancements and economies of scale.

Next Steps:

- Support coordination between federal, state, and local entities that play a role in permitting geothermal, other emerging energy technologies, and new transmission. Develop permitting roadmaps to improve permitting efficiency and transparency.
- Consider the ability to interconnect Oregon renewable energy resources when evaluating future transmission corridors and upgrades, giving higher priority to investments that support such interconnection.

3. **Oregon has excellent floating offshore wind and marine energy resources, but costs are uncertain, and local communities have many concerns.** Floating offshore wind has comparable projected costs to enhanced geothermal in the Lazard's levelized cost of energy analysis but higher projected costs in the National Lab of the Rockies ATB analysis. Marine hydrokinetic energy lacks cost projections. Oregon has one of the best wind and wave resource areas in the country, which could provide renewable energy during periods of low production from solar and onshore wind. Oregon is also poised to be a global leader in wave energy, which could have positive economic effects for Newport, Coos Bay, and other coastal communities. However, Oregon Tribes, coastal industries, and coastal communities have concerns about how offshore energy facilities could affect the environment and their livelihoods.

   Next Steps:

   - Development of the PacWave test facility and the Oregon Offshore Wind Energy Roadmap included extensive outreach with Tribal leaders, fishing industry representatives, community organizations, and coastal communities. Lessons learned from these efforts should be applied to other emerging technologies and local communities in Oregon.
   - State agencies should coordinate with OSU/PacWave to help attract wave energy researchers and developers.
   - State agencies should support implementation of the Recommended Strategies and Actions for the Seven Objectives identified in the Oregon Offshore Wind Energy Roadmap.

4. **Tribal coordination and community engagement are needed early and often throughout clean energy development processes.** Development of emerging clean energy facilities should be seen as a partnership between potential developers, Tribes, and the local communities that would be affected by the projects. In Oregon, coastal Tribes and communities have been at the forefront of emerging energy developments, including the development of the PacWave test facilities and ongoing discussions about offshore wind. Central and eastern Oregon Tribes and communities are likely to be the most affected by

enhanced geothermal developments. Utility-scale storage facilities could be sited anywhere in Oregon. Regardless of the facility type, development can only be successful with support from Tribal partners, community-based organizations, municipal leaders, and community members.

Next Steps:

- Lessons learned from marine energy discussions in coastal communities should be applied to other emerging technologies and communities in Oregon.
- Development of the Oregon Offshore Wind Energy Roadmap includes a list of 10 key recommendations for policymakers relating to Tribal coordination and community engagement. Lessons learned from this process should be applied to other emerging technologies that affect local communities in Oregon.
- Tribal and community benefits agreements should be developed between communities and developers to ensure an equitable distribution of the costs and benefits associated with new emerging technology facilities.

Cost Comparisons

Cost projections for the emerging technologies presented in the report are derived from several sources and, wherever possible, are specific to conditions in the Pacific Northwest. Emerging technologies, by definition, lack a prolonged commercial track record with documented construction and operating costs, making estimates for projected costs of emerging technologies difficult. This report uses costs and projections from the *Annual Technology Baseline* report developed in 2025 by the National Laboratory of the Rockies, and Lazard's *2026 Levelized Cost of Energy report*.[3] [4] Both sources provide side-by-side cost comparisons for existing and emerging technologies, including comparisons of each technology, known as the levelized cost of energy. LCOE projections are calculated for some of the technologies presented here, though marine hydrokinetic energy and iron oxide batteries are not included due to lack of data.

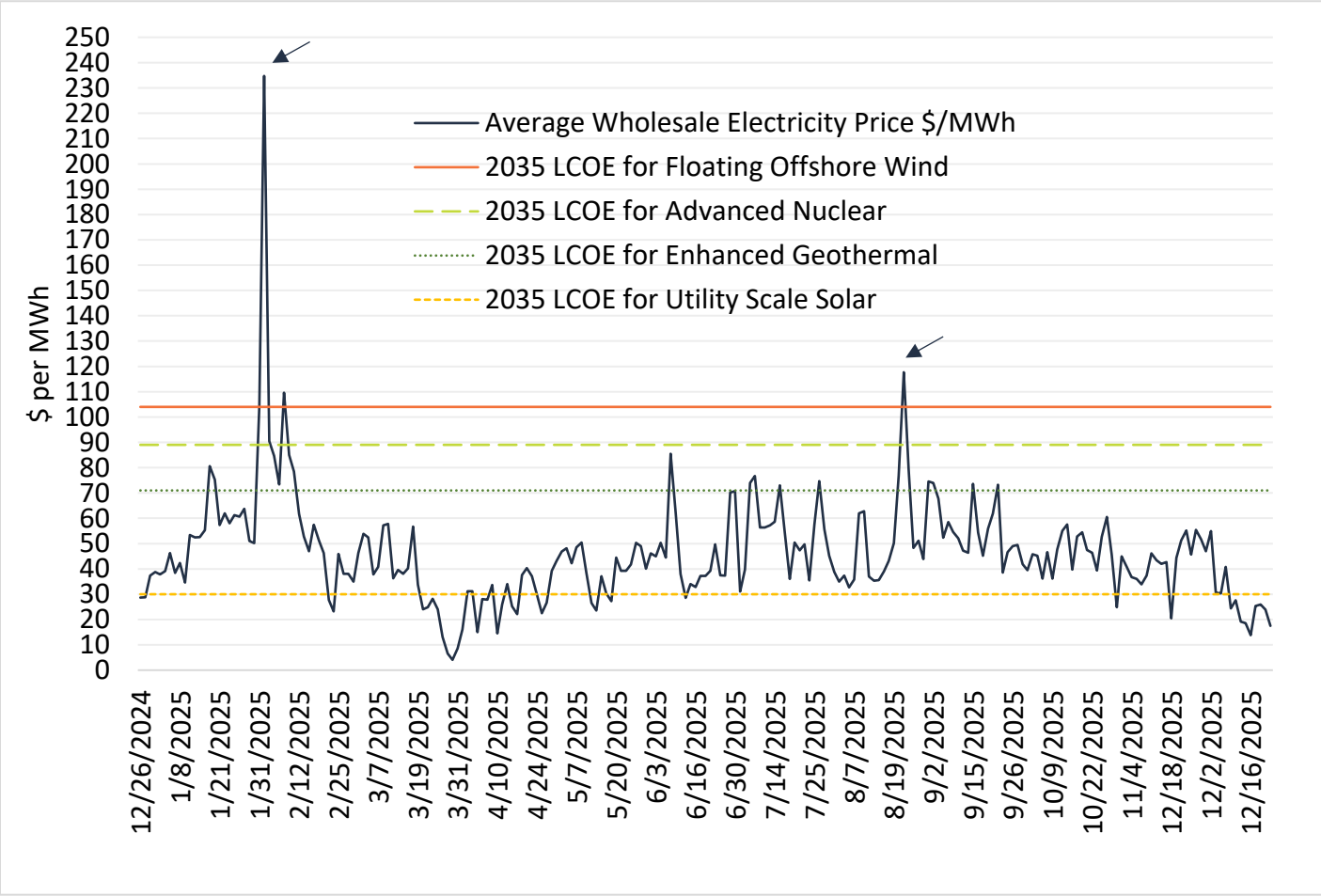
LCOE provides an easy way to compare projected energy costs across different types of electricity generation technologies, but it does have limitations. The LCOE is a calculation of the total lifetime costs to build and operate an energy facility divided by the total lifetime energy generation of the facility. It is presented in units of dollars per megawatt-hour of electricity and represents the rate at which an energy facility must sell energy to recover all capital, operations, and maintenance costs. Energy facilities provide more than just megawatt hours to the electric grid, and LCOE does not describe how energy generators may play a role in future markets. For example, LCOE takes into account the low cost for power from facilities that do not have ongoing operational fuel costs like solar, wind, and hydro, but it does not include the value of a facility to provide flexible power when needed, like hydro, natural gas, and geothermal do. Both low-cost variable and dispatchable resources provide value to rate payers and are necessary for Oregon to meet clean energy goals.

Dispatchable energy refers to electricity sources that can be turned on and off or ramped up and down (dispatched) on command to meet real-time grid needs.

One way to look at LCOE projections is to see how future technologies might interact with Oregon's wholesale electricity markets. The Mid-Columbia price hub, often referred to as simply Mid-C, is a key wholesale electricity trading point in the Pacific Northwest. Trading prices at Mid-C represent wholesale electricity costs across the Pacific Northwest over the course of the year. The relative cost-competitiveness of emerging technologies can be assessed by comparing their projected LCOEs against Mid-C prices from last year.

Figure 1 shows daily average wholesale electricity costs at the Mid-C price hub throughout 2025.[5] Superimposed on the wholesale price graph are projected 2035 LCOEs for emerging technologies from the NLR *Annual Technology Baseline* report. The 2035 values were selected as representative spot prices with the expectation that emerging technology projects could be operational by that time, but it should be taken into consideration that energy costs will change over the next decade. For reference, the LCOE for solar energy, represented by a dashed line at $30 per MWh, is included as an example of low-cost, mature renewable energy technology. The graph shows that projected costs for floating offshore wind and advanced nuclear would rarely offer cost-competitive energy. Enhanced geothermal would also rarely be competitive but has the lowest projected costs of the three.

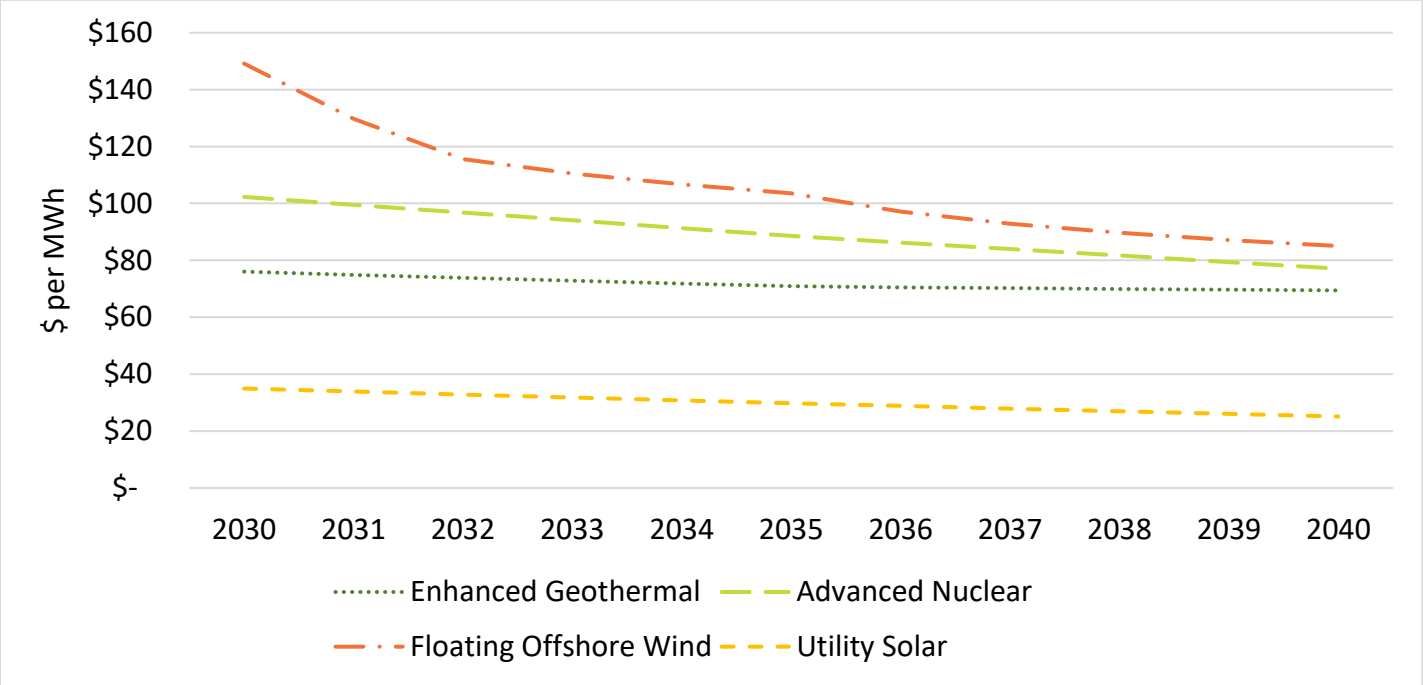
Figure 1: 2025 Wholesale Electricity Prices at the Mid-C Price Hub Compared to Projected 2035 LCOE for Emerging Technologies and Solar[i]



[i] The National Laboratory of the Rockies Annual Technology Baseline values are based on the following within the ATB spreadsheet: Solar - Utility PV R&D Tab, Class 5, Moderate | Floating Offshore Wind Tab, Class 12, Moderate | Nuclear Tab, Nuclear-Small, Moderate | Geothermal Tab, Geothermal – Deep EGS / Flash, Moderate

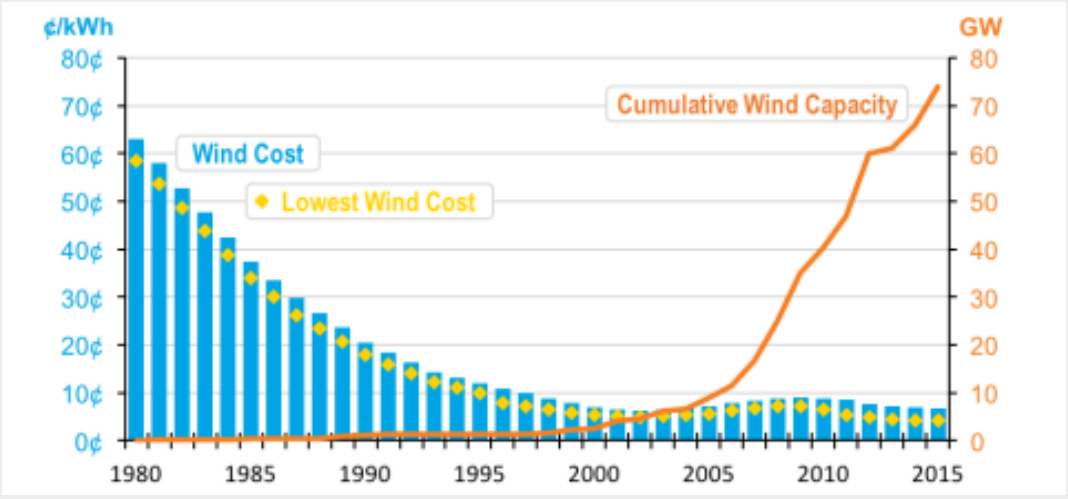
Emerging technology prices are expected to decline over time, improving their overall competitiveness in Oregon markets. Figure 2 shows projected LCOE values declining for facilities developed from 2030 to 2040. Enhanced geothermal, advanced nuclear, and offshore wind are expected to level off well below $100 per MWh in that timeframe.

Figure 2: 10-year Levelized Cost of Energy Projections Derived from National Laboratory of the Rockies Annual Technology Baseline Data



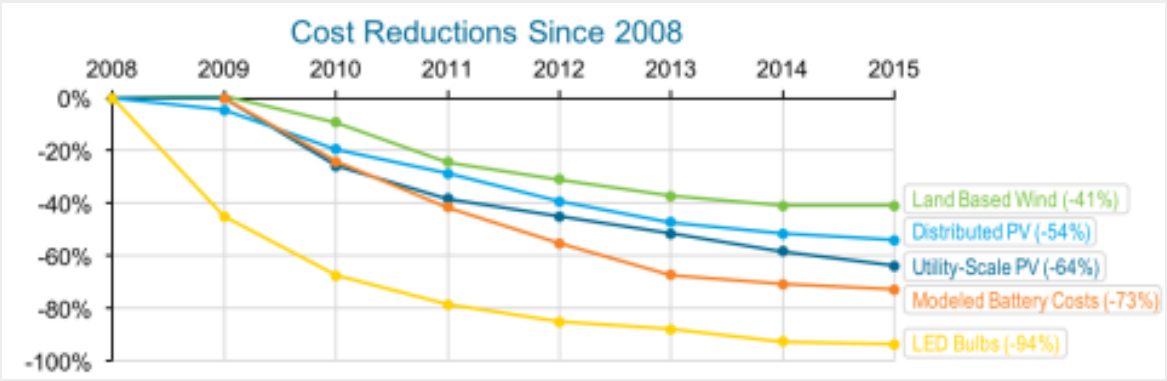
Emerging renewable energy technologies have the potential to transform global energy systems. Solar and wind energy are among the cheapest energy sources available, but 20 years ago they were more costly emerging technologies. As pilot facilities are built, and technologies are proven, costs will come down and volumes will increase. The following charts were developed in 2016 to demonstrate dramatic cost reductions associated with emerging wind and solar technologies.[2]

Figure 3: Decreasing Costs and Increasing Volume of Wind Turbines from 1980 to 2015[ii]



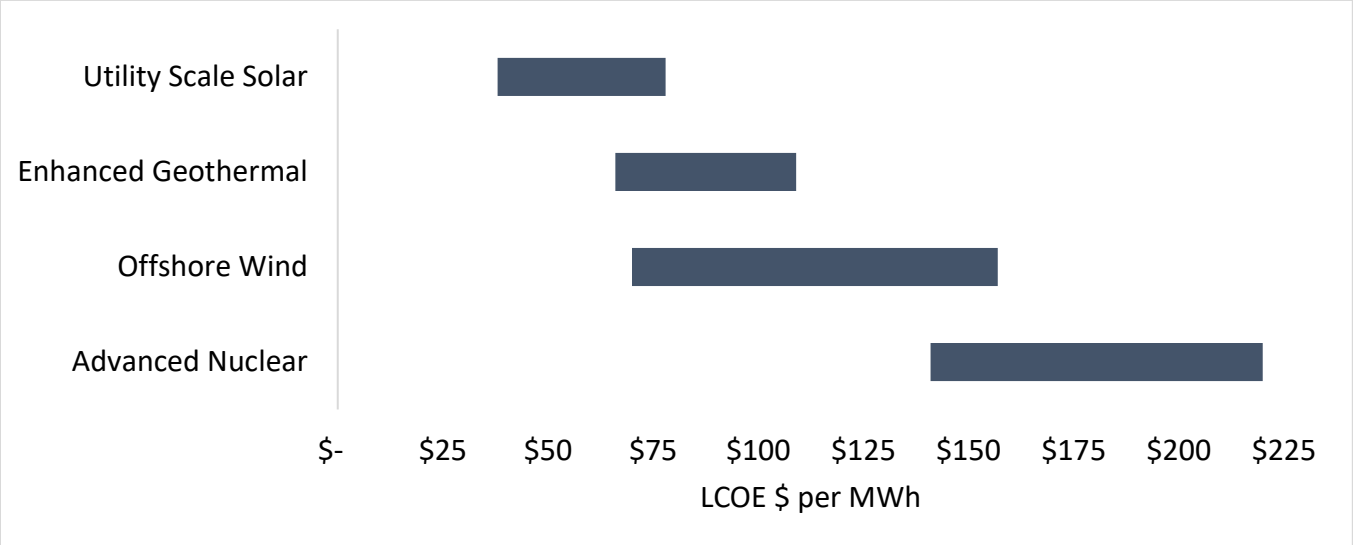
ii. Charts are from a 2016 U.S. DOE blog post (please forgive the low-resolution): https://www.energy.gov/policy/articles/6-charts-will-make-you-optimistic-about-americas-clean-energy-future

Figure 4: Cost Reductions of Four Emerging Technologies from 2008 to 2015



The Lazard LCOE analysis shows similarly higher costs for enhanced geothermal, advanced nuclear, and offshore wind. Unlike the National Laboratory of the Rockies LCOEs, the Lazard values are presented as a range. NLR values are more specific because they differentiate between specific installation conditions and timelines, while Lazard provides a range that is inclusive of different conditions. Figure 5 shows the 2026 Lazard LCOE assessments for emerging technologies are all more expensive than solar. Lazard's assessed the LCOE for offshore wind to be lower than advanced nuclear, but the Lazard report does not differentiate fixed bottom and floating offshore wind. Lazard values align with the NLR projections for enhanced geothermal and floating offshore wind, but its projections for advanced nuclear, at $141 to $220 per MWh, are considerably higher than the $82 per MWh NLR projection. This reflects the high degree of uncertainty in assessing costs for technologies that are still evolving toward commercial viability.

Figure 5: Lazard Levelized Cost of Energy Projections for Emerging Technologies and Solar



Common Risks and Challenges

Each emerging technology review provides an overview of risks and challenges specific to that technology and specific to Oregon. In some cases, emerging technologies like enhanced geothermal, will require much smaller land areas compared to solar or wind, but face longer development timelines as the technologies mature. Site selection, permitting, long lead times, transmission access,

workforce, and utility interconnection agreements are a few of these common challenges, many of which are subjects of other state agency studies, which are linked below.

Cross Agency Frameworks

Emerging technologies may face long development timelines and regulatory uncertainty. Responsible development can be supported by cross-agency frameworks that ensure efficient and transparent processes are in place for the developers and communities involved in projects. The state plays an important role ensuring all voices are heard and considered as siting and permitting decisions are made. Similarly, Tribal, federal, utility, and local regulations may affect how facilities are developed, including adjacent infrastructure such as roads, transmission, and access to water and sewer. While these processes can slow siting and permitting and create challenges to the fast development timelines needed to meet state goals, they are essential to ensure Oregonians have a say in energy decisions and ensure potential negative outcomes are considered and addressed. Cooperation between agencies can help to simplify the development process while maintaining strict standards for responsible development.

EO 25-29 directed ODOE and other state agencies to propose cross-agency frameworks to support development of advanced technologies that increase access to affordable, safe, and reliable clean energy. Following the release of the order, ODOE has been consulting with Tribes in Oregon, and meeting with the Oregon Public Utility Commission, Departments of Environmental Quality, Land Conservation and Development, State Lands, Geology and Mineral Industries, and others. The meetings have identified many cross-agency frameworks that already exist or are in progress, including:

- Oregon Department of Energy's Oregon Renewable Energy Siting Assessment Tool provides geospatial maps and information to prospective developers on different siting considerations, including environmental, ecological, cultural, and logistical opportunities and constraints.
- Oregon Department of Energy's Report on Reducing Barriers to Clean Energy Deployment recommends actions such as convening recurring forum discussions on cross-jurisdictional topics, including opportunities to align siting, interconnection, and procurement processes to support further conversation and actions on these topics.
- Oregon Department of Land Conservation and Development's Accelerating Clean Energy Deployment Through Oregon's Land Use Planning Framework reviews existing land use rules and practices and recommends actions and rule changes to accelerate deployment of clean energy resources and grid infrastructure needed to deliver reliability and clean energy to Oregon consumers.
- Oregon Department of Land Conservation and Development's Offshore Wind Energy Roadmap provides four principles guiding the roadmap pathways including meaningful engagement, credible information, regional coordination, and a holistic accountable approach.
- Oregon Department of State Lands' 2024 Asset Management Plan identifies a new classification of Renewable Energy Lands including characteristics, management requirements, performance expectations and opportunity considerations.

Continued coordination between agencies aims to provide consistency across agency actions and communications, providing developers and communities with information that is accessible, easy to use, and reliable.

The agencies also discussed other opportunities for interagency coordination, especially as some of these emerging technologies mature. Of note was the complexity involved in navigating the siting and permitting process for different types of energy facilities. For example, siting a geothermal plant in Oregon involves, at a minimum, navigating processes and timelines across eight different federal, state, and local agencies. For this reason, the agencies determined that collaborating on the development of technology-specific roadmaps would be beneficial in helping developers plan and navigate these processes.

The roadmaps should include information about siting, permitting, financial incentives, community engagement, and operational and monitoring reporting requirements for each type of facility. The following proposed actions would leverage existing cross-agency activities and facilitate the development of the roadmaps:

1. State agencies involved in regulating, permitting, and/or incentivizing specific types of emerging technology energy facilities should collaborate on roadmaps for developing facilities on federal, state, and private lands, including providing information on timelines, key deliverables, financial incentives and requirements for each process. Agencies should request additional items to include from developers and communities.
2. State agencies should coordinate with federal permitting agencies to fill in the federal permitting information for the roadmaps. This work may include collaboration with one or more national labs who may be able to offer federally funded technical assistance.
3. The state should recognize Tribal sovereignty and coordinate with Tribes to understand their needs and interests. State agencies should use their expertise and authorities to collaborate with Tribes on shared interests in developing emerging energy technologies.
3. State agencies should coordinate with Bonneville Power Administration and electric utilities to identify where interconnection agreements and power purchase agreements fit into the development process.
4. Once all the development resources are identified, ODOE, or a consortium of state agencies, should build and maintain web resources to help guide developers through the development process. The web resources should include contacts for staff at each agency identified in the roadmaps. Electric utilities should be invited to provide information relating to interconnection and power purchase agreements on resource pages.
5. Once a roadmap is complete, state agencies should continue to coordinate with each other, Tribes, federal agencies, utilities, project developers, industry associations, and community partners to identify opportunities to streamline processes while maintaining protections for cultural resources, the environment, and wildlife.

Permitting an Enhanced Geothermal Project



Two enhanced geothermal projects underway at Newberry volcano in central Oregon are currently involved in permitting their proposed facilities. The facilities are located on national forest land, meaning they must get a permit from the U.S. Forest Service to break ground. Once the site is permitted by USFS, the Bureau of Land Management must provide a permit for wells to be drilled below the surface, even if the facility is not on BLM lands. The well must also be permitted by the state Department of Geology and Mineral Industries. The electricity generating plant will need to be permitted by the county or state Energy Facility Siting Council, depending on the facility size. Other Tribal, local, state, and federal agencies may be involved in each step of construction, each with their own timelines and requirements that increase the project development complexity. The following represents a partial list of agencies that may be engaged in permitting a geothermal facility at Newberry volcano:

- U.S. Department of Agriculture (U.S. Forest Service): land use permits on national forest lands.
- U.S. Department of the Interior (Bureau of Land Management): subsurface use permits on national forest lands.
- Oregon Department of Geology and Mineral Industries: drilling / resource extraction permits.
- Oregon Water Resources Department: water use permits.
- Oregon Department of Energy: siting energy facilities exceeding 55.5 megawatts in nameplate capacity.
- Oregon Department of Environmental Quality: site pollution controls.
- Oregon Public Utility Commission: cost recovery oversight for investments made by Oregon's investor-owned utilities.
- Deschutes County: multiple actions, including siting energy facilities below 55.5 megawatts in nameplate capacity.

Conclusion

Emerging clean energy technologies have the potential to support Oregon's clean energy goals. As technologies develop, it is important to consider how each technology might affect Tribes and local communities, compete in future energy markets, and support reliable and resilient operations of the grid. The following pages provide an overview of different emerging electricity generation technologies. Each technology comes with its own unique benefits and challenges, and each could potentially play an important role in Oregon's electricity resource mix. Each technology has the potential to contribute more consistent and dispatchable power to the grid, a role currently filled by hydropower, coal, and natural gas, and one which will be crucial to meeting Oregon's objectives of clean, affordable, and reliable energy. At the same time, it is important for Oregon decisionmakers to understand how each technology might fill other specific needs, support economic development, or result in negative outcomes such as affecting other industries or using land or water resources.

Ultimately, decisionmakers can use this information to inform policies that will guide Oregon to a clean, reliable, and affordable energy future.

Individual Emerging Technology Reviews Follow:

- Advanced Nuclear
- Enhanced Geothermal
- Floating Offshore Wind
- Long-Duration Energy Storage
- Marine Hydrokinetic

Other Related Topics published by ODOE:

- Accelerating Clean Energy Deployment Through Oregon's Land Use Planning Framework
- Floating Offshore Wind Study: Benefits & Challenges for Oregon (2022)
- Report on Reducing Barriers to Clean Energy Deployment

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Emerging Technologies: Advanced Nuclear

Technology Summary



Advanced nuclear technologies include a diverse set of reactor concepts that have the potential to generate electricity, industrial process heat, and hydrogen for future U.S. energy markets. The design of these facilities departs from traditional large-scale facilities in size, coolant choice, fuel type, operating temperature, and safety features. All nuclear power plants currently operating in the U.S. use light water reactors, or LWRs.[1] Some of these facilities, like the retired Trojan nuclear power plant in Oregon, experienced safety concerns and high costs that contributed to facilities closing down.[2] Emerging nuclear technologies aim to overcome issues associated with traditional LWRs by introducing new safety mechanisms and reducing construction costs. One of the primary safety concerns for traditional nuclear power plants is associated with runaway thermal cycles and release of radioactive materials, such as the Fukushima Daiichi accident in Japan.[3]

Advanced nuclear technologies use passive safety design strategies that aim to maintain safe operating conditions without the need for pumps, fans, or external power supplies. Innovative fuels for advanced nuclear facilities are also expected to improve safety compared to traditional nuclear power plants by utilizing smaller fuel particles with special coatings that can withstand extreme temperatures without damage.[4] For example, TRISO particles are small pellets of uranium encapsulated in layers of graphite and ceramic to remain stable at high temperatures.[5] However, the same layers that make TRISO particles stable in a reactor also make them harder to recycle with current technologies, which may add cost and complexity to future waste management.[6]

Interest in nuclear power — particularly advanced nuclear — is growing. Nuclear energy can help achieve greenhouse gas emissions reduction goals and enhance grid reliability. Existing nuclear plants provide a steady source of electricity, but they cannot ramp up or down quickly to meet supply and demand needs and occasionally must be taken offline for refueling. Some modular and advanced nuclear design concepts have the potential to provide more ramping flexibility, which could be used to meet changing electricity supply and demand needs. Another advantage of advanced nuclear power is that facility siting is less constrained by geography than renewable resources that use rivers, wind, or solar energy to operate. These attributes have led to growing interest in advanced nuclear potentially replacing retired coal power plants.[7]

Along with the potential advantages of advanced nuclear, there are drawbacks to consider. Nuclear power generation requires radioactive fuel to operate. Advanced nuclear designs may improve operational safety but still generate dangerous and long-lived radioactive waste products during energy production and fuel manufacturing. Facility components in contact with radioactive materials also become waste when facilities are decommissioned. In some cases, advanced nuclear technologies may generate more waste than traditional nuclear power plants per unit of electricity generated.[8] This waste must be collected and stored appropriately. Waste is currently stored on site at nuclear facilities because there is no designated federal repository for radioactive waste. Cost is also a concern for nuclear energy facilities during construction and operation, and for long-term waste management. A

more detailed discussion of financial considerations is described in the Anticipated Costs section below.

There are many types and variations of modular and advanced reactors, but this topic focuses primarily on three that are actively being considered for commercial operations.

Small Modular Reactors

SMRs represent a diverse set of emerging nuclear power plant technologies that can generate up to 300 MW per unit.[9] They are designed for factory fabrication and modular construction with the intent of improving safety and bringing down construction costs. In addition to passive cooling strategies and advanced fuels, SMR safety is also improved by incorporating smaller core sizes and less fuel inventory on-site — less radioactive material in the core means catastrophic events are likely smaller in scope. Costs and development timelines may be lowered through modular components and factory fabrication. This lower cost and lower risk model has yet to be realized, and significant uncertainty remains. Some SMRs, such as the NuScale Power Module, use light water technology similar to conventional nuclear power plants while others, like those in development by GE-Hitachi and x-energy's XE-100, use alternate or "advanced" cooling methods.[10] [11] The smaller footprint and scalability of SMRs could be a solution for grid-constrained regions with new large loads, such as data centers and industrial facilities.[9] If successful, this could make SMRs more competitive with new natural gas and renewable resources. Drawbacks to SMRs include uncertainty in costs and construction timelines, as well as radioactive waste streams that may generate more waste per kWh than conventional nuclear power plants.[8]

Non-Light Water Reactors

Non-light water reactors represent several proposed nuclear technologies with novel cooling strategies. These reactors may be SMRs or larger facilities that use molten salt, high-temperature gases, or liquid metals as a coolant rather than water. Some molten salt reactor designs include systems that store energy as heat in the salt and enable the facility to ramp power up and down as needed to meet grid supply and demand needs.[12] Molten salt reactors have the disadvantage of using highly corrosive materials that require on-site chemical processing, and present the potential for environmental damage if not handled properly.[8] High-temperature gas reactors use helium as a coolant, enabling them to operate at hotter temperatures than conventional water-cooled facilities. In addition to electricity production, the high heat could be used to generate hydrogen or to provide process heat for industrial applications.[13] Liquid metal reactors use molten sodium or lead as a coolant. They incorporate passive over-heating protection strategies and have the advantage of operating at lower pressures than conventional water-cooled reactors, which also improves safety.[14]

Fusion Energy Systems

Unlike other nuclear energy systems, fusion energy generation comes from energy released during the fusing of atomic particles, rather than splitting atoms. Although not yet viable, fusion technologies are increasingly considered part of the advanced nuclear landscape. Fusion is of great interest because it holds the promise of being able to generate incredibly large amounts of power. It also does not generate any long-lived radioactive waste – although the fuel input and the facility itself would likely be radioactive and require decommissioning. While it has not been demonstrated to be a

viable energy generation technology yet, some emerging companies, such as Commonwealth Fusion Systems and Helion Energy, have raised large amounts private capital to develop fusion technologies.[15] [16]

Resource Potential

Modular and advanced nuclear technologies have the potential to provide significant new energy resources to the grid. In 2023, more than 20 countries, including the United States, committed to tripling nuclear energy capacity by 2050 at the COP28 UN Climate Change Conference in Dubai.[17] As a result, the U.S. Department of Energy set new deployment targets, including the addition of 35 GW of new nuclear capacity by 2035 and a sustained pace of 15 GW per year by 2040.[18] To achieve these ambitious global and domestic capacity targets, the cost of building and operating nuclear facilities must come down, and fuel enrichment and manufacturing capacity must be dramatically increased. In addition to the challenges described above, nuclear energy in the U.S. faces fuel supply chain vulnerabilities, including limited uranium supplies, geopolitical risks, and rising costs.[19]

Recent Developments

There have been several notable milestones for advanced nuclear facilities in the United States. In 2023, the U.S. Nuclear Regulatory Commission approved the NuScale SMR design — the first SMR design to be certified in the U.S. In March 2026, the NRC also announced the approval of a construction permit for TerraPower's Natrium advanced reactor project in Kemmerer, Wyoming.[20] This was the first advanced nuclear reactor in the U.S. to be approved for construction and was followed by an announcement that the project would also receive up to $2 billion in federal subsidies.[21] Similarly, in December 2025, the U.S. Department of Energy announced $800 million in federal funding for SMR facilities in Tennessee and Michigan.[22] In May 2026, U.S. DOE announced $94 million in federal subsidies for site preparation and fuels production, including $8.8 million for expanded nuclear fuels production in Richland, WA.[23]

Siting of nuclear energy facilities is not allowed in Oregon until there is a national repository for radioactive waste. In addition, prior to final approval by the Energy Facility Siting Council, a facility would have to be approved by a majority of voting Oregonians. There are nuclear projects proposed in neighboring states that may serve Oregon customers. TerraPower's Natrium project, on the site of a retiring coal facility in Kemmerer, WY, is being developed in partnership with PacifiCorp and will likely serve Oregon customers of Pacific Power.[24] The proposed advanced nuclear development closest to Oregon is a small modular reactor at the Columbia Generating Station near Richland, WA. The proposed facility is referred to as the Cascade Advanced Energy Facility and — instead of being connected directly to the grid — may be co-located with an Amazon data center.[25]

Despite this progress, advanced nuclear technologies have yet to demonstrate cost-effective commercial operation, though several facilities have demonstrated technical feasibility. The *Akademik Lomonosov* nuclear power plant in northern Russia is a floating SMR that has been in operation since 2020.[26] A second land-based SMR facility is also underway in Russia with commissioning currently scheduled for 2028.[27] In China, a modular reactor using advanced fuel pellets began operation in 2021.[28] Flamanville 3 in Normandy, France achieved full power operation in 2025.[29] Except for the

French facility, information about these facilities, including construction and operating costs, is not available.

Figure 1: The *Akademik Lomonosov* nuclear power plant in northern Russia. Photo credit: Rosatom[30]



Many advanced nuclear technologies are still in the conceptual stage, with just five test reactors having successfully demonstrated sustained nuclear reactions, also known as criticality.[31] In the U.S., only the NuScale SMR reactor design has been approved by the U.S. Nuclear Regulatory Commission.[32] [33] The NuScale power module uses conventional light water reactor technology that has been scaled down into a small modular reactor. Although the NRC has approved the Kemmerer Natrium reactor and the Clinch River, Tennessee SMR for construction, those reactors are still pending design approval.[34] [53] Fusion technologies are still in the proof-of-concept stage, with different designs being tested in research settings but not ready for piloting.[35]

Anticipated Costs

Projected costs for advanced nuclear energy vary by source and availability of data. Some technologies, such as fusion reactors, are still in the research stage and lack cost projections. The Annual Technology Baseline data published by the National Laboratory of the Rockies in 2025 projected the levelized cost of energy for advanced nuclear technologies, including large facilities rated at 100 MW of capacity and small modular reactors rated at 300 MW of capacity. The projected NLR costs range between $65 and $159 per megawatt-hour in 2035 depending upon the specific technology type.[36] The 2026 Lazard's levelized cost of energy estimates for new nuclear facilities is $175 to $255 per megawatt-hour.[37] For reference, the projected levelized cost of energy for utility scale solar installations in 2035 is $20 to $55 per megawatt hour from NLR and $40 to $98 from Lazard's report.

As with any emerging technology, it is difficult to foresee construction costs. For example, in 2015 NuScale energy partnered with Utah Associated Municipal Power Systems to develop a small modular

reactor facility in Utah. The initial cost estimate was $3 billion with a levelized cost of energy around $58 per MWh. By 2023, the revised cost of construction was $9.3 billion for a facility that was 30 percent smaller than the original proposed project, and the project was canceled.[38] Similarly, the 1,630 MW Flamanville 3 advanced nuclear facility in France began operation in 2025, but at an adjusted cost of almost $28 billion compared to an initial cost estimate of $3.9 billion.[29] Cost overruns have been common throughout the history of nuclear energy development and are not unique to emerging advanced nuclear technologies. Historically nuclear power projects have experienced cost overruns of about 66 percent or about $1 billion per project.[39]

Figure 2: The Flamanville 3 Advanced Reactor in Normandy, France. Photo credit: World Energy[40]



There are other taxpayer costs associated with nuclear energy that are not captured in facility construction and operating costs. The nuclear industry requires security on its international and national supply chains, generation sites, and waste management. One report found these security costs represent a federally funded subsidy of about $4 billion per year.[41] Long-term storage of spent nuclear fuel also represents ongoing subsidized costs for the nuclear industry. The Nuclear Waste Policy Act of 1982 required that the federal government provide for storage of spent nuclear fuels by 1998.[42] To date, there is still no permanent federal waste repository and the U.S. Department of Energy has defaulted on agreements with utilities all across the country to begin accepting spent fuel for disposal. For example, U.S. DOE is reimbursing Portland General Electric for costs associated with storing about 5,000 tons of radioactive waste at the site of the decommissioned Trojan nuclear power plant. The total cost to tax payers for all U.S. utility storage reimbursement through 2024 is $44.5 billion.[43] Advanced nuclear reactors will continue to depend on federal subsidies for security and long-term storage costs for the foreseeable future.

Development of the Oregon Energy Strategy included energy modeling to evaluate different scenarios for future loads and new generation to meet those loads. Advanced nuclear energy technologies were considered in the model but were not selected as a generation resource because of their high projected costs. The strategy also recommended policy actions, including development of this emerging technologies report to evaluate how nuclear energy, and other emerging technologies, may play a role in meeting Oregon's energy needs.[44]

Challenges to Commercial Development

There are several technological and policy challenges that would have to be overcome before advanced nuclear facilities reach widespread commercial development. While some advanced nuclear technologies have demonstrated technical feasibility, they have not yet demonstrated that they can overcome significant challenges to nuclear energy development in the U.S. including:[45]

- High upfront and operational costs that have proven challenging to estimate
- Long regulatory approvals processes for licensing, construction, and operating permits
- Lack of regulatory framework for some advanced nuclear technologies
- Scarce or geopolitically sensitive fuel resources
- Lack of repository and mechanisms for used fuel transportation, storage, and disposal
- Public opposition

Additional policy challenges exist at state levels. As of 2026, there are 10 states, including Oregon, that have restrictions on the construction of new nuclear energy facilities.[33] Oregon, California, Connecticut, and Maine require a means for radioactive waste disposal to be in place before a new facility can be constructed. Other states have outright banned construction of nuclear energy facilities or require approval by voters or the state legislature; in Oregon, voter approval is required.[33]

The timeline for development is also a major barrier. Even if restrictions were to be lifted and a nuclear facility were proposed in Oregon, it would initiate a prolonged permitting and public comment process. This includes federal and state approvals, which could take several years. If approved, construction of the facility would also likely take many years. Electricity demand has been rising and is expected to continue to rise rapidly in the next decade. Energy modeling completed for the Oregon Energy Strategy projected demand for electricity doubling in Oregon by 2050.[47] Utilities and regulators will need to consider the timelines for energy development in their planning processes as well as costs. If technological advancements or regulatory decisions shorten any of these timelines, modular or advanced nuclear options may become more practicable.

Effects on Local Communities

According to a 2025 Gallup poll, Americans' favorable opinions on nuclear energy are near an all-time high.[48] Even as interest in nuclear power is growing, many Oregonians are concerned about the potential effects of nuclear power plants on local communities. During the 2025 Oregon Legislative Session, five bills were introduced concerning nuclear energy. These included two bills to study the feasibility of nuclear power in Oregon, two that could have helped enable the development of small modular reactors in Oregon, and one that would have repealed state laws requiring the existence of a

federal repository for spent nuclear fuel and voter approval.[49] Written testimony for these bills was mixed, but there were more submittals in opposition than in support. None of the bills passed. In Kemmerer, WY, the site of a proposed new nuclear facility, residents are split between those who favor economic development opportunities and those who are concerned about the potential risks and effects on their community.[50]

Proposed bills in Oregon and Washington prompted the Confederated Tribes of the Umatilla Indian Reservation to create a draft nuclear policy to help their staff respond to and engage with external partners on conversations regarding nuclear power policies. CTUIR has indicated that the policy "maintains a strong stance of opposition to nuclear activities that threaten Tribal values, rights, and resources," and they conducted a survey to gather input from tribal members.[51]

Potential effects on communities vary across the different technologies. Apart from fusion technologies, all other technologies create radioactive waste, both in the creation of the fuel and after it is used. Risks increase with larger amounts of fuel. If not handled appropriately, the fuel and waste could contaminate local lands and waters, and potentially become airborne. Exposure to radioactive materials can have a negative effect on human health, and this varies depending on the type of radiation and duration of exposure. The risk of exposure is borne by the communities nearest to fuel mining and production facilities, power plants, and waste repositories. People living near these facilities, including downriver and downwind, bear the health and environmental risks the most. Communities may also benefit from jobs and economic development that comes with large energy projects. For example, in 2015, development of the Watts Bar Unit 2 nuclear reactor in TN employed nearly 3200 workers during construction and added about 250 permanent workers for the operation of the plant.[52]

Additional Resources

- U.S. Department of Energy Advanced Nuclear webpage
- U.S. Department of Energy Advanced Small Modular Reactors webpage
- Fusion Power Energy Resource & Technology Review (2024)
- U.S. Department of Energy Fusion Science and Technology Roadmap

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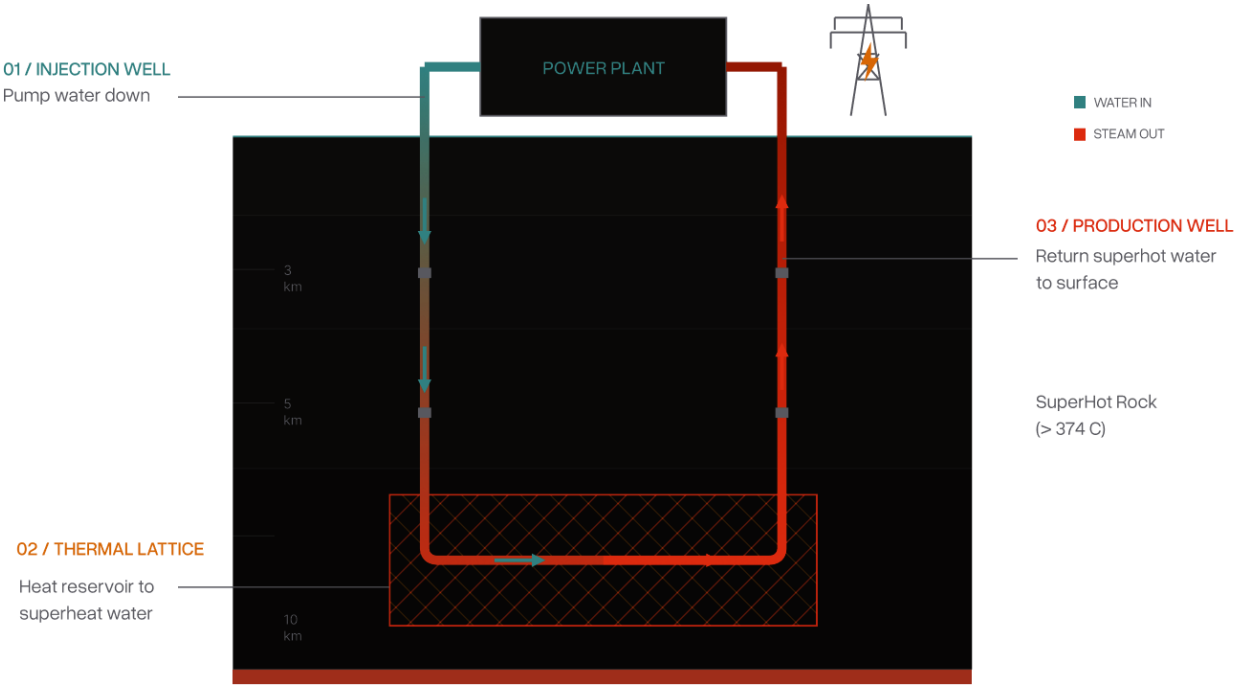
Emerging Technologies: Enhanced Geothermal

Technology Summary

Geothermal energy comes from heat generated continuously within the earth. The heat is a renewable, carbon free resource available 24/7 and can be used to generate electricity, provide space and water heating, or heat for industrial processes. Traditional geothermal energy facilities, including several in Oregon, use hot water wells to generate electricity. While Oregon has abundant geothermal resources, it is difficult to find hot water reservoirs, and the potential of drilling a dry well creates financial risk. Enhanced geothermal systems, also referred to as EGS, reduce this risk by harnessing energy from hot, dry rock deep underground, eliminating the need to find hot water reservoirs and tapping into a much hotter resource.

There are several types of emerging enhanced geothermal technologies. Flash systems pump water into the ground and use the steam generated in the hot rock to spin a turbine. Binary systems work similarly, but transfer heat from the water to a different fluid that spins a turbine. There are also different configurations used to gather the heat from the ground. Closed-loop systems use sealed pipes that pass through the hot rock to collect energy. Open loop systems use injection wells to pass water through fractures in the hot rock, which is then gathered as steam through adjacent collection wells. All EGS configurations recover the water used so it can be reinjected back into the hot rock, resulting in nearly continuous electricity production. Figure 1 shows the primary components of enhanced geothermal energy systems.[1]

Figure 1: Open Loop Enhanced Geothermal System Diagram; image courtesy of Mazama Energy



Enhanced geothermal facilities would provide power regardless of the weather or time of year, diversifying the portfolio of clean renewable energy resources in Oregon and supporting more reliable and resilient grid operations. Oregon has excellent geothermal resources and is poised to be a leading state in geothermal development with the potential to provide some of the lowest cost

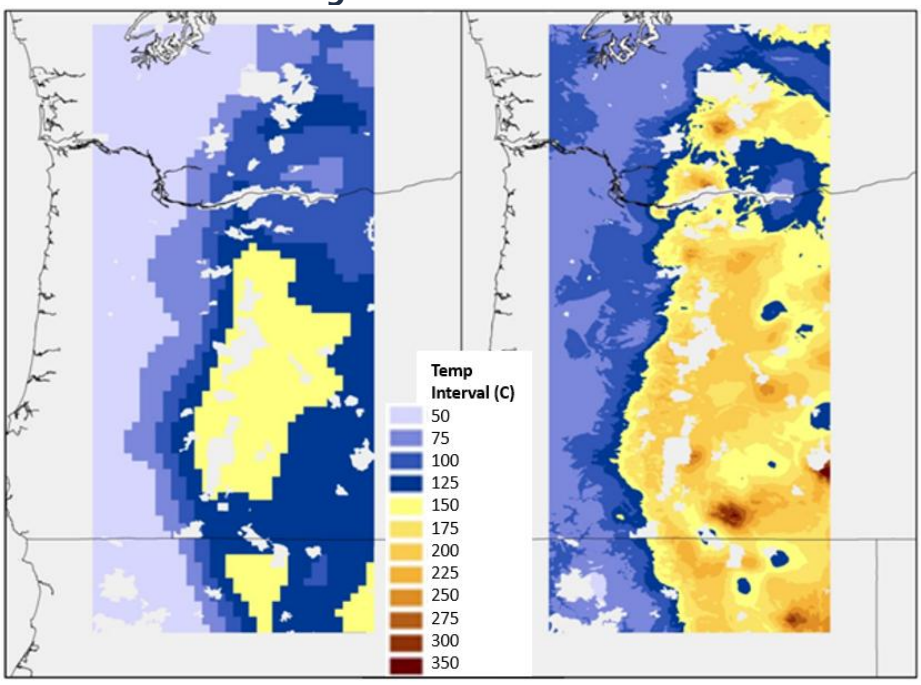
geothermal energy in the country. It has been more than a decade since Oregon's largest conventional geothermal power plant was developed near Vale, with no plans for additional facilities. Enhanced geothermal technologies are reinvigorating the industry in Oregon with active exploration and development projects on Mount Hood, Newberry Volcano, and other potential sites in eastern Oregon.

Resource Potential

Enhanced geothermal technologies are expanding the potential for geothermal project development. The U.S. Geological Survey estimates that enhanced geothermal in the Great Basin, including much of southeast Oregon, could help capture enough geothermal energy to produce as much as 135,000 MW of peak generation.[2] For reference, as of 2024 there are about 3,970 MW of conventional geothermal power plants operating in the United States.[3] In 2023, the National Laboratory of the Rockies[i] estimated that 90,000 GW of EGS capacity could be economically built across the country by 2050.[4] Sixty-one percent of all geothermal capacity contracted for in western states since 2021 has been EGS (approximately 1,007 MW of 1,661 MW total).[3]

Recently updated EGS resource data revealed a much greater geothermal resource potential in Oregon than was originally assumed. In 2023, the U.S. DOE, working with the National Renewable Energy Laboratory (NREL), completed the Enhanced Geothermal Shot Analysis, which modeled potential EGS development in 16 states, including Oregon, using updated cost and performance assumptions.[5] The left side of Figure 2 shows assumed geothermal resources taken from a national resource map generated in 2006, primarily for traditional geothermal resource availability. The right side of the figure shows significantly more geothermal energy resources identified in the NREL Enhanced Geothermal Shot Analysis.

Figure 2: Oregon Geothermal Resource Potential for Traditional Compared to Enhanced Geothermal Technologies



[i] Formerly known as the National Renewable Energy Laboratory (NREL).

Recent Developments

Enhanced geothermal technologies are rapidly moving from research and development sites to full commercial operations. Decades of research and projects in multiple countries have demonstrated the technical viability of EGS for electricity generation. Early developments date to the 1970s when researchers successfully demonstrated the concept at the Hot Dry Rock project at the Fenton Hill site in New Mexico.[6] Today, several enhanced geothermal systems are already in commercial use and technology improvements are reducing the time and costs associated with future commercial developments. The first commercial EGS sites were developed in France and Germany in the early 2000s, followed by projects in the UK, Australia, Japan, and Italy.[6] In New Mexico, XGS Energy is developing a 150 MW enhanced geothermal facility to support Meta's data center portfolio.[7] The New Mexico project corresponds with a state geothermal study co-authored by many public, university, and private contributors.[8] Other emerging field-scale development and exploration drilling projects are supported by public-private partnerships at 21 federally funded sites in Idaho, New Mexico, Nevada, Oregon, California, Alaska, and Washington.[9]

The Newberry volcano in central Oregon is being used for two geothermal pilot projects. The Newberry Crater has one of the best geothermal resources in the country, with temperatures exceeding 700°F at relatively accessible depths. The first to break ground was the Mazama Energy project, which started with an existing well that was drilled more than 10 years ago by Altarock Energy. Mazama has since drilled additional wells and developed cracks within the subterranean rock where water can move between wells to gather heat. In 2025, the Mazama team set a world record with a well that reached 612°F and have successfully demonstrated steam generation at the site. The next step will be the installation of a steam turbine to generate electricity.[10] Mazama Energy believes the Newberry site could one day generate up to 5 GW of carbon free electricity.[11]

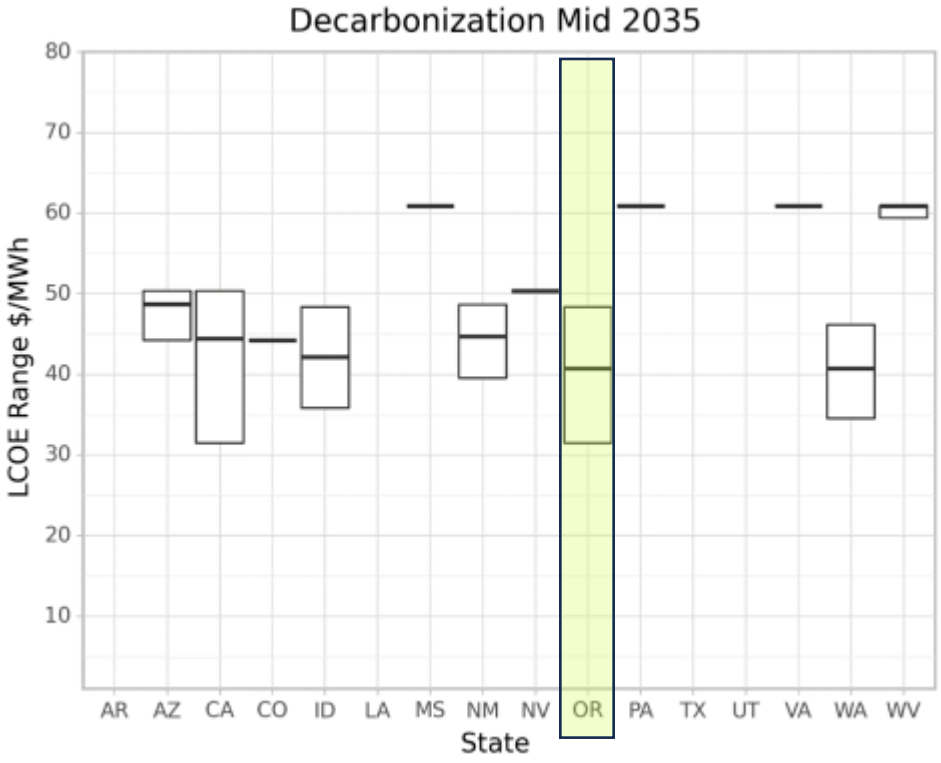
A second EGS facility, known as Project Obsidian, is being developed by Quaise Energy on the south side of Newberry volcano. This project uses innovative "millimeter wave" drilling technology, which is capable of faster and cheaper geothermal well development than other technologies in superhot rock.[12] Drilling began in 2026 for a well to support a proposed 50-megawatt power plant with the potential to expand to over 1,000 megawatts in the future.[13] The superhot rock at these facilities produces very high energy density heat, and Newberry also serves as a test site for developing new high temperature drilling techniques. In principle, the entirety of eastern Oregon is prospective for EGS. However, as the barriers section discusses, a lack of subsurface data and cost of drilling are slowing potential rollout.

Anticipated Costs

Projected costs for geothermal energy vary by source. The 2025 Annual Technology Baseline report projected the levelized cost of energy for enhanced geothermal to range between $51 and $146 per megawatt-hour in 2035, depending on subsurface conditions and type of plan developed.[14] 2035 values were selected as a reasonable estimate for when new enhanced geothermal energy projects may come online in Oregon. The favorable subsurface conditions in Oregon are consistent with cost estimates around $71 per MWh in 2035. This aligns closely with Lazard's levelized cost of energy projections of $66 to $109 per MWh.[15]

Some studies have predicted much lower costs for enhanced geothermal. In 2023, the Enhanced Geothermal Shot report found that if technical and policy barriers could be overcome, costs as low as $45 per MWh by 2035 could be achieved. This was presented as an aspirational target, but the analysis singled out Oregon as having the potential to be one of the lowest cost EGS markets in the country, with LCOE costs between $30 and $50 per MWh.[16] Even if the aspirational target is not met, when compared to advanced nuclear, offshore wind, and wave energy, enhanced geothermal is still projected in the ATB and Lazard's analyses to be the lowest cost, zero-emission emerging energy resource in Oregon by 2035. Some of the reductions in costs are expected to come from existing oil and gas drilling operations shifting to enhanced geothermal development.[17]

Figure 3: Range of 2035 Costs for Enhanced Geothermal System Electricity Generation by State[16]



Challenges to Commercial Development

There are several technological and policy challenges that need to be overcome before enhanced geothermal systems reach widespread commercial development. The U.S. Energy Information Administration has identified specific technological challenges, including:[18]

- Lack of subsurface data to inform site selection and lower project development risk.
- High costs of deep drilling and operating drills in hot rock.
- The capability to create and sustain flow through rock fissures that are located deep underground.
- Mitigating risks associated with induced seismicity.[ii]

[ii] Data collected at the Newberry site in Oregon demonstrates little seismic risk.

Additional barriers include long and complex permitting processes and limited access to transmission. Permitting may include multiple federal, state, and local agencies with unique requirements and timelines. Enhanced geothermal promises to be less location dependent than conventional geothermal, but in Oregon, some of the best resources may lack easy access to transmission. Building new transmission may be more costly and time-consuming than building the geothermal facilities.

Like all the emerging technologies evaluated in this report, the timing to overcome these barriers is uncertain and will depend upon successful demonstration projects. The two facilities under development at Newberry volcano will demonstrate new technologies and drilling techniques that will inform options to overcome these barriers.

Effects on Local Communities

Enhanced geothermal energy development can provide local economic benefits, but there are some aspects of development that could negatively affect communities and the environment. Oregon's best geothermal resources are in central and eastern Oregon, including some Tribal lands, and many small, rural communities. Enhanced geothermal energy has the potential to be require less land than solar and wind developments, but geothermal projects may still require new transmission lines and roads to service the facilities. Concerns over seismic activity with oil and gas fracking in other parts of the country have raised fears over potential seismic activity induced from pumping water deep underground.[19] The United States Geological Survey is tracking seismic activity at Newberry volcano and has found some induced seismic activity, though nothing that represents a safety concern.[20] Lawrence Berkely National Lab has also been monitoring 10 geothermal sites across the country, with decades of seismic data, and has not found significant induced seismic hazards.[21] Geothermal facilities will include pumps, fans, motors, vehicles, and other equipment that can generate noise pollution that is disruptive to nearby communities. Other disruptions may include new roads for site access, dust, construction noise, and large equipment on local roads.

Geothermal sites can support broader economic development for local communities by providing jobs and infrastructure that could be leveraged to drive more economic growth opportunities nearby, such as developing new roads or transmission lines. However, these may not be desirable by some or all people in these communities. Understanding local interests, needs, and concerns with EGS developments is essential to informing EGS policy and development choices. Coordination with Tribes, environmental advocates, and local communities is critical for responsible and successful project development.

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Emerging Technologies: Long-Duration Energy Storage

Technology Summary



Long-duration energy storage, or LDES, refers to technologies capable of storing and then delivering energy to the electric grid or end users for long periods of time. While definitions vary, the U.S. Department of Energy defines *long-duration* as offering a minimum of 10 hours of discharge at full power, though some technologies seek to extend this period to hundreds of hours or across seasons.[1] [2] These systems can provide important grid services such as balancing variable renewable energy, managing prolonged constraints on the grid such as peak loads from heat waves, or even supporting seasonal differences in grid loads and generation. They can also be used by commercial and industrial facilities, such as data centers, to support operations and provide backup power. Large volumes of energy can also be stored with multiple units of shorter-duration storage technologies, such as lithium-ion batteries. Emerging LDES technologies seek to reduce the cost of long-term storage compared to these existing shorter-duration storage technologies. As Oregon increases the amount of variable renewable energy on the grid and climate change drives more extreme and prolonged weather events, LDES could be a critical technology for maintaining grid reliability.

Long-duration energy storage technologies vary widely. Pumped hydro storage facilities date back more than 100 years and are in widespread global use. Other technologies, such as iron-based batteries, are just emerging. Energy can be stored mechanically, such as compressed air, or as fuel, such as hydrogen generation from surplus renewable energy. All the technologies have a recharge period when energy flows into the storage facility, and a discharge period when energy is delivered back to the grid. This topic will focus on iron-based batteries, compressed air storage, and hydrogen, which are long-duration energy storage technologies emerging across the U.S. Some technologies, such as lithium-ion batteries, are primarily used for short-term storage applications and will not be included in this analysis. Additional energy storage technologies may be covered in future emerging technology reports.

Iron-Based Batteries

There are several emerging iron-based batteries, including iron-air and iron-flow, that are specifically designed for long-duration, large-scale energy storage. Both types of iron-based batteries can withstand many charge/discharge cycles, are safe to operate, and utilize more abundant and lower cost materials than conventional lithium-ion batteries.[3]

Iron-air batteries operate via a reversible "rusting" reaction. During discharge, iron reacts with oxygen in the air, creating rust and electricity. When charging, the rust is converted back into iron in a process that also releases oxygen. Iron-air batteries are designed for long discharge — up to 100 hours — but have low round-trip efficiency, losing about half the energy in a single charge/discharge cycle.[4] This

low round-trip efficiency limits iron-air batteries to applications where they can be charged with free or very low-cost electricity, such as energy from solar or wind that might otherwise be curtailed.[i]

Iron-flow batteries can provide 100+ hours of cost-effective energy storage and are much more efficient than iron-air batteries. Iron-flow batteries are comprised of two liquid electrolytes made from iron salts dissolved in water. Pumps circulate the electrolytes, speeding up the chemical reactions and improving round-trip efficiency to about 70 to 80 percent.[5]



Iron-flow batteries.
Source: ESS Inc, Wilsonville.

Compressed Air Energy Storage

Compressed air energy storage operates by compressing air with electricity — often from renewables — into underground caverns or rock formations. During discharge, compressed air is released and used to spin turbines that generate electricity.[6] Compressed air can also be used to increase the efficiency and output of conventional natural gas power plants, tripling energy output and reducing natural gas consumption by up to 60 percent.[7] Although compressed air has been in use for storing energy from the grid since 1978, there is renewed interest in advanced types of compressed air storage that do not need to work in conjunction with natural gas plants.[8] Compressed air storage projects have not yet been developed in Oregon or the Pacific Northwest.

Hydrogen Energy Storage

Hydrogen can be generated, stored, and used as a carbon-free fuel in specialized electric power plants. Electricity can be used to generate hydrogen (and oxygen) gas from water using devices known as electrolyzers. Electrolyzers have been used since the early 1900s. Today, more than 95 percent of global hydrogen is made using steam to separate the hydrogen from methane in natural gas in a process known as steam methane reformation. The process emits 10-12 kilograms of carbon dioxide for each kilogram of hydrogen (this is roughly equivalent to the embodied energy and cradle-to-grave carbon emissions associated with one gallon of gasoline).[9] [10] However, when powered by clean electricity, electrolyzers can produce carbon-free hydrogen. When hydrogen is burned in a combustion turbine to generate electricity, no carbon dioxide is emitted; however the process results in other pollutants such as nitrogen oxide, or NOx, emissions.[11] Hydrogen can also be used in a fuel cell, which can generate electricity without the emissions associated with a combustion turbine.

Resource Potential

The resource potential of long-duration energy storage technologies is primarily associated with their operational value to electric utilities, grid operators, and end users. LDES facilities may be co-located with solar or wind to enable the facilities to deliver energy when it is most valued or placed in strategic locations to manage congestion on transmission infrastructure, improve resilience and

[i] In this context, "curtailed" refers to unused output of solar or wind energy facilities that corresponds with periods of oversupply on the grid.

reliability, or to provide backup power. In each case, the resource potential is site-specific and determined based on specific operational needs.

In the Pacific Northwest, a promising use case for LDES would be to provide backup power during prolonged grid outages. Natural hazards such as winter storms, summer heat waves and wildfires result in regular prolonged power outages in Oregon. Short-duration storage technologies, such as lithium-ion batteries, are too expensive to provide the many hours or days of backup power necessary during these events. LDES aims to reduce the cost of energy storage to a level where it may be used for multi-day backup power.

Recent Developments

Iron-Based Batteries

The market for long-duration, iron-based batteries is growing rapidly, with record market growth in the first quarter of 2026.[12] While the market continues to be dominated by lithium-ion batteries, iron-based batteries are demonstrating advantages for long-duration storage applications.[5] By 2034, the market for iron-based batteries is forecasted to grow to $25 billion from $1.75 billion in 2025.[13]

Both iron-oxide flow batteries and iron-air batteries are approaching commercial viability, with multiple utilities investing in iron-based batteries. In February 2026, Form Energy announced a partnership with Google and Xcel Energy to develop a 300 megawatt, 100-hour iron-air battery in Minnesota.[14] Additional iron-air facilities are underway in Colorado, Georgia, California, and New York.[15] ESS Inc Energy Solutions, an iron-oxide flow battery manufacturer in Wilsonville, Oregon, recently wrapped up a 21-month demonstration project with Burbank Water and Power where their batteries were coupled with an existing rooftop solar installation.[16] ESS Inc. is also collaborating with the Salt River Project, an electric utility in Arizona, to develop a 50 MWh facility that will be able to provide 5MW of power for up to 10 hours.

Compressed Air Energy Storage

Interest in compressed air energy storage systems has steadily grown in the last decade as a large-scale solution for supporting clean energy grids. Until 2025, there were only two compressed air storage facilities in operation. The first was built in 1978 in Huntorf, Germany, and the second is a 110 MWh plant in McIntosh, Alabama, built in 1991. Both of the facilities were used to boost the output and efficiency of conventional natural gas power plants.[18] In 2025, the Nengchu1 compressed air storage facility began commercial operation in Hubei, China, where it is used to balance variable renewable energy on China's grid. It is the largest compressed air storage facility in the world, with a 300 MW output and 1,500 MWh storage capacity. It is also the first large-scale non-combustion facility, meaning it does not operate in conjunction with a natural gas plant.[19]

In the U.S., the proposed Willow Rock compressed air storage facility in California received a $1.76 billion U.S. DOE loan for construction. It would add 500 MW of storage capacity, expected to provide 4000 MWh of long-duration energy storage for the southern California grid.[20] The facility is anticipated to begin operating by 2030.[21] A 2023 Pacific Northwest National Laboratory and Bonneville Power Administration study on potential geological formations capable of hosting a compressed air storage facility identified multiple sites in eastern Washington and Oregon.[22]

PacifiCorp included compressed air energy storage as a potential resource in its 2025 Integrated Resource Plan, but the modeling did not select it as a least-cost storage option.[23] Portland General Electric's and Bonneville Power Administration's most recent planning modeling efforts have not included compressed air storage as a resource option.

Hydrogen

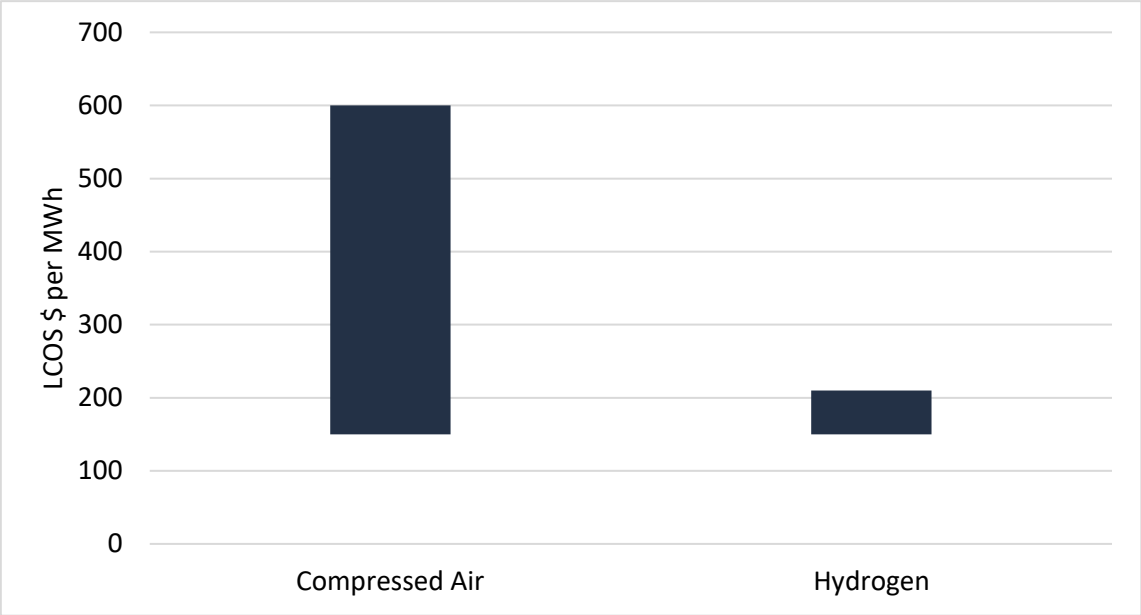
The availability of clean hydrogen is expanding rapidly – installed capacity of hydrogen electrolyzers expanded nine-fold globally from 2021 to 2025.[24] While most hydrogen is used for industrial purposes, there have been advancements in hydrogen storage and electricity production facilities. Across the globe and in the U.S., testing is underway on turbines that use hydrogen to generate electricity. The Advanced Clean Energy Storage project in Delta, Utah aims to combine hydrogen production, storage, and electricity generation in a natural gas power plant that has been modified to burn hydrogen.[25] On a smaller scale, Pacific Gas and Electric Company in California announced completion of a long-duration energy storage microgrid in Calistoga, CA.[26] The 8.5 MW facility combines on-site hydrogen storage, a hydrogen fuel cell, and lithium-ion batteries to provide up to 48 hours of isolated microgrid operations. In England, researchers at the University of Birmingham have developed a new way to split water into hydrogen and oxygen using a low-temperature approach that could make the clean fuel more affordable and easier to produce.[27]

In the Pacific Northwest, hydrogen development suffered a significant setback in 2025 when the Trump administration announced that it was cancelling federal funding commitments for the Pacific Northwest Hydrogen Hub.[28] The hub included projects across Oregon, Washington, and Montana that would have demonstrated the use of hydrogen as a safe and reliable means of energy storage, including for electricity generation during periods of peak demand on the grid.[29] The cancellation of the Pacific Northwest Hydrogen Hub award was a blow to the region but other smaller initiatives remain. In February 2026, the Oregon Institute of Technology was awarded $1.11 million to develop applied research, education, and training in hydrogen production, solar and solar thermal advancements, emerging battery technologies, and long-duration energy storage.[30]

Anticipated Costs

Projected costs of emerging LDES technologies vary. The U.S. Department of Energy tracks several emerging energy storage technologies, including compressed air storage, and hydrogen storage.[31] Iron-oxide batteries are not included in the U.S. DOE assessment. The costs are reported as levelized cost of storage, which is a similar metric to the levelized cost of energy metric reported for emerging generation technologies, but accounts for specific storage cost considerations such as round-trip efficiency, operations and maintenance, and number of lifetime charge and discharge cycles. LCOS does not consider the cost of the electricity used for charging, as this value can vary by location, source, and time of day.

Figure 3. Levelized cost of storage estimates from U.S. DOE Long-Duration Storage Shot Technology Strategy Assessments.[32]



The cost to build compressed air or hydrogen storage facilities is a large barrier to adoption, although each technology has a range of potential costs. Hydrogen storage costs depend on how the hydrogen is stored, with storage in a natural geologic formation being cheaper than above-ground containers.[33] It is also important to note that the LCOS for hydrogen only includes the costs involved in creating and storing hydrogen but does not include costs to develop fuel cells or combustion turbines capable of using hydrogen as a fuel. This would further increase the total costs to use hydrogen as storage for electricity generation. Compressed air costs are also heavily dependent on siting facilities at specific geological formations that can also be cost-effectively linked to the grid.[34]

There is some evidence that the levelized cost of storage for iron-based batteries is close to the low end of the values calculated for the other long-duration storage technologies evaluated by the U.S. DOE. A recent study by Energy Solutions Intelligence estimated an LCOS for iron-oxide flow batteries at $90-160 per MWh, which is near the bottom of the cost range for hydrogen.[35] Another study by the same organization estimated an LCOS for 100-hour iron-air batteries at about $60/MWh by 2035.[36]

The LCOS for these technologies, even at the lower end, is mostly higher than the price of electricity sold through the Pacific Northwest regional pricing hub over the course of 2025.[37] However, there is an additional benefit that long-duration storage could provide that is not captured in the LCOS: addressing costs from renewable energy oversupply situations. In the Pacific Northwest, seasonal variations in hydropower and wind energy create periodic conditions where the supply of electricity exceeds demand.[38] When this oversupply occurs, generators must curtail generation, and this can lead to revenue losses. An example of this is Bonneville Power Administration's Oversupply Management Protocol that requires BPA to reimburse generator owners for lost revenue. Ultimately, this means the surplus energy is not only wasted, but costs ratepayers money. The last time the protocol was used in 2023 resulted in BPA reimbursing almost $3 million to 26 different generators for curtailments during seven days of oversupply.[39] More LDES options could have reduced or eliminated these curtailments,

provided the energy back to the grid when needed, and reduced or eliminated the reimbursement costs.

Challenges to Commercial Development

Long-duration energy storage technologies face several challenges to widespread commercial deployment. A 2024 Center for Climate and Energy Solutions report prepared for their Long Duration Energy Storage Working Group identified three key barriers:[40]

- Overcoming technical challenges
- Reaching economies of scale in deployment (while keeping pace with emerging grid needs)
- Addressing gaps in recognizing the full value of LDES in utility and transmission planning processes and government incentive structures

Another major challenge is access to grid infrastructure for LDES connections. Siting options for compressed air storage and some hydrogen storage are limited to unique locations with specialized geological formations, which may not be near existing transmission lines or substations. LDES is most cost-effective when able to interconnect with grid infrastructure and/or be co-located with energy generation, particularly near large-scale renewable energy facilities that offer low- or no-cost charging during periods of overproduction. In another example, electrolyzers that generate clean hydrogen also require a consistent source of water to operate.

Securing siting and permitting approvals for some LDES projects is a complex process that can take months or years to navigate. Facilities that require more land and subsurface resources, such as compressed air and geologic hydrogen storage, often require permitting processes that can take several years.[41] Different types of energy storage facilities may require approvals and permits from many different authorities, including Tribal, county, state, and/or federal approvals, and this may entail land use, environmental, cultural resource, or other assessments and approvals. Other facilities, such as standalone battery storage facilities, may only need county approval. An advantage of iron-based battery storage is that it does not have many of the risks associated with lithium-ion batteries, such as fire risk, which may lead to shorter permitting timelines.

Effects on Local Communities

Long-duration energy storage projects have the potential to provide many benefits to Oregon communities and households. LDES technologies offer opportunities to make Oregon's grid more reliable and resilient by getting the most out of variable renewable solar and wind resources. Some technologies may also come with fewer environmental, health, and safety concerns than some other grid support technologies. For example, iron-based batteries have low toxicity, low fire risk, and minimal waste profiles compared to lithium-ion or other forms of battery energy storage technologies. Batteries could also offer local community energy resilience benefits by providing a longer-term source of electricity during power outages or other emergency operational needs. In 2023, the U.S. DOE Office of Clean Energy Demonstrations announced awards for 15 LDES projects with the goal to increase community control of local power systems, mitigate risks associated with disruptions to the grid, and help communities develop reliable and affordable energy systems.[42]

Understanding the effects of LDES development in or near local communities and on the environment is important to informing policy and development choices. Large geologic energy storage facilities, such as pumped hydro and compressed air, may be controversial, as they are often located on or near Tribal lands and rural communities. For example, the proposed Swan Lake pumped hydro facility in Klamath County experienced strong pushback from Tribal members. In 2024, the Klamath Tribes General Council voted 77 to 8 against a $40 million Tribal compensation package associated with the proposed facility.[43] Similar opposition has been voiced by the Affiliated Tribes of Northwest Indians regarding a proposed hydro facility near Goldendale, WA.[44] Facilities may also require the development of roads to access the sites, generate noise pollution, and require new transmission lines. While most long-duration storage is not dependent on geology, local communities may have concerns about the chemicals used in the batteries, operational noise, or even the visual aesthetics of the facilities. Early, frequent, and transparent communication, coordination, and consultation with Tribes, environmental advocates, and local communities are critical for responsible and successful project development.

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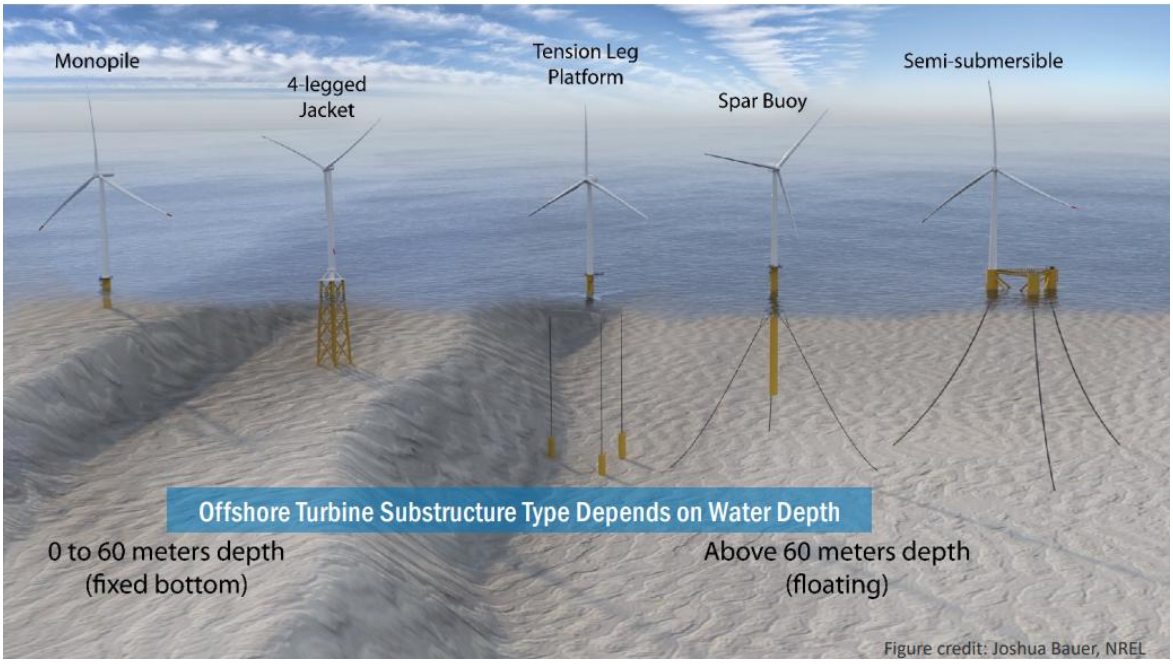
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Emerging Technologies: Floating Offshore Wind

Technology Summary

Floating offshore wind combines existing wind turbine technologies with innovations that enable them to operate in deep ocean waters like those off Oregon's coast. Most existing offshore wind facilities are mounted on rigid foundations fixed to the sea floor, which requires sites where water depths do not exceed 60 meters, or about 200 feet. Floating offshore wind turbines can operate in deeper waters because they are mounted on buoyant platforms rather than fixed to the ocean floor. Platforms are moored to the seabed with cables, stabilizing the structure while accommodating for wave and wind motion. In addition to allowing for operations in deeper waters, floating offshore wind also provides access to stronger, more consistent wind resources farther from shore.

Figure 1: Offshore Wind Mounting Strategies. Image Courtesy of NREL.[1]



Floating offshore wind structures are similar to those on land but have some important differences. Floating offshore wind technologies are often larger than land-based turbines. For example, Portland General Electric's Wheatridge Renewable Energy Facility uses wind turbines with a capacity of 2.5 megawatts each and a hub height – the height of the nacelle that the blades spin around – of around 90 meters. Offshore wind turbines are much larger, with emerging turbines up to 26 MW each and hub heights up to 200 meters.[2] To accommodate for the large size, offshore wind turbines are typically assembled at a port and towed to their site. Turbines must be designed to withstand the effects of the saltwater environment, stronger winds, and ocean waves and currents, which increases maintenance costs and the cost of materials that are used in construction. Floating offshore wind facilities also require underwater transmission cables, offshore substations, and other electrical equipment capable of withstanding marine environments.

Figure 2: GE 12 MW Wind Turbine Nacelle and Blade. Photos courtesy of GE.[3]





Floating offshore wind has been a topic of ongoing conversations in Oregon, especially along the south coast, which has the best offshore wind resource on the west coast of the contiguous U.S. As an energy resource it has the potential to provide abundant clean electricity and complement the increasing amounts of variable solar and wind generation in Oregon's electricity resource mix. Offshore winds blow consistently, making it a resource that could provide power when solar and onshore wind resources are not available. It also has the potential to bring industries and jobs to Oregon, supporting economic development in coastal and rural areas of the state as well as industrial centers along the Columbia River.

Resource Potential

Offshore wind energy developments along the West Coast of the United States have the potential to generate about half of the electricity used in western states.[4] A 2026 study describes the *technical potential* for about 90 GW of floating offshore wind development on the West Coast, generating 355 terawatt-hours (355,000 gigawatt-hours) of annual energy production. However, not all the technically possible offshore wind sites are economically feasible.[4] Most of the west coast is suitable only for floating offshore wind resources, and development of floating offshore wind farms will be limited until technology and siting challenges can be overcome. The *West Coast Offshore Wind Transmission Study* conducted by Pacific Northwest National Laboratory, which took into consideration more economic data on floating offshore wind development, concluded that floating offshore wind could provide about 33 GW of energy to the western U.S. by 2050.[5]

Figure 3: National Laboratory of the Rockies Coastal Wind Resource Assessment[1]

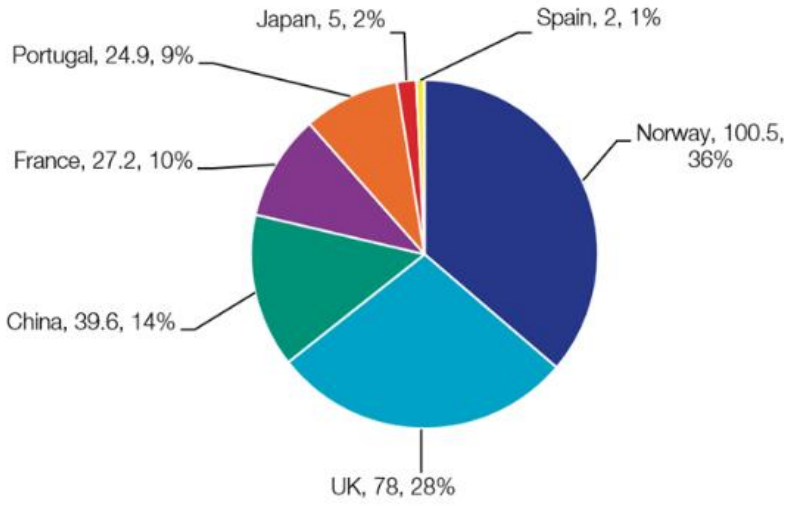


In 2024, the Bureau of Ocean Energy Management identified two lease areas for potential development, comprising about 3 GW of potential capacity off the southern Oregon coast.[6] Opposition from Tribes, the fishing industry, and local communities, as well as the withdrawal of four of the five potential lease bidders, resulted in the planned lease auction being postponed. In 2025, as a result of Federal policy changes, BOEM rescinded both Wind Energy Areas off Oregon.[7] From 2024-2026, Oregon developed an Offshore Wind Energy Roadmap, which described potential alternative futures for Oregon related to offshore wind energy, and recommended policies and actions the state could take to facilitate responsible development while securing the interests of state coastal uses, resources, and community well-being.[8]

Recent Developments

Floating offshore wind technologies have reached several significant milestones in recent years, driven by technological advances and development of new commercial projects. As of late 2025, global operational floating wind capacity reached around 277 MW across 16 projects in seven countries, a 13 percent increase from the previous year.[9] Most floating offshore wind facilities (78 percent) are operating in the United Kingdom, Norway, and China. In May 2026, the largest single wind turbine installed on a floating platform began operating in China — a 16 MW turbine[i] located 70 kilometers offshore.[10]

Figure 4: Operational Floating Offshore Wind Capacity by Country[9]



There are currently no floating offshore wind projects operating or in development in the United States and local, state, and federal actions continue to limit development opportunities. In 2021, the California legislature set planning targets for offshore wind development in state waters for up to 5 GW by 2030 and 25 GW by 2045.[11] In conjunction with this, the federal Bureau of Ocean Energy Management issued leases for floating offshore wind energy exploration in areas off the coasts of California and southern Oregon in 2022. On July 30, 2025, BOEM announced it would rescind all designated offshore wind areas on the U.S. Outer Continental Shelf, which precluded additional leases from being issued for these areas, including unleased areas identified off Oregon. The federal

[i] A 26 MW turbine was also installed in China in 2026 but it is on a fixed platform at a test facility.[2]

government also provided buyouts for existing lease holders in exchange for investing those funds in other types of energy projects, including natural gas and geothermal developments.[12] [13]

Recent Oregon Actions

Offshore wind energy development in Oregon has been the topic of several state-led reports and planning documents in recent years. In 2022, the Oregon Department of Energy published the *Floating Offshore Wind: Benefits & Challenges for Oregon* report as directed by House Bill 3375 (2021). The *Oregon Territorial Sea Plan*, last updated in 2023, outlines ocean management policies for offshore renewable energy development within state waters and in federal waters out to an ocean depth of 500 fathoms (about 3,000 ft). In 2026, the Oregon Department of Land Conservation and Development published the *Oregon Offshore Wind Energy Roadmap* to define standards to be considered in the processes related to offshore wind energy development and approval as directed by House Bill 4080 (2024).

Anticipated Costs

Projected costs for floating offshore wind are higher than other renewable energy development options. Costs depend on water depths where the development will occur, which can range from 80 to over 1,300 meters, and distance to shore, which ranges from 27 to over 200 kilometers. The 2024 *Annual Technology Baseline* projects a 2035 levelized cost of energy for floating offshore wind between $63 and $289 per megawatt-hour, reflecting the wide range of conditions for development.[14] The conditions off the southern Oregon coast align with some of the lowest *Annual Technology Baseline* cost estimates with projections of about $104 per MWh in 2035. Lazard's LCOE projects[ii] $105 to $167 per MWh for offshore wind.[15] These projected costs are higher than some other emerging technologies, such as enhanced geothermal, but lower than advanced nuclear, which Lazard's projects to be above $200 per MWh.

Challenges to Commercial Development

Even with the advantages offshore wind brings to the grid, costs will need to decrease before these facilities can compete in U.S. energy markets. Floating technologies have been demonstrated to work but are still being tested and improved. Existing developments demonstrate the viability of the technologies, but there is still a great deal of uncertainty in how or when offshore technologies and practices could be more standardized. Standardization is key to economies of scale that will bring costs down, including establishing robust supply chains and training workers to produce necessary materials and components.[16] In addition to supply chains, supporting infrastructure, like deep-water ports able to build, maintain, and transport the turbines to and from their sites, will need to be developed.[17] A skilled workforce, capable of installing and maintaining offshore facilities, will also need to be developed. These challenges drive higher costs for development, leading to an LCOE that

[ii] Lazard's does not differentiate between floating and fixed offshore wind installations, except to note a single fixed offshore wind facility in Virginia with a levelized cost of energy of $92 per MWh.

is much higher than most electricity generation resources being procured in the Pacific Northwest today. Technological, logistical, and policy barriers will need to be overcome before floating offshore wind is developed in Oregon.

There is also significant pushback from coastal communities who have voiced concerns about how floating offshore wind could affect their culture and way of life. This includes concerns about the environmental health of the ocean and access to ocean locales, which could affect existing fishing, seafood, tourism, and recreation industries. Prior to the Bureau of Ocean Energy Management recission of offshore wind lease areas off Oregon's coast, there was local and Tribal opposition, including a lawsuit from the Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians.[16] CTCLUSI indicated they were concerned that insufficient study had been conducted on how a floating offshore wind facility would affect the marine environment in the Tribe's ancestral territory.[19] The Oregon Offshore Wind Energy Roadmap charts a path for future development that could help address these concerns and secure the interests of coastal communities if implemented.

Effects on Local Communities

Floating offshore wind development has the potential to bring significant economic development to coastal communities. One report found that developing an offshore wind staging area in Coos Bay would inject hundreds of millions of dollars into the local economy to develop a new wharf and facilities, as well as prepare the land and bay for turbine fabrication and transportation.[20] Communities near offshore wind developments would gain jobs needed to directly support offshore wind operations, and other supporting economies like hotels and restaurants. These in turn would indirectly support local shops and provide additional tax revenue for counties. The *Oregon Offshore Wind Roadmap* recommends that the state support a study that assesses the economic costs, benefits, and jobs that could be realized from Offshore Wind Development.[22]

The Oregon Department of Land Conservation and Development's *Oregon Offshore Wind Energy Roadmap* provides an **in-depth assessment of community perspectives** on the benefits, concerns, barriers, and opportunities associated with offshore wind resources.

One concern many Oregonians have is how floating offshore wind facilities will affect their communities. Floating offshore wind facilities will inevitably involve contact with the physical marine landscape, flora, and fauna. Questions arise about how this might affect ancestral Tribal waters and first foods, local fishing and tourism economies, and coastal community culture. The Offshore Wind Roadmap recommended that a cumulative impact assessment, accounting for all proposed wind development sites, could help local communities better understand development effects.[8] Information gathering and dissemination can be further bolstered by working with an Oregon-specific science group and by the state providing information and updates on actions and findings relevant to community effects from offshore wind development.[23]Additional information can help to build trust in local communities and support development of specific community benefits agreements as recommended in the Roadmap.[24]

Tethys: Studies on the Effects of Offshore Wind on Marine Life

Tethys, a marine energy resource organization maintained by the Pacific Northwest National Laboratory and sponsored by the U.S. Department of Energy, collects studies on potential effects of offshore wind facilities.[18] These resources include information about community benefit agreements, the effects of turbines on aquatic life and bird migrations, and many other studies that inform responsible offshore energy development.

Additional Resources

Floating offshore wind has been the topic of several in-depth studies in Oregon. For more information see the following reports:

- Floating Offshore Wind Study: Benefits & Challenges for Oregon (2022)
- Oregon Offshore Wind Energy Roadmap (2026)
- TETHYS Environmental Effects of Wind and Marine Renewable Energy

Resources

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Emerging Technologies: Marine Hydrokinetic Energy

Technology Summary

Marine hydrokinetic energy technologies capture the energy from the motions of ocean waves, tides, and currents, and convert it into electricity. Water is about 800 times more dense than air, meaning marine hydrokinetic technologies can be much smaller than wind turbines while producing an equivalent amount of energy.[1] Several different technologies have demonstrated technical feasibility. A 20 MW tidal energy turbine facility in Nova Scotia, Canada, generated electricity for 37 years by harnessing some of the highest tides in the world.[2]

Types of Marine Hydrokinetic Energy

Tidal: Tidal energy systems capture kinetic energy in tides to generate electricity. Tidal energy facilities are site specific and require subsurface conditions that create tides that can be cycled through hydro turbines.

Ocean Current: Ocean current energy systems would use continuous ocean currents, such as the gulf stream, to spin turbines. No commercial ocean current energy facilities have ever been developed.

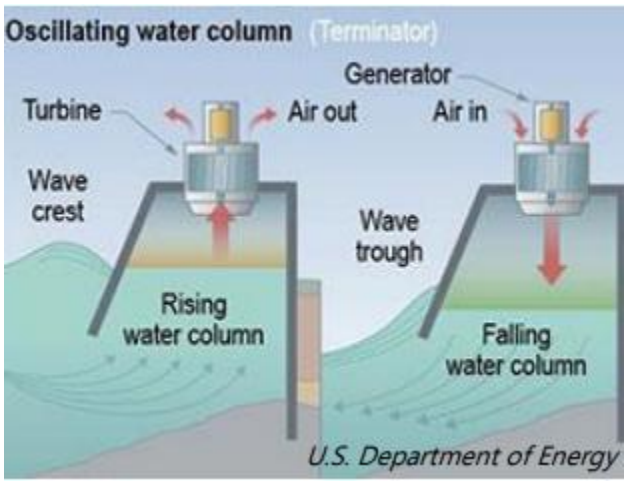
Wave: Wave energy systems capture kinetic energy in ocean waves to generate electricity. Wave energy converters are the most promising emerging technology for marine energy generation off the Oregon coast.

Some marine hydrokinetic technologies are better suited for certain environments than others. For example, most coastal regions don't experience the types of tides found in Nova Scotia, but that facility and other successful marine hydrokinetic projects provide valuable information about operations in harsh marine environments that could inform future technologies.

Marine hydrokinetic technologies can complement a diverse portfolio of renewable energy resources in Oregon to provide a consistent and predictable flow of renewable energy. Diversified resources will be important to Oregon and other west coast states in meeting grid decarbonization targets and maintaining grid reliability.[2] Like other renewable resources, development of marine energy projects has the potential to reduce Oregon's dependency on fossil fuels. Oregon is also a leader in wave energy research, including Oregon State University's O.H. Hinsdale Wave Research Laboratory in Corvallis and the PacWave Wave Energy Test Facility developed by OSU in partnership with U.S. DOE.

Wave energy converters are the most promising emerging technology for marine energy generation off the Oregon coast. There are different formats of wave energy converters, but all of them capture energy from the movement of waves in different ways that can subsequently spin a turbine. One example is the oscillating water column shown in Figure 1, which uses the rise and fall of waves to collect air and then push it through a turbine. Overtopping devices similarly use water captured from waves spilling over the top of the device to spin a turbine. Attenuators and wave surge converters use ocean movements to power a hydraulic motor that spins a turbine.[3]

Figure 1: Oscillating Water Column Wave Energy Devices. Images Courtesy of U.S. DOE and Tethys

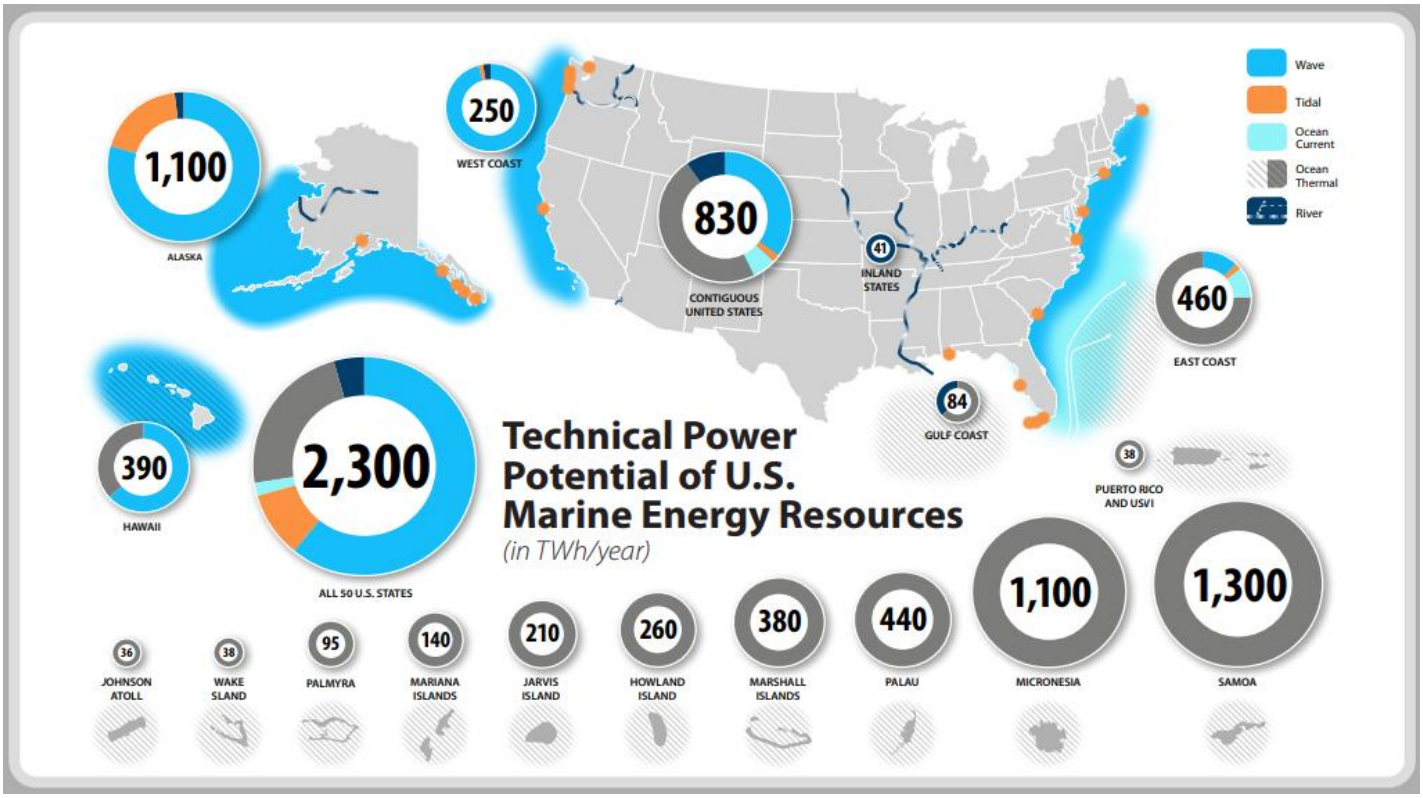




Resource Potential

Marine energy has the potential to contribute a significant share of carbon free electricity to the U.S. grid. A report by Pacific Northwest National Laboratory found that marine energy resources could account for more than 57 percent of all electricity generated in the country using a 2019 baseline.[5] A 2011 study determined that the total wave energy available on the Oregon coast is 143 million megawatt-hours per year – enough energy to power about 28 million homes.[6] A more recent study found 250 million megawatt-hours of annual potential along the whole west coast, and more than 2.3 billion megawatt-hours available nationally.[7]

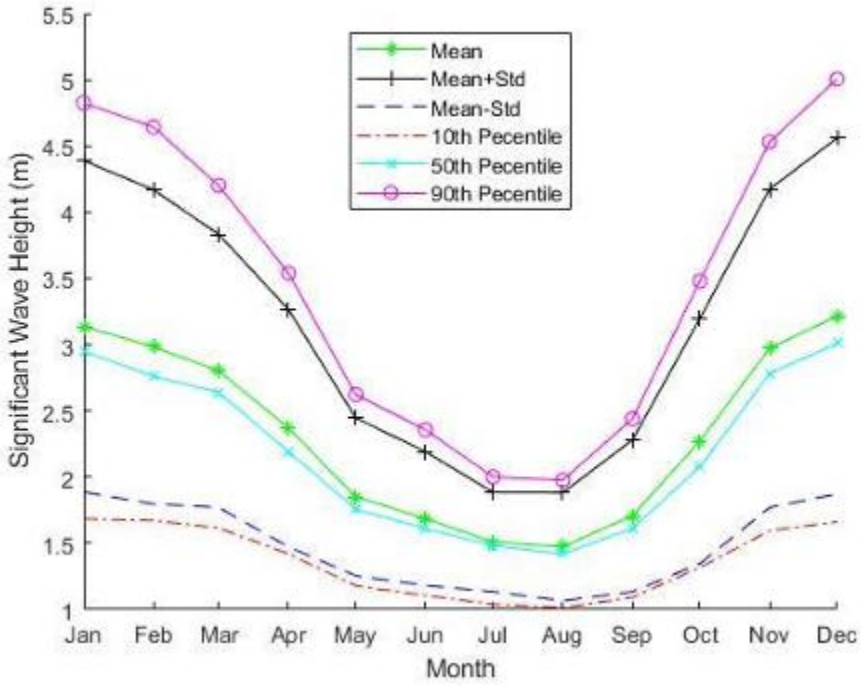
Figure 2: Marine Energy Potential in the U.S.[7]



Note: One terawatt hour (TWh) is equal to one million megawatt-hours (MWh).

In Oregon, wave energy would be ideally suited to complement increasing amounts of solar energy on the grid. Oregon's wave energy resources are strongest during the winter months when solar production is lowest. Data from the PacWave South test site off the coast of Newport demonstrates the winter peaking nature of wave energy in Oregon. Wave energy is also available at night when solar resources are shut down, regardless of season.

Figure 3: Wave Height by Month at the PacWave South Test Site[8]

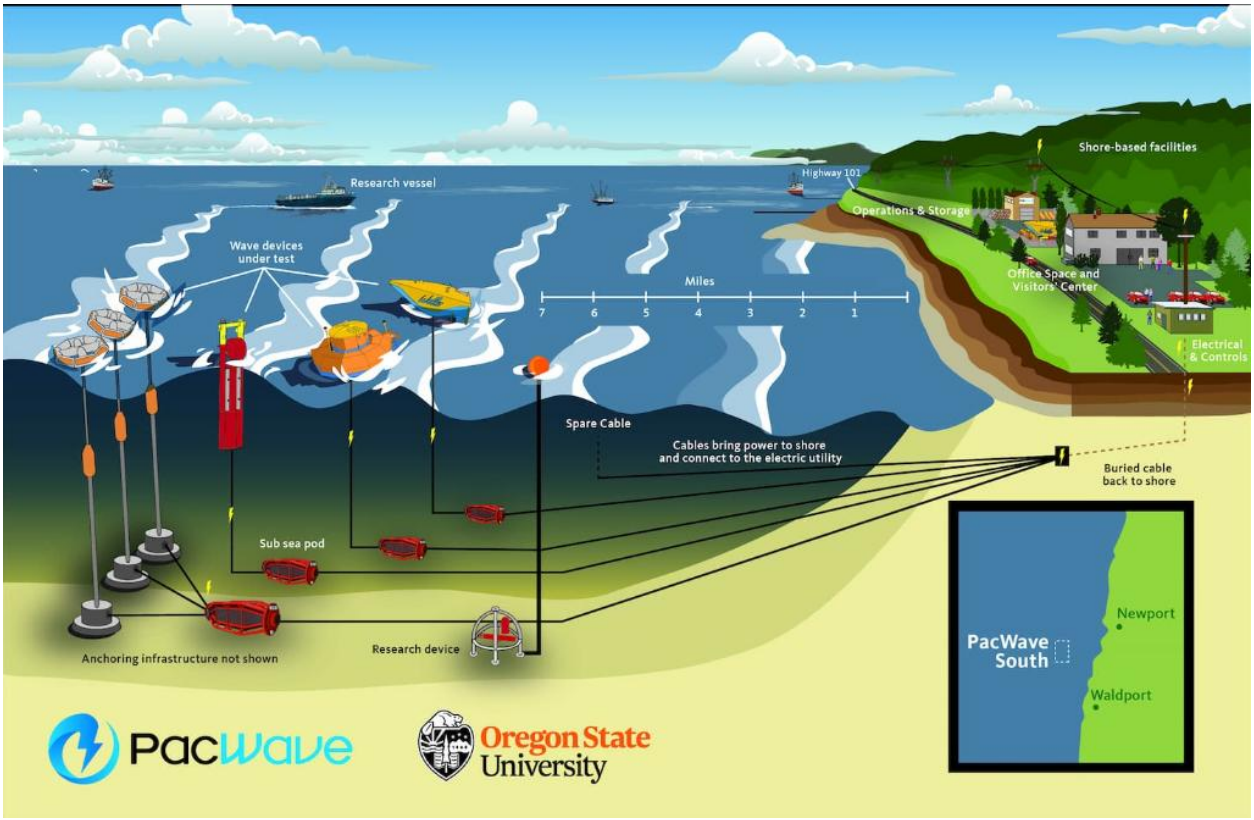


Recent Developments

Most of the recent developments in marine energy are from test sites evaluating wave energy technologies, including sites in Oregon waters. Oregon is a global leader in research and development of marine hydrokinetic energy technologies. Oregon State University, a member of the Pacific Marine Energy Center consortium of regional universities, serves as the research hub. This includes the marine energy initiatives centered around the PacWave test facilities, also supported by the U.S. Department of Energy. PacWave consists of two test areas off the central Oregon coast especially suited to testing emerging wave energy converters. PacWave North, located two miles off Newport, facilitates small-scale prototype testing. PacWave South — situated about seven miles offshore — offers four 5 MW-capable testing berths for up to 20 MW of total capacity.[7]

U.S. DOE's Water Power Technologies Office awarded roughly $25 million to fund research and demonstration projects at PacWave, backing companies like CalWave and Columbia Power Technologies to deploy diverse wave energy converter designs in open ocean conditions.[10]

Figure 3: PacWave South Site Configuration



PacWave is already capable of delivering energy to Oregon loads. Energy generated at the facility travels through an underwater transmission cable and connects to the grid in Newport. PacWave has an interconnection agreement with Central Lincoln People's Utility District and a power purchase agreement with Bonneville Power Administration.[11] Transmission, interconnection, and power purchase agreements are significant barriers to many emerging energy technologies. PacWave's efforts will provide valuable data and information and real-world experience that will be helpful for future marine energy projects as well as for offshore wind projects looking to interconnect with the grid.

Anticipated Costs

Marine energy devices are not included in the two cost indexes used for other technologies in the emerging technologies report. Those include the National Laboratory of the Rockies Annual Technology Baseline and the Lazard's Levelized Cost of Energy report. The scale of economic barriers for marine energy technologies is not yet known. At PacWave, costs and performance of wave energy converters will help to inform future cost estimates.

Challenges to Commercial Development

Marine hydrokinetic energy technologies face many technological, economic, and policy challenges before they become commercially viable. Like all ocean-based technologies, they must be able to operate in turbulent, corrosive ocean environments and be able to function in changing ocean currents and wave directions. Like floating offshore wind, wave energy technologies must be tethered to the sea floor, which will require working in deep water off the Oregon coast. Facilities like PacWave

are designed to test a variety of technologies that will be reviewed and improved over time. As the most promising technologies emerge, they will need to develop standardized designs and establish supply chains to lower costs sufficiently to compete with established renewable energy generation, like onshore wind and solar.

With so many potential technology pathways and options in marine hydrokinetic resources, continued funding for PacWave and other test sites is critical to advancements in wave energy converter technologies. Some sites, such as the 3 MW Sotenäs project in Sweden, have been decommissioned due to limited funding.[11]

Demonstration sites play an important role in understanding cost drivers, identifying failures, testing solutions for optimizations, and supporting more cost-effective technological innovations. Demonstration projects help tease out which technologies can most cost-effectively and reliably supply power to the grid and help lower costs.

Siting wave energy converters requires identifying locations that are best suited for development. Considerations include the frequency and power of the waves, seasonal variations, and hazards such as hurricane frequency and energy security. GIS resources and analysis at the National Laboratory of the Rockies is helping to optimize marine energy site selection.[14] On-shore resources also affect marine energy site selection. Access to workforce, seaports, and transmission may be especially challenging for marine energy resources that require specialized training and equipment. The U.S. DOE, in partnership with organizations like the Pacific Marine Energy Center, are collaborating to identify and address these and other barriers to deployment.[13]

Effects on Local Communities

Wave energy development is already bringing some economic benefits to Oregon coastal communities. Newport's deepwater harbor serves as the launching ground for PacWave research and testing initiatives, bringing some jobs and investment to that area. Expanding these facilities would bring more jobs to build, operate, and maintain the facilities. In turn, these jobs and revenues would feed into the local economy and bolster tax revenues.

Offshore renewable energy development in Oregon state waters is guided by the Oregon Territorial Sea Plan (TSP). Oregon's territorial sea is a strip of ocean under state jurisdiction that reaches from the shoreline to 3 nautical miles out to sea. The PacWave North test site falls within state territorial waters and represents a state permitting process guided by the TSP. PacWave South is further off the Oregon coast, but transmission and communications cables still pass through state waters to reach shore and are therefore governed by the TSP. Tribes and coastal communities in Oregon have expressed concerns about the effects of offshore energy development on existing economies, including fishing and tourism.

Energy Justice Framework for Marine Energy

Part of the planning and construction process for the PacWave facilities included development of an Energy Justice Framework for Marine Energy developed by Pacific Northwest National Labs in partnership with local Tribes, fishing industry, environmental organizations and community members.[17] This framework focuses on three tenets of Environmental Justice including:

1. Distributional Justice: concerning the fair distribution of benefits and costs
2. Procedural Justice: ensuring inclusive decision-making and equitable engagement
3. Recognition Justice: addressing the recognition and incorporation of diverse values, needs, and perspectives.

Marine energy facilities will inevitably involve contact with the marine landscape, flora, and fauna. Communities have expressed concerns about underwater noise created by these facilities, or changes in the sea floor from moorings or foundations that could displace wildlife and natural habitats. These changes could disrupt local industries and traditional fishing zones for local Tribes. There are also concerns about sea mammals colliding with equipment or becoming entangled in lines.[14] Continuing to work with Tribes and local communities is essential to understanding and addressing these concerns, and to finding ways to develop hydrokinetic wave facilities responsibly.

Additional Resources

- Department of Land Conservation and Development: Oregon Territorial Sea Plan
- Pacific Northwest Laboratories: TETHYS Environmental Effects of Wind and Marine Renewable Energy

Resources

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Energy 101

Just about everything involves energy. It's part of our daily lives – from driving our cars and heating our homes to turning on our computers and firing up the grill after a long day.

This section builds the foundation of the energy story: how energy is produced, used, and transformed. These Energy 101s were developed for people new to energy or specific energy topics, along with those looking for a resource 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.

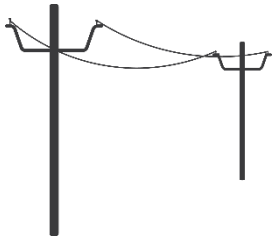
101s this year touch on a variety of topics. We look at important emerging topics like firm power and how utilities keep the lights on, what happens to solar and wind technologies when they reach the end of their useful lives, and how federal policy changes affect Oregon's energy and climate work. We also provide primers on community benefits frameworks, Oregon electric utilities, energy facility siting and permitting, and industrial symbiosis. In the 2026 report we introduce legislative briefs, which provide an overview of energy-related bills from the 2025 session that are anticipated to inform bills in future sessions.

Energy is intertwined in everything that Oregonians do – from powering vehicles to supporting our livelihoods and economy, to electricity and fuels that serve as the backbone for industry and businesses. Energy affordability, access to energy, and the effects of energy choices on communities and individuals also affect Oregonians and Oregon's economy. Everyone should have the opportunity to engage in energy choices, whether it's options to reduce energy use and costs for homes, businesses, and industry, or how we meet the challenge of transitioning our energy systems to cleaner, more renewable resources while minimizing negative outcomes for Oregonians. We hope these 101s continue to build foundational knowledge so readers can make informed choices about the energy resources, uses, and investments that can change our work, lives, and communities.

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Oregon Electric Utilities



This article provides information about electric utilities in Oregon, including some key differences between types of utilities. It also discusses electric utility histories and governance structures.

Electric utilities provide electricity to Oregonians within their exclusive service territories. They procure or generate electricity, maintain and operate local distribution grids, and bill customers to pay for services. Some utilities also plan for and operate pieces of the transmission system.[i] Utilities are central players in implementing energy regulations and policies. They also have an important role ensuring system reliability and affordability.

Types of Electric Utilities

Broadly speaking, there are two types of electric utilities in Oregon: investor-owned and consumer-owned. Investor-owned utilities are for-profit corporations with shareholders. Private boards govern IOUs and the Oregon Public Utility Commission regulates them. The OPUC is an independent state agency with a three-member commission appointed by the Governor. They "ensure Oregon utility customers have access to safe, reliable and high-quality utility services at just and reasonable rates. This is done through robust and thorough analysis and independent decision-making conducted in an open and fair process."[12] OPUC approves IOUs' resource and investment decisions, rate schedules,[12] and other regulatory filings such as wildfire mitigation plans.

Consumer-owned utilities are not-for-profit entities. Locally elected boards or city councils govern and regulate COUs. COUs include municipal utilities, people's utility districts, and electric cooperatives. These are often referred to as munis, PUDs, and co-ops. There are differences between the various types of COUs in Oregon. Municipal utilities are owned and operated by city governments. PUDs are special purpose local government organizations and are not restricted by municipal boundaries. Electric cooperatives are independent, not-for-profit businesses owned by their consumer members.[18] [19] Oregon's Tribal co-op, the Umpqua Indian Utility Cooperative, is organized under Tribal sovereignty.[20] However, some features are common to all Oregon COUs, including: 1) COUs are operated on a non-profit basis; 2) are not subject to OPUC oversight on core utility decisions such as planning, procurement, and ratemaking; 3) COUs are democratically accountable to their customers or members; and 4) COUs are "preference customers" entitled to first access rights to power generated by BPA.

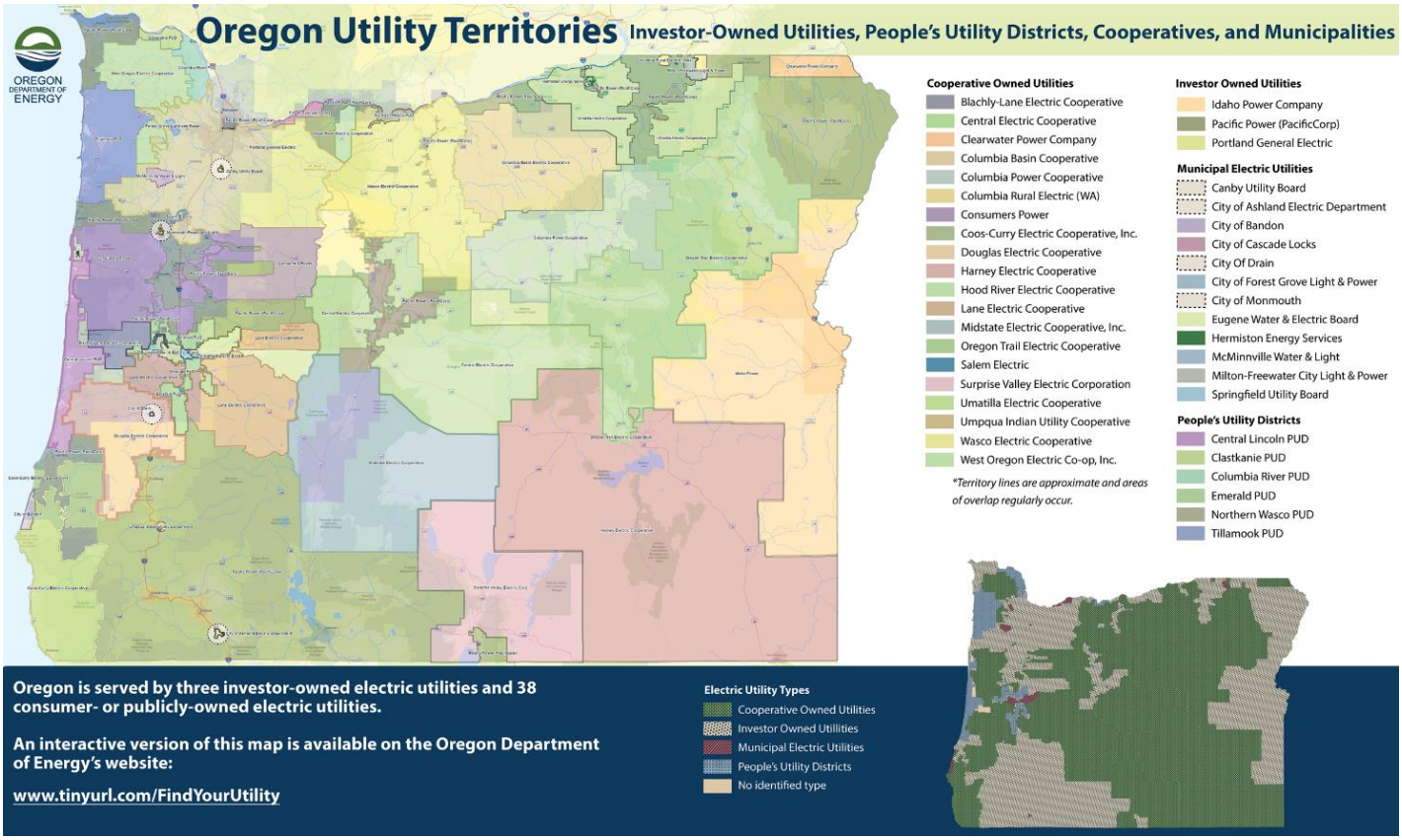
Oregon Utilities by the Numbers

As of the date of this report, three electric IOUs – Portland General Electric, PacifiCorp, and Idaho Power – operate in Oregon. Oregon also has 38 electric COUs, including 19 cooperatives, a Tribally owned cooperative, 12 municipal-owned utilities, and six People's Utility Districts. As of 2025, IOUs served 1,611,554 Oregon customers (74.3 percent of Oregonians) and accounted for 56.2 percent of

[i] Transmission refers to the movement of large volumes of high-voltage electricity across long distances, and is distinct from electrical distribution, which refers to the movement of lower voltage electricity shorter distances. Refer to Energy 101: Electricity Transmission for more on this subject.

Oregon electricity sales. Excluding the Umpqua Indian Utility Cooperative,[ii] COUs served ,558,573 customers (25.7 percent of Oregonians) and accounted for 39.1 percent of electricity sales – with electric service suppliers accounting for 4.7 percent of electricity sales to 62 customers.[5] ODOE provides a map of utility service territories online: Find Your Utility.

Figure 1: Electric Utility Service Territories in Oregon[6]



Shifting Service Territories

Electricity service territory was an especially active topic in Oregon in 2026. Idaho Power and Oregon Trail Electric Cooperative entered into agreements for OTEC to purchase and transfer ownership of those assets all of Idaho Power's Oregon service territory, and both utilities have filed with the OPUC to have the transaction approved. Idaho Power explained that the sale is intended to avoid complexities of operating in multiple jurisdictions, given that its Oregon territories represent a small portion of their business.[7] PacifiCorp announced and then cancelled non-binding negotiations to sell some distribution assets to OTEC in Wallowa County.[8] [9] Citing differing state policies across its six-state operations, PacifiCorp is also proposing to sell its Washington service area and certain Washington-based generation assets to Portland General Electric. PacifiCorp and PGE have filed with the OPUC to have the transfer approved by March 1, 2027.[10] Altogether, these developments reflect a shifting electric utility landscape and, in the case of the OTEC acquisitions, an expansion of COU service territories in Oregon.

[ii] Data for UIUC are not included in OPUC's Utility Statistics Book; based on DEQ GHG Reporting data for 2024, UIUC sold 23,172 MWh of electricity, or 0.00037% of the electricity sold in the state.[4]

Electric Utility History

Oregon's electric utilities have their roots in municipal and investor-owned utilities founded in the late 1880s. Through the 1920s, cities and investors formed municipal and private utilities in some areas across the state — particularly in urban areas. The expansion of electric service was accompanied by legislation to regulate utilities. The Oregon Public Utility Act of 1911, modeled on a similar 1907 Wisconsin statute, defined public utilities to include entities that delivered heat, light, or power. The 1911 Act authorized the Railroad Commission of Oregon to regulate non-municipal utilities. The 1911 Act included many features of the "regulatory compact" of today — in exchange for the opportunity for profits and monopoly rights within a service territory, the Act required IOUs to provide adequate and safe service to all customers at reasonable rates, and to submit to oversight from a state commission on ratemaking, service reliability, safety, and transparency.[11] Today, the Oregon Public Utility Commission oversees regulation of investor-owned electric utilities in Oregon.

In the 1930s, the state and federal government took action to expand the availability of electricity in rural areas. Oregon adopted a 1930 amendment to Oregon's Constitution for the establishment of people's utility districts[13] — governmental entities that can provide electric service beyond municipal boundaries. Congress passed the Rural Electrification Act of 1936 to provide low-interest financing and other support for rural electric cooperatives.[14] In the same year, Congress formed the Bonneville Power Administration. Congress required that BPA sell hydroelectric power on a preferential basis to rural customers and public entities.[15] These developments led to the formation of many of Oregon's PUD and cooperative COUs in the 1930s and '40s, and expansion of rural electrical service.[16] In 2001, the Cow Creek Band of Umpqua Tribe of Indians established the Umpqua Indian Utility Cooperative, the first formal Tribally owned electric co-op in the Northwest.[17]

Electric utilities often operate as monopoly electricity suppliers in their territories. This practice is based on the treatment of utilities as natural monopolies and has origins in the late 1800s and early 1900s. A natural monopoly is a type of business where high up-front investment costs make competition between companies inefficient.[1] As an example, imagine multiple utilities constructing and maintaining electricity lines to the same households and neighborhoods. This situation would be costly for consumers and offset advantages from the entities' competition. To avoid this outcome, Oregon law generally protects utilities' monopoly provision of electricity within geographical areas designated as their exclusive service territory. In turn, these utilities are subject to regulation to mitigate potential harm from monopoly power.



Lineworkers on a utility pole, circa 1953. Photo courtesy of Portland General Electric and Oregon Historical Society.

However, utilities' monopoly power over the electricity sector has decreased in several ways over time. The federal Public Utility Regulatory Policies Act of 1978 requires utilities to buy output from qualifying small renewable generators and cogeneration facilities at a utility's "avoided cost" rate.[iii] This policy is designed to support a fair and open market for independent electricity producers.[2] The OPUC has imposed procurement requirements to support competitive bidding for some IOU investments. Oregon created a direct access program in 1999. This program allows non-residential customers in IOU territories (typically large industrial users) to contract for power from third-party energy service providers.[3] Additionally, advancements in wind and solar — which are characterized by greater variability based on geography and weather conditions than electricity from conventional power plants — and other factors are making regional markets for electricity generation more important.[iv] While utilities' monopoly over generation has decreased, they retain monopolies on electricity distribution in their service territories.

Utility governance structures and regulatory oversight address the monopolistic power of electric utilities and the public interest in electricity. This is accomplished by the regulation of IOUs by the OPUC and through appointed or directly-elected COU governing boards. Because of the role played by OPUC and COU governing bodies in managing electric utilities' monopoly characteristics, public policy serves an important role in grid planning, operations, security, and affordability.

BPA and Preference Customers

The Bonneville Power Administration is a nonprofit federal power marketing administration created to market electric power from the Bonneville Dam on the Columbia River and to construct facilities necessary to transmit that power. BPA now markets electricity from all 31 federal hydroelectric facilities in the Pacific Northwest, known as the Federal Columbia River Power System, as well as one non-federal nuclear plant and several small non-federal resources. BPA also owns most of the region's high voltage transmission system.[21] [22]

Consistent with federal policies promoting widespread access to electricity service, federal law requires BPA to give preference to public entities and rural customers when BPA markets electric power.[23] Many COUs purchase all of their electricity from BPA, which is among the least expensive electricity in the country.[24] BPA retains its role in providing electricity to COUs as preference customers. BPA also provides benefits from the federal hydro system to rural and residential customers within IOU service territories through the Residential Exchange Program established by the Northwest Power Act of 1980.[25]

Electric System Management and Regulation

To deliver power to customers - and ensure there is enough of it — utilities plan and procure resources. These processes differ across utilities. In planning, IOUs develop integrated resource plans

[iii] The avoided cost rate is intended to represent the incremental cost to the electric utility of electric energy or capacity which, but for the purchase from the QF, the utility would have to generate itself or purchase from another source. For more information, refer to Energy 101: Public Utility Regulatory Policies Act of 1978 (PURPA).

[iv] For more information on electricity markets, refer to Energy 101: Electricity Day-Ahead Markets (2024).

(IRPs) as part of their regulated process. Some COUs also have formal planning processes and COUs enter into long-term contracts with BPA to procure power. In cases of COUs that procure all or most of their power from BPA, this contracting may cover their planning needs. In addition to utility-level planning, the Northwest Power and Conservation Council produces regional Power Plans. BPA is required to act in accordance with the regional Power Plan, and this plan informs utility actions across the region.

Resource procurement and ratemaking are further processes that OPUC oversees for IOUs and boards or city councils review for COUs. Resource procurement is the investment by utilities in generating and other infrastructure. The utility planning efforts described above guide resource procurement decisions. Utilities set rates for electricity that aim to recover the costs of resource procurement and utility operations from ratepayers. This ratemaking process establishes the price that Oregonians pay for electricity. The OPUC is presently investigating a multiyear ratemaking framework to provide more long-term, stable ratemaking for Oregon IOUs.

Beyond the core utility roles of planning, procurement, and ratemaking, Oregon policy regulates utility action in a few areas. Notably, HB 2021 (2021) provides clean energy targets applicable to the state's large IOUs and electric service suppliers. These targets require these entities to reduce their greenhouse gas emissions by 100 percent by 2040. Since 2007, Oregon's Renewable Portfolio Standard has promoted the use of new renewable resources like wind and solar over fossil fuel resources like coal and natural gas. It applies to both IOUs and COUs. The RPS requires each utility to obtain at least 5 percent of the electricity they provide to Oregonians from qualifying renewable resources. In 2026, utilities that historically have supplied over 3 percent of all electricity sales in Oregon must obtain at least 25 percent of their electricity from qualifying sources. The obligation of large IOUs increases to 50 percent by 2040. OPUC oversees IOU compliance obligations under the RPS while COU governing bodies oversee COU compliance with the RPS.

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Developing Community Benefit Frameworks to Support Clean Energy Goals



Community Benefits Frameworks, Plans, and Agreements are all slightly different in their approach. While each seeks to address the needs of host communities, they vary in their legal structures and implementation. In a report developed for the Oregon Department of Energy by Oregon State University capstone students, Community Benefits Frameworks[1] are described as:

> *A set of guidelines to use that sets the stage for plans or agreements at the project level. An umbrella term describing a range of commitments, less formal funds, and payments that a developer may provide to a community (Bingham[2] et al., 2025).*

A community benefits agreement differs from a plan or framework because it is a formal, legally binding contract negotiated between a developer and a community entity, such as a community-based coalition or municipal government (Bingham et al., 2025).[1]

Oregon State University developed the report "Community Benefits for Energy Projects in Oregon" for the Oregon Department of Energy as a landscape review to help the Department determine next steps from a recommended action in the Oregon Energy Strategy:

> *Develop a community benefits framework at the Oregon Department of Energy that can be used as appropriate across the agency to address outreach and engagement, workforce needs, prioritizing environmental justice communities, and equitable practices.*[3]
>
> Federal uncertainty highlights the need for a formalized state community benefits framework that provides meaningful involvement with Environmental Justice communities as defined in HB 4077.[4] [5] Community Benefits Plans were required in many Federal Inflation Reduction Act and Infrastructure Investment and Jobs Act grant-funded programs. Changes in federal policy [have] result[ed] in community benefits plans no longer being required or funded by the federal government.
>
> A community benefits framework would provide a foundation to continue supporting and funding community benefits through the state for energy-related programs and projects. It would provide an opportunity for ODOE-administered projects and programs to learn more about community needs and interests, and could direct benefits by utilizing metrics to develop an implementation plan. It could serve as a starting point for broader consideration of how to incorporate community benefits considerations in programs across the state. ODOE commits to applying the energy strategy's Equity and Justice Framework in developing and implementing the community benefits framework.[6]

ODOE maintains the importance of supporting communities who are disproportionately affected by climate change, communities with limited infrastructure, and rural and coastal communities in the clean energy transition. These groups can be supported and prioritized by using a community benefits approach.

It is important to know that Tribal Benefit Agreements have also been utilized in project development but are outside of the scope of this 101. TBAs differ in significant ways from Community Benefit Agreements (CBAs) by recognizing Tribes as sovereign nations, acknowledging the history and

contemporary contexts of how Tribal sovereigns exist in the U.S., and providing a broader scope for negotiation given the sovereign authority of Tribal nations.[7]

Oregon State University Capstone

ODOE collaborated with Oregon State University capstone students to better understand the landscape of community benefits. OSU and ODOE developed two questions to research:

1. What types of community benefits are currently being provided by clean energy projects and programs in Oregon, and what do these suggest about host community expectations?
2. What approaches have federal and state agencies outside of Oregon used to develop community benefits frameworks for clean energy development, and how do these frameworks vary in their design features and development processes?

OSU determined that a combination of case study analyses and interviews would best address these overarching questions. Students anticipated that the case studies methods would give high-level findings about processes and design, and the interviews would provide complementary details regarding community and developer experiences.[1]

Key Takeaways

Oregon State University's final report names five findings and five recommendations for ODOE to consider when developing a community benefits framework for clean energy development projects.

Findings

1. Frameworks range between standardization and flexibility: There were no standardized approaches to community benefits frameworks across jurisdictions (e.g., mandatory versus voluntary approaches, project size thresholds, participation requirements).
2. Communication and engagement matter: Early and sustained communication can help clarify expectations, build trust, and create opportunities for community input. However, the presence of engagement requirements does not necessarily result in meaningful participation.
3. Community capacity shapes participation: Some communities may lack the legal or technical expertise and political power needed to engage effectively in negotiating and implementing community benefits.
4. Accountability and oversight remain underdeveloped: While some jurisdictions employ or recommend accountability mechanisms, many frameworks lack clear enforcement authority and long-term monitoring responsibilities.
5. Economic and workforce benefits emerged as common priorities: Jurisdictions varied in the benefits recommended, though economic development and workforce and contracting equity emerged as the most common priorities across jurisdictions.

Recommendations

1. Balance standards and flexibility: Establish a baseline set of requirements for community benefits while maintaining sufficient flexibility to allow communities to shape benefits according to local needs and circumstances.

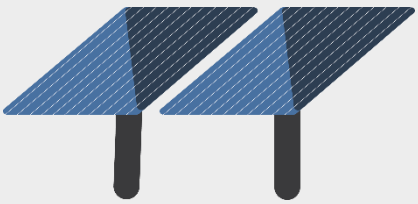
2. Require early and sustained engagement about community benefits: Set minimum requirements and expectations for how developers engage host communities.
3. Provide legal and technical assistance to communities: Create a funding or support mechanism to provide legal and technical assistance to communities negotiating benefits.
4. Strengthen accountability and oversight: Require an accountability and oversight process that includes community members in an oversight capacity.
5. Require a community needs assessment: Require a community needs assessment process prior to community benefits implementation.[1]

Community Benefit Considerations and Clean Energy Deployment

Governor Kotek issued Executive Order 25-29[8] in November 2025, focusing on reducing greenhouse gas emissions and advancing Oregon's clean energy future. Among other directives, the EO directed agencies to look at opportunities to accelerate deployment of clean electricity and transmission infrastructure. Agency responses to this directive identify the potential of including community benefits frameworks, plans, and agreements as a way to encourage meaningful engagement in siting processes and encourage benefits directly to the communities who are most affected by the clean energy transition.

For example, ODOE was directed to "evaluate and recommend actions to update siting and permitting processes to facilitate deployment of renewable energy, energy storage, and grid infrastructure needed to deliver reliable and affordable clean energy to Oregon consumers" (2.c.).[8] The report addresses this by noting, "Division staff will work with ODOE's Communications and Strategic Engagement Team staff to establish practices that could be employed during the NOI stage to better make people aware of the proposed project and encourage their review and comments."[9]

Benefits of Early Engagement



In November 2024, what would be the state's largest solar farm was approved on nearly 10,000 acres of active farmland in Morrow County. With almost 4 million solar panels that can produce up to 1,200 megawatts of power, there are potential negative economic impacts to the local economy with so many acres being removed from production. In addition to other state and local requirements, solar projects that propose to remove more than 12 acres of high-value farmland from production must also meet the requirements of a State Land Use Goal Exception. Specifically, they must justify multiple valid reasons for removing high value farmland from production, which is protected by Land Use Goal 3 (Agriculture Lands). The company seeking a site certificate to build the project, Pine Gate Renewables, collaborated with the community and local government to address the effects on the surrounding dryland wheat producers caused by the removal of nearly 10,000 acres from the local agricultural economy over the stated 40-year life of the facility. This was calculated at $1,179 per acre for a total of $11.08 million. The establishment of an agricultural mitigation fund in the amount of $11.08 million was one of the reasons accepted by EFSC to justify an exception to Goal 3. The fund will be administered by the county and is designed to support projects that improve the long-term viability and resilience of Morrow

County's wheat farms and supporting organizations.[10] Projects will be selected by a nine-person advisory committee of local agricultural interests and two members selected by EFSC to represent statewide or regional interests.

ODOE was also directed[8] to develop a framework for strategic transmission siting. A recommendation in this report is:

> **Framework[11] for community benefits.** The Oregon Energy Strategy recommends developing a community benefits framework at the Oregon Department of Energy that could inform how to incorporate community benefits in energy-related projects across the state. The first step in developing this framework has been undertaken in collaboration with Oregon State University. OSU conducted a case study analysis of eight jurisdictions outside of Oregon, five Oregon case studies, and conducted twelve interviews to map best practices in implementing community benefits frameworks, plans, and agreements. A future step could be to develop a model framework that could be utilized and adapted as needed to support communities in negotiating benefits around transmission development.

The Department of Land Conservation and Development was directed to develop a framework to accelerate energy deployment through Oregon's land use planning.[8] DLCD recommended normalizing community benefit conversations (2.h.)[12] noting:

> "Community benefit conversations should include all cities, rural communities, rural neighborhoods and properties, and Tribes that stand to be [affected]. Community benefits should provide mutual uplift. Having all the right entities in the discussion is the only way to ensure that everyone is heard and everyone's issues are addressed."

Conclusion

Currently, ODOE does not have a formally adopted community benefits framework, though the agency will continue to move forward in developing one per the Oregon Energy Strategy's Cross Cutting Action 12. As the state continues to explore ways to reduce barriers to and accelerate clean energy deployment, it will need to consider how to include community benefits frameworks, plans, and agreements utilizing best practices and examples from across the country.

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Energy Facility Siting and Permitting in Oregon



Siting means choosing where to put something, like a building or a project. It involves picking an optimal spot based on a number of considerations, going through applicable review and public engagement processes, and getting the needed permissions and rights for construction. This process ensures that the chosen location is suitable for the intended use and considers factors like the effects on the environment, Tribal Resources, nearby properties, land use and resource needs, accessibility, and post-approval regulatory compliance.

State Energy Facility Siting Overview

Oregon Energy Facility Siting Council

The Oregon Energy Facility Siting Council plays a central role in reviewing and approving many energy facilities in Oregon, including electricity generation, transmission, and natural gas pipelines. The Council's role is to ensure developers meet state laws and rules governing the siting of energy facilities. These regulations help ensure the state meets its energy needs while also protecting natural resources, Tribal and community interests, and public health. The framework used today was established in 1975, when the Oregon Legislature created EFSC and the Oregon Department of Energy.[1] EFSC is a separate government body from the department, composed of seven volunteer members who serve up to two four-year terms. Members are appointed by the Governor and confirmed by the state Senate.

EFSC has final decision-making authority over whether to authorize an energy facility that falls within state jurisdiction. The Oregon Department of Energy's Siting Division provides staff support to EFSC by coordinating review of proposed large energy facilities—conducting regulatory, technical, and environmental analyses, facilitating public and agency engagement, and advising on compliance with Oregon's siting standards.

Jurisdiction

Not all energy facilities fall within state jurisdiction. Depending on size and type, certain projects may instead be regulated at the federal level (for example, hydroelectric dams or liquefied natural gas terminals) or the county level. Many renewable energy projects fall within EFSC jurisdiction when they exceed statutory thresholds set in Oregon law, while others remain under local control or cross between federal and state jurisdiction. This means that energy development in Oregon can span several layers of governmental authority, and jurisdiction can vary significantly from project to project.

The centralized EFSC and Energy Facility Siting Division system was designed to bring consistency, transparency, and efficiency to decisions about where large-scale energy facilities can be built and how they should operate over time. At its core, Oregon's siting system ensures that major energy projects undergo a coordinated, statewide review, replacing what would otherwise be a patchwork of local and state permitting processes.

Federal and local jurisdiction can intersect with state jurisdiction. While these reviews can happen in tandem, this requires significant planning and coordination by the developer, and can affect the Siting

division's review and overall EFSC timeline. To date, these multijurisdictional reviews have only occurred on transmission line projects.

Many proposed renewable energy projects are not required to be reviewed by EFSC and are instead reviewed at the local government level. However, for these projects, ORS 469.320(8)(a) authorizes developers to opt in to EFSC or local governments to defer jurisdiction to EFSC. Opting in to the EFSC process may be advantageous for projects that span county boundaries, involve multiple local approvals, or benefit from the predictability of a single statewide review structure. To date, no developers have opted in to EFSC, and no local governments have deferred regulatory authority to EFSC.

EFSC Site Certificates

When EFSC issues a site certificate, it is a binding agreement authorizing a developer to construct and operate a facility under defined statutes, rules, and conditions. To receive a site certificate, a developer must demonstrate that the proposed facility meets Oregon's siting standards, which include requirements related to environmental protection, land use, public safety, and other resource considerations.

The siting process is deliberately thorough. Proposed projects are reviewed not only for their location and design, but also for how they will minimize, avoid, or mitigate potential negative outcomes. ODOE staff conduct the technical review and provide recommendations, while EFSC makes final decisions in public, quasi-judicial meetings. This structure helps ensure that decisions are based on a clear evidentiary record and that Tribal governments, members of the public, and local, state, and federal partners have meaningful opportunities to participate.

Over time, EFSC has reviewed a wide variety of energy facilities, including wind, solar, geothermal, hydro, natural gas, coal, and nuclear electrical generation, high-voltage transmission lines, pipelines, nuclear research reactors, and energy storage technologies. As Oregon's energy landscape continues to change, so too does the siting program. Recent applications increasingly incorporate battery storage, hybrid renewable systems,[i] and large transmission corridors needed to integrate new clean energy resources into the grid.

Tribal Coordination

To facilitate stronger Tribal government review of EFSC applications, the process includes providing notification letters to Tribal governments at the same time as applicable state agencies. The review processes also include cost reimbursement agreements to support time of Tribal staff.

Compliance

Beyond initial approval, EFSC also oversees ongoing compliance. Certificate holders are responsible for constructing, operating, and ultimately decommissioning facilities in accordance with their site certificate conditions, while ODOE staff monitor performance, conduct inspections, and review

[i] Hybrid renewable systems incorporate more than one type of renewable energy resource at one facility, such as the Nolin Hills Wind Power Project and the Biglow Canyon Wind Farm, which are approved for solar and wind electricity generation as well as battery storage.

amendment requests. This long-term oversight ensures that facilities continue to meet state standards throughout their operational life.

Today, Oregon's siting system is an important tool for balancing the state's need for clean, reliable, and affordable energy with its responsibility to protect communities and natural resources. The process provides predictability for developers, transparency for the public, and accountability throughout the lifetime of energy projects, supporting a statewide energy transition grounded in environmental stewardship and public trust.

Executive Order 25-29 Report on Siting and Permitting Large-Scale Electricity Infrastructure



Executive Order 25-29 directs Oregon agencies to streamline siting and permitting processes for clean energy projects, energy storage, and transmission infrastructure.[2] In response, the Oregon Department of Energy's Energy Facility Siting Division evaluated its statutory authorities, rules, and practices to identify opportunities for greater efficiency while maintaining strong protections for public health, communities, and natural resources.

ODOE conducted a comprehensive assessment of Oregon's major energy permitting pathways to identify what already works well, what streamlining efforts are already underway or planned for, and where additional opportunities exist to increase efficiency. The report included an evaluation of statutory requirements, administrative rules, agency practices, and recent project experiences to inform near-term streamlining opportunities and longer-term strategic improvements across state, local, and federal interfaces.

Oregon's centralized siting process provides several foundational efficiencies that help minimize the amount of time it takes to site a facility, including:

- A single statewide review for large energy facilities
- Established, uniform siting standards
- Consolidated public processes
- Coordinated technical reviews across multiple agencies

These elements can create clarity and predictability relative to many states with decentralized systems.

Despite structural strengths, there are several reasons that can increase the time and effort to move projects through siting and permitting:

- Incomplete application submittals
- Increasingly complex projects, especially hybrid and multi-component clean energy systems
- Insufficient early Tribal outreach and coordination by the project proponent, where early and consistent engagement can ensure Tribes have the opportunity to have a say in how best to protect their resources

- Increase in controversy and public opposition that extend timelines and require significant staff and legal resources
- Multi-jurisdictional reviews involving federal agencies, with specific timelines, requirements, and stage gates
- Insufficient staffing capacity across agencies as the volume and complexity of projects has grown
- A thorough process that requires an applicant to demonstrate compliance with standards and includes enough evidence to withstand legal challenges

ODOE's Siting Division is already taking steps to improve efficiency and transparency, including:

- Strengthening relationships, protocols, and requiring project proponents to seek earlier engagement with Tribes
- Updating rules to clarify requirements and reduce procedural ambiguity
- Expanding public engagement tools, including improved notices and virtual participation that aim to make it easier for the public to follow and participate in proceedings
- Adopting digital tools for filings, GIS analysis, and workflow management that will facilitate faster internal processes

These improvements provide measurable benefits today and support more substantial reforms ahead.

The report identifies additional actions that could meaningfully streamline processes, but may require statutory and rule changes and would require additional resources, and/or funding:

- Modernizing contested case procedures to reduce delay while ensuring fairness
- Leveraging artificial intelligence and automation to support document review, data processing, and analysis
- Increasing staffing within the ODOE Siting Division and reviewing agencies to address workload constraints
- Evaluating opportunities for more parallel or concurrent reviews across Tribal governments, agencies, and jurisdictions
- Strengthening interagency coordination on state jurisdictional reviews through shared schedules, joint guidance, and clearer expectations

Further information on past, current, and future streamlining ideas can be found in the report.

How is Jurisdiction Determined?

Determining which government entity has authority over a proposed energy facility is a foundational early step in the siting and permitting process. Jurisdiction is shaped by several factors, including the type and size of the facility, land ownership, and the defined authorities of Tribal, state, local, and federal governments. This can lead to significant project complexity, so understanding these distinctions helps applicants, communities, and agencies anticipate the appropriate review pathway(s) and coordinate across multiple permitting processes when needed.

Table 1: Renewable Energy Project Primary Permitting Jurisdictional Thresholds

Renewable Energy Type	County[ii]	County with HB 2329[3]	EFSC	Oregon Water Resources Commission	Oregon Department of State Lands	Federal Government
Solar Photovoltaic *High Value Farmland*	< = 100 acres	> 100 acres & < = 240 acres	> 240 acres	N/A	N/A	N/A
Solar PV *Arable Farmland*	< = 100 acres	> 100 acres & < = 1,280 acres	> 2,560 acres (4 sq. miles)	N/A	N/A	N/A
Solar PV *Other Land*	< = 320 acres	> 320 acres & < = 1,920 acres	> 3840 acres (6 sq. miles)	N/A	N/A	N/A
Onshore Wind	N/A	< = 100 Average MW Capacity	> 100 Average* MW Capacity or > 300 Peak or Nameplate** MW Capacity	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	> 3 Miles & < = 200 Offshore (BOEM)
Battery Storage	All projects	N/A	N/A	N/A	N/A	N/A
Hydroelectric	N/A	N/A	N/A	Projects in waters of the state. Oregon licensing process is done in coordination with FERC[4] both	N/A	Projects in waters of the U.S. (FERC)

[ii] ORS 469.320(8)(a) allows for developers to opt in to state jurisdiction or local governments to defer to state jurisdiction for wind, solar, battery energy storage and associated transmission lines.

				> and < 100 THP[5]		
Pumped Hydroelectric	N/A	N/A	N/A	Oregon licensing process is done in coordination with FERC	N/A	All projects (FERC)

*"Average" equals the peak or nameplate capacity divided by the amount listed in ORS 469.300(4).
**"Peak or Nameplate" equals the manufacturer maximum rated capacity of all combined wind turbines.

The type and size of a facility are the basis for determining projects that are subject to Energy Facility Siting Council jurisdiction. Oregon Revised Statute 469.300 defines the types of facilities that fall within EFSC jurisdiction and establishes thresholds that determine when a facility must obtain a site certificate before construction or operation.[6] When a project meets or exceeds EFSC thresholds, the Council becomes the primary permitting authority for the state. Thresholds apply to a range of project types, including thermal power plants, high-voltage transmission lines, natural gas pipelines, wind and solar energy facilities above certain capacities, geothermal developments, and nuclear projects. As indicated in the tables below, the legislature periodically updates these thresholds.

Table 2: Solar Photovoltaic Power Generation Facility State Jurisdictional Threshold Changes Over Time

Agricultural Capability	Pre-2013	After 2013 HB 2820[7]	After 2019 HB 2329	After 2023 HB 3179[8]
High Value Farmland	>100 Acres	>100 Acres	>160 Acres	>240 Acres
Predominantly cultivated land	>100 Acres	>100 Acres	>1,280 Acres (2 square miles)	>2,560 Acres (4 square miles)
Other land	>100 Acres	>320 Acres	>1,920 Acres (3 square miles)	>3,840 Acres (6 square miles)

Table 3: Wind Power Generation Facility State Jurisdictional Threshold Changes Over Time

Capacity	Pre-2019	After 2019 HB 2329	After 2025 HB 3874
Average MW Capacity	35	50	100
Peak or Nameplate MW Capacity	105	150	300
# of Turbines based on 2.5 MW Nameplate Capacity and 500 feet in height	42	60	120

Table 4: Geothermal Generation Facility State Jurisdictional Threshold Changes

Capacity	Pre-2019	After 2019 HB 2329
Average MW	35	50
Peak or Nameplate MW	38.85	55.5

Certain facilities may qualify for statutory exemptions from EFSC review, often based on design characteristics or efficiency standards. Exemptions change the permitting pathway but do not remove a project's obligation to comply with other applicable state and local laws. Recent rulemaking clarified exemption criteria, ensuring they are applied consistently while maintaining alignment with Oregon's energy and environmental goals. With passage of HB 4031 in 2026, developers of solar, wind, marine, and geothermal projects of any size can elect to have their projects reviewed at the county level until Dec. 31, 2028 if their project meets certain federal tax credit eligibility requirements.[9]

County Jurisdiction

If a proposed energy facility does not meet EFSC thresholds, primary permitting authority typically rests with the county where the project is located. Counties evaluate land use compatibility under local zoning ordinances and comprehensive plans that are consistent with Oregon's statewide land use planning goals and apply any local conditional use requirements. This approach allows smaller or less complex projects, such as distributed renewable energy facilities or transmission segments below jurisdictional thresholds, to be reviewed under a local framework tailored to community needs and resource considerations. This approach can lead to differences in siting processes between counties because of varied land use requirements and local ordinances.

ORS 469.320(8)(a) allows for developers to opt in to state jurisdiction or local governments to defer to state jurisdiction for wind, solar, battery energy storage and associated transmission lines.

Counties also play a critical role in all EFSC proceedings because they provide important data and expertise. EFSC relies on local land use information and ordinances to inform their decisions. County governing bodies serve as Special Advisory Groups for EFSC, providing recommendations and context related to local planning and community impacts throughout the siting process. Counties are compensated for their time and efforts through cost reimbursement agreements.

Land Ownership

Land ownership also affects which Tribal governments, federal, state, or local government agencies hold jurisdiction over siting and permitting requirements. Oregon's mix of Tribal, private, state, and federal lands shapes which authorities are involved in siting decisions and which processes apply.

- **Tribal trust and reservation lands** are subject to Tribal and federal authority. Oregon's nine federally recognized Tribes are sovereign governments, and the state does not have jurisdiction over any proposed energy facilities on these lands. Coordination for proposed projects near Tribal lands requires engagement early in the process to identify and protect cultural and natural resources.
- **Private lands** serve as the location for most EFSC-jurisdictional renewable energy and transmission projects.
- **State lands** may involve additional coordination with agencies authorized to manage the property, such as the Department of State Lands.
- **Federal lands** introduce federal permitting requirements, even when a project is otherwise consistent with state siting provisions.

What's that Acronym?

In siting processes, many of the entities and regulations are commonly referred to by their acronym.

EFSC: Energy Facility Siting Council

FERC: Federal Energy Regulatory Commission

LCDC: Land Conservation and Development Commission

NEPA: National Environmental Policy Act

CATEX: Categorical Exclusion Determination

EA/FONSI: Environmental Assessment/Finding of No Significant Impact

EIS: Environmental Impact Statement

BLM: Bureau of Land Management

USFS: U.S. Forest Service

More acronyms: EFSC-Acronyms-and-Abbreviations.pdf

Some types of energy facilities fall within exclusive or shared federal jurisdiction. In these cases, state authority may be limited or preempted. Federal jurisdiction commonly arises in the following situations:

- Interstate natural gas pipelines and certain hydroelectric projects, which are regulated by the Federal Energy Regulatory Commission (FERC).
- Transmission lines or renewable energy projects located on federal lands, which require federal environmental review under the National Environmental Policy Act (NEPA) and permitting from agencies such as the Bureau of Land Management (BLM) or the U.S. Forest Service. If these meet or exceed EFSC's statutory thresholds, they are also state jurisdictional.
- Facilities owned or operated by federal power authorities, such as the Bonneville Power Administration.

Where federal jurisdiction applies, Tribal governments and state and local governments may participate as cooperating agencies or issue supporting permits in the federal agency decision-making process. When multiple jurisdictions are involved, applicants must navigate

multi-layered review pathways. Thoughtful coordination among agencies can help reduce confusion and shorten approval timelines.

Siting Steps at County, State, and Federal Levels

County and state siting approval processes are similar in their purpose and goals. Decisions must be based solely on evidence submitted for the record and provide opportunities for public review and comment. EFSC members or county officials work to ensure that applicants meet certain requirements and adhere to the law. In general, as long as all applicable requirements are met, applicants receive permits.

Most utility-scale projects are proposed on lands zoned for agricultural use, which requires a conditional use review as part of the siting approval process. The Land Conservation and Development Commission (LCDC) establishes the base review requirements that must be applied. These include an exception to Statewide Planning Goal 3 (Agricultural Land) for solar projects that exceed specific acreage thresholds, which applies to both state and county jurisdictional projects.

Counties must meet state laws when approving energy projects. The processes by which they consider these approvals are determined by the Land Conservation and Development Commission's procedural and substantive requirements, in addition to any locally adopted substantive requirements. Further information on the county process and comparison of county review vs. EFSC review can be found in ODOE's Report on Siting and Permitting Large-Scale Electricity Infrastructure.

The EFSC process is a consolidated and uniform pathway for energy projects that is inclusive of all state agency permitting processes.

Major Phases in the EFSC Review Process

- **Notice of Intent:** an applicant gives notice that they plan on submitting an application for approval to build an energy facility.
  - **Public Comment Period and Public Informational Meeting:** Notice is provided to adjacent property owners and anyone signed up to receive project notices. The notice establishes a comment period and one or more information meetings scheduled in the vicinity of the proposed facility. These meetings serve to provide the public with general information about the facilities, including potential impacts to communities and resources as well as their opportunities to participate in the review process.
  - **Project Order:** ODOE prepares a project order establishing all state and local standards or criteria that must be met in the application.
- **Application:**
  - Developer submits application, including all information requirements as outlined in the Project Order.



- **Completeness Review:** ODOE conducts a completeness review of all application materials and requests additional materials as needed until application is deemed complete and ready for the next phase. Once an application is complete, ODOE provides public notice of its availability and holds one or more public information meetings in the vicinity of the project to help prepare them for the Draft Proposed Order step.
- **Draft Proposed Order:** ODOE creates a draft order for site certificate based on its assessment of the complete application. The order includes the assessment of the application, including findings of fact and how those facts do or do not meet the statutory and rule requirements for a facility, as well as conditions for each phase of the facility that the certificate must abide by.
    - Comment periods are provided for public input on the complete application and Draft Proposed Order. This provides an opportunity for the public to comment on the DPO within the context of siting statues and rules. Commenters who provide applicable comments at this phase are then eligible to participate at the contested case phase.
- **Proposed Order:** ODOE revises the Draft Proposed Order based on EFSC's discussion and deliberations, including input from the public to create a final proposed order for EFSC to consider.
- **Contested Case Proceeding:** A contested case provides an opportunity for those who properly raised an issue during the public comment period to challenge ODOE's recommendations to EFSC.
- **Final Order and Possible Site Certificate:** ODOE prepares a final order for EFSC to consider, and EFSC decides if an application will receive a site certificate.
- **Next Steps:**
    - Preconstruction: If a facility is granted a site certificate, the next step it enters into is preconstruction. At this phase, a project finalizes build plans, works to obtain any additional permits needed, and finalizes mitigation and revegetation plans among other tasks. The certificate holder works closely with siting staff to ensure that all preconstruction conditions are met before moving into the construction phase.
    - Construction: At this phase, a certificate holder has met all their preconstruction conditions and has received a verification of completion from ODOE. This allows the certificate holder to move into construction. This phase is closely monitored by ODOE to ensure certificate holders adhere to all construction conditions of their site certificate and includes monthly inspections and semi-annual reports.
    - Operations: Once a facility has completed all construction activities, it moves into operations. Operational facilities have a set of certificate conditions that must be met,

What are Contested Cases?

Contested cases are designed to have a third-party hearing officer further evaluate specific issues from ODOE's recommendation to EFSC. While it plays an important role in ensuring appropriate compliance, and further establishes the record on those issues that could be appealed to the Oregon Supreme Court, it adds additional time to the process.

To participate in a contested case a person or group must make an applicable comment during the open comment period at the Draft Proposed Order phase. Applicable comments are ones that are clearly tied to siting statute and rules and demonstrate how an application is not meeting a specific statute or rule.

and ODOE siting staff monitor the facility through site inspections, annual reporting from the certificate holder, and incident reporting from the certificate holder.

- Retirement: At the end of the life of a facility, it will move into the retirement phase. At this phase, a project must formally submit a retirement plan to EFSC for approval. This plan should outline how the facility will be decommissioned safely and render the space back to the usable condition it was in prior to the facility being built.

Federal Siting

When a federal agency develops a proposal to take a major federal action, such as move toward a siting approval, the law requires the applicants conduct a National Environmental Policy Act assessment. The environmental review under NEPA can involve three different levels of analysis: [10]

- **Categorical Exclusion (CATEX)** applies to routine actions that are in a predefined category of projects that have already been analyzed and that "normally do not significantly affect the quality of the human environment." A CATEX determination would exclude the need for additional NEPA analysis.
- **Environmental Assessment (EA)** is used to determine if a project could potentially have significant impacts and could result in a Finding of No Significant Impact (FONSI), which would preclude the need for a full Environmental Impact Statement or the project transition to an EIS.
- **Environmental Impact Statement (EIS)** is a comprehensive, detailed study mandatory for major federal actions that are known or expected to significantly affect the quality of the human environment. Some complex projects conduct this type of analysis without an EA ahead of time. An EIS provides an assessment on the specific potential effects and examines alternatives that would mitigate those negative effects.

Further information on Federal review steps can be found in ODOE's Report on Siting and Permitting Large-Scale Electricity Infrastructure.

Compliance

State of Oregon

ODOE's Siting Division is funded and authorized to ensure that all facilities remain in compliance with site certificate conditions throughout their entire lifecycle.[6] This includes oversight pursuant to ORS 469.310,[iii] which establishes the policy that energy projects, as defined, must be constructed and operated "in a manner consistent with protection of the public health and safety and in compliance with the energy policy and air, water, solid waste, land use and other environmental protection policies of this state."[6]

ODOE's Siting division works with certificate holders to review certificate conditions at each phase of project:

- Preconstruction
- Construction
- Operations

[iii] Oregon Revised Statutes

- Retirement/Decommissioning
- Incidents
- Violations
- Requests for Inspection

At each phase, division staff review conditions and confirm with the certificate holder that they are in compliance. If any condition is out of compliance, the Siting Division works with the certificate holder to come into compliance with the condition.

Further information about each phase can be found in the Report on Siting and Permitting Large Scale Electricity Infrastructure.

For projects authorized at the county level, counties are not explicitly obligated to ensure compliance with land use decisions. Ongoing compliance monitoring requires that counties have sufficient staffing and resources to undertake consistent, proactive compliance activities; most counties where utility scale energy facilities are constructed do not have sufficient resources.

Federal Level Compliance

The actions, terms, and conditions stated in the Record of Decision are enforceable by federal agencies and private parties. The ROD can be used to compel compliance with or execution of mitigation, monitoring, and enforcement measures identified therein.[11] Once the ROD has been issued, the Lead Agency Official for the NEPA review remains responsible for overseeing and demonstrating compliance with the ROD and all applicable requirements.

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Reliability, Firm Power, and Keeping the Lights On



We live in a time of rapid change in the electricity landscape. More extreme weather is becoming the norm. Large electricity users, including data centers, are significantly increasing electricity demand. Electricity networks are nearing their limits, requiring upgrades and expansion. Electrification, coal retirements, and a shift to clean resources are all changing how energy is used and generated. These rapid changes are creating concerns over electricity reliability or the ability to "keep the lights on." This has become a region-wide concern that affects Oregon as part of a broader interconnected regional electricity system.

Electricity system reliability refers to whether there is enough power to meet demand across all hours of the year. It this context, every resource has its strengths and limitations. Power planners need to understand the amount of power that can be available, with a high degree of certainty, to meet electricity demand every hour of the year. In the Northwest, the most difficult challenge lies in meeting demand during a prolonged cold or heat event that coincides with a low hydro year. As technologies evolve and the electricity system diversifies, it is important to consider not just how individual technologies operate, but how a portfolio of resources can supply electricity reliably.

Resource Adequacy, Firm Power, and Resource Sufficiency

The job of electricity system planners and operators is to make sure the system is ready to meet daily fluctuations in electricity demand, seasonal differences, and high stress events. This requires operating the electricity system in real time while planning over different time horizons (hours, days, months, years).

This is because the electricity system is dynamic, constantly adjusting to shifts in human behavior, economic activity, industrial processes, and changing weather. For example, on weekdays, household power demand rises as people wake up and start their days. It flattens as many people leave home for school and work — and it rises again in the late afternoon and evening, settling at a lower level while people sleep. Weekends look different. Industrial demand has a different daily and weekly profile, depending on the industry. Throughout the year, there is also variability. Fall and spring tend to have relatively mild temperatures and lower heating or cooling needs, while winter and summer experience more extreme highs and lows. Weather can also fluctuate from year to year, and extreme weather years can challenge electricity systems.

In system planning, the concept of "resource adequacy" refers to "having enough resources to provide electric service under a range of conditions or scenarios with a sufficient degree of reliability."[1] This means sizing the system for when electricity demand is expected to reach record highs, or peaks, while accounting for uncertainty in generation such as unplanned generator outages and variability in renewable generation.

Ensuring resources are available to generate enough electricity during critical periods is key. This is where sufficient and firm power comes in.[i] Firm power is defined as: "Power or power-producing

[i] This article focuses on firm power, as opposed to firm *loads* or firm *energy requirements*, which are detailed in the Northwest Power Planning and Conservation Act. Discussion of firm transfer capacity on transmission lines is also out of scope.

capacity, intended to be available at all times during the period covered by a guaranteed commitment to deliver, even under adverse conditions."[2] For many decades, the power system relied almost exclusively on firm technologies, such as natural gas, nuclear, geothermal, coal, and hydro. With an evolving resource mix that includes variable renewable resources, battery storage, virtual power plants, and other technologies, a key consideration for system planning is how to account for the contribution of each resource to system needs, and to identify the least-cost portfolio of resources that can work together to meet electricity needs reliably and in line with state policies.

An Evolving Electricity Mix

The resources that produce electricity in the region have evolved as technologies have advanced. Figure 1 is taken from the 2005 Northwest Regional Power and Conservation Plan. It provides a snapshot of resources powering the Northwest over time. In 1960, hydropower supplied virtually all the region's needs. Twenty years later, the resource mix included coal, hydro, natural gas, and nuclear. By then, the hydroelectric system was no longer sufficient to meet regional load growth. By 2003, more coal, natural gas plants, wind, and other resources were added to the mix.

Figure 1: Changing Pacific Northwest Sources Electricity Generation in the Northwest, 1960-2003[3]

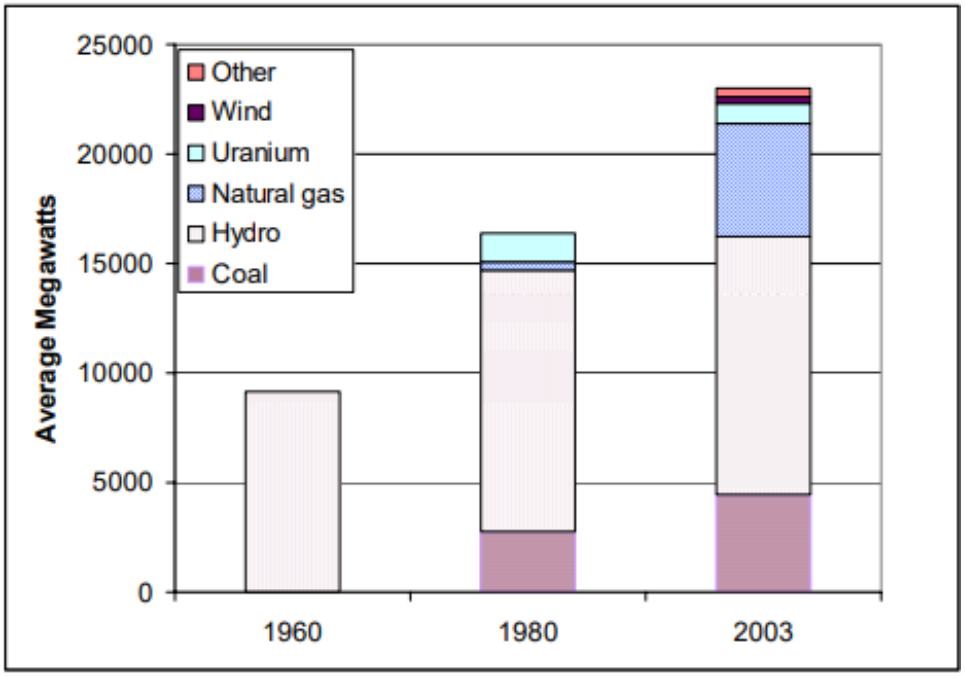
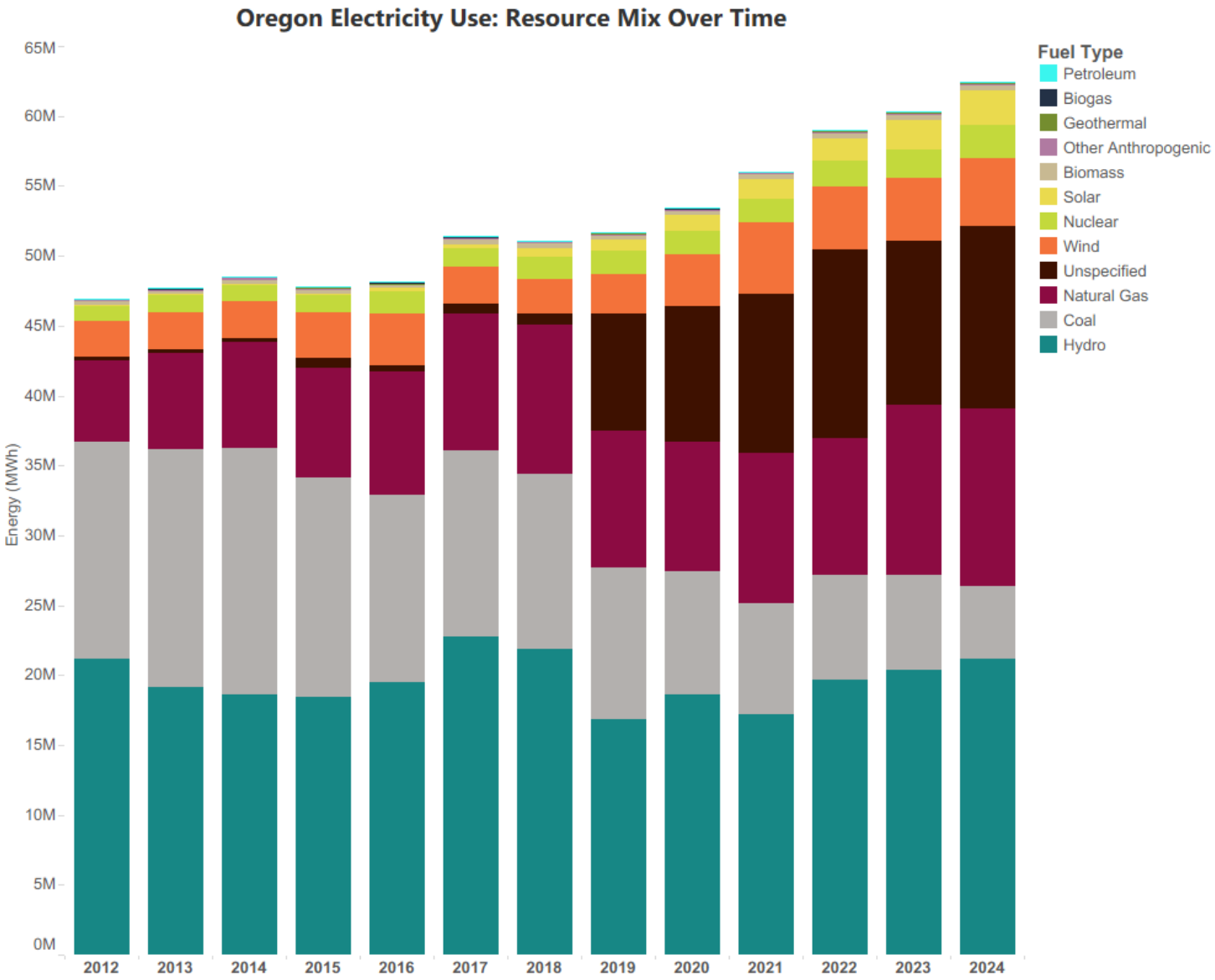


Figure 2 provides a closer look at how the electricity resource mix in Oregon has evolved in recent years. From 2012-2024, many Pacific Northwest states established policies that drove a shift in resources. Wind, solar, and natural gas power production increased, while coal power decreased. Hydropower production in Oregon and the Northwest fluctuates each year based on snowpack and precipitation, meaning the same system of dams can produce different amounts of electricity depending on water conditions.

Figure 2: Oregon's Electricity Resource Mix, 2015 - 2024[4]



An accounting change is responsible for the increase in "unspecified" power in 2019.[ii] Unspecified power is electricity purchased from the market where the specific source is not identified. It may come from a mix of resources across the West, including hydro, gas, coal, wind, and solar. Market transactions have been increasing over the past several years and are expected to further grow with the establishment of electricity day-ahead markets in the West.[iii] This is important, because electricity markets provide an efficient way to take advantage of resources located outside of Oregon – like solar power produced in the southwest and wind in states located to the East – and to export power from

[ii] ODOE does not have access to the data necessary to produce the resource mix for market purchases but is looking into options on how to report this information in the future.

[iii] Extended Day Ahead Market and Markets+.

Oregon when it is abundant. Natural gas and coal resources from outside the region also help meet demand, especially at times when the grid is stressed.[iv]

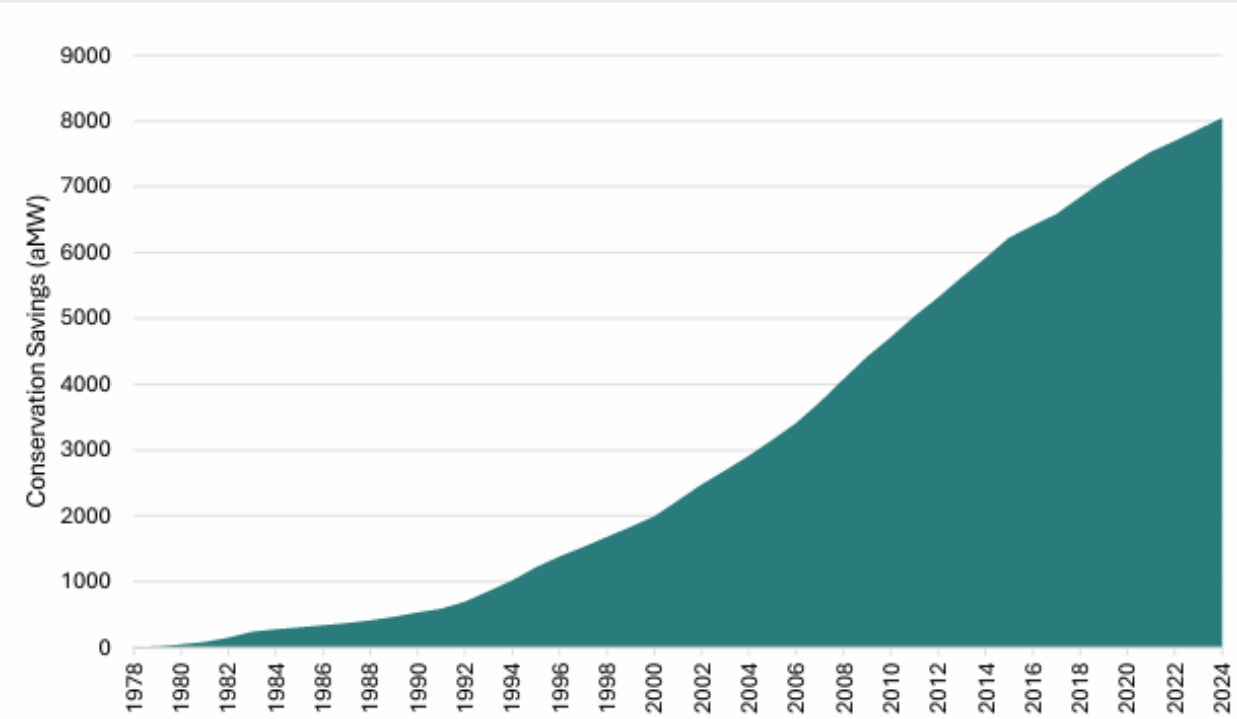
As these images illustrate, Oregon and the region have transitioned to a more diverse system over time. Regional forecasts are showing continued diversification with increasing shares of variable[v] renewable resources and batteries, driven by economics and state clean energy policies.

Distributed Resources

The portfolio of resources that can meet energy needs goes beyond utility-scale electricity generators. It also includes technologies and measures that can take place at community or building level. Reducing energy consumption (energy efficiency or conservation), shifting energy consumption in time (demand flexibility), and generating and storing power locally (such as through rooftop solar PV and batteries) are all examples of distributed resources. These resources can be deployed individually or bundled into virtual power plants, described further in this document.

Since the 1980s, energy efficiency or conservation has been recognized as a top priority to meet resource needs in the Northwest. The Northwest Power Act defines conservation as "any reduction in electric power consumption as a result of increases in the efficiency of energy use, production, or distribution."[5] Over the past 45 years, energy efficiency has reduced regional demand for electricity by more than 8 GW of power, more than 6.5 times the generating capacity of the Bonneville Dam.[6 7]

Figure 3: Northwest Conservation Savings Since 1978[8]



[iv] Under Senate Bill 1547, Oregon's investor-owned utilities must eliminate all coal-generated power from electricity sales to their customers in Oregon.

[v] Variable renewable resources are technologies whose electricity production levels vary – go up or down – with the availability of naturally occurring resources. Examples are wind and solar power.

Another important area of opportunity is shifting electricity consumption in time, often referred to as demand response or demand-side flexibility.[vi] Demand response is not a new concept. In Oregon and around the world, utilities have contracted with large electricity users to reduce operations when called on. This generally has occurred during rare instances of critically high peak demand or system stress.[9] More recently, smaller electricity users are also shifting their energy use. For example, price signals are encouraging customers to shift electricity use away from higher-cost peak periods to lower-cost off peak periods, or participating in active demand response or "virtual power plant" programs.

These programs deploy existing devices flexibly, and coordinate distributed resources such as rooftop solar PV panels, batteries, and other standby generation.[vii] A virtual power plant can orchestrate all of these resources in configurations that support power system reliability. For example, as of 2026, PGE operates a VPP portfolio that contains a mix of flexible load, solar, battery, and dispatchable standby generation across more than 230,000 participating customers. PGE has called on these resources hundreds of times over the past year, including during regional peak events.[10] PGE's 2023 IRP sets an aspirational goal to grow its VPP capacity to 25 percent of historic peak demand.[11]

Defining Reliability and Firmness for Critical Periods

The idea of "firmness" can be thought of as a guarantee of availability regardless of weather or economic conditions. If you make firm plans, it means that you've agreed with others to meet at a certain place and time to do something together and participate through the whole activity. Similarly, ensuring reliable, firm power requires planning to determine – with a high degree of certainty – which resources can be relied upon to be available, at a designated place, to reliably generate electricity for a duration of time.

Each resource has strengths and limitations in this regard. System planners have tools to help ensure that they can determine which resources they can count on, at what level, when, and for how long. The following is a summary of common challenges that different resources face.

Table 1. Common challenges and approaches for different resources

Resource	Common Challenge	How This is Addressed
Hydropower*	Snowpack can vary greatly year-to-year and between seasons; rain and other weather can also affect hydro availability.	Planning is conducted using a historical low water year, so that even in a low hydro year, reliability can be maintained.

[vi] Note that demand-side flexibility is often characterized as a broader concept than demand response, and reflects the many ways in which demand shifting can support power system needs such as peak demand, frequency regulation, and integrating variable renewable resources.

[vii] Dispatchable standby generation refers to customer-owned backup generators.

Natural gas	Natural gas generators can face fuel supply and delivery risks.	Historical data on forced outages, seasonal operational constraints, fuel supply challenges, and other issues affecting operations are accounted for in estimating plant availability.
Nuclear power	There is a need for periodic maintenance and refueling.	Historical performance and forced outage data are accounted for in estimating plant availability.
Geothermal	The heat of a geothermal source declines over time (steam field degradation) and there is a need for periodic maintenance.	Historical performance and forced outage data are accounted for in estimating plant availability, and power output is derated to account for steam field degradation.
Variable renewable resources (solar, wind)	Solar and wind power generate more or less electricity depending on how strongly the sun is shining and the wind is blowing.	Seasonal and hourly performance data are used to calculate the contribution these resources can be expected to make during critical events. Data can be calculated in geographic clusters to account for different climates and local needs.
Demand response	Incentives and technologies must be aligned to generate consistent and predictable responses in energy consumption.	Price signals, direct load control, and customer notifications are examples of tools used to generate reliable results. As with power plants, historical performance during tests and events are used to demonstrate the amount of demand reduction that can be counted on. Demand response might be bundled into different products demonstrating the ability to shift a certain amount of load, for a certain duration, with a certain frequency.
Batteries (Battery Energy Storage Systems or BESS)	Battery capacity and recharge times limit how and how long batteries can effectively operate.	The contribution of batteries to reliability is primarily determined by how long and how frequently they can discharge during periods of system need. They are often combined with other resources (including other batteries or variable renewable resources) or strategically located on the electricity system to provide more durable reliability support.

*Storage hydropower is the single largest firm resource in the Pacific Northwest.

While Table 1 addresses each resource separately, it is important to design a system where resources work together. Particularly as Oregon and much of the region transitions away from fossil resources and towards more variable renewables, the challenge is not substituting capacity 1:1, but rather investing in a resource portfolio with the capabilities needed to meet reliability needs.

How are Resource Contributions Measured?

There is no single methodology or metric used across the U.S. to measure the contribution of different resources to critical hours. However, a commonly used indicator is Effective Load Carrying Capability (ELCC). This is a measure of how a resource's expected performance during critical hours compares to what a "perfect resource" would provide.

For example, a solar facility might have a nameplate (or maximum) capacity of 100 MW, which it can generate at noon on a sunny, summer day. But it may only be able to provide 30 MW of power during other times, such as a critical summer peak period in the early evening. In that case, its ELCC would be 30 percent. So if planners are trying to ensure that there are enough resources to meet early evening peaks in July, they know that solar can be relied on to provide 30 MW to support that need.

The ELCC may also fall with increasing amounts of installed solar capacity. This is because ELCC is not just a measure of predicted performance, but of the potential of a resource to contribute to reliability needs. If the grid becomes saturated with solar, for example, adding more solar power will have diminishing returns in meeting resource adequacy needs. In this case, its ELCC will be reduced.

The ELCC of resources can range from very low to very high and differ across seasons. The Western Resource Adequacy Program[viii] has published a range of preliminary ELCCs for solar in the Northwest across winter and summer months.[12,13] The highest ELCC in the WRAP sub-region that covers Oregon is 78.5 percent in June, and the lowest is near-zero in November. This makes sense when considering the difference in how much sun the region sees in

Measuring Firmness: The Western Resource Adequacy Program

Starting in 2019, numerous utilities from across the West launched an effort to understand the resource adequacy problem in the region and identify possible solutions. The effort resulted in a region-wide approach for evaluating and addressing resource adequacy to support reliable electricity delivery. Participants in the program must demonstrate that they have enough resources to meet their share of regional capacity needs for the upcoming season – winter or summer. If they fall short, they have time to secure more resources in time for the season. The program includes an operational component allowing participants to pool and share resources during tight grid operating conditions.

In Oregon, Clatskanie PUD is a member of WRAP, along with BPA who serves utilities throughout Oregon and the region.

[viii] The Western Resource Adequacy Program is an initiative of the Western Power Pool to bring utilities together to support resource adequacy across the West.

winter versus summer.[ix] The ELCC is higher when solar is combined with batteries, because together solar and batteries can produce more power to support system needs.

Another example comes from PJM, an electricity market in the Midwest and Mid-Atlantic. PJM publishes ELCC ratings for resources participating in its three-year forward market, which is part of how the region plans ahead. Some of the highest ELCC values in that region for their 2027/2028 forward auction are for nuclear power (95 percent), demand response resources (92 percent), and diesel generators (92 percent).[14] [15] [x]

In the Pacific Northwest, the greatest risks that system planners need to prepare for are low hydro years combined with either a multi-day winter cold snap or summer heat dome. The winter event is particularly challenging because in winter, solar output is limited and there is a risk that there may also be low wind generation.

Average vs. Peak Loads

While the power system is built for critical periods, it operates at much lower levels most of the time. This means it is important to consider a mix of resources that can provide power day-to-day, and those that can provide predictable power from time-to-time. The difference between average and peak loads can be significant. In 2025, the Pacific Northwest had a winter peak of 35,700 MW,[16] while annual demand for the past few years has been around 22,000 average MW. That means that the system, on average, runs at a little over 60 percent of its peak need.

Example: the 2024 Cold Snap

In January 2024, the Northwest power system experienced a critical period demonstrating the challenge of securing resource adequacy during a low hydro year when temperatures dropped over several days. While people might best remember outages on the distribution system due to ice accumulation, the broader system faced its own challenge of maintaining adequate resources to meet high demand combined with energy shortfalls. During this window, several utilities across the region were operating under emergency protocols.[17] [18] [xi]

This example is useful to help understand the idea of firmness and resource adequacy. The graphic below shows the role that hydropower, natural gas, imported electricity, coal, wind, and solar played in meeting resource needs across the four northwestern states over the week of January 11 – January 17, 2024. Note that the resource mix in Oregon is different across utilities, and that this image does

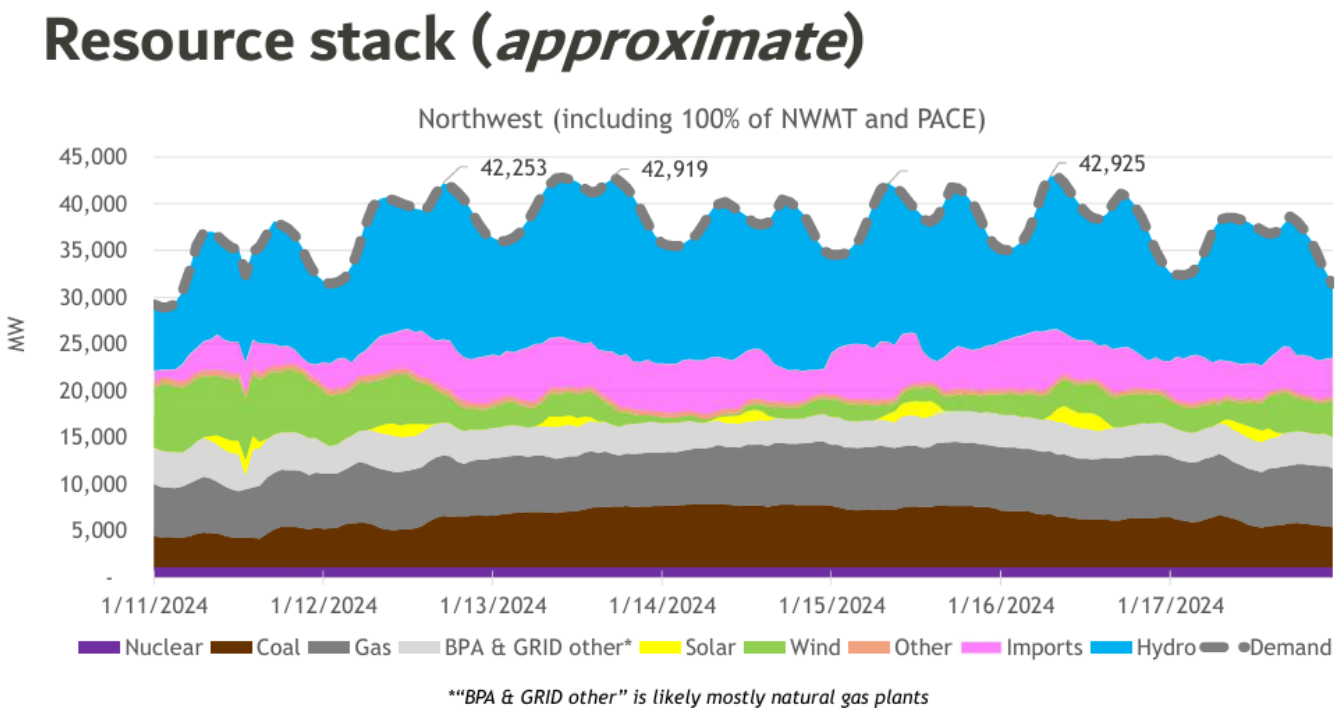
[ix] WRAP does not use a single definition of "firmness." Instead, it uses a resource accreditation framework that assigns each resource a Qualified Capacity Contribution (QCC)—the amount of dependable capacity that resource contributes toward meeting reliability requirements. QCC is calculated differently depending on the resource type.

[x] Note that diesel generators tend to be deployed rarely, and only during critical times on the power system. While they generate harmful air emissions, they can be turned on and off quickly and run for prolonged periods of time if needed.

[xi] The RC West Reliability Coordinator placed four entities on some level of emergency alert: Energy Emergency Alert Watch (EEA Watch), an EEA 1 (all resources in use or committed, energy deficiencies 1 expected), or an EEA 3 (balancing area is at risk of not meeting firm load and maintaining contingency reserves and is preparing for potential rotating power outages).

not represent the resource mix of any individual utility.[19] However, these resources all contributed to meeting Oregon's electricity needs over that week as part of an interconnected system.

Figure 4: Approximation of Northwest Power Generation Around the January 2024 Cold Snap[20]



While these were the resources providing power during this critical week, there was more to the story. Several other dynamics were occurring on the power system:

- The Northwest was a net importer of an average of 4,900 MW per hour during the five days from January 12 – January 16, 2024 across the AC intertie, one of the big transmission lines linking Oregon with California.[18] At the same time another key transmission line, the DC intertie from California to Oregon, was down for maintenance. This intertie has a transfer capability of 3,100 MW south to north. California and the desert Southwest had available capacity that could have been exported to Oregon had the intertie been available.[20]
- Demand response programs were deployed in several utility service territories and are not reflected here. While the region has historically relied on hydropower for flexibility, demand response can help capture the flexibility opportunity of temporarily reducing loads to reduce pressure on the power system.[21] One well-documented example is the Alberta Independent System Operator, who during the January cold snap sent an emergency alert to their customers to limit electricity use to essential needs only. Within three minutes, the system load dropped by approximately 170 MW.[22]
- An unexpected outage at the Jackson Prairie Natural Gas Storage Facility in Lewis County, WA created energy supply constraints on January 13, adding to reliability concerns over this critical period.[20] The loss of a compressor station in Canada further limited supply for a time.[23] Coordination between the natural gas and electricity sector is increasingly important to maintain reliability, highlighting the growing interdependence between them, particularly during critical periods.

- The hydropower system was managed flexibly, dispatching hydropower during the day as demand increased and relying on imported power at night to conserve water in reservoirs for the next day's peak period. Operations at the lower Columbia dams created additional storage, allowing upstream generation to increase without exceeding prescribed flows and producing hundreds of additional megawatts. Coordinated releases from Canadian reservoirs provided further support.[10]

As this example shows, resources in Oregon, the Northwest, and the broader region work together towards meeting reliability needs. Different generation technologies, transmission lines, and distributed resources all play a role in maintaining reliability. As a hydro-dependent region, the Northwest must plan for low hydro years, while seeking a complementary portfolio of resources to deliver needed electricity at all times.

Conclusion

The electricity landscape is rapidly changing. There is a need to build new resources to supply steeply rising electricity demand, respond to extreme weather events, and to meet Oregon's clean energy goals. It is important to consider the full portfolio of resources that can meet the state's policy objectives reliably and at least cost. The Oregon Energy Strategy finds that the least cost path builds on existing resources, including hydro and natural gas, incorporates low carbon generating technologies like wind, solar, and batteries, and mobilizes demand-side resources including energy efficiency, and demand flexibility.[24] Emerging technologies like enhanced geothermal and long duration storage can also play an important role, as they mature over time. Imported energy plays an important role, and allows Oregon to take advantage of abundant resources in the Southwest and Intermountain West. System planners have the tools to calculate the contribution of these resources to the most critical system needs, and how these resources can work together to maintain reliability throughout the year.

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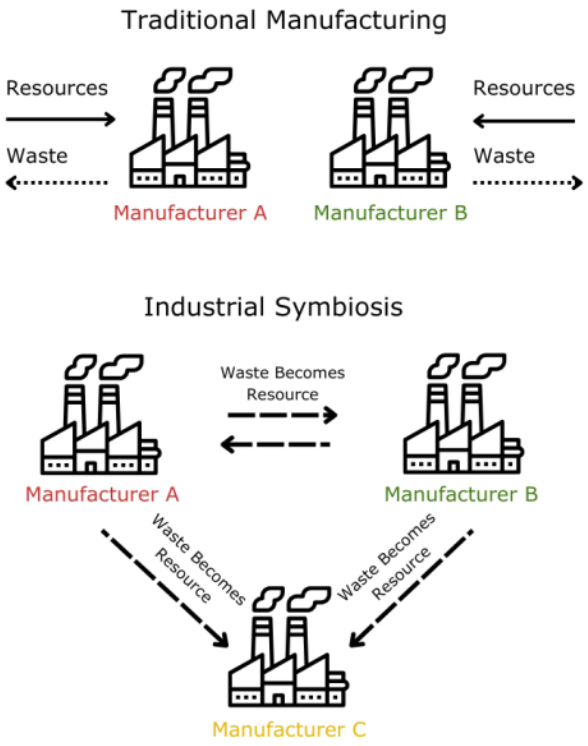
Industrial Symbiosis

Industrial symbiosis is emerging as an opportunity within the broader circular economy framework to reduce energy consumption, enhance resource efficiency, and strengthen local and regional economies. As Oregon advances climate and economic development goals, industrial symbiosis offers a practical pathway to support economic competitiveness and the state's energy goals. While industrial symbiosis can be applied to many different sectors and waste streams, this 101 will focus specifically on the energy-related implications.

Industrial Symbiosis and Circular Economies

A circular economy is an economic system designed to minimize waste and keep materials in use by reusing, repairing, and recycling rather than discarding. Unlike a traditional linear economy, where goods are produced, used, and discarded, a circular approach reduces the need for new raw materials and the energy required to produce them. This approach lowers overall energy use through processes that reduce extraction and manufacturing, recover waste heat and biogas, and encourage shared resource infrastructure as energy and water systems.

Figure 1: Comparison of Inputs and Outputs for Traditional v. Industrial Symbiosis



Industrial symbiosis is one of the most practical ways circular economy principles show up in a real-world industrial setting. Industrial symbiosis is the practice of harvesting waste streams (typically energy, water, or materials) from one industry to be repurposed as a valuable resource for another industry.[1] The increase in industrialization has led to an increase in greenhouse gases, resulting in adverse consequences for the environment and human health.[2] Industrial symbiosis is one way that Oregon can continue to grow in a way that allows for the reduction of greenhouse gases without jeopardizing its economic growth.

Typically, industrial symbiosis projects happen when businesses within industrial areas, ports, or business parks are located close enough to share physical "waste" streams. Common types of exchanges include:

- Waste heat from one facility supplying heat or steam to another
- Byproducts or waste materials becoming input for nearby businesses
- Water treatment systems capturing biogas to generate power for the grid

Examples of industrial symbiosis exist throughout the world. One of the most well-known is the Kalundborg Symbiosis in Denmark, where businesses and public utilities exchange energy, water,

steam, and materials through an elaborate integrated network. Kalundborg Symbiosis was the world's first network like this, developed in 1972, and is now estimated to be saving businesses and utilities in the network over 24 million euros, and reducing over 635,000 tons of carbon dioxide and 100 gigawatt hours of energy per year (Per Møller, Kalundborg Symbiosis, Personal Communication, [September 23], 2025).

There are emerging examples of industrial symbiosis in the Pacific Northwest. In Washington, Chomp[i] on Vashon Island is delivering renewable natural gas to a local food manufacturing plant and capturing waste heat from the facility to manufacture certified organic dry fertilizer.[3] In Oregon, the Port of Morrow is engaging in the beginning stages of industrial symbiosis with feasibility planning being completed, with support from the Oregon Legislature and industry partners, like Lamb Weston, Oregon Potato Company, and Boardman Foods.[4]



Impact Bioenergy (now Chomp) in Washington State, featuring a renewable natural gas balloon[3]

Benefits

Industrial symbiosis offers a wide range of benefits, including fewer primary materials used, a reduction in CO2 and other greenhouse gas emissions, energy and water savings, and economic growth. For businesses, it can reduce both energy and operating costs by improving operational efficiency and lowering long-term costs. By sharing energy, water, and material resources, industry can minimize their reliance on volatile markets and potentially limit exposure to supply chain disruption. Participation in an industrial symbiosis network could also open access to infrastructure that would be too expensive for a single company to build or maintain on its own. In addition, recovering value from byproducts that previously required disposal can create new revenue streams and reduce waste. These combined benefits help businesses become more resilient and competitive, especially in sectors with energy-intensive operations, such as food processing or manufacturing.

Communities have the potential to experience gains when industries collaborate through symbiosis, as these networks naturally encourage economic vitality, reduce pollution, and make efficient use of existing infrastructure. For urban communities, symbiosis can lead to more efficient land use, lower

[i] Impact Bioenergy was rebranded as Chomp in 2023.

emissions, and job creation in high-paying, in-demand sectors, like green energy, green building design, and sustainable manufacturing. For rural communities, the potential advantages can be even more pronounced. Rural regions, particularly in Oregon, often rely on a small number of large employers, like agricultural processors, timber mills, fisheries, or manufacturing plants. Industrial symbiosis can help stabilize these anchor industries through cost savings and shared services and make communities more attractive for new business investment.

At a systems scale, industrial symbiosis can help reduce total energy demand and make energy use more efficient. By capturing and reusing waste heat or developing biogas, symbiosis networks reduce the need for new or peak energy generation. Symbiosis has the potential to enhance grid stability because shared infrastructure, district loops, or co-located renewable energy projects can smooth out variability and decrease reliance on fossil fuel systems. In rural areas, where grid constraints or reliability concerns are common, these shared systems can be particularly valuable.

Barriers

Key barriers to adoption of industrial symbiosis projects can be categorized into five main themes: cost, technology, knowledge, geography, and regulatory uncertainty.

Cost

High upfront costs remain one of the most significant challenges to expanding industrial symbiosis in Oregon. Many symbiosis projects require upfront capital investments in shared infrastructure, such as heat recovery systems, pipelines, and upgrades to treatment facilities and other processing equipment that exceed what individual businesses can finance on their own.[5] Even when long-term cost savings are clear, the payback period can be too long for smaller or cash-constrained businesses, especially in communities with limited access to financing tools (like rural or historically marginalized communities). Without stable funding programs, grants, or incentives, communities and firms often struggle to move past the concept stage into full implementation. This makes sustained public funding or private investment and predictable financing mechanisms essential for implementation of industrial symbiosis systems statewide.

Technology

Sites participating in industrial symbiosis often require specialized equipment, processes, and technical expertise. For example: capturing and sharing waste heat, shared steam loops, or biomass processing, along with engineering expertise to develop and integrate the new systems and processes into processes and existing infrastructure. Aging infrastructure may not be compatible with the needed modern technologies without substantial retrofits. Small and rural communities often lack technical staff or the funding to hire consultants to conduct feasibility studies. Without technical assistance and feasibility studies, projects struggle to move beyond planning.

Knowledge

One of most commonly cited barriers to industrial symbiosis is a lack of understanding or awareness of the concept.[6] Most businesses are unfamiliar with the concept, unsure about how to identify resource-sharing opportunities, or concerned about privacy and sharing of proprietary information with local competitors. Communities may not know how to evaluate waste streams or structure

agreements that protect public and private interests. Building knowledge through study tours, case studies in the region, and technical facilitation would help partners see practical opportunities.

Geography

Geography is incredibly important in determining whether symbiosis is feasible, especially in a state a large as Oregon. Industrial symbiosis is easier to achieve in dense corridors where businesses are located close together, allowing for a short distance transport of heat, water, or materials. This is why industrial symbiosis is best suited for initial implementation at locations like industrial parks and ports. (Thomas Helsgaun, GreenLab, Personal Communication, [September 25, 2025]

Regulatory Uncertainty



Regulatory uncertainty is another major obstacle, particularly around permitting for wastewater reuse, air emissions, and bioproduct transports.[7] Businesses often express concerns around navigating overlapping federal, state, and local requirements, which can create delays and increase project costs. Clarifying regulations, improving permitting consistency, and creating guidance for symbiosis exchanges can significantly reduce these barriers and build alignment from potential industry partners.

Oregon Policies

With the passage of House Bill 4086 in 2026, the state expanded its policy framework around industrial symbiosis by directing Business Oregon to develop a statewide Industrial Symbiosis Roadmap by May 2027. The Roadmap is required to identify and describe industrial symbiosis opportunities throughout Oregon, examine best practices and emerging technologies, analyze barriers to adoption such as infrastructure gaps or permitting constraints, and recommend key performance indicators to track statewide progress. This is the most comprehensive policy effort Oregon has taken to date on industrial symbiosis.

The Legislature's directive has shifted and expanded Business Oregon's work by formalizing its role as a convener and technical facilitator for industrial symbiosis projects. In addition to developing the roadmap, the agency is funding targeted technical assistance to four early-stage efforts: COR Healthy Communities (Portland), Clatsop County, Klamath Falls Community, and the Port of Morrow. Collectively, this policy and the programmatic changes position Business Oregon as a central hub for advancing voluntary industrial symbiosis initiatives, while also helping local communities and businesses build practical pathways toward shared economic and environmental benefits. Business Oregon also applied for and received a U.S. Department of Energy grant to support industrial symbiosis pilot projects; however, the grant award is under further review by the federal government.

Conclusion

Industrial symbiosis represents a practical and scalable strategy for advancing Oregon's economic, environmental, and energy objectives simultaneously. By linking businesses through shared resource systems and transforming waste streams into inputs, industrial symbiosis can reduce energy consumption, strengthen local resilience and create new opportunities in rural and urban economies. As Oregon continues to pursue its climate and economic development goals, these integrated

approaches offer a pathway to support industry growth while lowering emissions and reducing long-term infrastructure and operating costs.

Oregon's recent legislative action signals a commitment to exploring expanded opportunities statewide. The development of a comprehensive Industrial Symbiosis Roadmap paired with technical assistance to early pilot communities positions the state to help communities move from isolated projects to coordinated systems-level strategies. With growing interest from industry, communities, and now the Legislature, Oregon is poised to build a more circular, efficient, and resilient industrial economy that supports local prosperity and long-term goals.

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Solar Panel and Wind Turbine Recycling

Lower operating costs and policies supporting clean energy development are driving large-scale solar and wind generation developments in Oregon.[1] With this expansion, there are questions about what happens to these technologies when they reach the end of their useful lives.

All forms of energy production require the extraction of raw materials and generate waste streams. Waste from energy production generally falls into two categories. The first includes emissions produced during fuel combustion, which can contain pollutants such as greenhouse gases, fine particulate matter, carbon monoxide, and nitrogen oxides. These waste streams can contribute to climate change, air and water pollution, and can degrade human health.[2] The second includes waste related to infrastructure materials used throughout the lifecycle of the technology, including raw material extraction, manufacturing of energy-generation technologies, operational and maintenance activities (excluding fuels), and end-of-life disposal. This waste can contribute substantially to landfill volumes and without proper management, may affect land and water quality.

While wind and solar technologies do not generate combustion waste, they are consumables that will need to be replaced over the lifetime of a generation facility. This is comparable to hydroelectric, coal, nuclear, and natural gas facilities, which also need to replace turbines and other mechanical components as the equipment wears out.

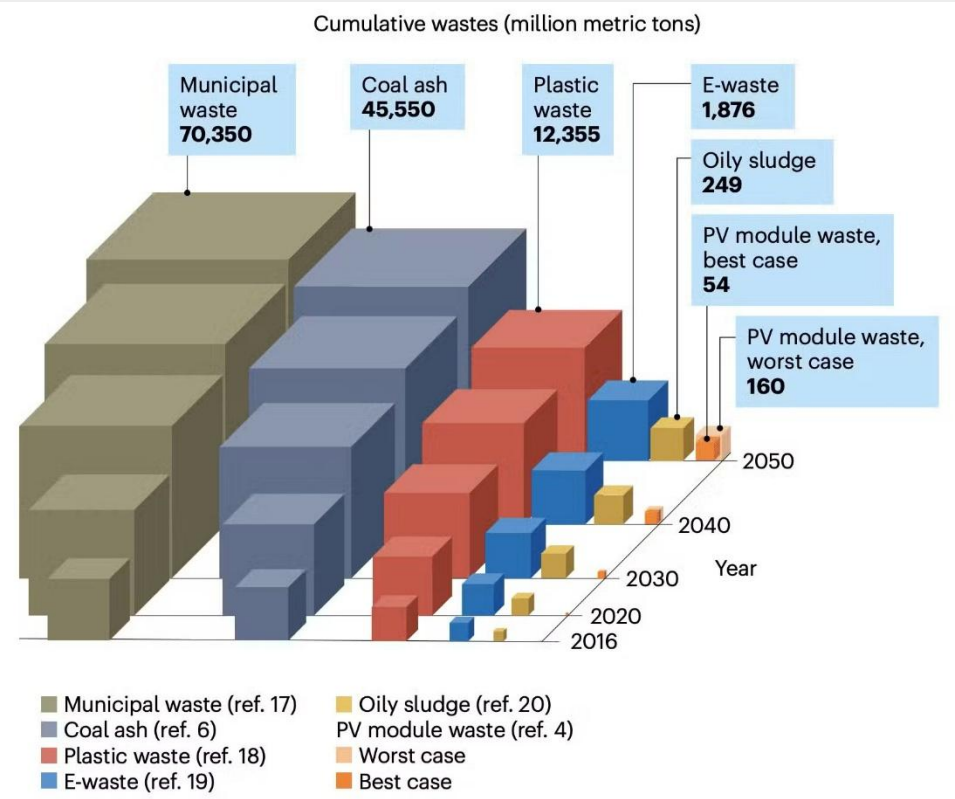
As with other energy technologies, there are opportunities to recycle or repurpose waste streams generated by wind turbines and solar panels. Although waste is produced across all components of these facilities — including roads, fencing, transmission lines, collector systems, substations, inverters, and transformers — this section focuses specifically on the waste associated with wind turbine blades and solar panels.

Waste Production

Wind turbine blades and solar panels can become waste when they reach the end of their useful lives, but waste from electricity generation is not exclusive to these technologies. For example, coal generation, which was the predominant type of electricity generation in the U.S. from 1950 to 2015, produces large amounts of waste from mining and processing as well as combustion at the generating site.[3]

In 2015, coal plant byproducts made up the second-largest waste stream in the United States after household waste, producing roughly 89 kilograms of waste for every megawatt-hour of electricity generated.[4] While it's important to find ways to reduce all waste streams, it's also important to bear in mind the relative size and toxicity when prioritizing waste reduction efforts.

Figure 1: Cumulative Waste Produced per Year by Waste Producer Type[5]



Solar and Wind Development Trends

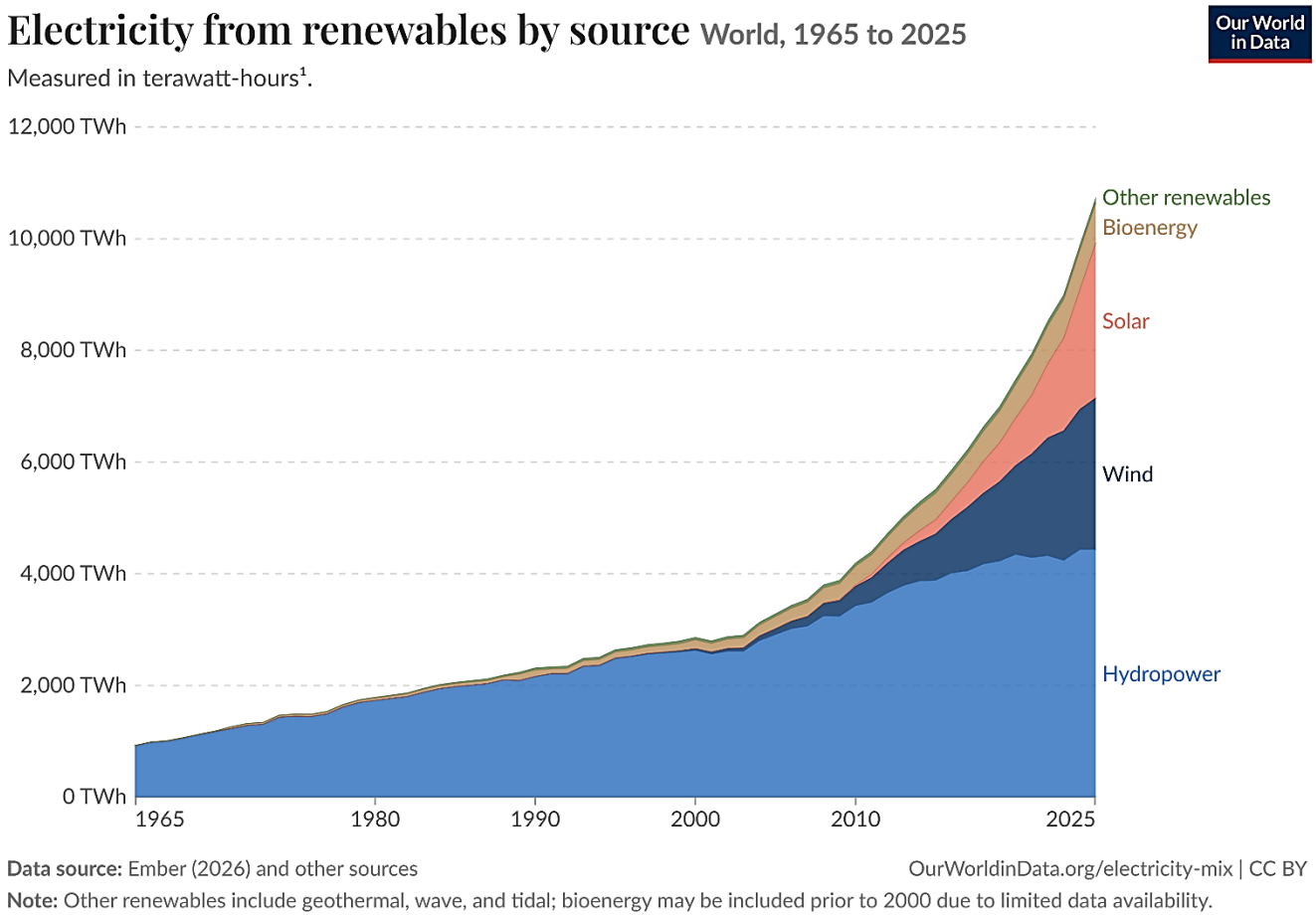
The rapid expansion of renewable energy is reshaping Oregon's electricity system, driven by policy mandates, growing customer demand for clean power, and declining technology costs. As the impacts of climate change intensify, energy providers are increasingly shifting toward renewable electricity. This transition is motivated by several factors:

(1) The declining cost of renewable technologies—solar is now often the least-cost option for adding new generation, and renewable energy technologies overall are typically more cost-effective and faster to deploy than traditional facilities.[6] As a result, global wind and solar generation has expanded rapidly, increasing from 378.20 terawatt-hours in 2010 to 5,491.78 TWh in 2025.[7]

(2) State policies such as Oregon House Bill 2021 (2021), which directs the state's large investor-owned utilities (IOUs) and electricity service suppliers (ESSs) to decarbonize their retail electricity sales by 2040,[8] and the state's Renewable Portfolio Standard.[9]

(3) Strong customer demand for clean energy, reflected in high voluntary renewable energy program enrollment by PGE and Pacific Power customers.[10]

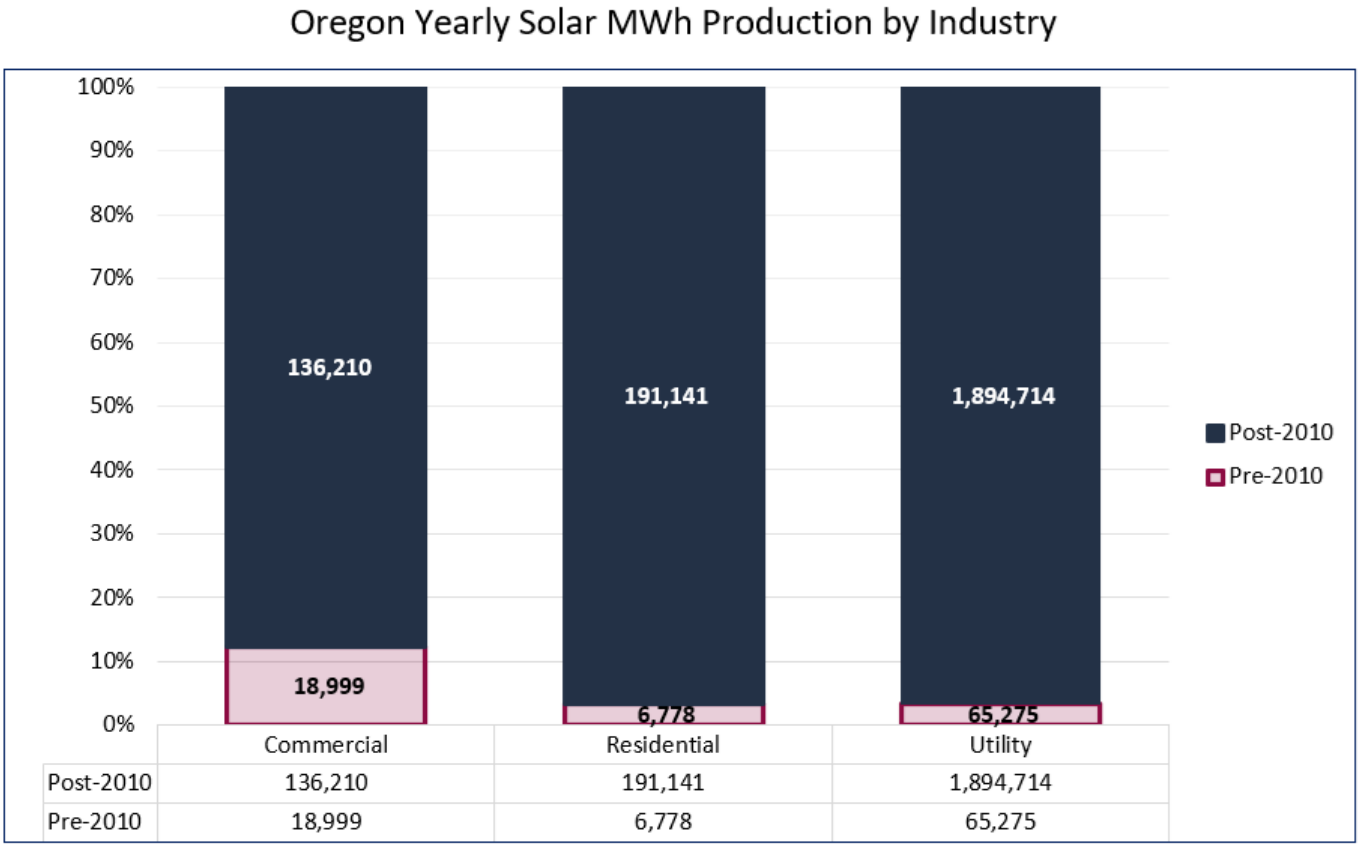
Figure 2: Renewable Electricity Generation Worldwide by Year[11]



1. Watt-hour A watt-hour is the energy one watt of power delivers for one hour. Since one watt equals one joule per second, a watt-hour equals 3600 joules of energy.
Metric prefixes are used for multiples of the unit, usually:
- kilowatt-hours (kWh), or a thousand watt-hours;
- Megawatt-hours (MWh), or a million watt-hours;
- Gigawatt-hours (GWh), or a billion watt-hours;
- Terawatt-hours (TWh), or a trillion watt-hours.

In Oregon, solar generation rose from 6,400 MWh in 2012 to 2,001,400 MWh in 2024. Wind generation increased from 6.3 million MWh in 2012 to 9.5 million MWh in 2024.[12] The International Renewable Energy Agency estimates that more than 90 percent of solar modules installed before 2010 will reach end-of-life within the next decade.[13] Oregon has approximately 24 MW of solar installations that were installed before 2010.[14]

Figure 3: Oregon Solar Production by Year[15]



	Commercial	Residential	Utility
Post-2010	136,210	191,141	1,894,714
Pre-2010	18,999	6,778	65,275

By contrast, wind turbines may not follow a comparable end-of-life timeline. Although no utility-scale wind or solar projects in the state have yet reached the end of their operational life, ongoing repowering and routine maintenance activities continue to generate waste streams.

For example, according to its application for a site certificate, the permitted 1,200-MW Sunstone Solar Facility is expected to generate a substantial amount of replacement materials over its lifespan. When constructed, this facility is expected to include approximately 3,937,536 solar modules. Each year, an estimated 5,118 solar modules would be replaced, resulting in roughly 204,720 modules requiring on-site storage over the life of the facility. These routine module replacements are projected to produce about 550 cubic yards of waste per month or a total of 198,000 cubic yards throughout the facility's anticipated 30-year operational period.[16] That amount of waste would fill approximately 6,600 standard 30-yard roll-off dumpsters.

Oregon currently has 50 utility-scale wind farms with a combined operating capacity of 4,181 MW.[17] Modern wind turbines generate an estimated 10 to 15 tons of blade waste per megawatt over their operational lifespan.[18] Recycling or repurposing blades from existing wind farms as they are decommissioned or repowered could divert a cumulative total of between 41,810 and 62,715 tons of waste from landfills. According to one estimate, the cumulative end-of-life wind turbine blade waste in the United States is projected to exceed 2.2 million tons by 2050.[19]

Repowering an energy facility involves retrofitting, upgrading, or replacing components such as solar panels or turbine blades and nacelles to more modern and efficient equipment. This process can extend the facility's operational lifespan and enhance its overall energy generation capacity. To date, at least six wind facilities, or portions of wind facilities in Oregon, have been repowered — extending their operational life and increasing their generating capacity.

Solar and Wind Technology Components and Recycling Options

Effective planning for end-of-life management of solar and wind technologies requires detailed insight into their component materials, the limitations of existing recycling pathways, and the advancement of new recovery methods that can keep valuable resources in use across the renewable energy sector. Over the past century, the ability to harness energy from natural resources has advanced significantly, supported by innovations in composite materials and manufacturing that have made renewable energy technologies more cost-effective and widely deployed. Continued progress in material recovery strengthens the potential for industrial symbiosis across the energy and manufacturing sectors and supports the broader development of circular economies, where waste streams from one industry can be used by other industries. Learn more in the Industrial Symbiosis Energy 101.

Wind turbines rely on a mix of recyclable steel, composite materials, and valuable critical minerals, but their blades remain the primary recycling challenge due to their complex construction and large size. Modern wind turbine blades are composed of steel, glass fibers, carbon fibers, basalt fibers, and various polymers.[20] Other key materials used in the steel and generator components include critical minerals such as neodymium, dysprosium, praseodymium, electrical steel, nickel, and cobalt.[21] Many of these critical minerals can be extracted from recycling generator magnets, transformers, and structural components. The gearbox and shaft are typically made of recyclable steel, while the blades—constructed from glass and carbon fiber thermosets, which are polymers that permanently harden when cured and cannot be remelted—pose greater recycling challenges due to their permanent curing process and large size, which complicates removal and transport.

Figure 4: Diagram of Geared Wind Turbine[21]

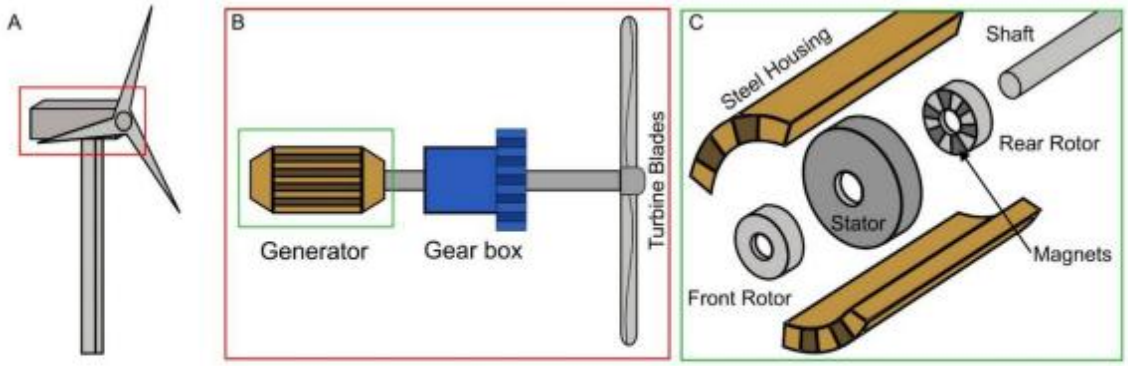


Figure 12. Structure of a typical wind turbine generator including A) wind turbine, B) drivetrain interior, and C) generator parts. *Figure by Willey Kemp, ORNL.*

Turbines of the Past

While wind turbines have been around since the 7th century, the first electricity-generating turbine was built in 1887 by electrical engineer James Blyth to power his holiday home in Scotland. This turbine was comprised of cloth sails on a wooden frame.[22] At the time, locals considered Blyth to be eccentric, and the technology was not widely adopted. In 1980, the first large-scale utility wind turbines were installed in California, beginning the era of modern wind turbines supporting the electric grid.[23]



Recycling Logistics

Wind turbine recycling presents substantial logistical challenges. The size of turbine blades and the limited number of facilities capable of processing their composite polymers require energy producers to plan carefully for end-of-life management. Landfill disposal costs range from $60 to $150 per ton, while recycling blades for use in cement production typically ranges from $80 and $200 per ton.[24]

Wind turbine blades are engineered to withstand harsh environmental conditions for decades, making them suitable for repurposing in outdoor applications. Around the world, companies are converting decommissioned blades into architectural elements, benches, playground structures, and other durable installations. While these repurposed products can be practical and long-lasting, the market for them remains limited.[21]





Shredded turbine blade fibers can be used to enhance the strength of concrete. The material must be processed through multiple shredding cycles to achieve a fine, uniform product, which reduces the need for traditional reinforcement materials and helps lower construction time, cost, and overall material use. Companies such as REGEN Fiber are developing improved processing methods to produce cleaner, higher-quality fibers.

In 2022, Oregon completed its largest wind turbine repowering project at the Shepherds Flat facility. More than 900 blades were removed, sectioned, compressed, and transported — by rail and truck — to a processing facility in Missouri. There, the blades were repeatedly shredded until the resulting material met the specifications needed for use as concrete reinforcement.[25]







Learn more:

SCAN OR CLICK

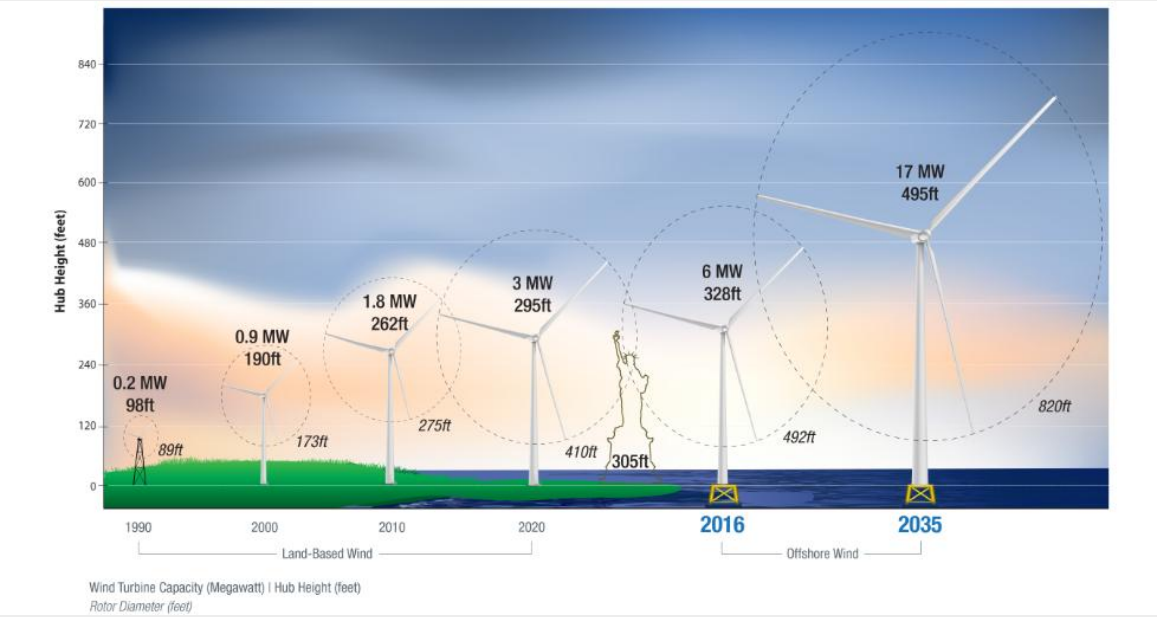
Spotlight: Offshore Wind

Offshore wind turbines are designed to withstand stronger and more consistent wind conditions than onshore turbines. While the overall recycling process is similar for both types, offshore projects introduce additional logistical considerations. Offshore rotor diameters – the full span of the circle covered by the blades – can reach nearly 500 feet, compared to typical onshore diameters of 190 to 300 feet.[26] Although these larger blades support higher energy production, they also create significant challenges for end-of-life management and recycling.

Blade removal in offshore environments requires specialized marine vessels and can only be performed under suitable weather conditions. Once retrieved, blades must be cut into smaller sections to enable transport and further processing. As a result, offshore blade recycling involves more complex handling and processing methods due to the larger scale of components and the additional logistical challenges not present in onshore installations.

While there are no current offshore wind installations on the west coast, HB 4080 (2024) directed the Department of Land Conservation and Development to develop an Offshore Wind Roadmap to develop standards for future offshore wind projects.

Figure 5: Typical Size of Wind Turbine by Capacity and Location[26]



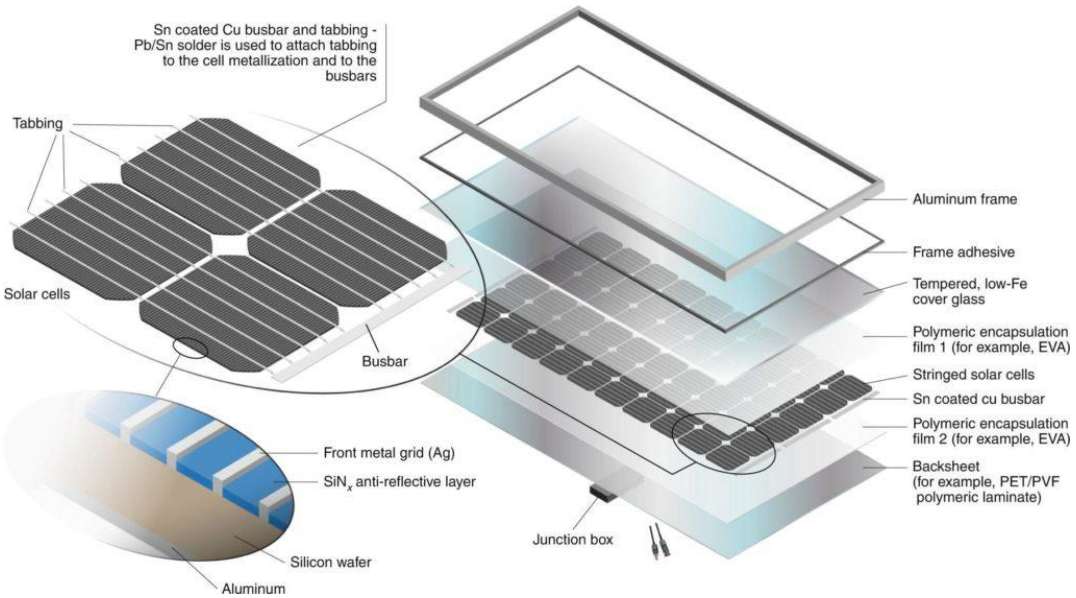
Solar Beginnings



People have been using passive solar design to heat homes, grow crops, and tell time for centuries. While the power of the sun has been studied and revered for generations, the full power to utilize it as an energy source at scale is relatively new. The photovoltaic effect was first demonstrated in 1839 by Edmond Becquerel, then a 19-year-old working in his father's laboratory. Although the phenomenon was recognized by scientists, it remained largely a scientific curiosity until 1954, when Bell Telephone Laboratories developed the first single-crystal silicon solar cell. This early "solar battery" was designed to power telephone repeaters as an alternative to expensive conventional batteries. While the technology was not yet economical for large-scale production, it marked the beginning of serious research into solar electricity.[27] These early solar cells are still capable of producing power, demonstrating the longevity of solar technology.[28]

Solar panels contain valuable materials that are difficult to separate and recover, making current recycling processes costly and labor-intensive. Modern solar panels are typically composed of glass sheets layered over specialized photovoltaic cells mounted within aluminum frames. These cells contain silicon and various critical minerals.[29] Because the cells are bonded to the glass during manufacturing, they can be difficult to separate during recycling, complicating material recovery. Solar panels also contain valuable minerals such as silver, cadmium, tellurium, copper, gallium, and indium.[30] Most of these materials are currently obtained through mining that occurs primarily outside the United States, which means they often need to be imported and can carry significant environmental and financial costs. Improving domestic recovery of these minerals could create significant economic opportunities and support job growth within the United States. However, each panel requires manual disassembly for recycling, and in many cases, the cost of this process exceeds the market value of the materials recovered.

Figure 6: Diagram of Photovoltaic Module Components[31]



Solar panels must be processed at specialized recycling centers that are capable of isolating the different component materials.[31] Electronics, wiring, aluminum frames, and sealants are removed before the glass and photovoltaic cells can be separated. Glass removal is essential, and it must be handled carefully because contamination from other panel materials significantly reduces its potential for reuse. To detach the glass from the ethylene-vinyl layers, recyclers apply heat to the tempered glass. Once separated, materials can be crushed for recovery. Recycled glass can be used to manufacture new glass products or for industrial applications such as sandblasting. Heat and chemical processes can be applied to the encapsulating polymers to extract silicon, silver, copper, aluminum, and other minerals. Recovery of critical minerals reduces dependence on mining and mineral imports.

The cost to recycle solar panels is a major barrier to widespread recycling. Current market constraints and data limitations contribute to uncertainty regarding the economic feasibility of recycling solar components. Recycling a solar panel currently costs between $20 and $30, while the recovered materials are valued at only $3 to $12. In comparison, landfill disposal costs range from $1 to $5 per panel.[32] Additionally, many local recycling facilities do not accept solar panels, making it difficult for homeowners and small businesses to locate appropriate disposal options. In many cases, individuals must coordinate panel collection through a solar installer.

The growing volume of end-of-life solar panels, combined with the high value of the critical minerals they contain, is creating a market opportunity for advanced recycling solutions in Oregon and beyond. A study by Rystad Energy estimates that the solar panel recycling market could reach $2.7 billion by 2030.[33] In Oregon, however, this market is still emerging. As more panels reach end-of-life, demand for recycling services is expected to increase. The high environmental and economic costs of mining critical minerals used in solar panels further underscore the importance of recovering existing materials.[34]

Advancements in recycling technologies, infrastructure, and policy are beginning to reduce barriers to recycling. Reuse remains the most cost-effective and resource-efficient disposal method, particularly when components remain functional for their original purpose. When facilities repower or upgrade to higher-efficiency panels, older panels often retain significant remaining service life and may be sold on the secondary market for residential use at lower cost. Solar technology continues to improve; whereas panels installed around 2010 typically produce 250–300 W, modern panels now exceed 400 W. For large solar facilities, this increase in output can be substantial, creating a strong incentive to upgrade to more efficient panels even before the existing ones reach the end of their life.

Figure 7: Recoverable Materials in Solar Photovoltaic Panels[35] [36]

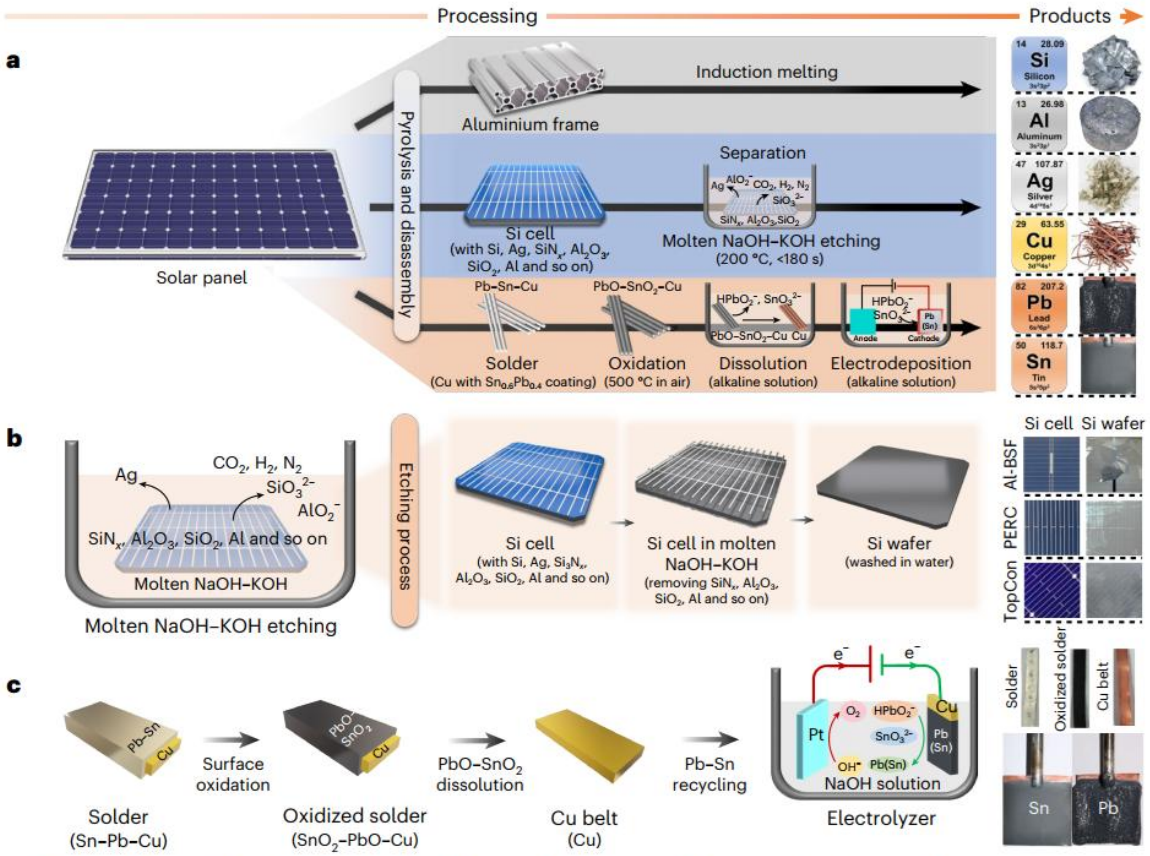


Fig. 1 | Schematic diagram of the recycling of an EoL PV panel and the recycled products. a, Flow chart showing the recycling of EoL PV panels including the initial dismantling process, the induction melting of Al frames and glass, the salt-etching process, and the recycling of solders; the pictures on the right are the recycled products. **b**, Schematic of the salt-etching process in molten NaOH–KOH. **c**, The recycling of solders including the oxidation, the alkali leaching and the electrodeposition.

Supporting Policies

Current state statutes do not explicitly mandate recycling for solar or wind components, though policy tools exist to help manage end-of-life materials. Oregon administrative rule 345-022-0120 requires energy facilities to demonstrate reasonable efforts to minimize waste to receive a site certificate from the Energy Facility Siting Council, although the Council has discretion in applying that requirement on wind and solar facilities. In addition, policies that classify solar panels as hazardous waste help divert them from standard landfill streams, making it easier for waste management facilities to identify and redirect old panels to recycling or repurposing programs. This approach aligns with emerging federal efforts such as the EPA's proposed universal waste regulations under the Resource Conservation and Recovery Act, or RCRA, for streamlining the collection, transport, and recycling of solar panels, whether they are classified as hazardous or not.[37]

The efficacy of policies governing the disposal of wind and solar resources at the end of their lives are in the earliest stages of being tested. Decommissioning requirements vary significantly across states, and some states have not adopted such requirements at all. As more renewable energy facilities undergo repowering, as sites eventually reach decommissioning, and as recycling technologies and

markets continue to evolve, existing policies may need to be revised or new policies developed to address emerging real-world conditions.[38]

Solar and Wind Recycling Future

Although cost and logistical challenges persist, ongoing research is driving the development of improved recycling methods, including processes that recover clean fibers and significantly expand the value and potential uses of recycled blade materials.

Companies such as Carbon Rivers are pioneering techniques to separate glass fibers from decommissioned wind turbine blades, which typically contain about 50 percent glass fiber.[39] Traditional recycling methods often yield materials suitable only for low-value applications, such as cement fillers.



Photo courtesy: Carbon Rivers

Advancements in blade manufacturing are also expected to simplify recycling. Current research indicates that blades made with dynamic thermosets can achieve performance levels comparable to traditional thermosets.[40] Dynamic thermosets allow resins and carbon fibers to be separated under heat or pressure, enabling fiber recovery. In contrast, traditional thermosets form permanent bonds between resins and fibers, limiting the ability to recover high-quality materials and restricting their reuse.

Similar progress is being made in solar panel recycling technologies. Historically, recycling has been more expensive than the value of the recovered materials. Enhanced recovery techniques — such as vacuum distillation, microwave-assisted processes, green chemical solutions, and hybrid systems — enable more efficient extraction of silicon and high-value metals.[41] Improved recycling can also help buffer supply shortages, reduce geographic dependence, decrease environmental and social impacts from mining, and support more stable access to raw materials. As demand for these minerals continues to grow, recycling and recovery from solar panels can reduce exposure to price volatility, geopolitical risks, and bottlenecks. Encouraging circular mineral use is a strategic consideration for sustaining long-term supply chain resilience.[42]

Material reuse in manufacturing also supports a more circular solar industry. For example, SOLARCYCLE and Arizona State University have partnered to develop solar panels using specialized recycled glass.[43] Recovered glass from decommissioned panels typically cannot be incorporated into new solar panels due to contamination, such as embedded silicon particles and antimony residues, which prevents it from meeting the purity standards required for photovoltaic manufacturing.[44] The SOLARCYCLE process allows glass from decommissioned panels to be repurposed into new panels, contributing to a more sustainable product lifecycle.

Ongoing updates to photovoltaic standards are significantly improving panel durability, ensuring that systems can better withstand weather exposure, mechanical stress, and long-term degradation. These enhanced durability requirements extend the operational lifespan of solar panels, reducing the likelihood of premature failures and lowering the volume of panels entering the waste stream. By keeping panels in service longer, these standards also reduce the overall cost per kilowatt-hour over

the system's lifetime and help minimize environmental impacts associated with manufacturing, transport, and end-of-life management.[45]

Conclusion

Managing end-of-life materials from solar panels and wind turbines is a complex and evolving challenge. However, continued advancements in recycling technologies and manufacturing practices are steadily reducing costs and lowering barriers to recycling and repurposing these waste streams. These efforts hold significant potential to divert large volumes of material from landfills, particularly as Oregon's solar and wind sectors continue to expand.

Recovering critical minerals domestically, from both solar panels and wind turbine components, reduces the environmental and economic impacts associated with mining, lowers emissions from long-distance transport, and helps retain more value within local and national markets. As recycling technologies improve and markets mature, the ability to reclaim materials such as steel, aluminum, copper, silicon, glass, and rare earth elements will strengthen the resilience of renewable energy supply chains.

Together, investments in improved recycling processes, durable product design, and supportive policy mechanisms can enhance the environmental and economic sustainability of solar and wind energy systems. These actions position Oregon to capture the long-term benefits of a circular renewable energy economy while minimizing the waste generated by its growing clean energy infrastructure.

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Effects of Federal Changes on State Energy and Climate Activities



Almost since its inception in 1975, the Oregon Department of Energy and other state agencies have partnered with the federal government to implement energy and climate policies, projects, and programs. From federal support for Oregon to participate in Hanford Nuclear Site cleanup issues to formula funding through the longtime State Energy Program, ODOE's partnership with the federal government has helped Oregon make progress on its energy, environmental, and climate goals.[i]

In addition to long-term funding for specific activities and programs, Oregon has also benefitted from significant one-time investments, such as the 2009 American Recovery and Reinvestment Act.[1] ARRA was a nearly $800 billion economic stimulus package designed to help the U.S. recover from the Great Recession. ARRA allocated more than $4.2 billion in economic assistance to Oregon, including $55.9 million to ODOE for energy projects and programs.

Congress also passed two major pieces of legislation related to investments in energy and climate in 2021 and 2022: the Infrastructure Investment and Jobs Act[2] and the Inflation Reduction Act.[3] Since their passage, ODOE secured over $275 million in formula and competitive grants[ii] from the laws, supporting energy projects around grid resilience, energy efficiency, renewable energy, workforce training, and more. As a state, Oregon was awarded even more funds related to climate and energy that did not go through ODOE: for example, Oregon is a member of the Pacific Northwest Hydrogen Association, which was awarded $1 billion to support clean hydrogen projects in Oregon, Washington, and Montana.

Upon the U.S. presidential transition on January 20, 2025, the administration began pulling back federal energy and climate policies and funding. On inauguration day, Executive Order 14154 *Unleashing American Energy* rolled back previously established policies and programs related to energy, including support for electric vehicles and vehicle emissions standards, regulations for energy efficient appliances and equipment, National Environmental Policy Act requirements, and others.[4] The Executive Order also temporarily froze disbursement of funds provided by the Inflation Reduction Act and Infrastructure Investment and Jobs Act that targeted climate change and clean energy initiatives. In July 2025, H.R.1, sometimes referred to as the One Big Beautiful Bill Act, eliminated some renewable energy tax incentives that had been enacted as part of the Inflation Reduction Act of 2022.[5] IRA tax credits, including clean vehicle credits, clean electricity investment credits, and residential clean energy tax credits, were set to expire in 2032; H.R.1 terminated the credits in 2025 and 2026 instead.

Further actions in 2025 and into 2026 have canceled funding and programs, and created uncertainty among state energy offices, businesses, and communities, including in Oregon. It is likely that additional federal actions throughout the remainder of the administration's term will make more changes to energy and climate policies, projects, and programs. Outlined here are some effects of federal changes identified by OODE as of the date of this report.

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[i] Learn more about ODOE's history of federal funding: https://energyinfo.oregon.gov/blog/2025/6/23/odoe-at-50-history-of-federal-funding

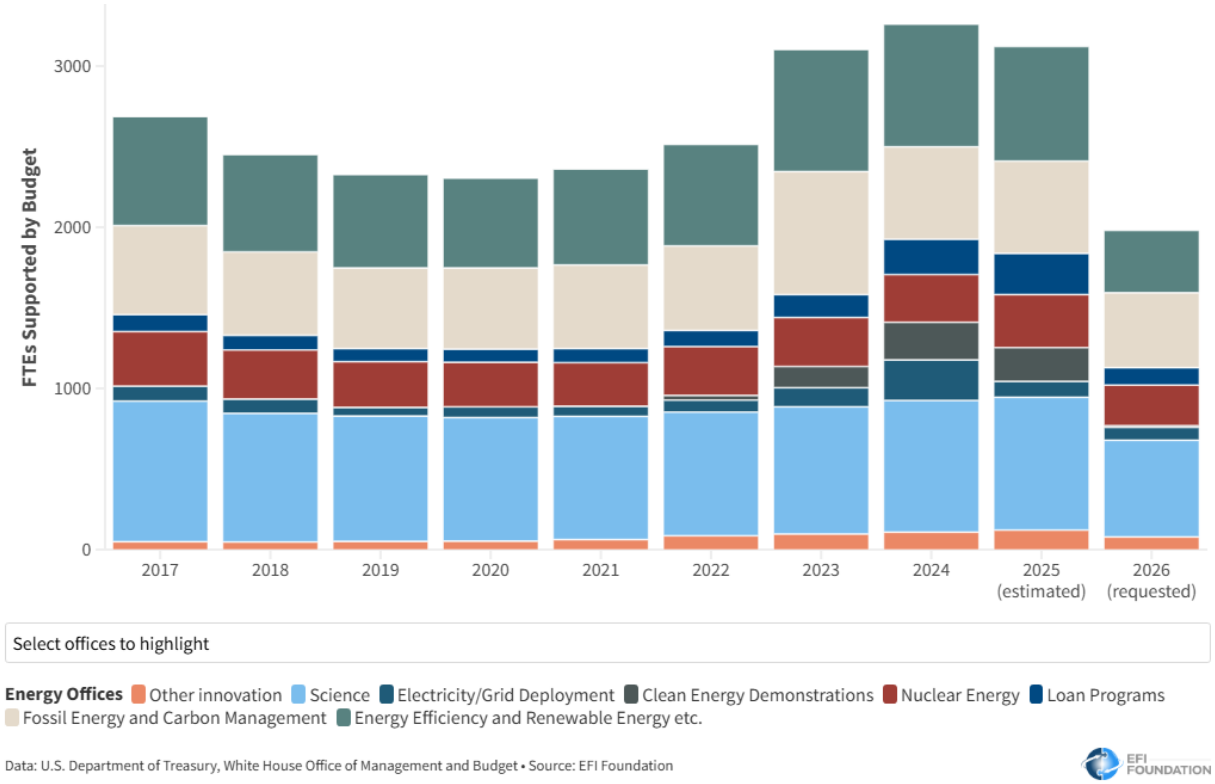
[ii] Formula grants are distributed automatically based on a preset standard (such as population). Competitive grants are awarded based on an evaluation against specific criteria and other applicants.

Changes in Clean Energy and Climate Policies at the Federal Level

Federal Staffing and Leadership

The U.S. Office of Personnel Management, which is the chief human resources agency for the federal government, reports that the number of federal employees has been reduced by more than 270,000 since January 20, 2025.[6] The number of U.S. Department of Energy staff has reduced by nearly 3,000, while the U.S. Environmental Protection Agency has reduced by more than 2,000 in that same time period. State energy offices, including the Oregon Department of Energy, have experienced slower response times from federal partners following the reduction in staff. ODOE used to meet with the U.S. DOE Office of Community Engagement regional partner monthly to discuss outreach and engagement strategies, but the office was closed in November 2025.[7] The U.S. Energy Information Administration, which is responsible for publishing important reports and energy data, announced delays in releasing some of its reports, including its International Energy Outlook and annual marketing report on uranium.[8]

Figure 1: Staffing Trends in U.S. DOE Science and Energy Innovation Programs[9]



The Bonneville Power Administration and the U.S. DOE Office of Environmental Management are two examples of programs where staffing shortages are of particular interest to Oregon. BPA is responsible for delivering electricity throughout the Pacific Northwest, including operating 15,000 miles of high voltage transmission lines that move power from the federal Columbia River hydropower dam system. Early in 2025, and although it is funded by ratepayers in the northwest, BPA was one of the many federal agencies facing staffing cuts. Staff being cut were involved in engineering, power distribution, and line work as well as modeling and resource planning. By spring of 2025, more than 400 BPA employees had been laid off, had rescinded job offers, accepted buyouts,

or retired early, causing Oregon's senators and former BPA administrators to warn of power outages and public health and safety risks.[10] Some of those workers were offered their jobs back,[11] and at a Congressional hearing in May 2025, Energy Secretary Chris Wright indicated that U.S. DOE would not pursue additional staffing cuts at BPA.[12]

According to a 2026 report by the U.S. Government Accountability Office, the Office of Environmental Management had a vacancy rate of 45 percent at the end of FY 2025. The GAO reported that almost half of the vacancies were in "mission-critical positions" such as nuclear safety specialists and staff involved in treating radioactive waste and addressing contaminated buildings, soil, and groundwater.[13] The Office of Environmental Management is responsible for addressing the environmental legacy of nuclear waste production and sites across the country like Hanford in Washington state just north of Oregon's border. Oregon has a significant interest in ensuring the safe and timely cleanup of Hanford, which sits on the Columbia River. Radioactive and chemical contamination pose a threat to Oregon's farmland and fisheries, and staff at the Office of Environmental Management are important partners to the states of Oregon and Washington.

Climate Change

The current federal administration has taken several actions to roll back policies and efforts to fight climate change and reduce greenhouse gas emissions. As policies and programs have been rescinded or reduced, some federal agencies also received instructions from leadership to avoid certain words or phrases, such as "climate change," "emissions," and "sustainable," in public messaging and on websites, this also extends to any mention of disparately impacted populations including environmental justice and similar terms.[14]

In 2009, after the Supreme Court's ruling in Massachusetts v. EPA, the U.S. Environmental Protection Agency found that greenhouse gas emissions pose a threat to public health and wellbeing.[15] Known as the "Endangerment Finding," it established a legal basis for regulating emissions under the Clean Air Act. A contributing finding also noted that new motor vehicles, specifically, release the harmful greenhouse gas emissions that threaten public health. In February 2026, the U.S. EPA formally rescinded the Endangerment Finding, which also rescinded its regulation of vehicle and other sector emissions.[16] Shortly after the announcement, a group of states, including Oregon,[17] and a coalition of environmental and health groups filed a lawsuit against the U.S. EPA for its action, which remains active in the D.C. Circuit Court.[18]

As described in formal comments submitted to U.S. EPA by the Oregon Department of Environmental Quality, "Rescinding the Endangerment Finding and associated federal standards would have serious and far-reaching consequences for Oregon."[19] In addition to increasing health risks and climate-related hazards, DEQ pointed out that the action could undermine Oregon's clean energy transition. By creating consistency across markets and enabling long-term planning by manufacturers and utilities, federal rules reduce the costs associated with delivering cleaner technologies. Without federal standards, "Oregon would be left with a patchwork of state-level policies that cannot achieve the same extent of reductions in emissions."

In 2015, the United States joined 194 international parties in entering the Paris Agreement, which commits countries to reduce emissions, reassess and strengthen commitments over time, and provide financial support to developing countries to mitigate and adapt to climate change.[20] The U.S.'s

involvement with the Paris Agreement has changed through the most recent three administrations, withdrawing from the Agreement in 2020, rejoining in 2021, and withdrawing once again in January 2026.[21]

Fossil-fuel generated electricity, such as from coal and natural gas, is a significant contributor to greenhouse gas emissions and air pollution. In 2022, the electricity sector accounted for 24 percent of U.S. greenhouse gas emissions.[22] In 2023, over half of the national greenhouse gas emissions from electricity generation came from natural gas-powered electricity, and over 46 percent from coal.[23]

Figure 2: National Greenhouse Gas Emissions from Electricity Generation (2023)[23]



Coal use has been declining in the U.S. since its peak in 2007, with consumption dropping 64 percent by 2024.[24] In the energy sector, the drop in consumption is largely due to climate-related policies and technology and cost improvements for other resources, such as wind and solar. In April 2025, Executive Order 14241 was amended to designate coal as a "mineral," which effectively allows for expedited permitting for coal-fired power plants, providing financial incentives for coal production, and increasing coal mining on federal land.[25] This was one of multiple actions by the administration that encouraged the production and use of coal, which also included reducing pollution controls on coal-burning power plants and directing the Pentagon to buy more coal-powered electricity. An analysis by the New York Times found that harmful mercury emissions from coal-fired power plants increased by around 9 percent in 2025.[26]

While Oregon's only coal plant shut down in 2020, Oregon utilities can still buy coal-generated power on the regional market until 2030; coal made up about 8.3 percent of Oregon's electricity mix in 2024.[23] Federal action increasing the availability of this resource in the west and lowering its cost could result in higher greenhouse gas emissions per kilowatt hour in Oregon.

In April 2026, the U.S. EPA published a final rule to reduce regulations for oil and gas operators, including lifting some restrictions on vent gas flaring and changing some requirements for monitoring that flaring. The EPA argued the actions would save the oil and natural gas industry about $208 million per year,[27] but the actions would also increase the amount of methane emissions associated with natural gas use. As noted above, natural gas accounts for over half the greenhouse gas emissions from electricity generation. Natural gas is used to generate more than 20 percent of the electricity Oregonians use.[23]

Energy Facilities

In addition to lifting regulatory restrictions meant to curb greenhouse gas emissions from coal-powered energy generation, the federal administration has also taken action to keep coal plants open that were scheduled to close, citing the increasing energy demand in the U.S., including for data centers. Secretary of Energy Chris Wright issued an order in March 2026 to keep a unit of the

Centralia Generating Station coal plant in Washington operating; it had been scheduled to shut down in 2025.[28] This order followed others issued in December 2025 to keep coal plants in Indiana and Colorado operational.

In April 2026, following the March 2026 order, TransAlta, which operates the Centralia Generating Station, filed a request with the Federal Energy Regulatory Commission noting it would cost $19 million to keep the facility operating.[29] The company indicated that the fixed costs would be split equally between BPA and the California Independent System Operator, which are likely to pass costs along to consumers in the northwest. The company also reported that fixed costs will add up to about $8.2 million every 90 days.[29] In June 2026, the U.S. DOE extended the emergency order to keep the Centralia plant operational until September 12.[30]

At the same time coal plants were ordered to continue, the Interior Department stopped construction of five offshore wind projects on the East Coast in December 2025, citing unspecified national security risks.[31] Critics noted that keeping coal plants open to meet energy demand while canceling construction of new resources was contradictory.[32] Vineyard Wind I, the first utility-scale offshore wind facility in the U.S., was already partly operational at the time of the Interior Department's announcement. In January 2026, a federal judge ruled that construction and operation at the facility could continue.[33] Three other halted projects were also allowed to resume construction following preliminary injunctions issued by federal judges.

The Interior Department's action followed a Presidential Memorandum in January 2025 that withdrew the Outer Continental Shelf from wind energy leasing in its entirety, effectively stopping any new offshore wind projects in the U.S.[34] This included wind energy areas identified off the southern Oregon coast. The administration is offering payouts to energy companies that agree to cancel their offshore wind projects that are already under development. As of May 2026, the payouts offered total nearly $2 billion in taxpayer dollars.[35] While there are no wind facilities off of Oregon's shores today, Oregon has strong resources off its coast and potential for offshore wind projects in the future.[36] However, without federal funding for research and pilot projects, offshore wind generation will likely be further delayed.

Federal actions have also affected onshore wind facilities. In May 2026, the Associated Press reported that the American Clean Power Industry Association accused the Pentagon of delaying development of more than 250 onshore wind facilities across the U.S. by stalling national security reviews.[37] Typically, proposed wind facilities are reviewed by the Federal Aviation Administration to ensure facilities wouldn't interfere with radar systems or military and other aviation needs – oftentimes, this includes ensuring tall wind turbines are built with lights on the top so they can easily be seen at night. Without approval from the FAA, wind facility construction will be delayed or halted.

Oregon Renewable Energy Siting Assessment

The Oregon Renewable Energy Siting Assessment (ORESA) project was published in 2022 as an educational resource for users to explore data and information on renewable energy development in Oregon. The ORESA project goals were to develop baseline data and gather stakeholder perspectives to create a collection of information to support Tribes, communities,

policy makers, energy developers, and government agencies interested in potential projects or renewable energy policies.

A Mapping and Reporting Tool includes data on renewable energy, military training areas, economic development, land use, natural and cultural resources, and other important considerations. Users can interact with and browse spatial data, create site-specific reports to support early coordination on potential projects, and review additional information such as regulatory process maps, reports, and tools that are not reflected in the spatial data.

The ORESA project was funded through a $1.1 million U.S. Department of Defense Office of Local Defense Community Cooperation grant awarded to the Oregon Department of Energy, working with the Department of Land Conservation and Development and Oregon State University's Institute for Natural Resources.

https://www.oregon.gov/energy/energy-oregon/Pages/ORESA.aspx

Not all clean energy facilities have been negatively affected by recent federal action. Nuclear power, which produces no greenhouse gas emissions during electricity generation, has seen growing interest across the U.S. and across federal administrations. In May 2025, Executive Order 14302 was issued to "expedite and promote the production and operation of nuclear energy."[38] The EO aims to accelerate nuclear production by increasing capacity at existing reactors, constructing new large reactors, and providing federal loans and guarantees to spur construction.

The federal administration is also considering reducing safety and public health regulations for nuclear power plants. For example, in early 2026, U.S. DOE proposed including advanced nuclear reactors on its National Environmental Policy Act 'categorical exclusion' list, which is typically used for routine government actions where very little environmental impact is expected.[39] In addition, Executive Order 14300 (2025) mandated that the Nuclear Regulatory commission establish an expedited pathway for nuclear reactor designs previously tested by the U.S. Department of Energy or the U.S. Department of Defense, and NRC issued a proposed rule on April 2, 2026. ODOE submitted comments to the NRC expressing concern that this action could erode the statutory separation between U.S. DOE's "nuclear promotion" activities and NRC's nuclear safety obligation.[40]

Oregon's only nuclear plant, Trojan, closed in 1993,[41] and current state law makes it difficult to gain approval and build a new nuclear facility in Oregon. In 1980, Oregon voters passed Measure 7, under which the state cannot permit new reactors until there is a permanent federal nuclear waste repository and even then, a specific facility would have to be approved by voters.[42] Nuclear technology continues to evolve, as does interest by some Oregon leaders who have introduced recent legislation to further study advanced nuclear technologies, such as small modular reactors, as a carbon-free resource for the state. As Oregon decision-makers re-examine the state's nuclear policies, reducing public health and safety regulations at the federal level may increase Oregonians' concerns about the technology.

Transportation

Transportation accounts for about 35 percent of Oregon's greenhouse gas emissions by sector, primarily from petroleum fuel products.[43] Transportation-related programs and policies that increase

fuel efficiency and reduce greenhouse gas emissions are essential to meeting Oregon's climate goals. Federal corporate average fuel economy, or CAFE, standards have been an important tool in improving the average fuel economy of vehicles.[44] First enacted by Congress in 1975, CAFE standards regulate how far vehicles travel on a gallon of fuel for light-duty vehicles and for medium- and heavy-duty vehicles.

CAFE standards offer consumers vital information about fuel efficiency and fuel economy, including regulating miles-per-gallon ratings on new vehicle information stickers. In 2024, the National Highway Traffic Safety Administration estimated that fuel efficiency standards for model years 2027-2031 would save Americans over $23 billion in fuel costs.[45] Over time, CAFE standards require that vehicles sold by manufacturers get more fuel efficient over model years. The standards also set rules for manufacturers that don't meet those requirements, including potential fines or credit purchases from other manufacturers that over-perform on efficiency.

As part of H.R.1, associated fines for manufacturers not meeting the standards were eliminated.[5] In December 2025, The U.S. Department of Transportation announced an initiative to roll back CAFE standards,[46] and the NHTSA began a rulemaking process to reset standards for model years 2022-2031. In its draft Environmental Impact Statement for the proposed rulemaking, the NHTSA notes that rolling back standards from the 2024 update would reduce efficiency by about 13 to 17 MPG by model year 2031.[47] Further, fuel consumption, fuel costs, and air pollution would increase by rolling back the standards. For a typical driver, this would increase annual gasoline use by roughly 250-400 gallons, adding approximately $1,200-$1,900 per year in fuel costs at current Oregon gasoline prices.

California adopted the Advanced Clean Trucks regulation in 2020 and the Advanced Clean Cars II regulation in 2022 to increase sales of zero-emission light-, medium-, and heavy-duty vehicles.[48] Oregon followed California when the Environmental Quality Commission adopted both regulations in 2022.[49] In 2024, the U.S. Environmental Protection Agency granted California waivers to enforce these standards.[50] In June 2025, however, Congress voted to overturn the waivers through the Congressional Review Act by passing H.J. Res. 87 and 88.[51] [52] California, Oregon, and a coalition of other states are challenging these actions in court. The resulting regulatory uncertainty may affect automobile manufacturers' long-term investment decisions related to zero-emission technologies.

As discussed below, transportation policies and programs have also been affected by federal funding changes, such as the end of a tax credit for purchasing electric vehicles and EV chargers earlier than planned, as well as delaying funding for the National Electric Vehicle Infrastructure program that funds fast EV chargers along freeways nationwide, including in Oregon.[53]

Federal greenhouse gas emissions standards are foundational to Oregon's policies and programs that reduce emissions from transportation, such as Advanced Clean Cars II and Advanced Clean Trucks rules noted above. Weakening GHG regulations at the federal level potentially undermines Oregon programs while putting additional pressure on them to deliver reductions.

Energy Efficiency

In the Oregon Energy Strategy, published in November 2025, *energy efficiency* is identified as one of the five least-cost pathways for Oregon to reach its energy and climate policy objectives.[54] Energy efficiency means getting the same level of service (heating, cooling, comfort, transportation) using

less energy. The least expensive energy is the energy that is not needed in the first place. Reducing energy use through efficiency saves households and businesses money, reduces the burden on all ratepayers, and lowers the costs of transitioning the economy to clean energy. Strong policies and programs have supported increasing energy efficiency over the years, such as setting minimum appliance standards and providing incentives to ensure households with low incomes can access newer energy efficient technologies.

In early 2025, the U.S. Department of Energy announced its intent to roll back energy efficiency programs, as well as eliminate its office focused on energy efficiency.[55] This included regulations for appliance standards, which set minimum efficiency requirements that appliance manufacturers need to meet for equipment. In 2026, the Appliance Standards Awareness Project reported that without the national efficiency standards in place, an American household would have paid about $6,000 more on its utility bills over the last decade.[56] Further, businesses would have spent $330 billion more on utility bills over the last decade, and electricity use would have been 14 percent higher in 2025 nationwide without the standards.

Oregon has a history of leading on energy efficiency standards for appliances and other products. While some efficiency standards have been set at the federal level in the past, there are some products that do not yet have a national standard but would benefit from a state standard to achieve meaningful energy and water savings. Oregon established its first energy efficiency standards for 11 product categories in 2005, followed by six in 2007, three in 2013, and nine new and two updated standards in 2021.[57] Examples of appliances and equipment the state has identified for efficiency standards in the past include water coolers, televisions, computers and computer monitors, faucets and shower heads, and others. Often, federal standards are later modeled after standards first enacted at the state level. Thirteen of Oregon's previous standards have since been preempted by the federal government, meaning that a national standard has been adopted and applies to those products and that all states, including Oregon, cannot establish a different standard.

In addition to energy efficiency policy changes, administration actions have also reduced funding and incentive programs that support efficiency, as discussed below.

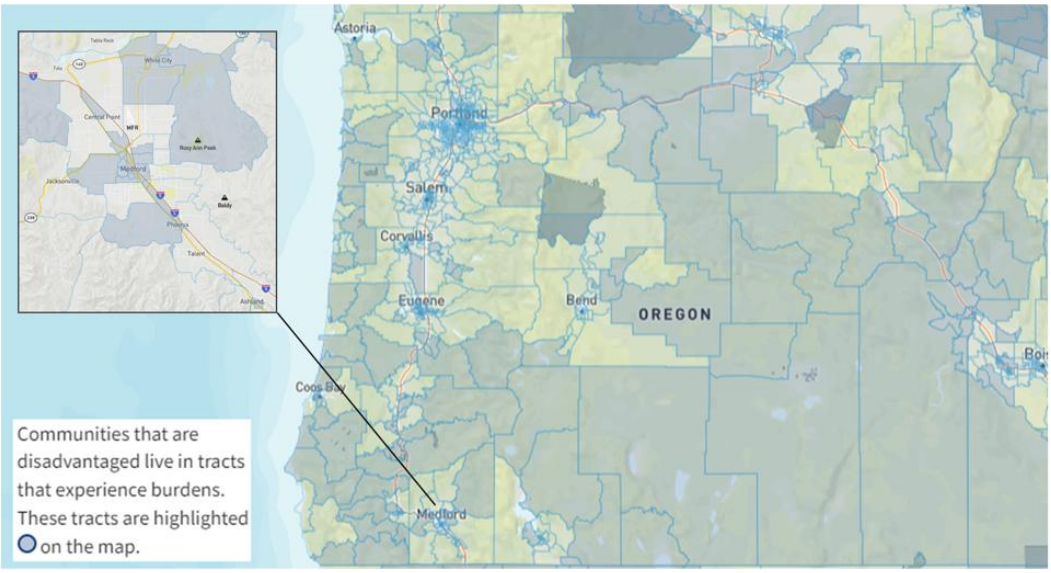
Equity

One of the most significant differences between past and current administrations is the approach to diversity, equity, and inclusion in federal programs and services. Executive Order 13985, *Advancing Racial Equity and Support for Underserved Communities Through the Federal Government*, was issued in January 2021 with a focus on making federal program and funding decisions that advance equal opportunity.[58] Later that month, Executive Order 14008 established the Justice40 Initiative, which created a goal that 40 percent of overall benefits from certain federal investments should flow to disadvantaged communities.[59] The order listed investments in clean energy, energy efficiency, clean transit, training and workforce development, and other efforts as examples.

Later in 2021, Congress passed the Infrastructure Investment and Jobs Act,[2] followed by the Inflation Reduction Act in 2022.[3] As noted above, the Oregon Department of Energy secured over $275 million in formula and competitive grants from the laws, supporting energy projects around grid resilience, energy efficiency, renewable energy, workforce training, and more. Both laws included Justice40 requirements, so awarded entities were to ensure at least 40 percent of the benefits flow to

disadvantaged communities. To aid in identifying disadvantaged communities, the White House made a Climate and Economic Justice Screening Tool available, which identified census tracts that defined the characteristics of a disadvantaged community.[60]

Figure 3: Snapshot of Climate and Economic Justice Screening Tool for Oregon (2024)[60] [iii]



Oregon, including ODOE, focused significant efforts on ensuring awarded grants were meeting Justice40 goals. However, in January 2025, Executive Order 14151 terminated all "diversity, equity, inclusion, and accessibility mandates, policies, program, preferences, and activities in the Federal Government."[61] This included rescinding the Justice40 Initiative for federally funded programs, removing an important tool for addressing past and potential future harms to those who are most affected by climate change.

While the federal government is no longer focusing on ensuring equitable access to government programs and benefits, the State of Oregon remains committed to advancing racial and environmental justice. In 2022, the Oregon Legislature passed House Bill 4077, which established the Environmental Justice Council.[62] The Council advises the Governor and state natural resource agencies on environmental justice issues. HB 4077 also directed the Council to develop an environmental justice mapping tool (due December 31, 2027) to provide information about environmental justice issues in the state to guide agencies as they develop policy and make funding and program decisions. Like other state agencies, ODOE regularly participates in Council meetings and continues to follow state guidance and laws to ensure its programs are equitable across Oregon communities who are disproportionately affected by environmental harms.

Changes in Clean Energy and Climate Funding at the Federal Level

Federal Funding Freezes

As discussed above, ODOE secured over $275 million in formula and competitive grants from the 2021 Infrastructure Investment and Jobs Act and the 2022 Inflation Reduction Act. As a state, Oregon

[iii] The original Climate and Economic Justice Screening Tool website was removed by the federal government in 2025. The Climate Program Portal created an archived version for the public to access.

secured even more funding, including as part of a $1 billion consortium to create a clean hydrogen hub in the Pacific Northwest. Table 1 shows the awards to Oregon from IIJA and IRA, as well as the current status of each.

Table 1: IIJA and IRA Awards to ODOE (Status as of October 1, 2026)

Grant Name	Status	State of Oregon Award Amount	Federal Act
Grid Resilience	Awarded	$50 million	IIJA
Infrastructure Investment and Jobs Act – State Energy Program	Awarded	$5.6 million	IIJA
Energy Efficiency Conservation Block Grant	Awarded	$1.9 million	IIJA
Home Energy Rebates – Retrofit (HOMES)	Awarded	$56 million	IRA
Home Energy Rebates – Electrification (HEAR)	Awarded	$56 million	IRA
Climate Pollution Reduction Grants – Planning Funds	Awarded	$3 million	IRA
Climate Pollution Reduction Grants – Implementation Funds	Awarded	$197 million	IRA
Energy Auditor Training – Competitive	Selected but Paused	$1.7 million	IIJA
Latest and Zero Energy Building Codes – Formula	Selected but Paused	$6.5 million	IRA
Training for Residential Contractors – Formula	Selected but Paused	$2 million	IRA
Solar for All	Program Canceled by U.S. DOE; Under litigation.	$86.6 million	IRA
Training for Residential Energy Contractors – Competitive	Project Canceled by U.S. DOE but reinstated	N/A	IRA
Resilient and Efficient Codes Implementation (ASHRAE)	Project Canceled by U.S. DOE	N/A	IIJA

Resilient and Efficient Codes Implementation (Earth Advantage)	Project Canceled by U.S. DOE; reinstatement in process after litigation	N/A	IIJA
Hydrogen Hub	Project Canceled by U.S. DOE; Under litigation	Up to $1 billion (as part of a consortium)	IIJA

The federal administration change in 2025 created significant uncertainty about federal funding and programs. On January 27, 2025, the federal Office of Management and Budget issued a memo pausing federal grants, loans, and other financial assistance programs until agencies could review programs and activities to ensure they were consistent with the president's policies and requirements, including Executive Order 14151 that focused on ending equity efforts.[63] The memo stated: "Federal agencies must temporarily pause all activities related to obligation or disbursement of all Federal financial assistance, and other relevant agency activities that may be implicated by the executive orders, including, but not limited to, financial assistance for foreign aid, nongovernmental organizations, DEI, woke gender ideology, and the green new deal." Lawsuits challenging the memo quickly followed[64] and on January 28, a U.S. District Court issued an administrative stay on implementing the memo.[65] The Office of Management and Budget then rescinded the memo but the White House Press Secretary Karoline Leavitt issued a statement clarifying that the funding freeze would continue.

The announced funding freeze had a significant effect on Oregon and the nation, as important programs such as Medicaid and childcare programs were at risk, in addition to energy- and climate-related programs. The freeze announcement lacked clarity about what programs or funding were affected, so the state, including the Oregon Department of Energy, was unsure which programs were truly frozen from further work. Other programs, including those supporting code development and workforce, received "conditional awards" but conditions were never communicated, and the statuses remain in limbo at the time of this report.

While the early days of uncertainty and funding freezes gained more clarity over time, some federal energy programs and projects have been outright canceled, while others continue to experience delays.

Program Funding Cancelations

Solar for All



In May 2024, ODOE Director Janine Benner joined federal and local partners to celebrate Oregon's nearly $87 million Solar for All award.

In April 2024, the U.S. Environmental Protection Agency announced that Oregon would receive an $86.6 million Solar for All grant to support renewable energy adoption for low-income Oregonians.[66] The Oregon Solar for All Coalition – which includes the Oregon Department of Energy, Energy Trust of Oregon, and Bonneville Environmental Foundation – applied for the highly competitive funding in fall 2023. The Solar for All program was originally designed to advance equity, environmental, and energy justice priorities in support of federal Justice40 Initiative goals to deliver benefits to disadvantaged communities. Awarded programs would reduce greenhouse gas emissions and other air pollutants, deliver the benefits of solar energy to low-income and disadvantaged communities across the nation, and mobilize financing and private capital to stimulate additional projects that reduce emissions.

Oregon's program aimed to serve about 8,000 households with low incomes – saving households over $83 million – and program funding would provide financial and technical assistance to support solar installations for homes with little to no upfront cost; solar on multifamily buildings with benefits for low-income residents; development of community solar projects; and workforce development activities.

Oregon's Solar for All Programs and Funding

- Solar installations at single-family households with little to no upfront customer cost | Oregon Department of Energy | $29 million
- Multifamily buildings that provide tangible benefits to low-income residents | Oregon Department of Energy | $10.86 million
- Financial and technical assistance to develop community solar projects under the Oregon Community Solar Program | Energy Trust of Oregon | $15 million
- Financial and technical assistance to develop Consumer-owned Utility Territory Community Solar projects | Bonneville Environmental Foundation | $11 million
- Workforce development activities | Oregon Department of Energy | $2.87 million

On August 7, 2025, the Oregon Department of Energy received a letter from the U.S. Environmental Protection Agency stating that the EPA was canceling all Solar for All program funding, including

Oregon's award.[67] ODOE first learned of the cancelation when EPA Administrator Lee Zeldin made an announcement on social media.[68]

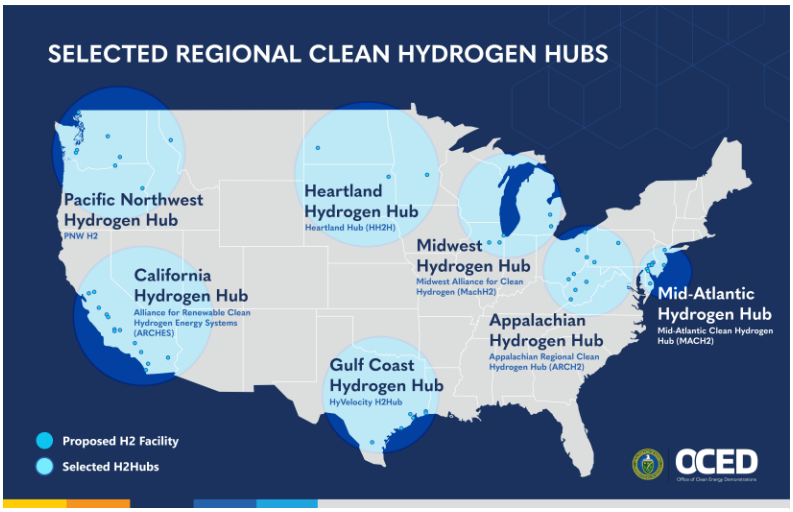
On September 5, 2025 the Oregon Department of Energy sent a letter to the U.S. EPA regarding the wrongful termination of the grant. In the letter, ODOE requested to formally initiate an administrative dispute with the goal that EPA return the obligated funds to Oregon.[69] The following month, on October 16, 2025, Oregon Attorney General Dan Rayfield announced Oregon was joining 23 other Solar for All awardees in a lawsuit against the EPA for illegally ending the $7 billion Solar for All program.[70] The lawsuit was filed in the U.S. Court of Federal Claims to recover damages for EPA's unlawful breach of the grant agreements that were already fully executed and the funding obligated under the program.

In September 2026, a federal judge ruled that the Solar For All program was illegally terminated, noting that Congress had clearly indicated that funds that were already obligated should have continued to be administered by the U.S. EPA.[71] As of October 1, 2026, it is unclear what this means for the program going forward or Oregon's award.

Without the Solar for All funding, Oregon has limited capacity to support solar installations on Oregon homes.[iv] Solar not only helps households lower their energy costs, it can also help the overall electric grid by reducing demand on the system, and minimizes potential greenhouse gas emissions from other energy resources that make up Oregon's electricity mix.

Pacific Northwest Hydrogen Hub

In October 2023, the U.S. Department of Energy announced it had selected the Pacific Northwest Hydrogen Association's PNWH2 Hub as one of the regional clean hydrogen hubs funded through the 2021 Infrastructure Investment and Jobs Act.[72] The Pacific Northwest Hydrogen Association is a multi-state nonprofit coalition of public and private partners spanning Oregon, Washington, and Montana, including the Oregon Department of Energy, and was selected to receive up to $1 billion to support the clean hydrogen hub.



Seven regional hydrogen hubs were announced in October 2023, including the Pacific Northwest Hydrogen Hub. (U.S. DOE Office of Clean Energy)

The PNWH2 Hub proposed to leverage the northwest's abundant clean power, including hydropower, as well as innovative local companies ready to help support a clean hydrogen economy. The hub would focus on decarbonizing hard-to-electrify sectors, such as heavy-duty vehicles, long-duration energy storage, agriculture and

[iv] The Oregon Department of Energy's Solar + Storage Rebate Program, which launched in 2020, ran out of state funding in mid-2024. Through administrative savings and canceled projects from previous funding rounds, ODOE was able to temporarily reopen the program in June 2026 with $1.1 million available to support new solar and storage projects. The funding was reserved within 10 minutes, and no additional funding has been allocated to continue the program.

industry, and ports. In addition to bolstering a clean hydrogen economy, projects funded by the hub were expected to create or support more than 10,000 jobs in the region.[73] This focus and attention on hydrogen was consistent with the low-carbon fuels pathway in the Oregon Energy Strategy, which acknowledges the important role that fuels play in Oregon's energy sector and the need to replace existing fuels with low-carbon alternatives like hydrogen to meet our climate goals.

On October 1, 2025, the U.S. Department of Energy announced it was canceling over $7.5 billion in funding for energy projects across the country (more on these project cancelations below).[74] Among the canceled projects: the Pacific Northwest Hydrogen Hub and the California Hydrogen Hub.

Losing a $1 billion investment in the region was a significant blow not only for jobs and the economy, but also for the potential greenhouse gas reductions that would come with clean hydrogen. The Pacific Northwest Hydrogen Hub remains active to continue clean hydrogen efforts and submitted an appeal to the U.S. DOE to reinstate the funding.[75] As of October 1, 2026, funding remains canceled.

Other Funding Cancelations

Resilient and Efficient Codes Implementation

The 2021 Infrastructure Investment and Jobs Act included competitive funding opportunities for Resilient and Efficient Codes Implementation programs, which support advancing energy efficiency in building codes that "save money for American homes and businesses, reduce greenhouse gas emissions, and encourage more resilient buildings."[76] Nonprofit Earth Advantage was awarded $2.9 million to support such energy efficient code efforts, including examining pathways to support the adoption of Building Performance Standards in Oregon. On a national scale, ODOE was also part of a team, led by ASHRAE and in partnership with other states, to develop energy code training materials to support workforce development and building official education. Both of these Resilient and Efficient Codes Implementation programs were canceled alongside many other U.S. DOE energy projects in October 2025,[74] though the project led by Earth Advantage was reinstated in June 2026.

The Oregon Energy Strategy identified energy efficiency as a key pathway to advance Oregon's energy objectives and highlighted the importance of building codes as a tool to improve efficiency in existing buildings. Unfortunately, the state can no longer count on federal funding to support and strengthen workforce development and help advance efficiency and resilience in existing buildings.

Building Resilience Infrastructure and Communities

The Federal Emergency Management Agency's Building Resilience Infrastructure and Communities, or BRIC, grant program provides funding to communities across the nation for "pre-disaster mitigation funding" to strengthen community resilience. The 2021 Infrastructure Investment and Jobs Act appropriated about $882 million in BRIC funding, and FEMA began awarding funds to projects around the country, including in Oregon. However, FEMA announced in April 2025 it was ending the program and did not distribute the funding.[77]

In July 2025, several states, including Oregon, filed a lawsuit to restore the funding for fiscal years 2020 through 2023. The lawsuits prevailed, and in March 2026 FEMA announced the program was reopening.[78] A letter from FEMA to the Oregon Department of Emergency Management in March outlined some of the potential projects that could have millions of dollars in funding restored, including projects for seismic retrofitting, battery and microgrids, backup generators, and hazard

mitigation plan updates.[78] For example, in Lane County, a $1.5 million grant was awarded to support the Blachly Lane Amy Hill Overhead to Underground project to place 1.75 miles of overhead powerlines underground.[79] Undergrounding power lines can improve grid resilience and reliability by protecting infrastructure from possible environmental hazards, such as wind or ice storms.

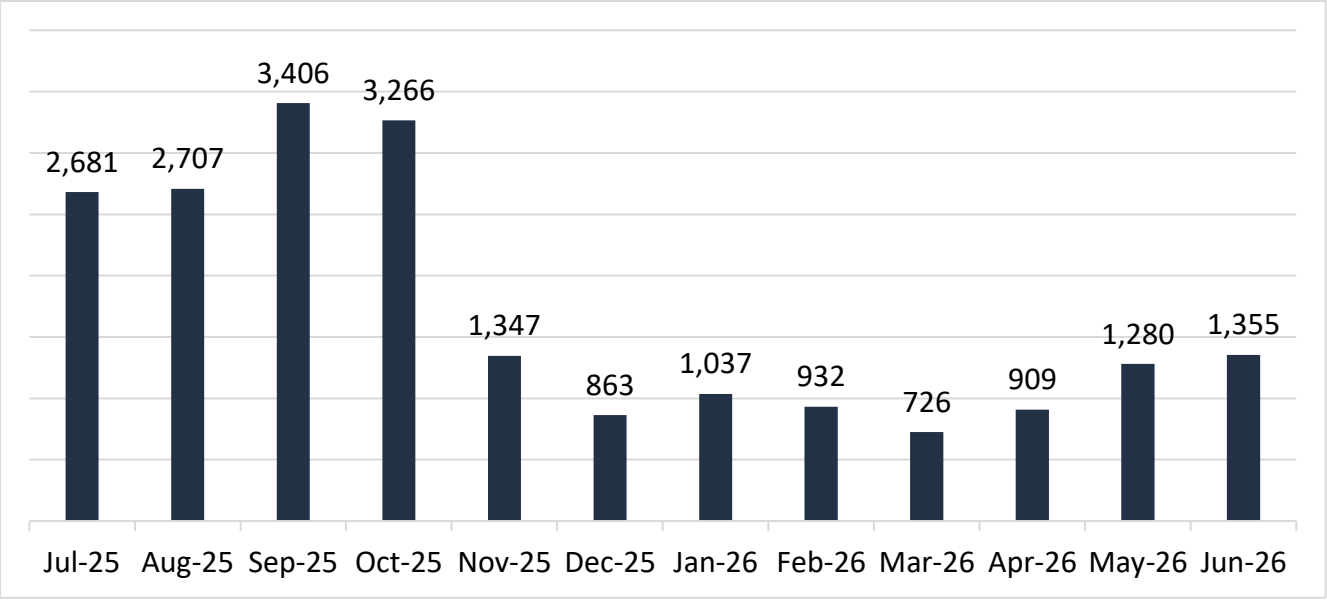
Tax Credit Cancelations

Tax credit programs have long been a tool for helping households, businesses, and energy developers invest in renewable energy, energy efficiency, and other energy technologies that save energy and reduce greenhouse gas emissions. The 2022 Inflation Reduction Act created new energy tax credits and expanded existing tax credits to further encourage technology adoption, such as solar, electric vehicles, efficient heat pumps, and other equipment.[80] For example, through the IRA, Energy Efficient Home Improvement Credits and Residential Clean Energy Property Credits were extended to 2033 and 2034, respectively. The U.S. Department of Treasury announced that more than 3.4 million households took advantage of about $8.4 billion in tax credits for clean energy and energy efficiency improvements in their homes in 2023.[81]

H.R.1 in 2025, also known as the "One Big Beautiful Bill Act," repealed much of the IRA's tax credit extensions.[82] For households taking advantage of the Energy Efficient Home Improvement Credit or the Residential Clean Energy Credit, H.R.1 changed the eligibility date for claiming tax credits to projects completed by December 31, 2025.

H.R.1 repealed electric vehicle tax credits as of September 30, 2025, including $7,500 for new EVs, $4,000 for used EVs, and $7,500 for light-duty and $40,000 for heavy-duty commercial clean vehicles. An Alternative Fuel Vehicle Refueling Property Credit, which subsidized up to 30 percent of the cost of installing refueling equipment for alternative fuel vehicles (including charging infrastructure), had been extended by the IRA to 2032 and increased the maximum business credit to $100,000. H.R.1 terminated the tax credit for projects installed after June 2026. In Oregon, the number of light-duty electric vehicle registrations was growing month-to-month but saw a steep decline immediately after the September 30 federal tax credit expiration.

Figure 4: Monthly Light-Duty Electric Vehicle Registrations in Oregon (Oregon DMV)



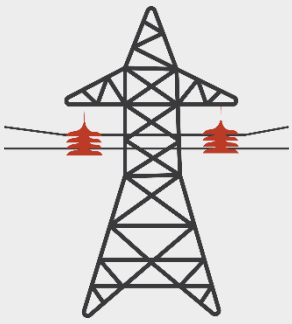
Businesses and contractors were also affected by H.R.1 changes. A Credit for Construction of Energy-Efficient New Homes had been extended to 2032 and offered tax credits to contractors who built and sold new energy-efficient homes; H.R.1 ended the credit as of June 30, 2026. An Energy Efficient Commercial Buildings Deduction allowed businesses to deduct purchase and installation costs for energy-efficient equipment more quickly than regular tax rules; H.R.1 also ended that deduction as of June 30, 2026.[82]

The IRA also established or expanded tax credits for clean energy production and energy efficiency. Previous tax credits for renewable energy generation were set to expire, so the IRA established a Clean Electricity Production Tax Credit with a base credit of 0.3 cents per kilowatt hour and a Clean Electricity Investment Tax Credit with a base credit of 6 percent of qualified investments for energy facilities producing renewable and clean power in 2025 and beyond.[3] The tax credits were designed to spur clean energy development across the country, lowering costs and helping to reduce greenhouse gas emissions in the energy sector. H.R.1 restricted both tax credits. Qualifying wind and solar facilities must begin construction before July 6, 2026 or begin producing electricity before January 1, 2028; other facilities are required to begin construction before 2033.[83]

Clean energy developers, including those in Oregon, have used tax credit programs to make their projects more feasible. The changes in H.R.1 meant that Oregon developers may have to meet accelerated timelines for energy facilities if they want to take advantage of the tax credit program(s). In response to the timeline change, Governor Kotek issued Executive Order 25-25 in October 2025 to accelerate wind and solar energy development in advance of the federal clean energy tax credits ending.[84] The order directed executive branch agencies, including the Oregon Department of Energy, to take actions to "accelerate and prioritize siting and permitting reviews, approvals, and processes necessary to expedite the permitting and development of solar and wind energy projects in Oregon that seek to qualify for federal clean energy tax credits." It also directed ODOE and the Energy Facility Siting Council to consult with developers to identify process changes within statutory authority that could help projects meet the federal tax credit deadline. ODOE and EFSC conducted outreach in late 2025 and early 2026 and have been working with developers to facilitate meeting the tax credit deadlines.

Executive Order 25-29: Accelerating Clean Energy Projects and Infrastructure

In addition to Executive Order 25-25, Governor Kotek also issued EO 25-29[85] in 2025 on reducing greenhouse gas emissions and advancing Oregon's clean energy future. The EO directed state agencies to "prioritize implementation of the Oregon Energy Strategy pathways," including getting clean energy projects built.



In September 2026, the Oregon Department of Energy submitted three major deliverables required under Governor Kotek's Executive Order 25-29: a report on Siting and Permitting Large-Scale Electricity Infrastructure, a report on Reducing Barriers to Clean Energy Deployment, and a Proposed Framework for Strategic Transmission Siting. Together, these reports and proposed framework address the issue of how to accelerate the pace at which clean energy projects and associated transmission infrastructure are permitted, built, and brought online in Oregon. These efforts will ultimately

support access to the energy needed for Oregon homes and businesses to continue to grow and thrive.

As articulated in the Oregon Energy Strategy and amplified in the executive order, demand for electricity is rising far faster than in recent history, driven by new data centers along with electrification, industrial growth, and climate change-driven reliability challenges. At the same time, many state-approved clean energy projects are struggling to move into construction because local and federal permitting processes are stressed, interconnection timelines and costs are increasing, supply chains are constrained, and the transmission system has become a limiting factor for nearly every major project. EO 25-29 asked agencies to diagnose these challenges and propose a coordinated, proactive state response. Alongside the Department of Land Conservation and Development's report, Accelerating Clean Energy Deployment Through Oregon's Land Use Planning Framework, ODOE's documents fulfill that directive and recommend concrete steps the state can take today to help meet this challenge.

Each document addresses a different stage of project development, but they collectively outline a roadmap to support EO 25-29's directive to "get clean energy projects built" and advance key elements of the Oregon Energy Strategy. The Oregon Department of Energy stands ready to act as quickly as we can on these recommendations, working in concert with leadership, other natural resource agencies, Tribes, state and local governments, developers, the public, and the legislature to continue balancing energy needs and impacts for current and future generations.

https://energystrategy.oregon.gov/implementing-the-strategy

Investor-owned electric utilities in Oregon have also expressed concerns about how the eliminated tax credits will affect efforts to transition to clean electricity – and meet the 100 percent clean electricity target outlined in HB 2021. In its 2025 Clean Energy Plan, PacifiCorp states "H.R. 1 would phase out and repeal these tax credits for new resources. If passed, all solar, wind, storage, and clean hydrogen facilities would no longer receive either production or investment tax credits if they are unable to achieve COD within the timelines being debated in Congress. This would have a material implication on the costs to comply with Oregon policies, including HB 2021 and the elimination of coal resources by 2030."[86] Portland General Electric states in its Integrated Resource Plan 2025 update, "Essential federal tax credits have been targeted for elimination by US Congress – could increase renewable costs by at least 30-50% or more."[87]

Project Cancelations

On October 1, 2025, the U.S. Department of Energy announced it was terminating 321 financial awards totaling nearly $8 billion that would have supported 223 energy projects and programs across the country, including in Oregon. In its announcement, U.S. DOE claimed the projects "did not adequately advance the nation's energy needs, were not economically viable, and would not provide a positive return on investment of taxpayer dollars."[88]

Reaction to the announcement was swift, with critics pointing out that the terminated projects were located in Democratic-run states.[89] Oregon was estimated to lose about $405 million in federal grants tied to energy and climate action; the awards were for 13 organizations across the state.[90] Portland

General Electric had three grants totaling over $60 million; other organizations were set to lose grants between $1-30 million. As noted above, the Pacific Northwest Hydrogen Association's $1 billion award was also terminated. The largest grant in Oregon was $250 million to develop a regional transmission project connecting areas east and west of the Cascade Mountains awarded to Warm Springs Power Enterprises, an enterprise wholly owned by the Confederated Tribes of the Warm Springs. Although initially listed as terminated, following review by the current Administration, the grant was allowed to move forward and continues to be honored.[91]

Portland General Electric was the prime awardee for three grants terminated in the U.S. DOE announcement, totaling over $60 million. U.S. DOE communicated that it would like to reinstate PGE's financial assistance for one of those grants, and PGE is evaluating the benefits and risks of reinstating the grant for approximately $45 million in total funding.

Several states and coalitions sued the U.S. DOE after the announcement in an effort to restore the billions in grants. In January 2026, a federal judge ruled that the administration violated the Fifth Amendment in canceling the grants because the cancelations were based on whether the projects were located in "blue" states.[92] While that particular lawsuit didn't cover all of the $8 billion in grants, a second lawsuit was filed in March 2026.[93]

In April 2026, the U.S. DOE announced it would "retain or modify" billions of dollars in grants that had been previously terminated or under scrutiny, including many of the projects canceled in October 2025.[94] Among the retained or modified awards are many Oregon-based awards, including for the Warm Springs Tribe, Portland General Electric, PacifiCorp, universities, nonprofits, and businesses;[95] [96] however, uncertainty remains around the status of the projects on the "retain or modify" list.

Conclusion

Oregon has been a leader in promoting clean energy and efficiency since the 1970s and became the first state to set a price on carbon in 1997.[v] Through setting standards, establishing foundational policies, and distributing funding, the federal government has been an important partner to the state. Federal policies and priorities naturally fluctuate with changes in administration over time. In recent years, changes to policy, programs, and funding have been particularly drastic, and have increased regulatory uncertainty and removed tools that Oregon jurisdictions, businesses, and households use to support progress on clean energy and climate change that prioritizes reducing barriers and increasing benefits to environmental justice and climate-affected communities.

In 2023, the Oregon Department of Energy undertook a modeling effort to assess Oregon's progress towards meeting the state's greenhouse gas reduction goals; ODOE found that the state had the program and policy infrastructure in place to meet its 2035 goal. In late 2025, ODOE updated the forecast, taking into consideration changes to the energy landscape – including increasing electricity demand as well as changes at the federal level. The updated forecast found that Oregon is no longer positioned to meet its 2035 greenhouse gas reduction goals. It's clear that if Oregon is going to close the gap between the projected emissions levels and where the state wants to be in 2035 and 2050,

[v] Learn more about Oregon's carbon standard: https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=323651

Oregon is going to have to step up with its own measures and, at least in the short term, will have little assistance from the federal government. Not only does this present a challenge to emissions reduction efforts, the reduction in federal funding will also increase the cost of these efforts for Oregonians.

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Fund for Oregon Resilience, Growth, and Energy (FORGE) Act: An Analysis of SB 1526 (2026)

Senate Bill 1526 (2026) would have taken the initial steps toward establishing an institution to provide funding tools for energy projects, similar to institutions in many other states. SB 1526 was introduced by the Senate Energy and Environment Committee and led by Senator Janeen Sollman. It was drafted by a work group brought together by Senator Sollman and passed out of committee with bipartisan support. However, the bill did not move out of the Ways and Means Committee prior to the adjournment of session.

Key Takeaways

- Many states have programs or institutions that provide low-cost loans and other financing mechanisms to support clean energy projects.
- SB 1526 proposed taking first steps toward establishing an entity in Oregon for the purpose of financing clean energy and resilience projects.
- While the bill came from a work group process and passed its initial policy committee with bipartisan support, it did not pass out of budget committee.

Background and Context

The Oregon Energy Strategy found that "a stable source of financing is critical to support the pace and scale of investment required to both reduce greenhouse gas emissions and enhance resilience to climate impacts." In 26 states, a clean energy fund provides such a funding source, sometimes part of a state agency and sometimes not.[1] Model programs include the Massachusetts Community Climate Bank, which is part of the state's housing agency, and the Connecticut Green Bank, which is described as a quasi-public agency.[2] [3]

Oregon has had clean energy loan programs in the past but currently lacks a program with the necessary scale and focus to meet state and local clean energy goals. Subsequently, legislators have introduced bills that would have created new energy-focused financing mechanisms, including cap and invest legislation (e.g., HB 2020 from 2019) and clean energy fund concepts.[4] In recent years, a work group had been meeting, most recently convened by Senator Sollman, and the legislature held informational hearings on the topic.[5]

Legislation Overview

SB 1526 would have directed ODOE to apply for funding from the Environmental Restoration Council to carry out initial work toward creating a nonprofit entity to finance clean energy and resilience projects in the state.

Given the budget dynamics facing the state during the 2026 legislative session, supporters of this concept developed a creative funding mechanism to get a new program started. A settlement with Monsanto had yielded $698 million, which was used to establish the Oregon Environmental Restoration Fund.[6] [7] The bill directed ODOE to apply to the Environmental Restoration Fund or other

sources for the funding required to carry out the elements of SB 1526. If the agency did not receive an award from that application, no further work would be done.

If ODOE were to secure sufficient funding, which was listed as at least $2 million in the bill, then the agency would recruit and convene an eight-member founding board, including the Director of the State Department of Energy, the Director of the Oregon Business Development Department or the director's designee, the Director of the Housing and Community Services Department or the director's designee, four members who represent nongovernmental organizations, and one member who represents a labor organization. The bill laid out other criteria for board members to ensure diversity and expertise across its membership.

The board, once appointed, would have been directed to form a nonprofit to facilitate the financing of clean energy and resilience projects. The bill also required an annual report from the new nonprofit to the Legislature. Once the nonprofit entity was established, Business Oregon and ODOE would have been required to work with the entity to support its work, with all agencies required to assist.

Perspectives and Outcomes

Supporters of SB 1526 included associations representing contractors, clean energy and environmental organizations, local governments, and climate advocates. In testimony, these supporters focused on the potential for economic development should the FORGE Act be established. For example, the Oregon Environmental Council and Climate Solutions put in joint testimony citing the success of clean energy funds in other states, pointing out that since launching in 2011, the Connecticut Green Bank has helped create more than 30,500 jobs, lowered energy costs for more than 8,500 businesses and 69,000 households, and generated an investment leverage ratio of $6.70 for every dollar spent.[8] [9] Several associations representing contractors submitted testimony in support, citing potential job creation and other economic growth, including the Northwest Native Chamber, Oregon Solar and Storage Industries Association, Building Potential, and more.[10–12] Another perspective raised by the Nature Conservancy pointed out that "Oregon has no shortage of plans, strategies, programs, and policies…that point to strategies and recommendations on what and where we need to invest; yet we often don't have enough funds to do the work."[13]

Opponents of the bill, or more commonly those who were neutral on the bill but had concerns, included members of the public, a think tank, and representatives of Oregon's consumer-owned utilities. These parties raised several potential issues with the legislation. While the bill specifically targeted the use of settlement funds from the Monsanto lawsuit, there were concerns that taxpayers may end up funding the work. A county commissioner pointed out that the existence of many different possible sources of funding created a burden on local governments as they would have to apply to each source and understand varying requirements.[14] Associations representing Oregon's consumer-owned utilities made specific requests for changes to and clarifications of the bill language.[15]

Even though the bill did not impose costs on the General Fund, it did not move out of the Ways and Means Committee and ultimately did not pass.

Conclusion

While SB 1526 was not successful in the 2026 session, the bipartisan support it received demonstrates that there is interest in financing tools that can support a variety of project types across energy, resilience, and restoration. Similar legislation in future legislative sessions seems likely.

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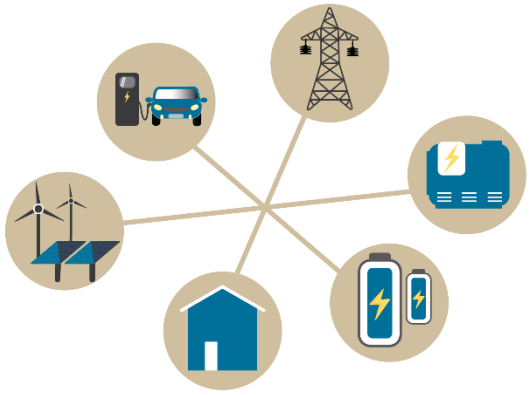
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Expanding Virtual Power Plants: An Analysis of SB 1582 (2026)

Senate Bill 1582 was proposed in the 2026 Legislative Session and would have required utilities to expand their virtual power plant programs and partner with third-party aggregators[i] to increase the pace at which virtual power plants are developed in Oregon. A similar bill, HB 3609, was introduced in 2025. SB 1582 was championed by Senator Courtney Neron Misslin; Representatives Mark Gamba, Sarah Finger McDonald, Dick Andersen, and Sue Rieke Smith also served as chief sponsors. The bill had a public hearing in the Senate Energy & Environment Committee but did not receive a vote to move out of committee.

Background and Context

Virtual power plants provide services to the grid by aggregating, coordinating, and utilizing distributed energy resources like smart appliances, grid interactive buildings, rooftop solar, battery storage systems, and electric vehicles. Utilities can use these customer- or utility-owned resources to provide power and better manage grid operations during periods of peak demand. This could provide financial benefit to customers for the use of their resources while also benefitting ratepayers.



Virtual power plants are currently legal in Oregon and are developed by utilities, which work with third parties including device manufacturers, installers, and aggregators, to enroll customers and operate these resources. Portland General Electric's VPP includes approximately 230,000 participating customers and roughly 600 megawatts of capacity.

Legislation Overview

SB 1582 would have changed how Oregon's investor-owned utilities develop virtual power plant programs, referred to as distributed power plant programs in the bill. Participating customers with batteries, load control devices such as smart thermostats, and electric vehicles would be offered payment, for five years or longer, to provide grid services to the utility. These services include reducing peak load, providing renewable energy for peak demand, deferring transmission and distribution system costs, and providing voltage support, emergency services, or any other services approved by the Oregon Public Utility Commission.

The legislation would also have required investor-owned utilities to offer standard, open access terms for customers or outside entities, to provide grid services. An aggregator is an entity that enrolls and coordinates multiple customer-owned energy resources so they can be operated together as a single resource; both utilities and third parties – such as contractors or manufacturers – can perform this function.[1] Under the bill, they would have been able to receive and manage all contracted program payments and customer participation, including customer compensation and incentives. As part of

[i] An aggregator is an entity that enrolls and coordinates multiple customer-owned energy resources so they can be operated together as a single resource. Both utilities and third parties can function as an aggregator.

VPP operations, the contracting utilities would have been allowed to communicate with and control customer devices but would also have been responsible for the costs of any necessary metering device upgrades. SB 1582 would have allowed utilities to provide a higher level of upfront payments for low- and moderate-income customers participating in a VPP program. Utility costs incurred in the program could have been recoverable through rates.

The bill directed the Oregon Public Utility Commission to review and approve or modify distributed power plant programs submitted by utilities, as well as to develop utility procurement targets and incentives for each five-year period of program operations. Utilities would have been required to report on progress toward procurement targets on an annual basis.

Perspectives and Outcomes

Supporters of SB 1582 included solar contractors and advocates, climate advocacy groups, and members of the public. They focused on various aspects of virtual power plants and their benefits. A one-pager for the bill submitted by 18 organizations mentioned that the policy change could save ratepayers money, make the grid more resilient and efficient, and help Oregon meet its energy and climate goals.[2] Other supporters, such as Columbia Riverkeeper, focused on how more virtual power plants and distributed resources would avoid the need to build larger, more expensive electricity generation projects.[3]

Opponents of SB 1582 included utilities and large industrial energy consumers. For example, Portland General Electric raised concerns about specific design elements of the bill, including provisions limiting the Public Utility Commission's review authority.[4] They also expressed concerns about workload at the OPUC, which is implementing several bills passed in 2025, and about paying more than the value the resource delivers. The Alliance of Western Energy Consumers was concerned that the bill would raise rates for large employers and also felt that the process behind this concept was too rushed for short session to allow for an analysis of cost impacts.[5]

SB 1582 was also expected to have a fiscal impact on the Public Utility Commission. While agency costs to implement new bills are to be expected, with limited resources available to lawmakers in 2026, very few bills with a cost could be passed within the budgetary constraints.

Conclusion

While SB 1582 did not pass, there is continuing interest in virtual power plants. This legislative concept or something similar may be seen in future legislative sessions, and work on virtual power plants by Oregon utilities is expected to continue.

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Policy Briefs

The primary purpose of the Biennial Energy Report is to inform local, state, regional, and federal energy policy development, energy planning, and energy investments, and to identify opportunities to further the state's energy policies.

Energy policy has implications for nearly every aspect of society. It influences our economy, infrastructure investments, land use choices, human health, air and water quality, and our pocketbooks. Understanding these influences is the purpose of the policy briefs in the Biennial Energy Report. These topics provide a comprehensive and statewide view of energy issues and policy discussions. "Energy" includes many intersecting systems that generate and distribute electricity to end-users, and that store and distribute fuels for home-heating, industrial processes, and transportation. It also includes the critical infrastructure, facilities, planning, and energy management that support these systems. A key consideration in analyzing the energy system is providing an assessment on how energy policy choices affect the equitable distribution of benefits and burdens to Oregonians.

This section of the report provides insights on energy topics that are being discussed in legislatures, city councils, communities, and homes. This year's report includes a review of the effects of data centers on Oregon, highlights some of Oregonians' concerns, and analyzes options to address them. It also includes a deep dive on transportation electrification for large trucks and buses, and how these could also support electric grid reliability, as well as a discussion about the potential in Oregon for sustainable aviation fuel to help reduce greenhouse gas emissions from the aviation sector. These policy briefs can be read as standalone documents, and there are cues in each discussion to point the reader to information and data found in other parts of this report or others that can provide additional background and insight.

ODOE has produced many policy briefs in previous Biennial Energy Reports and other standalone studies. You can find links to these and other data and analysis on ODOE's website.

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Data Centers and Oregon's Energy System

Data centers have become a major electricity load and one of the largest new sources of demand driving projected load growth for the Pacific Northwest.[1] Oregonians are seeing rapid development that is raising questions about energy, water use, land impacts, and effects on communities. This interest is shown in public meetings, media coverage, and direct inquiries to the Oregon Department of Energy. The pace and scale of this growth, combined with limited accessible Oregon-specific information, makes this an important and timely topic.

Bring Your Own Generation



Bring Your Own Generation[2] refers to the construction or procurement of electricity generation facilities specifically to serve a data center campus. These energy facilities can be located on-site at the data center, adjacent to the data center campus, or elsewhere on the grid.

This type of arrangement can protect retail customers from potential adverse reliability impacts associated with supplying power to large data center loads. However, it may also increase costs for retail customers when data centers outbid utilities for new generation projects, driving up market prices for those resources.

Data center developers find benefits in this strategy because it can enable them to begin operations more quickly than if they had to wait for the local utility to supply electricity. It also provides more independence from grid outages and direct control over the types of generation built, which can include distributed energy resources, microgrids, battery storage and fuel cells.

Data Center Basics

Data centers are the engines of the digital world. Every search query, streamed movie, online purchase, satellite image, virtual meeting, and artificial intelligence model depends on rows of computers running inside data center facilities. At its core, a data center is a physical building designed to house thousands of servers operating continuously every hour of the day.[3]

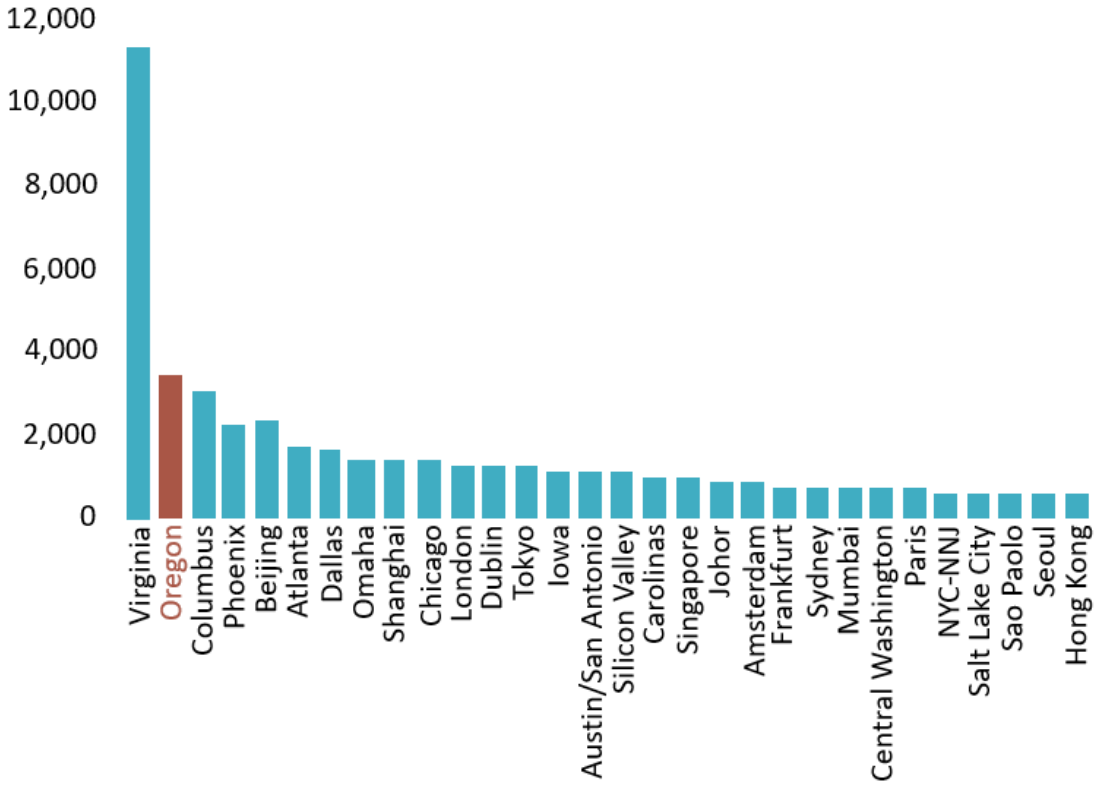
A modern data center is a fully engineered ecosystem. The computing equipment is only one piece. These facilities also depend on an intricate network of electrical systems, cooling technologies, and fiber-optic connections that all must work in lockstep.[4]

Even though they usually have large, often diesel-powered, backup generators, the daily operations of data centers rely on the electric grid. Generators are a safety net, used during testing and maintained for outages, but are not responsible for serving the continuous load of the facility.

Data centers come in several distinct forms; each built for a different purpose and scale of computing. While they share the same core function —to run digital infrastructure — their designs, sizes, and impacts vary widely. The U.S. Department of Energy groups them into five common categories, though other organizations may define data centers slightly differently:[5]

- **Modular/container** data centers are portable, factory-built units that can be deployed quickly in remote, temporary, or emergency scenarios. They typically use 0.1-2 megawatts of power and allow the addition of computing capacity in scalable increments.
- **Edge/micro** data centers are small, local facilities placed close to users or data sources to improve internet speed. These units often support telecommunications, emergency services, and real-time applications. Their power needs are typically under 1 MW.
- **Enterprise** data centers are medium-to-large facilities built and operated by a single organization for its internal IT needs. These sites are designed for security and customization and generally range from 1-10 MW.
- **Colocation** data centers provide shared space where multiple businesses lease racks or rooms while the operator provides power, cooling, and connectivity. These are large, multi-tenant buildings typically consuming 5-50 MW.
- **Hyperscale** data centers sit at the far end of the spectrum. These facilities support massive cloud, AI, and storage operations. They are engineered for high efficiency, extremely large computing footprints, and heavy power demand — often 50-200 MW per site or more.

Figure 1: Top Data Center Markets by Operational IT Load (2026)[6]



Source: Cushman & Wakefield Research, datacenterHawk , DC Byte

Why Oregon Attracts Data Centers

Table 1: Data Center Markets from Largest to Smallest by Total Megawatts[6]

Operational Market Size	Under Construction
Virginia	Virginia
Oregon	West Texas
Columbus	Atlanta
Phoenix	Dallas
Beijing	Columbus
Atlanta	Phoenix
Dallas	Reno
Omaha	Oregon
Shanghai	Iowa
Chicago	Austin

Data centers did not arrive in Oregon all at once, and their footprint in the state is the result of gradual expansion. Oregon's role in the sector began in earnest in 2006, when Google built its first facility outside California in The Dalles.[7] At the time, data centers often drew between 20 and 50 MW of electricity. New facilities now routinely require 50 to 250 MW, and next generation data centers proposed in Morrow County exceed 1,000 MW.[8] [9] This scale of electricity use is creating additional pressures on grid operators when preparing for future infrastructure buildout.

Oregon is becoming well-known as a state with an established presence of data centers.[10] Global rankings show Oregon in the upper tier of localities with data centers. Estimates of market size range from 2,200 MW – 3,600 MW of operational data centers.[11] This capacity places the state firmly as the second operational market in the United States, behind Virginia, which now exceeds 11,000 MW of active load.[6] [12] While Oregon's current position is significant, its long-term standing is likely to shift: several emerging markets are seeing expanding data center capacity at a much faster pace.[6] As these regions scale rapidly, Oregon's relative position may transition to a more mid-sized market over time, shaped by changes in energy availability, infrastructure constraints, and opposition from local communities.

Several conditions have made Oregon an attractive location for data center development:

- Affordable, reliable hydropower and access to new renewables that helps companies meet climate commitments[13]
- A relatively mild climate that supports energy-efficient cooling
- A tax structure without sales tax, combined with enterprise zone property tax incentives that can reduce operating costs[14]
- Strong fiber networks and access to subsea cables that provide high capacity, low-lag connectivity
- An established ecosystem, often described as "data gravity," that encourages companies to expand where infrastructure, expertise, and supply chains are already in place.

Oregon's Data Center Advisory Committee

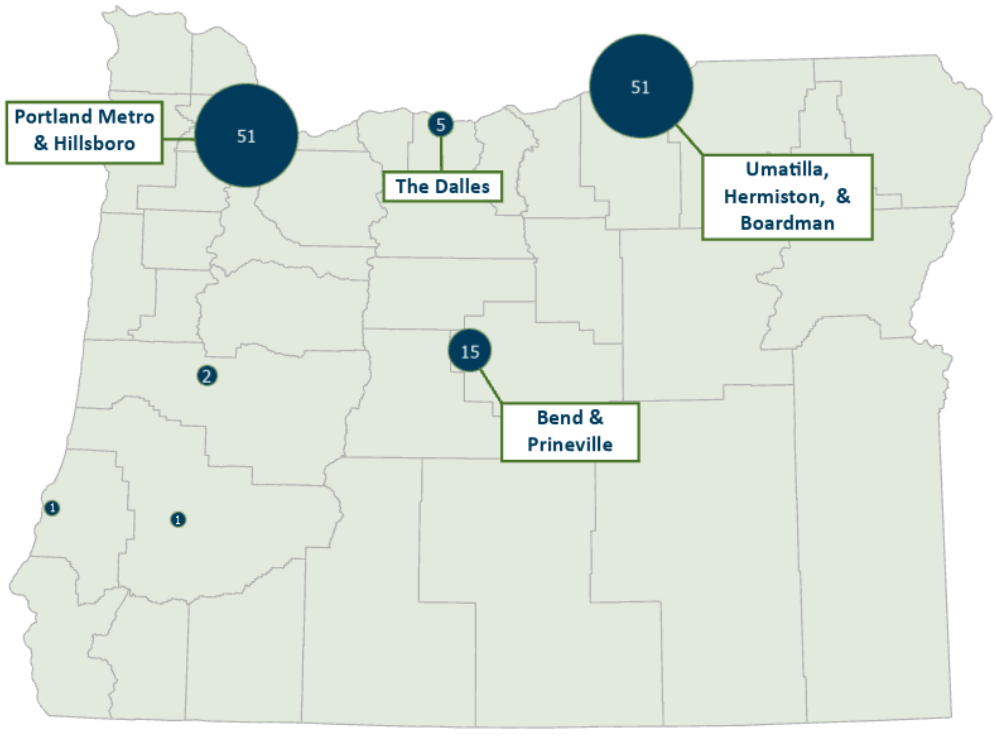
Governor Tina Kotek established the Data Center Advisory Committee in 2026 to develop recommendations for a comprehensive regulatory framework to guide data center development in Oregon. The committee's charge is to identify strategies that support economic opportunities while ensuring that utility costs, infrastructure investments, and environmental impacts remain sustainable and equitable for all residents, including low-income and working families.

Geography of Oregon's Data Center Growth

Over the past 25 years, Oregon's data center landscape has expanded in ways that reflect both the evolution of the industry and the constraints of the state's own infrastructure.

In 2000, Oregon hosted just eight known data centers, nearly all concentrated in the Portland metro area. As the industry matured and power-intensive hyperscale development took hold, growth shifted eastward to regions with more available land.[15]

Figure 2: Map of Data Center Locations in Oregon



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Hyperscale Facilities in Oregon in 2025

By the early 2010s, the Umatilla Basin emerged as the state's primary hub for large-scale development. This shift accelerated as hyperscale operators sought sites where utilities could support clustered loads and where local land use conditions were more compatible with large campus footprints. Central Oregon followed a similar trajectory by 2020, becoming a major development center as operators expanded beyond land-constrained metro areas. As of the publication of this report, Oregon hosts more than 120 facilities statewide, including 61 hyperscale installations concentrated in three regions: the Umatilla Basin, Prineville, and the Portland Metro area.[15]

Community Responses Across Oregon

Oregon communities are experiencing data center growth in very different ways, weighing opportunities for economic benefits, job creation, and infrastructure improvements alongside questions about land use, energy demand, and environmental impacts.

Perspectives from Tribal Governments:

Some Tribal Nations and Inter-Tribal organizations have emphasized the deep cultural and ecological impacts of data center expansion, particularly on water systems, fish habitat, and treaty rights. In a May 2026 presentation to the Oregon Data Center Advisory Committee, the Columbia River Inter-Tribal Fish Commission (CRITFC) expressed concerns over the potential that rapid increases in electricity and water demand from data centers could threaten instream flows and groundwater levels that are crucial for salmon and steelhead. They warned that surging peak loads can destabilize the grid, triggering emergency protocols that may suspend fish protections at federal dams. CRITFC called for holistic management of groundwater and surface water, and energy planning that prioritizes efficient cooling and wildlife-friendly hydropower to prevent further degradation of salmon habitat.[16]

Hillsboro: Halting Data Center Expansion

In response to growing community concerns over rapid data center expansion, Hillsboro City Council unanimously adopted a 120-day moratorium on land use applications for data centers and battery energy storage development starting July 27, 2026.[17] This was the first city council in the state to enact such measures.[18] The pause is intended to allow staff to research economic and environmental impacts, gather public input, and develop code updates addressing where and how such facilities should be sited.[17]

Umatilla Basin: Embracing Data Centers

Since Amazon Web Services (AWS) first arrived to Eastern Oregon in 2011, it has emerged as a mobilizer of economic development for the local economy.[51] Between 2012 and 2025, AWS invested approximately $54.8 billion in Morrow and Umatilla Counties, adding over $15.4 billion to the local GDP and supporting nearly 2,500 direct full time jobs.[20] Local leaders, such as former Mayor of Hermiston, Dr. Dave Drotzmann, noted that the Amazon payments added community assets, including a water tower and new city hall, without the use of additional taxpayer dollars.[21]

Perspectives from State Leadership

In late July 2026, Governor Tina Kotek directed the cancellation of a proposed $5 billion sale of 32 acres of state land for a data center project in Salem, emphasizing that state actions must reflect Oregon's values and serve the public interest.[22] The decision came amid significant backlash at a Salem City Council meeting where hundreds of residents joined hours-long testimony raising alarms over water usage, land use, and environmental consequences.[23] Shortly afterward, Governor Kotek publicly supported locally enacted moratoriums on new data center projects and has called for a statewide pause on new data center development until standards are put in place.[24]

In October 2026, Governor Kotek directed the Oregon Department of Environmental Quality to pause air and water discharge permit processing and issuance for new or expanding data centers until July 1, 2027 to allow time to "digest recommendations forthcoming from the Advisory Committee, and to

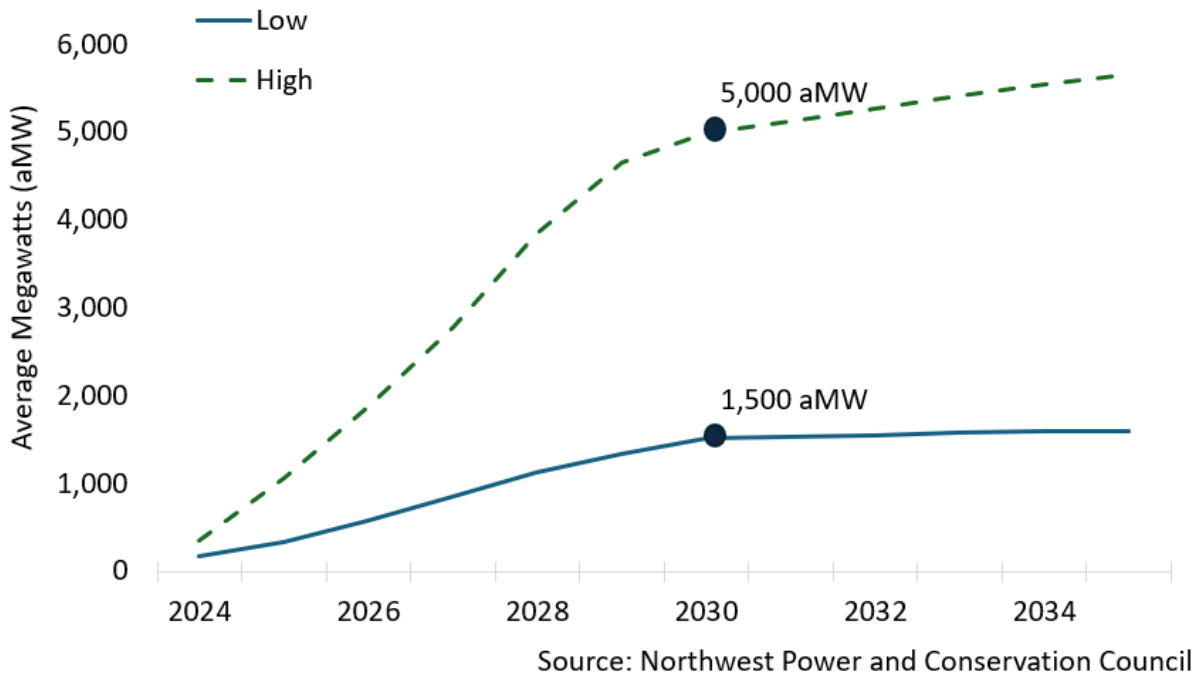
provide space for policy and/or regulatory reforms that may be considered in the upcoming 2027 session of the Legislature."[60]

Future Electricity Demand from Data Centers

Oregon is entering a new phase of data center development, and the amount of electricity these facilities may need in the coming years is significant enough to reshape how the region plans its future power system. Even though the exact number is uncertain, the trend is unmistakable: data centers are, and are likely to remain, one of the largest sources of new demand on the grid.

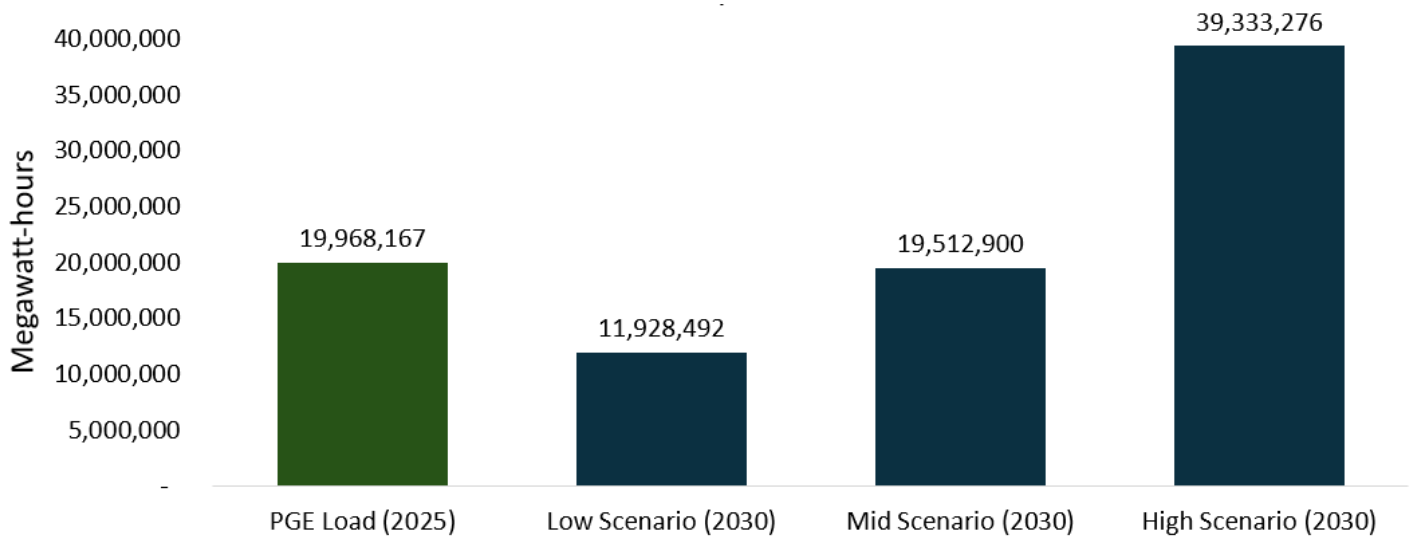
Forecasts from the Northwest Power and Conservation Council indicate that by 2030, new data centers across the Pacific Northwest could require **1,500 and 5,000 average MW** of continuous electricity.[25] Several factors contribute to this wide range of forecasted demand. Companies often submit interconnection requests in multiple jurisdictions when seeking a location to site but don't end up building in all of those locations.[26] Utilities also lack clear visibility into how quickly AI-related computing needs will grow, or whether and to what extent hardware efficiency improvements might offset rising consumption. At the same time, cooling technologies and facility designs are evolving rapidly, making it difficult to predict facility-level loads a decade ahead.

Figure 3: Data Center and Semiconductor Incremental Load Growth in the Pacific Northwest[25]



To illustrate the scale of this potential growth, the Council's forecast can be compared with Oregon's largest electric utility, Portland General Electric, and its total electricity sales in 2025.[27] Since the Council's projection are expressed in average megawatts, the value must be converted to annual megawatt-hours, the standard measure of annual energy use, for an apples-to-apples comparison. A 90 percent utilization rate was also applied. Under this conversion, the forecasted range of 1,500 to 5,000 average megawatts becomes approximately 11.9 million to 39.3 million megawatt-hours per year. For comparison, PGE delivered 19.9 million megawatt-hours in 2025.

Figure 4: Portland General Electric Load Compared with Data Center Forecasts (in megawatt-hours)



This means that, by 2030, the lower end of the data center forecast represents roughly two-thirds of PGE's current annual electricity sales, while the upper end is about double PGE's annual demand. Put simply, the electricity required to power new data centers alone could grow to an amount comparable to, or twice as large as, the total electricity needs of PGE's system today.

Because of this potential scale, regional energy planners, utilities, and policymakers are increasingly treating data center growth as a defining factor in Oregon's long-term energy outlook. To account for these emerging needs, ODOE incorporated the Council's mid-range load estimates into the Oregon Energy Strategy modeling.[28]

Oversight of Oregon's Data Centers

As data center development accelerates, Oregon's response is shaped by a multi-layered governance system that includes state agencies, local governments, community-owned and investor-owned utilities, and regional federal authorities, like Bonneville Power Administration. These institutions collectively determine how large new loads are evaluated, permitted, regulated, and integrated into the power grid.

Key Institutions and their data center-related activities

Oregon Department of Energy: Provides statewide energy analysis, implements the Oregon Energy Strategy and Building Performance Standard, and permits large-scale energy facilities that could be used to power data centers.

Oregon Public Utility Commission: Regulates investor-owned utilities, including resource planning, reliability requirements, cost allocation, monitoring progress toward clean electricity targets, and large-load interconnection approval. The OPUC also administers Oregon's POWER Act, which requires data centers served by investors-owned utilities in Oregon to be treated as a distinct customer class and ensures the new customer class pays for their proportionate share of the costs incurred to serve them.[28] [29]

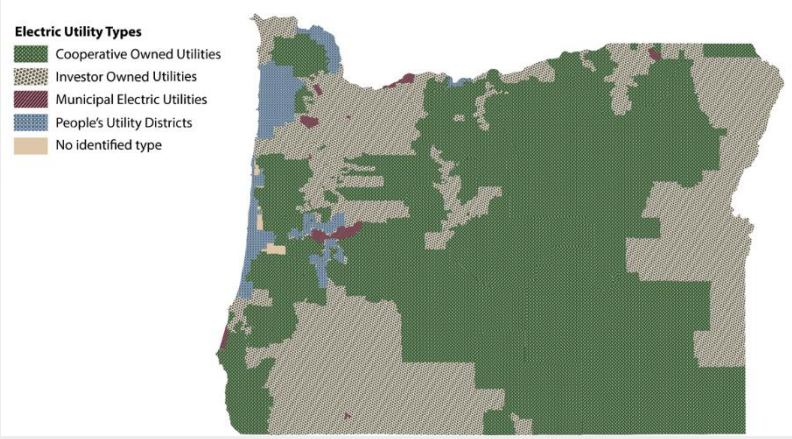
Oregon Department of Environmental Quality: Regulates air quality and emissions from stationary sources, including diesel backup generators at data centers and water quality for discharged wastewater. DEQ administers air and water quality permits and tracks greenhouse gas emissions from electricity suppliers.[31]

Oregon Department of Land Conservation and Development: Oversees statewide land use planning and monitors development trends, including the rapid expansion of data centers in Oregon.[32]

Local Governments: Evaluate and approve data center siting through zoning, land-use permitting, infrastructure impact review, and community-based planning processes. They provide critical on-the-ground perspectives on how new developments fit within local infrastructure capacity and land-use goals.[33]

Oregon's Utility Structure

Oregon is served by both investor-owned utilities (regulated by the OPUC) and consumer-owned utilities such as public utility districts, cooperatives and municipal utilities (regulated locally). This split results in different planning, cost-allocation and clean-energy requirements depending on service territory.



Consumer-Owned Utilities[i]: Specifically, Umatilla Electric Cooperative and Northern Wasco County PUD manage large loads through distinct rate classes, cost-allocation studies, and infrastructure investments.

Bonneville Power Administration (BPA): Oversees transmission planning within their territory, interconnection processes, and major grid-expansion initiatives that serve transmission and electricity demand across the region. BPA's transmission decisions shape siting feasibility and long-term capacity for data center regions in Oregon.[34] Additionally, BPA manages the sale and distribution of hydropower from federal dams, although much of the data center power needs are served by individual utilities.[35]

Northwest Power and Conservation Council: Develops a regional power plan that guides Bonneville and the broader Northwest on meeting future electricity needs with an adequate, efficient, reliable, and cost-effective resource mix. The 9th Power Plan responds to rapid load growth and increasing uncertainty by outlining a balanced portfolio of conservation, renewables, storage, and flexible generation to maintain system adequacy while supporting clean-energy and fish-and-wildlife objectives.[1]

[i] This includes electric cooperatives, municipal utilities, and people's utility districts.

Examples of Statewide Policies and Planning Tools

Building Performance Standard: Statewide program designed to reduce energy use in large commercial and public buildings by improving operational efficiency over time.[36]

HB 2021 (2021): Establishes clean electricity targets for large investor-owned utilities and electricity service suppliers, requiring 100 percent zero-carbon electricity sales to customers in Oregon by 2040 and prohibiting siting of new fossil fuel emitting power plants 25 MW or larger.[37]

HB 3546 POWER Act: Directs the Oregon Public Utility Commission to establish a dedicated service classification and tariff schedule for large energy users (i.e., data centers). It also directs OPUC to require investor-owned utilities to assign infrastructure costs and contractual obligations directly to those large new loads, unless broader system benefits are proven.[30]

Oregon Energy Strategy: Establishes pathways for meeting future load growth through efficiency, clean electricity, electrification, low-carbon fuels, and resilience. It provides recommended actions the state can take to meet its energy objectives and climate goals.[38]

Transformational Integrated Greenhouse Gas Emissions Reductions (TIGHGER) Project: Evaluates progress toward statewide greenhouse gas goals and identifies potential "gap measures" if emissions reductions are not expected to meet state goals. [39]

Emerging Pressures & Opportunities for the Energy System

Oregon's energy system is complex and interconnected. Every part of it, including generation and transmission to distribution, reliability planning, and clean energy policy, depends on the others functioning in balance. The scale of today's data center growth has the potential to stress multiple points of this ecosystem at once. Understanding the most significant risks requires looking across the full system to identify where strains are likely to appear first and what they mean for planning.

The key areas of concern include:

- **Significant electricity demand:** Very large, continuous loads that exceed historical planning assumptions and reshape long-term resource needs.
- **Rapid increases in system peak load:** Higher peaks that require utilities to accelerate capacity additions to maintain reliability.
- **Transmission and interconnection constraints:** Limited transmission capacity and long lead times for building out infrastructure create bottlenecks for resource development to serve new loads.
- **Reliance on on-site diesel backup generators:** Localized air quality, permitting, and community impact challenges tied to large fleets of backup engines.
- **Alignment with statewide clean-energy and climate goals:** Rising load that outpaces existing emissions-reduction trajectories and creates policy gaps.

Significant Electricity Demand

The continued expansion of data centers introduces a scale of electricity demand growth that is unprecedented in Oregon's history. Individual facilities routinely exceed 50 to 250 megawatts, and the next generation includes proposals surpassing 1,000 megawatts.[9] These developments exceed the

levels of infrastructure growth utilities have planned for in the past and can pose reliability risks. The Oregon Public Utility Commission has underscored this noting that "a load of 100 MW or more places unique burdens on the system and thus on other customers… [including] raising costs across the region by utilizing relatively scarce clean energy generation projects or limited transmission capacity," making these impacts difficult to isolate.[40]

Although rapid growth presents challenges for system planning and reliability, the steady, predictable baseload demand associated with data center facilities can also create opportunities for utilities to procure and develop new clean energy resources at scale. This type of sustained demand can support investments not only in clean generation, but also in the transmission and distribution infrastructure required to deliver that power. The passage of the POWER Act further ensures that the industries driving these infrastructure needs contribute their fair share.[41]

Emerging Best Practices in Data Centers

Several emerging operational practices offer opportunities to reduce energy use, water consumption, and local environmental impacts in data centers. Examples include:

- **Liquid Cooling**: Refers to a number of different cooling approaches, including direct-to-chip cooling, immersion cooling, etc., that transfer waste heat to a fluid at or near the point the heat is generated instead of transferring it to room air.[31] This method reduces the size and power consumption of fans serving the data center and has been shown to produce energy savings of 10-20 percent.[41] [42] In areas where water is scarce, best practices are emerging that optimize both water use and energy efficiency.
- **Battery Energy Storage Backup Power:** Backup power is essential for data center power continuity in the case of a grid outage.[33] Traditionally, data centers use diesel generators.[34] However, without additional environmental control equipment, diesel generators create measurable noise pollution for nearby communities and local wildlife, as well as air pollution such as nitrogen oxides and fine particulate matter that can increase rates of respiratory diseases, cardiovascular conditions, and cancer.[35] These outcomes can be minimized by using other technological solutions, such as replacing diesel generators with battery energy storage systems. Microsoft successfully implemented a pilot with Saft, a TotalEnergies subsidiary, to replace its diesel generators with four groups of 4 MWh batteries (16 MWh total) that provide 80 minutes of backup power at a Sweden Central data center.[44,47,48]
- **Demand Flexibility:** Refers to shifting or adjusting certain computing tasks in response to grid conditions, reducing electricity demand during peak periods, or moving workloads to locations with cleaner or low-cost energy. This operational approach increases grid stability and reduces stress on local distribution systems. Google has signed 1 gigawatt of data center demand response with utilities across the United States including, but not limited to, Tennessee Valley Authority, Entergy Arkansas, and Minnesota Power to shift non-urgent computing tasks, such as processing YouTube videos, when the grid is strained.[49]
- **Heat Reuse:** Refers to the practice of capturing low-grade waste heat from data center operations and upgrading it for beneficial use such as district heating or building heat.

This practice enables water savings and offsets fossil fuels used for heating.[42] As of 2024, Google's Hamina, Finland data center supplies approximately 80 percent of the local district heating demand by exporting upgraded waste heat to the municipal network.[50]

These practices represent actionable opportunities that policy, incentives, and collaboration can help advance lower-impact data center operations.

Rapid Increases in Peak Load

Peak electricity demand, or peak load, is the highest demand for electricity from all customers across a specific service area during a specified period of time (such as an hour, a month, or a year). It is one of the key metrics utilities and transmission providers track and forecast to assess future electricity demand — and plan for adequate levels of generating resources needed to keep the lights on.

In addition to their substantial overall consumption, data centers contribute significantly to system peak demand. Utilities build their system so that it is prepared to meet peak load on the hottest day and during a winter cold spell. As peak loads rise, utilities must accelerate the timelines for adding new generation and capacity resources to maintain grid reliability and meet regulatory obligations.

At the same time, data centers may offer emerging opportunities to support grid flexibility. For example, Portland General Electric and GridCARE completed a project in Hillsboro that uses advanced forecasting and flexible resources to accelerate large-load interconnections for data centers, allowing more than 80 MW of new demand to be integrated. This approach, which optimizes on-site resources, batteries, and flexible operations, shows how coordinated demand-management approaches, load-shifting strategies, and participation in demand-response programs can help reduce peak burdens.[51]

Transmission and Interconnection Constraints

Large data center campuses also require extensive upgrades to surrounding transmission and interconnection systems. Meeting these loads often depends on the construction of new high-voltage transmission lines, substation expansions, and dedicated interconnection facilities, all of which take a long time to build, need substantial capital investment, and require close coordination between developers and utilities. While the transmission and distribution systems are constantly being modernized, the speed of the load increases from data centers is occurring, in some cases, more quickly than the planning and permitting processes can accommodate.

While these infrastructure needs can shape regional development patterns and place pressure on existing utility planning processes, emerging national analyses point to consumer-side pathways that could complement traditional grid expansion to help meet rising demand.[52]

Recent analysis by Rewiring America suggests that hyperscalers could meaningfully strengthen grid capacity by investing in household-level electrification upgrades. The analysis found that replacing electric resistance heating with heat pumps in Oregon and other states, along with replacing less efficient air conditioning and water heating with efficient heat pump technologies across the US, could offset roughly one-third of the additional grid capacity associated with U.S. data center growth. Pairing these measures with solar-ready home investments could fully meet or even exceed projected hyperscale load growth nationwide over the next decade.[52] [53]

These ideas are already emerging in practice. For example, in July 2026, New Jersey passed the Data Center Fair Share Act, which incentivizes data centers to secure clean capacity by reducing demand on the grid elsewhere.[43] These voluntary demand reduction trade programs will help investment in customer-sited energy resources.[44]

In parallel with exploring new distributed solutions to relieve near-term pressures on the grid, Oregon has strengthened its regulatory framework to ensure that the costs of serving large new loads are allocated fairly and transparently. For investor-owned utilities, the POWER Act (HB 3546) provides new tools to manage these challenges by requiring facilities that use large amounts of energy to be treated as a distinct customer class and by enabling utilities to require contracts that ensure data centers pay for the infrastructure needed to serve them, unless broader system benefits can be demonstrated. This framework helps align infrastructure investment with cost accountability and supports more transparent planning for large, energy-intensive developments.[19]

The state's consumer-owned utilities have developed their own mechanisms to ensure that large new loads are integrated in ways that safeguard existing customers and the power system. At Umatilla Electric Cooperative, large industrial users are served through dedicated power-supply and transmission arrangements that directly pass wholesale costs to those customers.[56] Northern Wasco County PUD takes a similar approach by maintaining a distinct rate class for major energy users and requiring detailed engineering and cost-allocation studies to ensure 100 percent of customer-specific upgrade costs are recovered through dedicated contracts to prevent subsidization by residential or small commercial customers.[57]

On-site Diesel Backup Generators

Although data centers operate primarily on grid supplied electricity, they maintain large fleets of diesel backup generators to meet reliability and redundancy requirements. As of 2025, Oregon has more than 40 data center campuses either permitted or proposed that include 6,000 MW of backup electric generating capacity.[58] The testing and maintenance cycles for these engines, as well as their use in emergencies, creates localized air quality and noise impacts.

Oregon has responded to these concerns through the Oregon Department of Environmental Quality's Tier 4 streamlined data center air permit, which includes emissions limit requirements and encourages adoption of advanced pollution controls, providing a more efficient permitting pathway for facilities meeting higher standards. This framework reduces administrative burden while maintaining environmental and public health protections. Continued exploration of cleaner backup systems such as batteries, fuel cells, renewable diesel, or hybridized solutions, could in some cases reduce these localized impacts and better align data center operations with Oregon's climate goals.[58]

Alignment with Statewide Clean Energy and Climate Goals

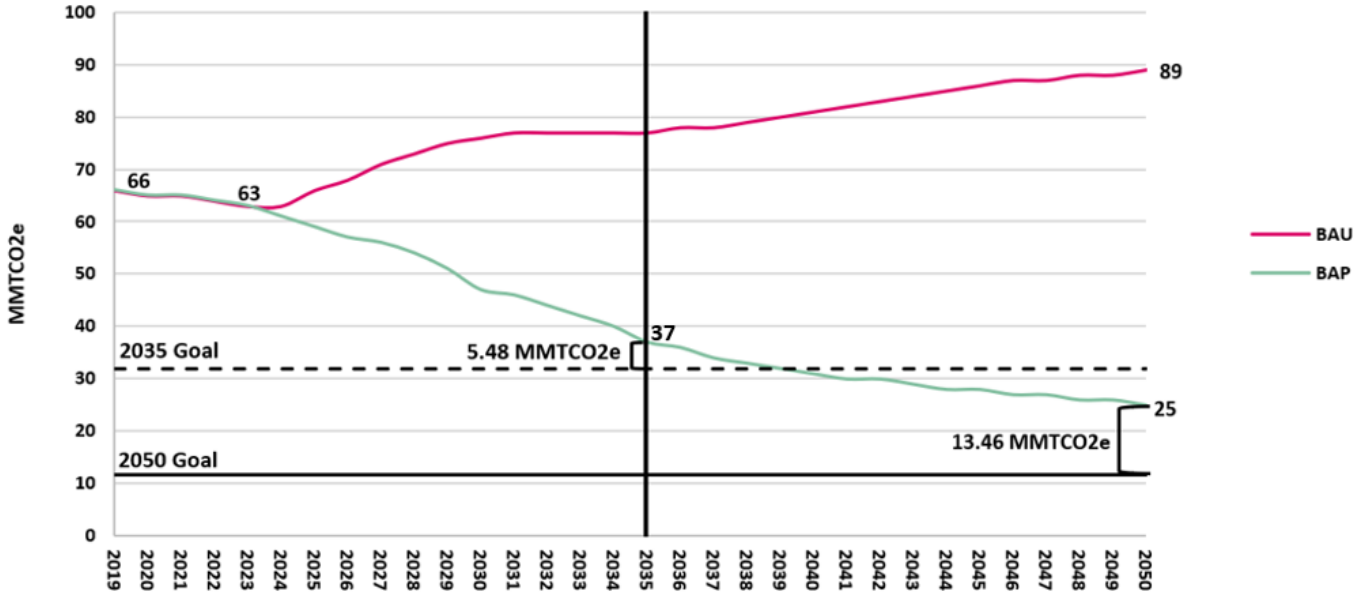
Finally, this growth trajectory has direct implications for Oregon's statewide energy and climate goals.

The TIGHGER (Transformational Integrated Greenhouse Gas Emissions Reductions) project found that under a high technology sector load scenario,[ii] Oregon is no longer on track to meet its 2035

[ii] The TIGHGER analysis is based on data provided by the Northwest Power Conservation Council (NWPCC). The NWPCC aggregates data related to data centers and chip fabrication facilities as part of its "Technology Sector." The baseline forecast completed under the TIGHGER project uses the "High" load forecast identified in the NWPCC's 9th Power Plan.

emissions reduction target through existing policies and programs alone. The chart below shows a gap of 5.48 million metric tons of carbon dioxide equivalent by 2035 and 13.5 MMTCO2e by 2050 between Oregon's greenhouse gas emissions reduction goals and the emissions reductions associated with programs and regulations currently in place. If all new technology sector loads in Oregon were sourced with 100 percent clean energy, the gap between forecasted emissions reductions and the state's 2035 emissions reduction goal would shrink by 3.90 MMTCO2e, or about 71 percent. However, additional emissions reduction measures or significant energy efficiency improvements will likely be required to close the gap entirely.[59]

Figure 5: Business-as-Planned Emissions versus Statewide Goals [59]



The state currently lacks a policy mechanism to address emissions from data center load growth across the state. The 100 percent clean electricity targets established under HB 2021 apply only to investor-owned utilities and electricity service suppliers. A substantial share of new and proposed facilities are located in parts of the state that are served by utilities not covered by 100 percent clean electricity targets, meaning that electricity procured to meet their demands may increase greenhouse gas emissions. While most consumer-owned utilities meet much of their electricity needs with zero-carbon hydropower from Bonneville Power Administration, the absence of greenhouse gas reduction requirements on new loads introduces uncertainty around future resource procurement and emissions trajectories.

The Oregon Building Performance Standard established in HB 3409 (2023) plays an important role in this area by requiring data centers over 35,000 square feet to report energy use, conduct energy audits, and implement cost-effective efficiency measures beginning in 2028. This is one of the few regulatory levers that influence behind-the-meter decisions and can help mitigate overall electricity demand growth, while improving operational efficiency.

Conclusion

Data center expansion is no longer a marginal issue but a central factor shaping Oregon's energy future. The state's existing policies provide an important foundation, yet the magnitude and

geographic distribution of anticipated loads will require additional and adaptive strategies to ensure the energy system can keep pace.

With some ingenuity, Oregon can capitalize on emerging opportunities, from grid-flexibility programs and distributed energy investments to clean energy procurement approaches that scale alongside these loads. By understanding the pressures and intentionally harnessing the benefits of this rapidly growing sector and adopting policies to safeguard limited resources, Oregon can ensure that future data center developments support reliability, protect affordability, and advance the state's long-term clean energy and climate vision.

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Sustainable Aviation Fuel: Benefits, Risks, Challenges, and Opportunities

Sustainable aviation fuel is a low-carbon, drop-in substitute for conventional jet fuel that presents an opportunity to advance Oregon's clean energy, resilience, and economic growth objectives. The Oregon Energy Strategy found that the least-cost path to meeting greenhouse gas reduction goals includes transitioning jet fuel to SAF by 2050, and recommended expanding access to low-carbon fuels like SAF, including developing a strategic roadmap to guide Oregon's fuel decarbonization actions. SAF is currently the only viable low-carbon fuel option for commercial aviation. As SAF demand grows, limited supply will heighten competition among states, making regional coordination critical for Oregon to secure and scale SAF for its long-term energy and aviation needs.

Fundamentals

What is Sustainable Aviation Fuel?

Sustainable aviation fuel is a jet fuel produced from non-petroleum sources such as seed or waste oils, agricultural or forest residues, municipal waste, renewable electricity, or captured carbon dioxide. SAF is compatible with existing aircraft and airport fuel systems but it must be blended up to 50 percent with petroleum jet fuel to be used without equipment modifications. Fuel innovation, testing, and greater supply are needed to meet international aviation fuel standards and achieve blends of higher percentages of SAF in commercial flights.[1]



Aviation Fuel Consumption in Oregon (2024)[2]

3.3 million gallons of aviation gasoline

241 million gallons of jet fuel

How is Sustainable Aviation Fuel Made?

Sustainable aviation fuel can be produced through several technology pathways that use a range of renewable or waste-based feedstocks. The most commercially mature pathway is the hydroprocessed esters and fatty acids process, or HEFA, which converts soybean and canola oils, used cooking oil, or animal tallow from agricultural or seafood processing into jet fuel. HEFA benefits from its similarity to existing petroleum refining and is the most common production pathway, but supply constraints for waste oils remain a challenge. There are also concerns about using agricultural land to produce fuel oils and that growing crops specifically for fuel production can diminish the greenhouse gas reduction benefits.

Hydrogen is required to produce almost all sustainable aviation fuel. In the HEFA process, high pressure hydrogen removes oxygen from oil-based feedstocks and reshapes their molecular structure to meet aviation fuel specifications. Most hydrogen used in refining is produced through steam methane reforming from natural gas.[3] Expanding access to renewable hydrogen, generated through electrolysis powered by renewable electricity or produced from biogas, could further reduce the carbon intensity of SAF and represents a potential opportunity for in-state production in Oregon.

Additional sustainable aviation fuel pathways are in varying stages of development and commercialization and use a broader variety of feedstocks, including some that are available in the Pacific Northwest. The feedstocks and the process determine what energy inputs are needed for production, which has implications for the lifecycle GHG emissions, not only for the production method but also the specific feedstocks used and how they are collected and transported. Table 1 shows different production pathways for SAF creation that are currently operating or are in the planning stages for commercial plants in the U.S. and includes the feedstock(s) for each production pathway. This includes pathways in early stages of commercial-scale development that are not operating at the same scale as HEFA facilities.

Table 1: SAF Production Pathways

Production Pathway	Potential Feedstocks	Benefits	Challenges
Hydroprocessed Esters and Fatty Acids (HEFA)	Vegetable or animal oils and fats, waste cooking oils or other waste lipids	Mature, commercial, refinery-ready	Limited waste oils available in Pacific Northwest, energy crop land use, GHG emission reductions are highly variable
Fischer–Tropsch (FT)	Biomass, municipal solid waste, forestry residues	High-quality drop-in SAF, versatile	High infrastructure development costs, complexity, feedstock processing needed
Alcohol-to-jet (ATJ)	Ethanol, butanol, methanol (bio or drop-in)	High feedstock availability, scalable	Higher cost, energy crop land use, nascent technology
Power-to-Liquid (e-SAF)	Renewable electricity, water, carbon dioxide	Unlimited feedstock potential, high emission reductions	High production costs, high energy intensity, requires significant clean energy development, challenging to scale

Fuel Consumption and Emissions

Sustainable aviation fuel has the potential to reduce lifecycle greenhouse gas emissions by 70 to 90 percent compared to conventional jet fuel.[4] In 2024, Oregon consumed almost 241 million gallons of jet fuel, resulting in over 2.3 million metric tons of carbon dioxide emissions.[2] Transportation is the largest source of economy-wide GHG emissions in Oregon, accounting for about 35 percent of total emissions. Aviation contributes roughly 3 percent, driven primarily by the combustion of commercial

jet fuel, commonly referred to as Jet A or Jet A-1.[i] [5] Emissions estimates are from the U.S. Department of Energy's Energy Information Administration and are calculated based on the combustion of the fuel and not the lifecycle emissions of extracting, processing, and transporting the fuel to Oregon airports. Aviation fuel used in smaller piston-engine aircraft represents a much smaller share of emissions and cannot be replaced by SAF.

How Much Fuel Does a Commercial Airplane Actually Use?[6]

Small commercial jets like a Boeing 737 or Airbus A320 consume 750 to 900 gallons per hour.

Large long-haul jets like a Boeing 777 or Airbus A350 consume 1,500 to 2,200 gallons per hour.

Sustainable aviation fuel delivers a wide range of lifecycle greenhouse gas emissions outcomes, influenced by feedstock type, production pathway, and blending level. While SAF produces carbon dioxide during combustion at levels comparable to conventional jet fuel, its overall climate impact is determined by the full lifecycle of the fuel rather than just at the point of combustion. When SAF is derived from renewable or waste-based feedstocks with lower carbon intensity, it can significantly reduce lifecycle emissions relative to conventional petroleum-based jet fuel. In addition, SAF combustion generally results in lower particulate matter and sulfur emissions, offering potential air quality benefits for communities near airports.

Aviation Gasoline Decarbonization

Fully decarbonizing Oregon's aviation sector will require a combination of fuel and technology innovation to meet the state's long-term clean energy goals. Smaller piston-engine aircraft rely on aviation gasoline or avgas, a high-octane fuel used for shorter flights, lower altitudes, and frequent landings. An estimated 3.3 million gallons of aviation gasoline were consumed in Oregon in 2024, emitting 27,000 metric tons of CO2.[7] Emissions estimates only include the combustion of the fuel and not the lifecycle emissions of extracting, processing, and transporting the fuel to Oregon airports. Electrification and low-carbon fuels such as hydrogen are the most viable long-term alternatives for short-haul, small aircraft that use aviation gasoline.[89]

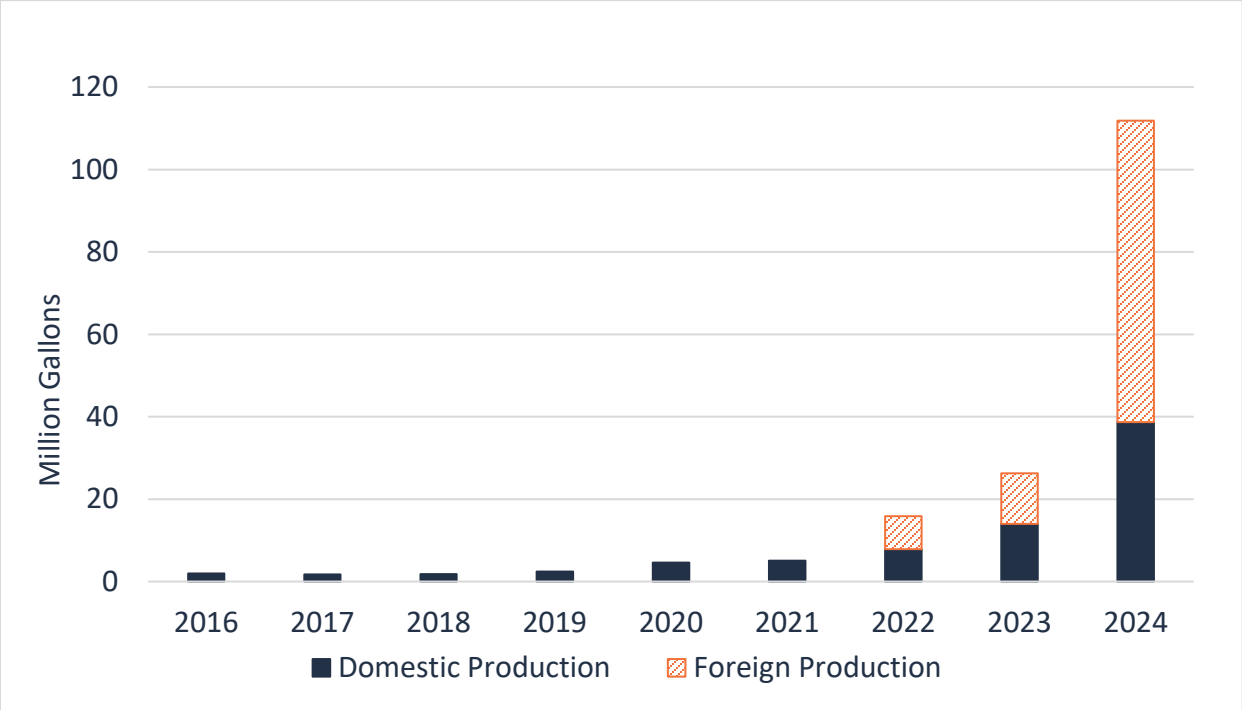
Regional and National Production

Sustainable aviation fuel production in the United States has increased in recent years, rising from 5.08 million gallons in 2021 to 38.7 million gallons in 2024, as shown in Figure 1 below. Nationally, sustainable aviation fuel represents about 2 percent of the roughly 71.4 million gallons of jet fuel consumed each day. Demand continues to outpace domestic supply, and in 2024 the United States imported more than 73 million gallons of sustainable aviation fuel, accounting for about two-thirds of total consumption.[10] U.S. airlines are investing in SAF as part of broader corporate climate commitments, and market activity indicates demand will continue to grow. Several major airlines have

[i] Aviation GHG emissions are based on state fuel consumption at Oregon airports. It is not a reflection of specific airline activity or a tracking of flights landing in or flying out of Oregon, or where the aircraft is when fuel is combusted.

established fuel-switching targets or invested in supply chain development. For example, American Airlines has set a target to replace 10 percent of its jet fuel consumption with sustainable aviation fuel by 2030 and used 2.9 million gallons in 2024.[11] United Airlines created a dedicated investment fund to support technology and feedstock development, with more than $200 million committed.[12] In 2025, the fund announced an investment in Twelve's first commercial production facility, AirPlant One, in Moses Lake, Washington.[13] Alaska Airlines, the first U.S. airline to use SAF in 2011, continues to identify it as a primary pathway for meeting its 2040 net-zero emissions goal.[14] With a premium fuel cost and without mandates, airlines are reluctant to invest more in market changing long term SAF offtake agreements that may put them at a competitive disadvantage.

Figure 1: Sustainable Aviation Fuel Estimated Global Production and Consumption[10]



International Markets

Sustainable aviation fuel availability, standards, and pricing are deeply affected by international policy and markets. The European Union is enforcing a 2 percent SAF fuel blending requirement for large airports as of January 2025. It will increase to 6 percent in 2030, 20 percent in 2035, 34 percent in 2040, and 70 percent in 2050. The United Kingdom has a similar SAF mandate of 1.5 percent SAF now, rising to 10 percent in 2030, 16 percent in 2035, and 22 percent by 2040. Japan, India, and Brazil have published 2030 targets of 5 to 10 percent. These mandates could drive global demand for SAF.[15]

Federal incentives have the potential to influence market development. The Inflation Reduction Act created a federal tax credit for sustainable aviation fuel, which was subsequently extended at a reduced level through 2027 under H.R. 1 (2025). Eligible producers can receive up to $1.00 per gallon.[16] Several federal grant programs that previously supported SAF production, transportation, blending, and storage are paused, creating uncertainty for project developers. Prior to this change in federal laws, the International Energy Agency forecasted in its *2023 World Energy Outlook* that the

U.S. would achieve 3 billion gallons of production by 2030 and was on a path to meeting 100 percent of domestic aviation demand in 2050.[17] Although federal targets and interagency coordination remain in place, reduced federal funding and shifting priorities have contributed to revised projections for national production. Updated estimates suggest the United States may reach approximately 2.1 billion gallons of annual SAF production by 2030, falling short of the federal goal of 3 billion gallons.[18] These trends underscore the need for stable state policy support and coordinated investment to scale SAF production and meet long-term decarbonization objectives for the aviation sector.

SAF Grand Challenge

Federal policy has been a significant driver in the development of sustainable aviation fuel, though the level of federal support has varied over time. In 2021, the U.S. Departments of Energy, Transportation, and Agriculture, together with the Environmental Protection Agency and the Federal Aviation Administration, launched the SAF Grand Challenge. This coordinated effort established national goals to reduce SAF lifecycle GHG emissions by at least 50 percent relative to petroleum jet fuel, expand SAF production to 3 billion gallons per year by 2030 (roughly 10 percent of projected U.S. jet fuel demand), and scale production to 35 billion gallons annually by 2050 to meet all domestic commercial aviation fuel needs. Federal agencies aligned financial assistance, information sharing, and engagement with agricultural producers, industry partners, and researchers to advance market development.[19] Some of this work was put on hold in 2025 but SAF demand and production continues to grow. The SAF Grand Challenge has since transitioned to the SAF Initiative, which remains a guiding federal policy framework intended to support the scale-up of SAF production, even as funding for market intervention has been reduced.[20]

In 2024, two facilities in the United States produced sustainable aviation fuel: Montana Renewables in Great Falls, Montana, and World Energy in Paramount, California, with a combined production capacity of approximately 84,000 gallons per day. Although World Energy ceased SAF production in 2025, additional facilities in Nevada, California, and Texas began operations that year, increasing national output to about 1.26 million gallons per day.[21] In June 2026, Twelve launched AirPlant One, a commercial-scale SAF facility in Moses Lake, Washington, using the power-to-liquids production pathway. This facility is capable of producing about 50,000 gallons, of SAF annually.[22] Although relatively small in scale, emerging projects such as AirPlant One demonstrate continued innovation in production technologies and highlight the diverse pathways under development as the SAF industry matures.

Interest in expanding domestic sustainable aviation fuel production continues to grow with eight facilities in various stages of planning and development in the Pacific Northwest and an expansion of the Montana Renewables facility in Great Falls, Montana to 200 million gallons annually by 2028.[23] NEXT Renewable Fuels, a subsidiary of NXTClean Fuels, is seeking permitting and siting approval to construct a renewable diesel and SAF facility at the Port Westward Industrial Park near Clatskanie, OR with a potential production capacity of up to 1.58 million gallons per day.[24] SKYNRG is pursuing

development of a SAF and renewable diesel facility at the Port of Walla Walla in Washington, with the potential to produce 50 million gallons annually.[25]

NXT Clean Fuels Plant

NXT Clean Fuels intends to construct a renewable diesel and sustainable aviation fuel production facility at the Port of Columbia County's Port Westward Industrial Park near Clatskanie, Oregon. The project would use the HEFA pathway to produce up to 1.58 million gallons per day of low-carbon fuels from used cooking oil, fish byproducts, and animal tallow.[24] The facility would produce renewable diesel and SAF and could adjust the production ratio in response to market demand. With an estimated cost of $2.5 to $3 billion, the facility would operate on approximately 145 acres and distribute up to 750 million gallons of low-carbon fuel annually. The project is expected to generate approximately 3,000 construction jobs, 250–300 long-term operational positions, and more than $45 million in annual tax revenue for state and local governments.[26] [27] Oregon currently has no in-state production for renewable diesel or SAF, and regional availability remains limited.

Some local farmers, Columbia Riverkeeper, and 1,000 Friends of Oregon have expressed doubt about the safety of the project and risks to the surrounding community, including concerns about the plant's natural gas use, feedstock availability, and potential impact to land, water, and air quality.[28] [29] Governor Kotek and the Oregon Department of Energy recognize the potential net benefit in decreasing GHG emissions from transportation fuels and have expressed support. The project would advance the low-carbon fuel pathway and policies identified in the Oregon Energy Strategy by increasing the availability of low-carbon fuels and building the associated infrastructure in the state.[27] [86] The NXT Clean Fuels Project has received all required local county and State of Oregon permits and is undergoing National Environmental Policy Act review administered by the U.S. Army Corps of Engineers.[30] Concerns about the financial health of NXTClean Fuels and the facility have also been raised by opponents of the project and have yet to be resolved at time of publishing.[31]



Figure 2: U.S. Sustainable Aviation Fuel Production Facilities[32]

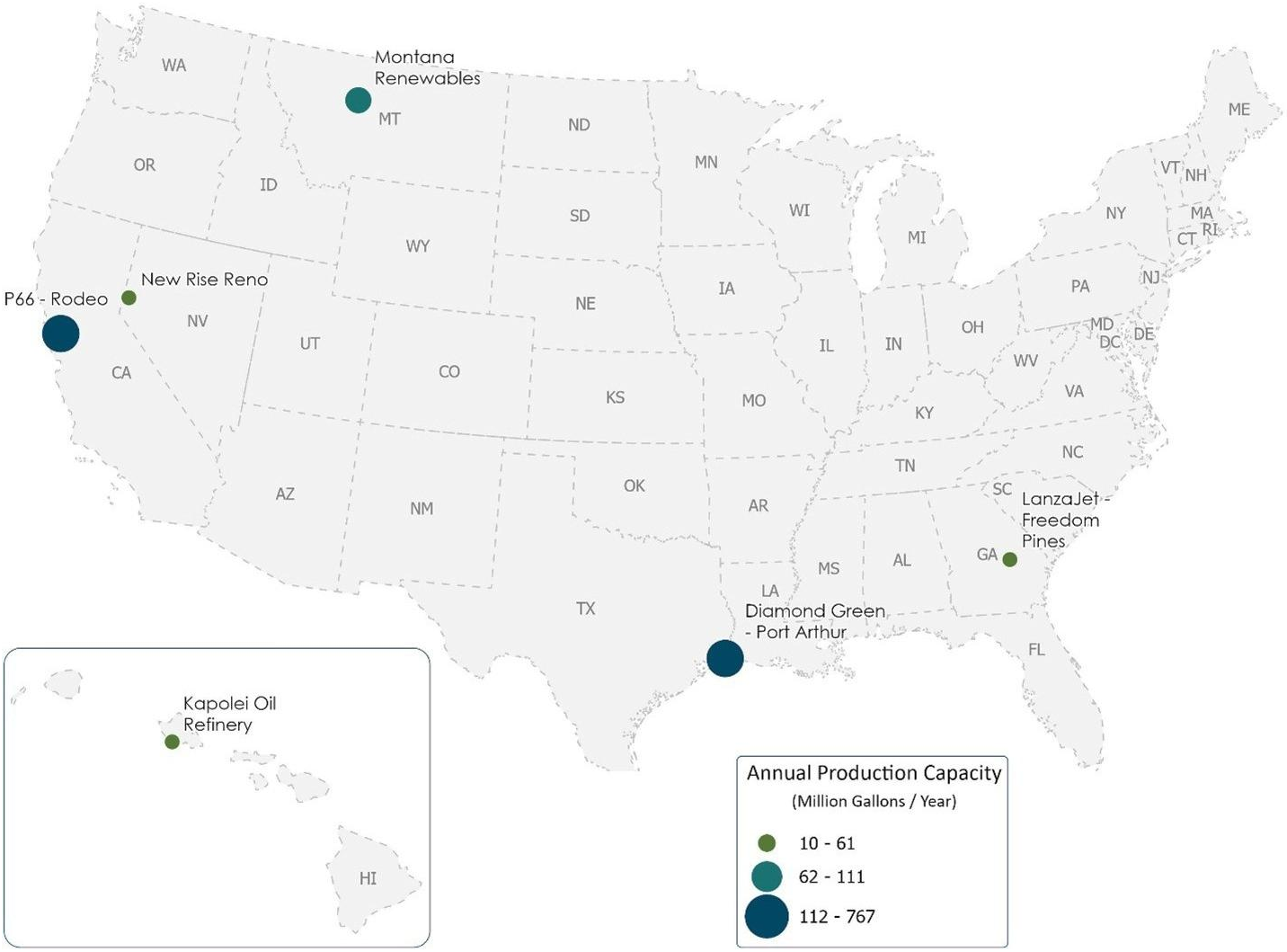


Table 2: Planned SAF Northwest Regional Production[32]

Producer	Location	Announced Annual Production Capacity of SAF & RD (million gallons)
NXTClean Fuels	Port Westward, OR	750
Montana Renewables	Great Falls, MT	facility expansion to 300
SkyNRG	Walla Walla County, WA	50
Twelve	Moses Lake, WA	0.5
Tidewater Renewables	Prince George, BC	96
Dimensional Energy	Richmond, BC	40
7 Mile Renewable Fuels	Kamloops, BC	306.6
Expander Energy Inc.	Mackenzie, BC	4.8-19
NWABF	Hoquiam, WA	60

The Port of Portland, which operates Portland International, Hillsboro, and Troutdale airports has established a goal of achieving net-zero carbon emissions by 2050. Efforts include upgrading building

systems and equipment at Portland International Airport, supporting renewable electricity development, reducing waste, and enabling the use of SAF by airlines.[33] The Port is a member of the Sustainable Aviation Fuels Coalition, a nonprofit organization of airlines, fuel producers, manufacturers, technology developers, and airports focused on accelerating sustainable aviation fuel deployment nationwide.[34] The Port completed a SAF Infrastructure Study in 2018 to identify potential barriers to accessing consistent and affordable supplies, and continues to coordinate with airports that share a common jet fuel distribution hub, developers, airlines, and other supply chain partners to assess demand and logistics.[35] In 2025, the Port collaborated with Delta Air Lines and Shell to facilitate the first commercial-scale delivery of sustainable aviation fuel to Portland International Airport.[36]

Delta Airlines, Shell, and Port of Portland Partnership

In September 2025, Delta Air Lines, Shell USA Inc., and the Port of Portland completed the first commercial-scale delivery of sustainable aviation fuel to Portland International Airport, marking a significant milestone for SAF deployment in Oregon. Montana Renewables in Great Falls, Montana produced 400,000 gallons of SAF using waste-based feedstocks sourced within the United States. The fuel was transported by rail to the Zenith terminal in Portland, where it was blended with conventional jet fuel by Shell and then delivered by barge to the Kinder Morgan terminal and sent by pipeline to PDX for use in Delta aircraft. The multi-step transport and blending process required for this delivery highlighted the infrastructure and logistical challenges that will need to be addressed to enable broader SAF use in Oregon.[36]

Oregon does not have a policy framework to guide the long-term decarbonization of aviation fuel consumption, but there are state policies supporting sustainable aviation fuel adoption. The Department of Environmental Quality's Clean Fuels Program is a market-based standard that reduces lifecycle GHG emissions from transportation fuels. Petroleum jet fuel is excluded from the program, so jet fuel suppliers are not required to participate and do not generate deficits. However, SAF generates credits for producers and importers when it meets certified carbon-intensity benchmarks. In 2025, over 982 thousand gallons received credits and this increased to over 2.8 million gallons in the first quarter of 2026. Monetization of these credits can help offset the higher cost relative to petroleum jet fuel.[37]

Aviation Industry

Sustainable aviation fuel is significantly more expensive than conventional jet fuel, typically costing two to four times more.[4] Periods of higher petroleum jet fuel prices, driven largely by global crude oil markets, could narrow this price gap, but sustainable aviation fuel continues to be a premium product. Jet fuel generally represents between 15 and 40 percent of airline operating costs, and price volatility directly affects ticket prices and overall financial stability.[38] U.S. market demand for sustainable aviation fuel depends on reducing the cost premium relative to conventional jet fuel. Federal funding has been helpful in addressing the higher cost for SAF, but recent changes in federal policy have canceled or reduced funding for programs and policies that supported SAF production and use. Several planned infrastructure projects have been canceled, and some existing producers have shifted focus toward renewable diesel production, where market margins and policy support are

comparatively stronger with better federal tax incentives, state-level policies, and corporate and consumer willingness to pay for lower-carbon fuels.[39]

Benefits and Concerns

Replacing petroleum jet fuel with sustainable aviation fuel can provide Oregonians with many benefits, including improving air quality and public health, supporting growth and access to more sustainable low-carbon fuels, and making progress toward state clean energy objectives. In-state production of SAF could extend these benefits further by supporting energy resilience, enhancing fuel supply security, and contributing to economic development and job growth in Oregon by converting waste streams into value-added fuel products.

These potential benefits should be considered alongside the risks and tradeoffs associated with using or producing sustainable aviation fuel in Oregon. Higher-cost fuels may increase passenger travel expenses or the cost of shipping goods by air. Limited supply means Oregon will compete with neighboring states to secure consistent access to sustainable aviation fuel. Additional production, distribution, and storage infrastructure may be needed at Oregon's fuel terminals and airports, requiring capital investment. Production facilities for low-carbon fuels are industrial operations that generate emissions and may pose risks to local air and water quality. Environmental justice communities located near industrial facilities are more likely to experience adverse effects and may not receive proportional economic benefits. New fuel infrastructure is required to meet the requirements of state and federal permitting designed to mitigate some of these risks. Developing an approach that maximizes the benefits of sustainable aviation fuel while mitigating potential harms can ensure strategic alignment of state efforts and serve as a signal of intent when federal funding is available.

Oregon Aviation Industry

Expanding access to sustainable aviation fuel could support Oregon's aviation sector while expanding economic development. While airline investments, offtake agreements, and dedicated funding mechanisms indicate strong industry interest, achieving broader market adoption will require expanded production capacity, cost-reducing technological advancements, and continued federal and state policy support.



Oregon Aviation[40]

96 public-use airports

90 general aviation airports

6 commercial service airports

21.5 million annual travelers

250,000 tons of cargo

Aviation plays an essential role in Oregon's economy, supporting commercial passenger travel, cargo movement, wildfire response, law enforcement, medical transport, agricultural applications, and emerging uncrewed aircraft systems and advanced-air mobility. The sector contributes an estimated

$24.2 billion in economic activity and supports approximately 73,000 jobs.[41] Oregon's aviation system includes 96 public-use airports, six of which provide commercial service, along with private, military, and general aviation facilities that support statewide transportation and emergency response needs. Commercial airports such as Portland International Airport, Eugene Airport, Redmond-Central Oregon, and Rogue Valley International in Medford serve as critical gateways for regional commerce, tourism, and access to national and international markets.[42] The state has a role in ensuring that policies that encourage SAF uptake in Oregon are weighed against any potential effects on the economic benefits of the aviation industry.

Cascadia Sustainable Aviation Accelerator

The Cascadia Sustainable Aviation Accelerator (CSAA) is a newly established regional coalition designed to advance sustainable aviation fuel production, deployment, and adoption, with the goal of positioning the Pacific Northwest as a global hub. It is funded by public and private investment, including $10 million from the State of Washington and $10 million from a philanthropic organization.[43] [44] CSAA is organized around four primary focus areas:

1. Policy, Education, and Advocacy: Introduce or revise policy measures that enable SAF production and deployment.
2. Feedstocks: Leveraging Pacific Northwest feedstock supply chains like woody biomass and agricultural feedstocks.
3. Research and Development: Reducing technological and market uncertainty through the newly opened Cascadia Sustainable Aviation Institute at Paine Field in Snohomish County, Washington.
4. Financing Production and Offtake: Implement financial tools and offtake agreements that support economic development through new fuel production and distribution.
5. Infrastructure: Improve fuel distribution and storage to ensure access of SAF throughout the region.[45]

CSAA brings together public agencies, academic institutions, aerospace leaders, industry, Tribal Governments, and community advocates to coordinate a comprehensive regional strategy. The coalition aims to help scale production to approximately one billion gallons of SAF annually by 2035, which would replace roughly 59 percent of current annual jet fuel consumption across Oregon, Washington, Idaho, Montana, and British Columbia, Canada.[2] [46] In May 2026, the Oregon Department of Energy joined Washington State Department of Commerce's Office of Renewable Fuels as state agency members. ODOE's participation will help ensure Oregon's interests and perspectives are integrated into regional planning and collaboration efforts as the SAF market continues to develop.

Sustainable aviation fuel currently carries a price premium relative to petroleum jet fuel, and costs are not expected to decline in the near term. Without government funding, these costs will likely translate into higher costs for traveling and shipping, which would have a disproportionate effect on low- and

moderate-income Oregonians and small businesses. One option to mitigate this economic consequence is to initially encourage low blend rates, limiting the potential for economic price shocks that negatively affect the industry. Blend levels could then increase as production expands, supply grows, and costs come down.[47]

Delivering sustainable aviation fuel to Oregon would require substantial investment in fuel distribution infrastructure. All jet fuel supplied to Oregon typically comes from the Olympic Pipeline or barge to the Kinder Morgan Willbridge Terminal, where it is filtered, stored, and certified as meeting fuel quality standards before being transported to PDX via a pipeline directly to the airport, or other airports in the state via truck.[48] SAF will require new transport, storage, and blending infrastructure at fuel terminals at the Critical Energy Infrastructure hub in Portland to support receiving and blending both conventional jet fuel and SAF to meet ASTM International fuel quality standards. The National Renewable Energy Lab evaluated fuel blending at airports or refineries as an alternative to fuel terminals and found it is possible but the need for additional infrastructure, insurance, certification testing, and capital investment make fuel blending at airports or refineries less feasible options. Terminals have existing tanks, equipment, staff, permitting, and expertise and have long offered blending as a service. SAF storage and blending may be able to utilize existing tanks to start but will likely need new infrastructure as supply grows and to improve the efficiency of the blending and distribution process.[49]

Health and Environmental Justice Considerations

Sustainable aviation fuel produces fewer air pollutant emissions than conventional jet fuel, contributing to improved air quality for airport workers and nearby communities.[50] [51] Although blend compositions can vary, sustainable aviation fuel generally results in lower particulate emissions and sulfur oxides from aircraft engines.[51] [52] These reductions are particularly important for ground crews working in close proximity to idling or taxiing aircraft. A national study by Third Way modeled the replacement of conventional jet fuel with sustainable aviation fuel at major U.S. airports between 2025 and 2050 and found that lower particulate emissions could reduce respiratory and cardiovascular risks, potentially avoiding 1,600 to 3,300 premature deaths and generating an estimated $20 to $35 billion in public health benefits.[53]

While the use of sustainable aviation fuel offers broad air-quality and health benefits, the environmental effects associated with production facilities warrant careful consideration. All fuel facilities and infrastructure come with environmental and community risks, which will be borne most strongly by nearby communities and the workers at these facilities. For example, fuel facilities generate air pollutants such as particulate matter, volatile organic compounds, nitrogen oxides, and odors from feedstock handling. Accidental spills may affect soil or water quality. Production processes often require substantial water use, and wastewater can contain contaminants that may enter rivers, groundwater, or wetlands. The Oregon Department of Environmental Quality permits and monitors these industrial facilities to maintain air and water quality standards.[54] [55] Most SAF production pathways use hydrogen that is typically derived from fossil natural gas. Renewable natural gas or renewable hydrogen could be used but they are in limited supply. Combustion of fossil natural gas can lead to significant site GHG emissions. These operational factors can affect environmental quality and contribute to health risks for nearby communities.

Energy Justice[56]

Energy justice is a goal of achieving equity in both social and economic participation in the energy system, while also remediating social, economic, and health burdens on those historically harmed by the energy system ("frontline communities"). Energy justice explicitly centers the concerns of marginalized communities and aims to make energy more accessible, affordable, clean, and democratically managed for all communities.

As Oregon considers opportunities to secure reliable access to low-carbon aviation fuels, the state will need to balance the benefits of in-state production with financial, infrastructure, and community-level considerations, including energy justice, associated with developing new fuel facilities. Industrial operations are often located near rural or lower-income frontline communities. Without safeguards, residents may face disproportionate exposure to pollutants, noise, light, traffic impacts, and other environmental harms. The state can encourage incorporation of community benefit agreements between developers and local jurisdictions to mitigate harm and ensure all benefit. Facilities are subject to local, state, and federal permitting and environmental review, but it will be important to assess both direct and indirect effects on natural resources and community well-being as part of any future planning and siting decisions.

Community Benefit Agreements[57]

Legally binding agreement between project developers and communities with explicit benefits they will receive for support of the project. Benefits are negotiated by communities and depend on their unique concerns and priorities. To learn more, please visit this article on community benefit agreements.

Low-carbon fuel economy

Strategic investments in sustainable aviation fuel can support and strengthen a low-carbon fuel economy in Oregon and the broader Pacific Northwest. SAF facilities that use the HEFA pathway typically co-produce renewable diesel, as both fuels rely on the same feedstocks and a similar chemical refining process.[58] [59] Oregon's consumption of renewable diesel has increased 479 percent in recent years, from 17.6 million gallons in 2020 to almost 102 million gallons in 2025, and demand is outpacing regional supply.[60] Increasing local and regional SAF production could improve access to renewable diesel as well. Hydrogen, a key input for HEFA production, has experienced reduced domestic growth due to federal energy policy changes. This trajectory may change with increased demand as SAF facilities scale, supporting development of a clean hydrogen economy in the Pacific Northwest.

The Oregon Energy Strategy found that the use of low-carbon fuels for hard-to-decarbonize sectors like aviation is necessary to meet state emissions-related goals.[56] Modeling conducted for the strategy indicates that achieving full replacement of petroleum jet fuel with sustainable aviation fuel by 2050 is an important pathway for meeting long-term emissions goals, as it represents the most commercially viable near-term option for reducing emissions from aviation. Demand for jet fuel in Oregon is increasing; Port of Portland is forecasting an annual increase in domestic and international aircraft

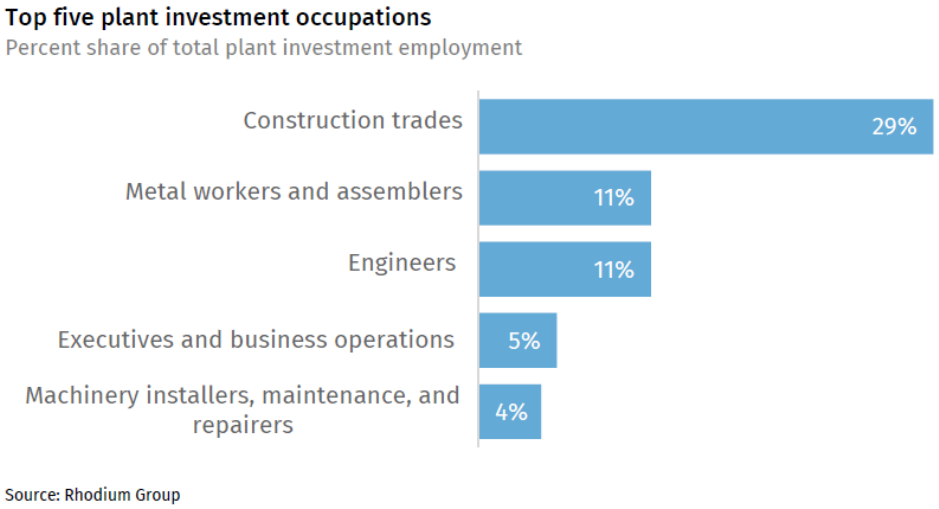
operations of 2.9 percent between now and 2045.[61] Electrification and the use of alternative low-carbon fuels may provide future opportunities for smaller aircraft, but sustainable aviation fuel remains the only option currently available for reducing emissions from larger commercial aircraft, which account for approximately 3 percent of Oregon's greenhouse gas emissions.[5]

Investment in emerging low-carbon fuels carries inherent risks, including uncertainty about future technologies and the relative availability of feedstocks. There is the potential for new fuels or technologies to emerge with attributes that are more beneficial for Oregon, and the state should continue to assess and evaluate these innovations to determine if new policies are warranted. There are also limitations in the volume of feedstocks that could be made available for use at these facilities. The feedstocks are renewable but only insofar as how quickly they can be replenished, where they came from, and what else they could be used for. These limitations underscore the need for coordinated planning to ensure adequate supply and continued reductions in transportation emissions.[3] [62]

Economic growth and jobs

The development of a Sustainable Aviation Fuel industry can not only support economic growth in Oregon but also retain more of the money Oregonians spend on fuels within state and local economies. Developing fuel and feedstock transport, storage, and production infrastructure creates short- and long-term employment opportunities, particularly near the siting of new infrastructure. Establishing new low-carbon fuel production facilities is likely to create the greatest economic benefits by expanding Oregon's industrial sector and generating new employment in urban and rural communities. The Oregon Department of Energy and the Institute for Policy Research and Engagement at the University of Oregon, are conducting the Oregon Energy Strategy Workforce Needs Assessment to evaluate what Oregon's workforce may need to meet the demands of new low-carbon fuel production, renewable energy generation, transmission, energy efficiency, and clean transportation. A Rhodium Group study estimated that a facility designed to produce approximately 100 million gallons of SAF annually can support an estimated 1,100 jobs during construction and 75-150 ongoing operations and management positions once in service. Jobs associated with these facilities include well-paying construction trade positions, metal workers and assemblers, engineers, executives and business operations managers, machinery installers, and maintenance and repairer crews. Construction and operation of these facilities indirectly support state and regional industries and businesses, including equipment manufacturing, fabrication, and feedstock supply industries, as well as local businesses like shops, restaurants, and entertainment venues. Nationwide, the buildout of SAF production capacity is projected to increase public revenues by an estimated $12-$18 billion by 2030.[63]

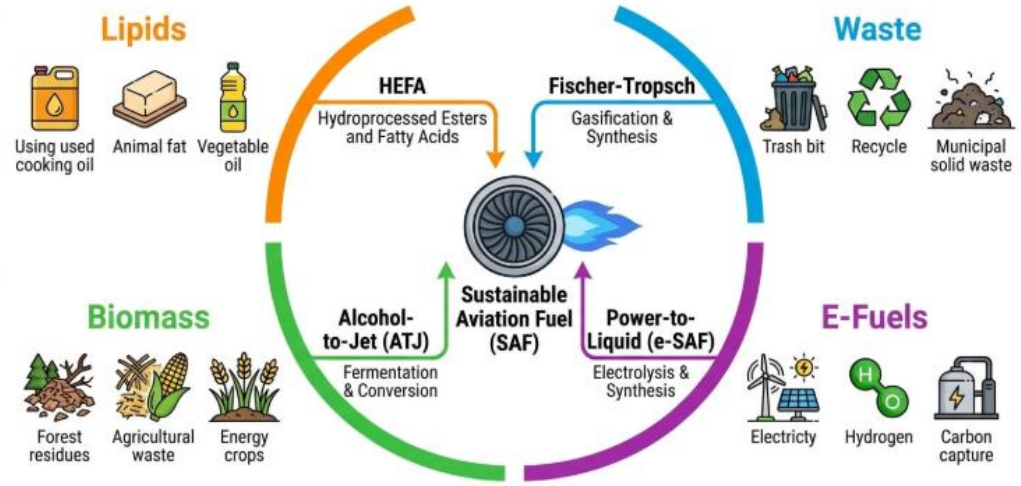
Figure 4: Top Five New SAF Plant Occupations[64]



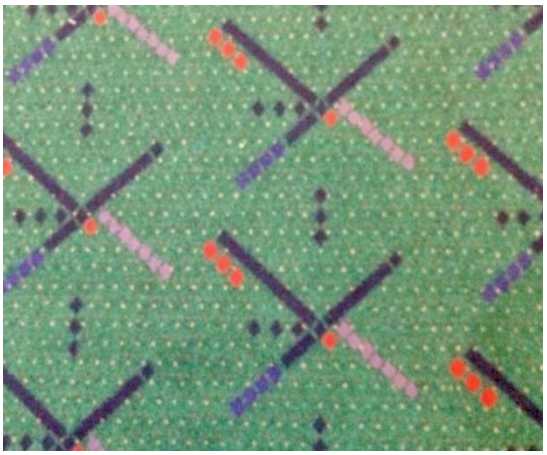
There is limited risk of job displacement in Oregon from the transition from conventional jet fuel to sustainable aviation fuel. Oregon imports all the jet fuel it uses, so jobs in this subsector are focused on the administration and distribution of fuels, which would not be affected by a change in the type of fuel. The Oregon Energy Strategy jobs analysis found that Oregon's fuel sector employs about 10,000 people, which would grow with the siting of low-carbon fuel production in the state.[56]

Collecting, transporting, and processing sustainable aviation fuel feedstocks could stimulate additional rural and regional economic activity. The feedstocks shown in Figure 5 could all be cultivated in Oregon and the greater Pacific Northwest. Using existing waste streams and supplementing them with additional resources cultivates an industrial symbiosis economy, where waste from industries or activities are used as a resource by another industry, improving economic efficiency and reducing waste – ultimately creating more local economic activities that are not as reliant on global trade costs and constraints. For example, the alcohol-to-jet process that uses biomass from agriculture waste or crops grown specifically for energy to create SAF would likely be sited near specific waste or energy crops. Economic opportunity would extend beyond plant operations to agricultural workers and managers in rural farming communities to consistently supply the plant with the needed biomass.[64]

Figure 5: SAF Feedstocks and Pathways[65]



Feedstock availability and costs are a key barrier to sustainable aviation fuel production. Waste fats, oils, greases, and woody biomass are available in Oregon, but are geographically dispersed, creating logistical challenges for economical collection, storage, and distribution. SAF will compete for many of these feedstocks with other low-carbon fuels such as renewable diesel.[66] [67] Each SAF pathway requires a distinct feedstock supply chain that is not yet fully developed. Resources like woody biomass from forest operations, agricultural residues from dairies or concentrated animal feeding operations, and fish byproducts from the seafood sector exist, but larger-scale facilities may need to source additional feedstocks from national or global markets to meet production requirements.[26]



Call Out Box: PDX Statistics[68] [69]

Opened in 1941

1 terminal, 4 concourses, 3 runways

400 flights per day on average (500 at peak times)

18.5 million travelers in 2025[70]

9,600 on-site jobs

$963 million annual contribution to the regional economy

Although developing low-carbon fuel refineries and feedstock supply chains in Oregon will involve significant upfront costs and long project timelines, continuing to rely solely on imported fuels carries long-term economic risk. In 2024, Oregonians spent $10.7 billion on imported petroleum fuels—most of which left the state economy.[2] This outflow increases transportation costs for households and businesses, making Oregon one of the highest-cost petroleum markets in the nation.[2] High fuel prices elevate logistical costs for exporting Oregon-made goods, reducing competitiveness in regional and national markets.[71] Transitioning from imported petroleum to in-state SAF and other low-carbon fuels would help retain economic value and reduce exposure to global price volatility. Airports near SAF production facilities with dedicated distribution infrastructure have fewer logistical and transportation expenses, which reduce SAF premium costs, but those scenarios are rare in this emerging industry. Just as important are the federal and state policies that reduce the price gap; producers send the fuel where there is demand and attractive pricing.[72] If Oregon depends solely on imported SAF, the state will compete with strong policy-driven demand in California and Washington, with no guarantee of securing needed volumes and a high likelihood of paying elevated prices.

Energy security

Expanding low-carbon fuel production and storage within Oregon could strengthen the state's energy security by reducing reliance on external supply chains and improving resilience to future supply interruptions, market volatility, or geopolitical disruptions.[73] Most of Oregon's jet fuel supply depends on a single pipeline, with smaller volumes transported to Portland by marine vessels. Increasing in-state SAF production would create additional supply pathways and provide more options during emergencies. The Oregon Department of Aviation's Strategic Plan identifies limited and inconsistent access to sustainable aviation fuel as an ongoing challenge for the aviation sector.[41]

Oregon Department of Aviation

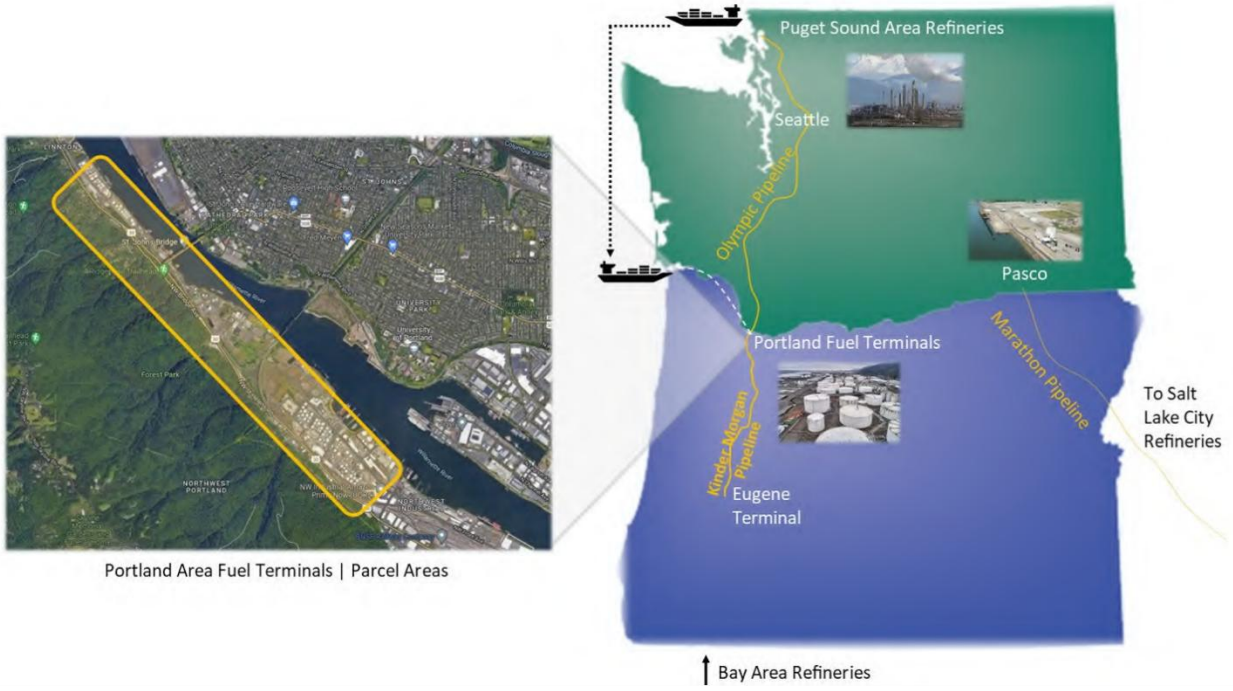
ODAV was founded in 1921 and is the United States' oldest state aviation agency[74]

Expanding fuel production and storage capacity outside high-risk areas can reduce vulnerability to major supply disruptions from natural hazards, including earthquakes. Oregon's Critical Energy Infrastructure Hub along the lower Willamette River remains a central storage and distribution point for liquid fuels, natural gas, pipelines, and high-voltage electric infrastructure, but it is also located in a zone of significant seismic risk. The Oregon Department of Environmental Quality's Fuel Tank Seismic Stability Program requires large-capacity fuel storage and distribution facilities to assess and mitigate seismic risks to their facilities. Each plan will identify specific measures that a facility will take to reduce risk and must be fully implemented within 10 years of DEQ's approval of the mitigation plan. As of October 2026, the City of Portland is considering zoning limitations on new storage tank and transloading capacity, as well as long-term drawdown measures to reduce fuel storage at the Hub over the next 10 years.

These local actions have important implications for the future of sustainable aviation fuel and other low-carbon fuels in Oregon. As currently proposed, Portland's CEI Hub policy would treat low-carbon fuels the same as conventional petroleum products, limiting opportunities to expand low-carbon fuel infrastructure and requiring a 20 percent reduction in total fuel storage capacity. Aviation fuels, including SAF, are exempt from the drawdown requirements, and there is a potential pathway for very modest future expansion of aviation fuel storage capacity — but the limitations to compatible fuels like renewable diesel may slow low-carbon fuel adoption in Oregon. As ODOE noted in formal comments to the City of Portland, "We are … concerned that including low-carbon fuels – such as renewable diesel and sustainable aviation fuel, in the same category as traditional petroleum-based fuels could hinder the development of the nascent low-carbon fuel economy in Oregon. These fuels are essential to meeting transportation-sector greenhouse gas emissions reduction goals as outlined in the Oregon Energy Strategy, as well as to improving local air quality."[75]

Developing low-carbon fuel production and storage outside the CEI Hub would reduce exposure to seismic and other natural-hazard risks and improve long-term resilience. However, Oregon remains heavily dependent on the CEI Hub's terminal network for fuel supply. Nearly all refined petroleum products and low-carbon fuels, including all jet fuel and SAF used at Oregon's commercial airports in Portland, Eugene, Redmond, and Medford, flow through this single hub. Strengthening alternative storage and distribution pathways will be essential to reducing this vulnerability and supporting a more resilient low-carbon fuel system statewide. The ODOE Energy Security Plan highlights opportunities to distribute fuel storage more broadly across the state to strengthen emergency preparedness and response.[73]

Figure 6: Map of Oregon and Washington Fuel Supply and Distribution System[73]



Policy Exploration

State and federal policies can play an important role in increasing sustainable aviation fuel use while minimizing harm to communities, the economy, and the aviation industry. Oregon currently provides financial incentives for SAF but lacks specific plans and goals that provide market certainty and encourage collaboration among state agencies, community and environmental organizations, airports, and industry partners. State plans and goals would need to include mechanisms to secure fuel from out of state or spur development of a SAF economy in Oregon, including fuel infrastructure and feedstock supply chains. This could include policies that support financing tools or direct monetary incentives. The following sections explore these policy needs and provide potential options, including examples of policies other states are implementing to advance SAF markets.

Setting Goals

Establishing clear goals for sustainable aviation fuel consumption and production would signal Oregon's long-term commitment to decarbonizing aviation and encourage collaboration among incumbent fuel suppliers, new market entrants, and public partners. Integrating SAF targets into Oregon's broader energy system planning would also ensure consistency across existing aviation, transportation, and low-carbon fuel policies.

Creating sustainable aviation fuel goals in Oregon would also align with emerging regional strategies. In 2024, California and Airlines 4 America set a goal to increase SAF availability to 200 million gallons by 2035, while establishing a working group to report on progress and evaluate potential barriers to meeting the goal.[76] The Port of Seattle set a goal to power all flights at Seattle-Tacoma International Airport with at least a 10 percent blend of SAF by 2028.[77] British Columbia has taken a different approach by requiring all aviation fuel sold in the province to include at least 1 percent SAF beginning in 2028, increasing over time, and pairing this requirement with a declining carbon-intensity standard

for qualifying SAF. This mandate is the first of its kind in North America, though limited regional supply and distribution constraints will need to be addressed for it to be successful.[78]

By setting sustainable aviation fuel consumption goals, Oregon can signal long-term demand certainty to fuel producers and investors. This could potentially de-risk private sector capital decisions and encourage development of local SAF production facilities, supply chains, and supporting infrastructure. An Oregon target could combine increasing consumption volumes through 2050 with declining carbon-intensity requirements to spur innovation and encourage use of local waste resources. Oregon could collaborate with airlines, fuel producers, and distributors to identify a target and develop procurement strategies to support achievement.

Infrastructure

Reliable access to sustainable aviation fuel will require in-state production or distribution from new regional facilities. No planned SAF production facilities in the Pacific Northwest are integrated with existing petroleum pipelines; Oregon will likely need additional storage and transport capacity, such as marine, barge, or rail shipments to Portland terminals, or new fuel terminals elsewhere in the state. To be successful, policy options encouraging infrastructure development must consider siting constraints, capital costs, and environmental and community impacts.

Other states are clarifying regulatory processes to reduce uncertainty for developers while ensuring the benefits of sustainable aviation fuel are realized. Minnesota created regulatory and environmental review roadmaps for SAF projects, outlining key steps and information requirements without reducing environmental safeguards.[79] The state of Washington established two-year environmental review timelines and is allowing SAF facilities to qualify as Clean Energy Projects of Statewide Significance. This designation allows for consolidated reviews but also requires developers to account for their ability to reduce emissions, achieve economic development goals, engage affected federally recognized Tribes, and document potential effects on environmental and public health.[80] [81] Colorado introduced a refundable tax credit to offset a portion of SAF production facility costs, which is available to producers, airports, and aviation businesses when new facilities come into service. The tax credit may be recaptured by the state of Colorado if SAF production reaches less than 60 percent of the facility's total annual production in any of the three taxable years following operation. This ensures SAF is produced in the state even when market forces are driving demand for other low-carbon fuels like renewable diesel.[82] These policies provide clarity to support development while maintaining environmental, community, and fiscal protections.

To strengthen long-term sustainable aviation fuel access, Oregon could conduct a statewide assessment of fuel infrastructure needs and use the results to guide investment. The Cascadia Sustainable Aviation Accelerator, of which ODOE is a member, is evaluating regional infrastructure and policy barriers. Oregon could build on this work by developing a SAF Infrastructure Strategic Plan, identifying priority locations for future facilities, and creating a regulatory roadmap for low-carbon fuel projects that incorporates community benefit frameworks. Applying the Oregon Energy Strategy's Equity and Justice framework will be important to ensure infrastructure decisions balance economic benefits, resilience, community impacts, and environmental protection. The state's developing environmental justice tool may help identify potential benefits and burdens to communities and natural resources. Oregon could also adopt maximum environmental-review timelines for

high-priority projects and consider designating low-carbon fuel facilities as critical energy infrastructure to support a resilient transition.

Feedstocks

A statewide sustainable aviation fuel feedstock strategy could help maximize GHG emission reductions and economic benefits. Waste feedstocks are dispersed and may be costly to collect, store, and transport, and many already serve other markets. An assessment of feedstock availability, developmental costs, and economic benefits could serve as the basis for such a strategy. ODOE conducted a statewide renewable natural gas feedstock inventory in 2018, which has been used to inform planning activities for uptake of this lower carbon fuel. A SAF feedstock inventory would help identify synergies between locally sourced industrial, municipal, agricultural, and forest waste that could reduce costs for feedstock collection and transport. Important considerations for the strategy should include:

- Whether energy crops, such as oil seeds and perennial grasses, should be encouraged,
- Whether and how other feedstock end uses could affect the economics of feedstock collection.
- How the commercial viability of different SAF production pathways affects the economic feasibility of feedstock collection. For example, woody biomass pathways are not yet commercially viable, and the uncertainty of the need for this feedstock should be taken into consideration.

Ensuring alignment with community priorities and environmental protection is key to making a strategy successful. Other states have adopted policies to encourage low-carbon feedstocks that consider their broader environmental and equity goals. Many limit use of energy crops, encouraging use of waste feedstocks and feedstock diversification, and/or require lower carbon feedstocks. California's Low Carbon Fuel Standard limits the use of energy crops in SAF and requires independent feedstock verification. Requiring fuel producers to track crop- and forestry-based feedstocks to their source can help ensure that SAF feedstocks are not directly or indirectly leading to land use changes that release more carbon than the fuel will save.[83] Illinois sets an annual 10 million gallon cap on the amount of SAF from soybean oil feedstock for their SAF purchase credit program to encourage the development of other feedstocks. Illinois also doesn't restrict the credit to in-state SAF production, which could encourage more regional feedstock economic development.[84] Minnesota requires at least a 50 percent lifecycle emissions reduction and integrates equity, water protection, biodiversity, and land-use safeguards. Successful policies in Oregon will need to take into consideration state priorities within the context of community interests and concerns.

Developing a sustainable aviation fuel feedstock strategy would inform a broader SAF policy framework, helping to foster a state SAF economy that supports increased SAF availability and use. ODOE is contributing to Cascadia Sustainable Aviation Accelerator's regional feedstock assessment, which will help characterize the volume and distribution of available feedstocks in Oregon relative to the rest of the region. Oregon could further advance this work through research grants and public funding to address barriers to using waste feedstocks, and explore opportunities related to woody biomass, captured carbon dioxide, renewable hydrogen, and other emerging pathways. Findings from this work should be considered against other Oregon priorities, such as how SAF feedstock

development intersects with state natural carbon sequestration goals, environmental justice goals, and economic development strategies.

Financing

Strategic investments and incentives that support new infrastructure, reduce costs, and encourage market participation can help expand sustainable aviation fuel production at a pace necessary to meet state climate goals. SAF currently costs two to four times more than conventional jet fuel, and while federal tax credits help offset costs through 2029, long-term federal support is uncertain. Oregon will compete for limited SAF with neighboring states, and near-term demand will be shaped by fuel pricing in an emerging market. Developing in-state production and distribution could strengthen access by reducing costs for delivery in Oregon. Clear state goals and stable incentives can reduce investment risk and signal long-term market viability but like supporting feedstock development, these policies should be constructed in a way that minimizes negative outcomes while maximizing benefits for communities and the environment.

States are testing various approaches to financing sustainable aviation fuel production and consumption. Illinois has a SAF purchase credit of $1.50 per gallon and it is applied toward the 6.25 percent state sales tax liability on the purchase of aviation fuel at point of sale.[84] Minnesota offers a per-gallon tax credit of up to $1.50 for SAF that meets strict sustainability requirements, including use of in-state waste biomass and a minimum 50 percent lifecycle emissions reduction, and requires the fuel to be used on flights departing from Minnesota airports. This approach ensures that economic benefits remain in state, but may limit flexibility for producers operating in a dynamic and evolving market where they may need to import or export fuel out of the state. Washington State enacted a per-gallon tax credit tied to lifecycle emissions performance. However, the credit will not take effect until in-state production reaches at least 20 million gallons per year. With commercial production in Washington still in the early stages, it will be years before these incentives become available.

Oregon could expand sustainable aviation fuel access through targeted financial incentives programs, or tax relief designed to reduce costs and spur infrastructure investment. Options include grants or low-interest financing for blending, storage, and airport distribution, or a per-gallon tax credit tied to emissions-reduction thresholds and Oregon-sourced feedstocks. Financial support to accelerate investment in sites to prepare them for development and updates to standards for industrial lands as recommended by the Oregon Prosperity Council could make Oregon an attractive location for a low-carbon fuel production facility.[85] Oregon could also explore expanding existing market transformation programs like the Climate Protection Program and the Clean Fuels Program to include aviation fuels. Transitioning from voluntary to mandatory participation for jet-fuel suppliers would enhance SAF credits, establish a transition timeline, and consistent demand. Collaboration with industry will be important to identify key financial barriers and the most effective policy approaches to reduce supply-chain risk for producers, increase blending capacity at fuel terminals, and bolster airline demand.

Strategic Planning and Regional Coordination

Strategic planning and regional coordination will be essential to support sustainable aviation fuel development and long-term decarbonization of Oregon's aviation sector. Aligning efforts across state agencies, local governments, airports, industry, and academic institutions can help create a

coordinated roadmap for feedstock supply, infrastructure needs, and regulatory pathways. Aspirational state goals aligned with regional partners could strengthen policy signals, and Oregon could lead by example through SAF procurement targets for state air travel.

Continued regional collaboration will help ensure reliable access to sustainable aviation fuel, support Oregon's economic opportunities, and manage risks associated with a transitioning fuel market. Additional SAF challenges —including fuel testing, engine manufacturer requirements, and safety evaluations — extend beyond state boundaries and require multi-state and private/public collaboration to overcome. Minnesota's SAF Hub demonstrates a model for coordinated infrastructure development, feedstock sourcing, research, and commercialization. Oregon and Washington are supporting the Cascadia Sustainable Aviation Accelerator, a regional partnership focused on scaling production, deployment, and use. Through the Accelerator, Oregon will evaluate policies, infrastructure needs, and feedstock availability to identify economic opportunities and support regional SAF production. This collaborative approach aligns with Governor Kotek's Executive Order 25-29, Business Oregon's forthcoming Economic Development Strategy, and the Oregon Department of Aviation's 2025 Strategic Plan, all of which emphasize coordinated regional planning and sustainable infrastructure development.

Conclusion

Sustainable aviation fuel offers Oregon a practical path to reduce emissions from commercial aviation and a broader opportunity to strengthen the state's clean energy economy and energy security. Leveraging Oregon's waste-based resources as feedstocks could bolster economic growth in rural communities, strengthen regional supply chains, and expand access to other high-demand, low-carbon fuels such as renewable diesel. Increasing the availability of SAF would enhance energy security by reducing reliance on imported petroleum fuels and retaining more transportation fuel investments in Oregon.

At the same time, policies driving economic investments must also be in place to attract sustainable aviation fuel producer investments. Establishing SAF consumption and production targets that are regionally aligned could foster more predictable market conditions for developers. These could be bolstered with policies that incentivize in-state SAF production and infrastructure development.

Achieving these outcomes will require coordinated planning, regional alignment, and clear regulatory frameworks to support market growth and new industrial development. Thoughtful planning and local engagement to address environmental, health, and equity considerations must be priorities when considering new fuel production and distribution infrastructure development. Identifying options to mitigate inequities associated with SAF-related infrastructure requires engaging with communities early and often and ensuring their input informs state and local siting and permitting decisions. Coordinated planning across state agencies, airports, industry partners, and regional initiatives can reduce timelines for developers while still enabling public input on infrastructure development and ongoing operations and eventual decommissioning.

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Flexible by Design: How Medium- and Heavy-Duty Vehicle Charging Can Support Grid Integration in an Era of Rapid Load Growth



Electricity demand in the Pacific Northwest is entering a period of renewed growth, with data centers emerging as the dominant near-term driver of load[i] growth.[1–3] Building electrification and electric vehicles are expected to contribute an increasing share of demand over time. Recent projections from the Northwest Power and Conservation Council indicate regional electricity demand could increase by roughly 1.8 to 3.1 percent annually over the next two decades, potentially doubling by 2046.[4] This marks a significant departure from historical trends, as electricity demand in the U.S. grew slowly over the past two decades and was largely offset by improvements in energy efficiency.[5]

Unlike many historical sources of load growth, emerging tech loads are often large, concentrated, and relatively inflexible. Oregon already hosts one of the fastest-growing data center markets in the country, and these facilities tend to operate with high-capacity, continuous electricity demand.[6] This shift creates new challenges for system capacity, reliability, interconnection timelines, and utility planning. Utilities must increasingly prepare for and accommodate large, concentrated loads – particularly data centers – that operate around the clock and have limited ability to adjust consumption in response to grid conditions.

At the same time, medium- and heavy-duty vehicle electrification is introducing another major source of high-powered load. While not the primary driver of demand growth in the near term, electric vehicles are projected to play a much larger role by 2030, and become one of the largest contributors to load growth over time, according to numerous studies.[1–3] Importantly, the effect of medium- and heavy duty electric vehicles on the power system depends not just on how much electricity these vehicles consume, but on the *shape* of charging demand: when, where, and how vehicles charge.[7]

Unlike many emerging tech loads, medium- and heavy-duty vehicle charging applications often have inherent flexibility that can be leveraged in different ways. Charging can be scheduled around predictable fleet operations and long dwell times,[ii] creating opportunities to actively manage electricity demand in ways that support grid reliability. Managed charging can provide value at both the bulk power and distribution system levels[iii] by reducing overall peak demand, improving the utilization of existing infrastructure, and helping keep EV charging loads within local feeder and equipment limits.[8] By reducing system costs and making more efficient use of existing grid assets, these benefits can help moderate future cost increases. In addition, when paired with battery energy storage, microgrids, or bidirectional charging technologies such as vehicle-to-grid or vehicle-to-building, electric vehicles and charging infrastructure may also provide resilience benefits by

[i] Load refers to the amount of electricity being used or required at a given time. Load growth refers to an increase in that electricity demand over time.

[ii] Dwell time refers to the period when a vehicle is parked and available for charging. For many medium- and heavy-duty fleets, overnight depot parking creates long dwell times that provide flexibility over when charging occurs.

[iii] The electric grid is often divided into two levels: the bulk power system, which includes generation and high-voltage transmission infrastructure that moves electricity across the region, and the distribution system, which delivers electricity from local substations to homes and businesses.

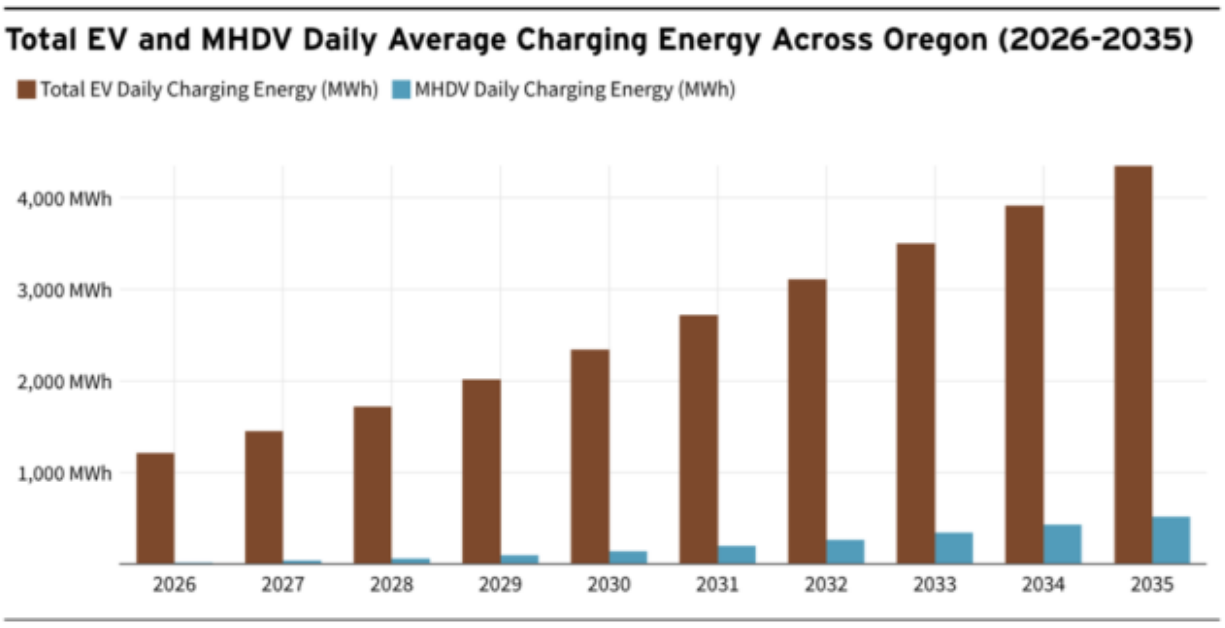
supplying backup power to home, businesses, or the grid, and maintaining essential fleet operations. With the right policies, infrastructure, and incentives, medium- and heavy-duty vehicle charging has the potential to function not only as new electric load, but a valuable source of grid flexibility, reliability, and resilience.

What Makes MHD Charging Distinct and Valuable

Oregon's medium- and heavy-duty vehicle sector represents a significant and growing opportunity for transportation electrification, as well as a potentially valuable source of load flexibility. Oregon has roughly 380,000 registered medium-and heavy-duty vehicles.[9] Though just over 1,050 of those vehicles were electric as of June 2026, state policies, manufacturer commitments, and broader market trends are expected to accelerate adoption over the coming decades. Much of Oregon's existing MHD fleet appears well suited for near-term electrification: class 2b and 3 vehicles, including commercial pickups and delivery vans, account for roughly 84 percent of Oregon's registered medium- and heavy-duty vehicles and are among the most commercially mature applications for battery-electric technology today.[10]

Transportation electrification is expected to create substantial new electricity demand in Oregon. A recent RMI report prepared for the Oregon Department of Environmental Quality estimates statewide EV charging demand could reach approximately 4.3 GWh per day by 2035, with MHD vehicles accounting for roughly 10 percent of total transportation electricity demand (Figure 1).[11] Unlike residential light-duty charging, which is typically small and dispersed, MHD charging often involves large amounts of electricity concentrated at fleet depots, warehouses, transit yards, ports, or industrial facilities. Heavy-duty truck chargers can require hundreds of kilowatts of power, and fleets may charge many vehicles simultaneously, creating substantial aggregate demand. These high-powered, clustered charging patterns can create localized challenges for distribution infrastructure and utility planning, particularly in areas where freight and industrial activity are already concentrated.[13]

Figure 1: RMI Analysis on Statewide EV Charging Demand – Total EV vs. MHDV



These impacts can be especially significant if charging is unmanaged.[7] Simultaneous charging at large fleet depots or freight hubs can produce sharp peaks in electricity demand, potentially requiring costly upgrades to substations, feeders, transformers, and other grid infrastructure. Studies in California and New York estimate that unmanaged charging could drive tens of billions of dollars in distribution system upgrades, while managed charging could reduce those costs by half.[14,15] High-powered charging that coincides with periods of high system demand or limited resource availability can also increase bulk power system costs and contribute to reliability challenges.[11] Because fleet charging infrastructure can often be deployed faster than traditional utility planning and infrastructure upgrades, unmanaged charging has become a growing concern for utilities and regulators nationwide.[16] Absent interventions such as capacity upgrades or managed charging, many locations on Oregon's electric grid are likely to face capacity constraints in the near future: RMI's study estimated that by 2035, approximately 33 percent of Portland General Electric feeders and 60 percent of Eugene Water & Electric Board substations could be capacity-constrained (see Figure 2).[11]

Figure 2: Utility Infrastructure Capacity Constraints Due to EV Load Growth in RMI's High Adoption, Unmanaged Charging Scenario

Utility	Asset Type	Total Assets	Assets Over Capacity (2030)	Assets Over Capacity (2035)
PGE	Feeder	556	155	179
Pacific Power	Transformer	249	5	11
EWEB	Substation	29	17	17
Idaho Power	Feeder	52	0	1

Not accounting for capacity expansions beyond 2025.

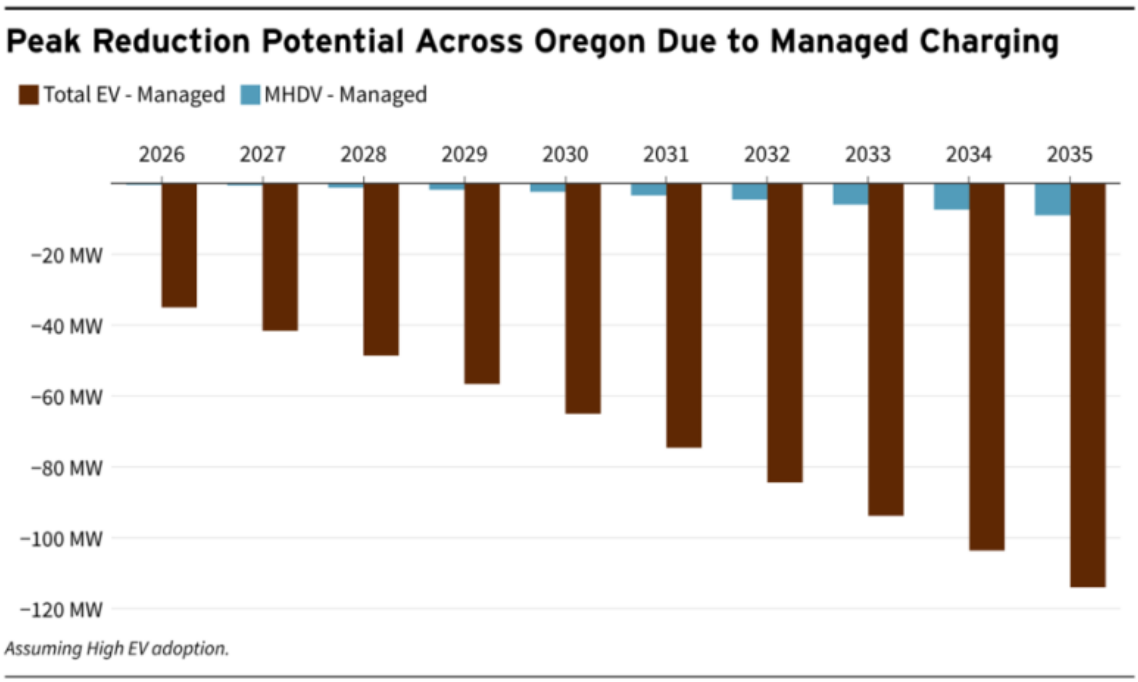
At the same time, the operational characteristics that make many medium- and heavy-duty vehicles strong candidates for electrification can also make them well suited for managed charging. Commercial fleets often operate on highly structured schedules, with predictable routes, centralized parking locations, and defined dwell periods. This is especially true for medium-duty and vocational applications such as delivery vans, local freight trucks, school buses, transit buses, refuse trucks, and drayage[iv] vehicles. In Oregon, DEQ fleet reporting data show that most MHD vehicles travel less than 100 miles per day, the majority return to a home base each night, and most remain parked for more than eight hours.[17] These characteristics can create opportunities for flexibility in both the timing and rate of charging, allowing fleets to shift charging within available dwell periods or charge at lower power over longer periods without disrupting vehicle operations.

As medium- and heavy-duty vehicle adoption scales, this flexibility could become increasingly valuable for managing the impacts of new electricity demand. Rather than behaving as purely inflexible load, many fleet charging applications can be actively managed in response to grid conditions and infrastructure constraints. RMI estimates that by 2035, relatively simple managed charging strategies could reduce Oregon's statewide EV peak load by more than 100 MW, or 35

[iv] A drayage vehicle is a truck used to transport shipping containers over short distances, typically between ports, rail yards, warehouses, and distribution centers. Drayage is the "first mile" or "last mile" of freight movement, connecting marine, rail, and trucking networks.

percent, while managing medium- and heavy-duty vehicle charging alone could reduce EV peak demand by nearly 10 MW (Figure 3).[11] More advanced or targeted charging management strategies could further reduce the grid impacts and costs associated with EV charging.

Figure 3: Peak Reduction Potential in RMI's High Adoption, Managed Charging Scenario



Load Flexibility as a Grid Resource

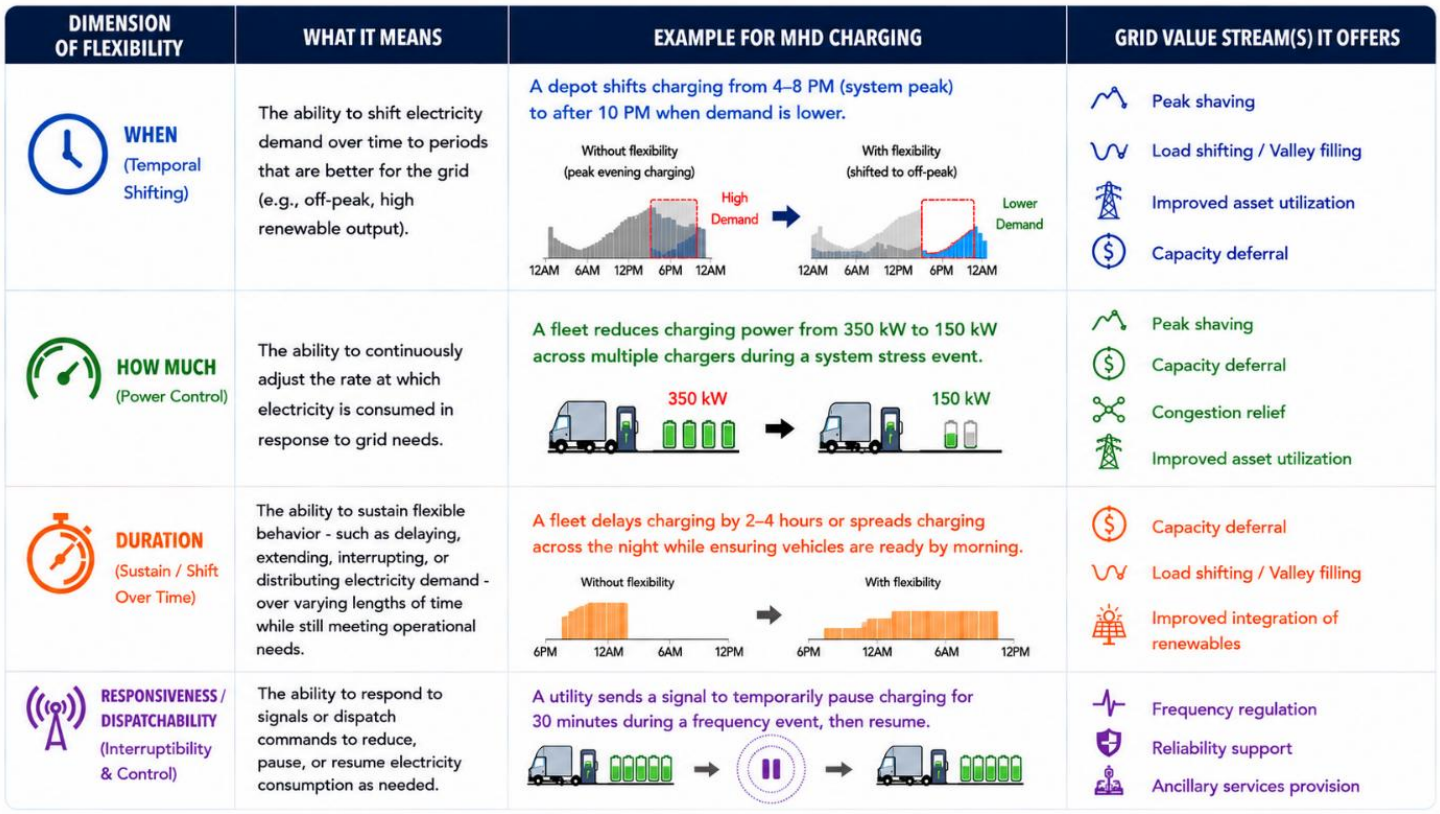
Electricity systems must continuously balance supply and demand. Historically, system flexibility came primarily from generators (supply) while electricity demand was treated as largely fixed. As demand grows and the grid becomes increasingly variable and constrained, the ability to shift or adjust electricity consumption is becoming increasingly important for managing grid conditions and infrastructure needs. Flexible loads can shift when and how they consume power in response to grid conditions, reducing peak demand, improving utilization of existing infrastructure, lowering system costs, and supporting renewable energy integration. Medium- and heavy-duty vehicle charging represents a particularly important emerging source of flexible load due to the operational characteristics discussed above, which creates opportunities to actively manage charging without disrupting operations.

Dimensions of Flexibility

Load flexibility is not one-size-fits-all. The value of medium- and heavy-duty charging depends on how it can be managed across multiple dimensions.[13] Flexible charging may involve shifting charging over time (temporal flexibility), adjusting charging power levels (power control), temporarily interrupting charging (interruptibility), responding dynamically to external signals (dispatchability), or changing where charging occurs within the system (spatial flexibility). These dimensions of flexibility can provide a range of grid benefits, including peak reduction, load shifting, renewable energy

integration, congestion management, improved asset utilization, ancillary services[v], and deferred infrastructure investments. Figure 4 illustrates the major dimensions of medium- and heavy-duty charging flexibility, real-world examples, and the value streams they can provide to the electric system.

Figure 4: Dimensions of MHD Charging Flexibility and Grid Value Provided[13]



Enabling Load Flexibility in Practice

Realizing the grid value of flexible medium- and heavy-duty charging depends not only on the operational characteristics of fleets, but also on the strategies, technologies, and charging infrastructure attributes used to shape charging demand. Capturing MHD charging flexibility in practice requires intentional planning across both charging operations and site design. A range of approaches can be used to influence when and how charging occurs, manage power demand, integrate distributed energy resources,[vi] and align electricity consumption with available grid capacity.

[v] Ancillary services are services that help grid operators maintain the reliability and stability of the electric system and include services such as frequency regulation and operating reserves. Flexible loads can provide some ancillary services by rapidly increasing or decreasing electricity consumption in response to grid conditions.

[vi] [vi] Distributed energy resources, commonly referred to as "DERs", are small-scale energy technologies located on the customer side of the electric meter or connected directly to the distribution system that can generate, store, manage, or reduce electricity consumption. Examples include rooftop solar, battery storage, and smart thermostats.

Managed Charging – Scheduling and Power Control Strategies

Managed charging is the primary strategy for enabling the load flexibility of medium- and heavy-duty electric vehicles. It includes a portfolio of strategies, from passive, behavior-based programs to active and dynamic coordination between electric vehicles, charging infrastructure, and utilities.

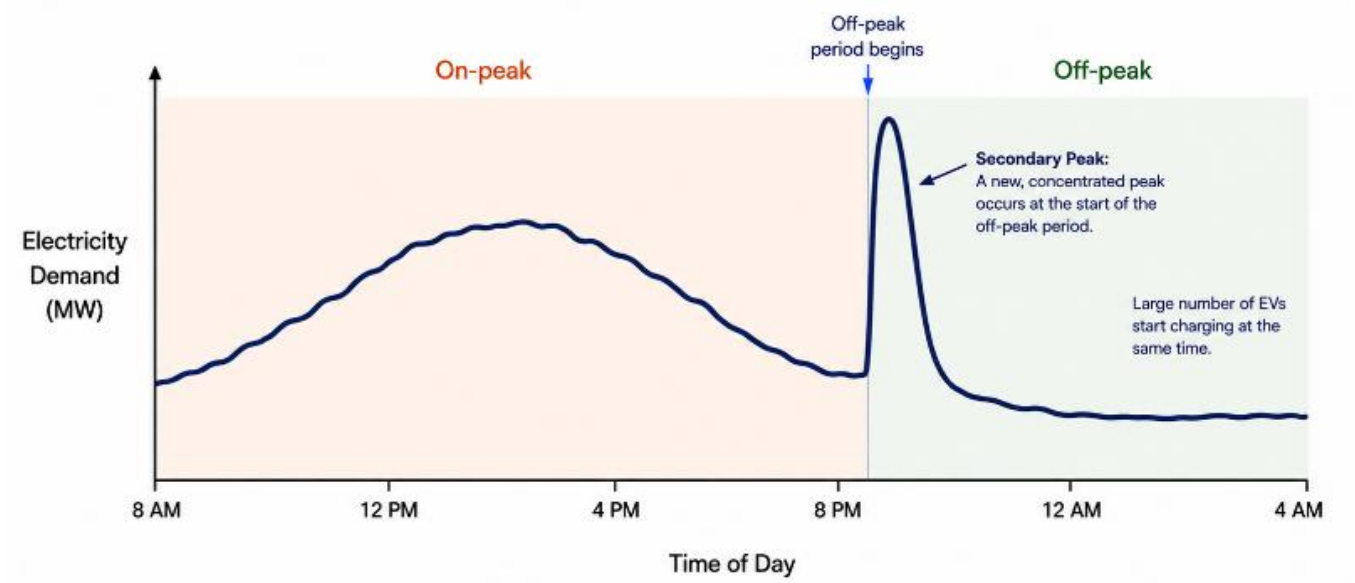
Passive Managed Charging

Passive managed charging relies on customer behavior in response to price signals and static charging schedules rather than real-time utility coordination. Customers typically program charging schedules through the vehicle or charging equipment to align with preferred charging periods. This approach places more responsibility on customer participation and behavior, while requiring less direct utility control or real-time oversight. The following are examples of passive managed charging strategies:

- **Simple Off-Peak**: Simple off-peak programs use rebates, bill credits, or seasonal pricing structures to incentivize EVs to charge during periods of lower electricity demand, typically overnight or during other non-peak hours.[8] These programs are typically structured around a simple distinction between on- and off-peak periods, rather than multiple pricing tiers.
- **Time-of-Use Rates:** Time-of-use rates vary electricity pricing by time of day to encourage charging during lower-demand periods. EV-specific TOU programs often include tiered rates that apply specifically to vehicle charging, while "whole home" approaches apply time-varying prices to all electricity consumption.[8] EV-specific rates require a way to separately measure vehicle charging, which can be accomplished through a dedicated EV meter or, where supported, charging data from the vehicle or charging equipment.
- **Demand Charges:** Demand charges are a component of many commercial and industrial electricity rates based on a customer's highest short-duration (typically 15- or 30-minute) power demand during a billing period. They are designed to help utilities cover the cost of maintaining sufficient generation, transmission, and distribution capacity to serve customers' peak demands. Because high-powered EV charging can produce large demand spikes, demand charges can significantly increase electricity costs. This creates a strong financial incentive for fleets to manage charging to limit their facility's peak demand, for example by staggering charging sessions, reducing charging speeds, or shifting charging to when other facility loads are lower.

Managed charging can create new "secondary peaks" if many vehicles begin charging simultaneously after charging has been delayed or reduced. This risk can be particularly pronounced with passive approaches, where many vehicles may respond to the same price signal or charging schedule.[8] In one simulation, off-peak demand increased by as much as 20 percent when charging began immediately after the on-peak period ended, demonstrating how passive approaches can shift rather than eliminate grid stress (See Figure 5).[18] More advanced active managed charging strategies can help address this challenge.

Figure 5: Illustration of Secondary Peak Risk from Passive Managed Charging



Active Managed Charging

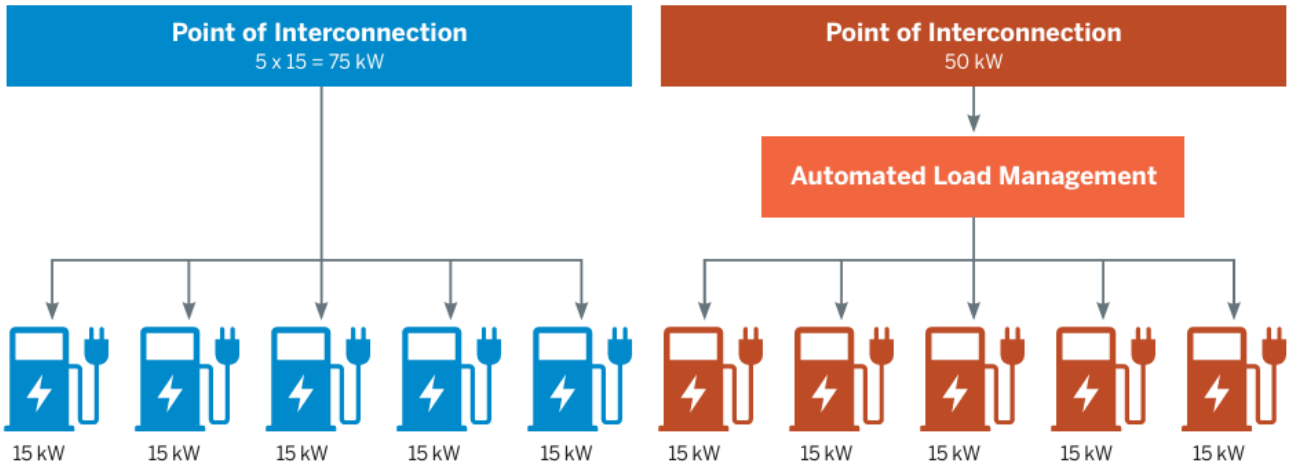
Unlike passive managed charging, which relies on customer behavior and static price signals, active managed charging uses two-way communication, software, and automated or remotely initiated controls to dynamically adjust charging in response to grid conditions, utility signals, or operational needs. These approaches can determine when charging occurs, how fast vehicles charge, and whether charging is temporarily paused. While some customers worry that active managed charging could leave a vehicle without enough charge when it is needed, these systems are designed to incorporate scheduled departure times, required state of charge, operating schedules, and other customer-defined requirements as constraints, allowing charging to be optimized within the flexibility available while ensuring vehicles are ready for their next trip. Many programs also allow customers to override or opt out of charging adjustments when necessary. When charging can be coordinated across many participating vehicles, relatively small adjustments across a portfolio can aggregate into meaningful flexible load while limiting impacts to individual customers or fleets. Common active managed charging strategies include:

- **Event-Based Demand Response**: During these events, utilities send signals to customers to reduce or pause charging during periods of grid stress or high demand. Because EV charging can often be delayed with minimal energy losses or operational impacts, it is particularly well-suited for demand response applications.[16] However, event-based demand response programs may not fully address the challenge of a secondary spike when all vehicles resume charging, and thus may not capture the full value of charging flexibility.[8]
- **Dynamic Pricing**: Under dynamic pricing, electricity rates change based on real-time or near-real-time grid conditions in the bulk or distribution systems. Price changes may reflect factors such as electricity demand, wholesale prices, renewable energy availability, or local grid constraints.[16] Unlike static time-of-use rates, dynamic pricing provides a more responsive, granular signal because prices may vary hourly or sub-hourly. Utilities are increasingly pairing

dynamic pricing with automated charging systems that optimize charging schedules based on customer needs and grid conditions.[16]

- **Automated Load Management**: Automated load management systems control charging demand at a site to keep total electricity use within specified limits.[16] These systems may cap total charging demand, share power across chargers, or stagger charging sessions to avoid infrastructure overloads, reduce peak demand, or lower electricity costs. In some cases, they allow the combined nameplate capacity of chargers to exceed the site's available electrical capacity. For example, Figure 6 shows five 15 kW chargers with a combined capacity of 75 kW served by a 50 kW interconnection. Automated load management keeps their combined demand below the 50 kW limit by adjusting charging power or staggering charging across vehicles, while still allowing all five chargers to be installed and available for use.

Figure 6: Using Automated Load Management to Allow the Same Charging Equipment to Operate at Sites with Lower Available Grid Capacity[16]

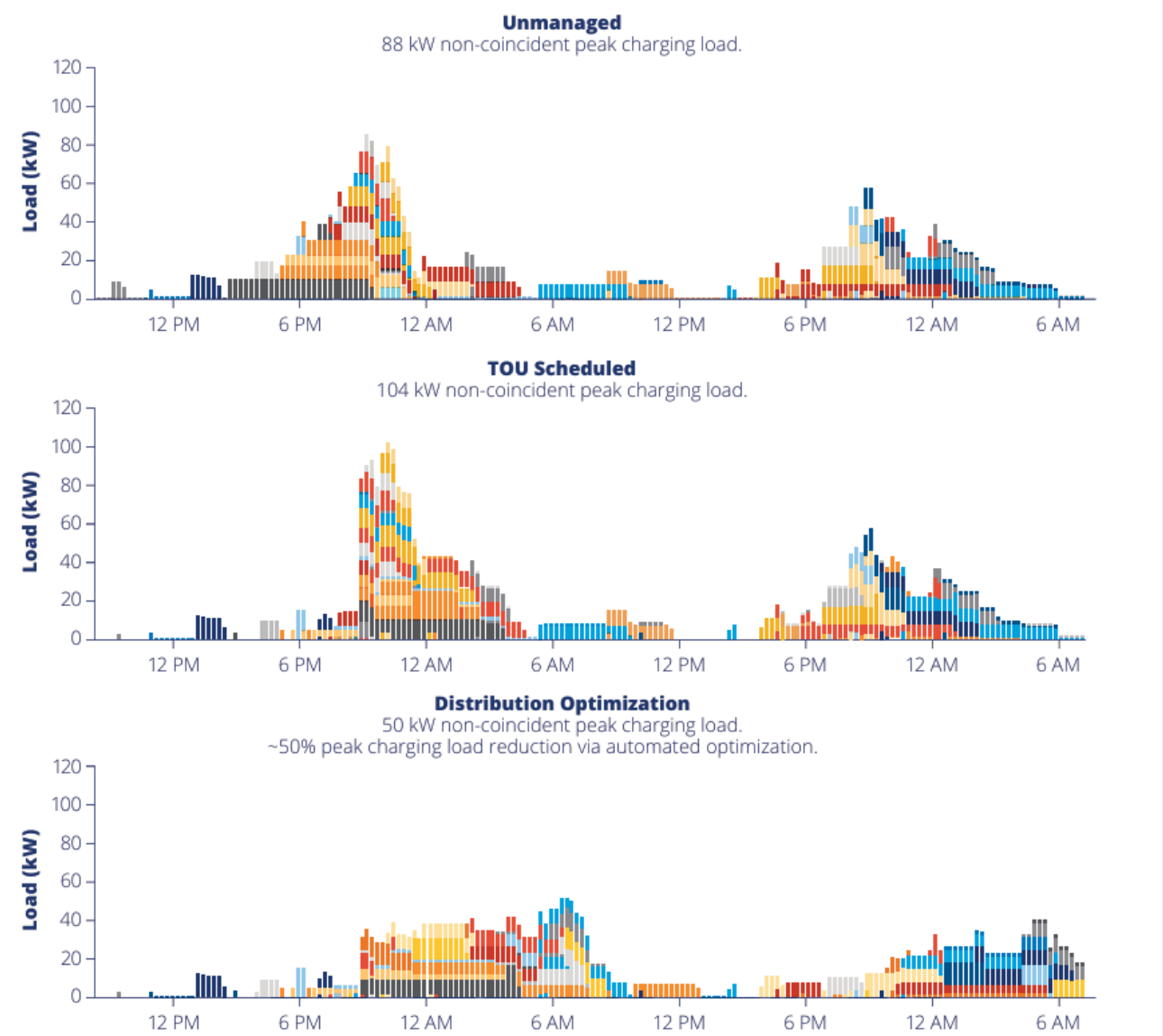


- **Dynamic Managed Charging**: Dynamic managed charging continuously adjusts EV charging in response to real-time or near-real-time grid conditions, utility signals, and customer charging needs.[16] Unlike automated load management, which primarily focuses on site-level demand limits, dynamic managed charging actively coordinates charging with external grid conditions. These systems can increase, decrease, delay, pause, or resume charging while still meeting vehicle operational requirements, helping avoid the secondary peaks associated with static charging schedules or demand response events.
- **Multi-layer Optimization**: Multi-layer optimization coordinates EV charging across multiple objectives and system constraints simultaneously.[8] As a more advanced control strategy than dynamic managed charging systems, multi-layer optimization is able to consider both bulk- and distribution-level constraints alongside fleet operational requirements and customer charging needs. While dynamic managed charging may optimize for a single objective, such as minimizing electricity costs, multi-layer optimization balances several objectives at once to coordinate charging across fleet and grid conditions.

Passive vs. Active Managed Charging

Not all charging strategies deliver the same grid benefits. Figure 7 provides an example of how different charging strategies can affect electricity demand over a 48-hour period. Using data from a subset of vehicles participating in Portland General Electric's managed charging program through WeaveGrid, the figure illustrates how unmanaged and time-of-use charging can concentrate demand into short periods, while more charging optimization can spread charging over time and substantially reduce peak load.

Figure 7: Example of Charging Load Profiles Under Different Management Strategies



Source: Portland General Electric and WeaveGrid

No single managed charging strategy is universally optimal. Each approach involves tradeoffs related to implementation cost, operational complexity, customer participation, grid value, and suitability for different parts of the electric system. Passive strategies that use prices, rates, or other incentives to encourage customers to change when or how they charge are generally simpler and less expensive to implement but offer less precision in managing grid impacts. Active strategies that use direct or

automated control to adjust timing or power can provide more targeted, responsive, and effective grid support, but require more advanced communications infrastructure, customer enrollment, software integration, and operational coordination.[8] Figure 8, adapted from the Energy Systems Integration Group, broadly categorizes common managed charging strategies by mechanism and timing and indicates their relative suitability for addressing grid challenges at different levels, as well as their implementation complexity and cost.

Figure 8: Suitability of Different Types of Managed Charging to Address Grid Challenges[16]

Managed Charging Strategy	Classification		Suitability to Address Challenges at Multiple Levels				Implementation Complexity	Cost
	Mechanism	Timing	Site	Distribution	Transmission	Generation		
Demand charge	Passive (pricing)	Preset						
Time-of-use rate	Passive (pricing)	Preset						
Dynamic price signal	Passive (pricing)	Dynamic						
Consumer response to event-based demand response	Active (control)	Dynamic						
Dynamic managed charging	Active (control)	Dynamic						
Automated load management	Active (control)	Preset						

Most to Least Suitable

Easier to Complex

Medium- and heavy-duty EV operators are not monolithic. Commercial fleets, transit agencies, school buses, and freight operators all have different operational requirements, risk tolerances, and charging behaviors. As a result, successful managed charging programs will likely require a portfolio of options that provide customers with flexibility and choice. Price-based strategies and active management can also complement one another rather than function as competing approaches. Electricity rates can provide a broad, ongoing shaping of charging demand while more active managed charging programs can serve as precise tools for responding to real-time grid constraints, reliability events, or localized distribution system needs. Designing effective programs therefore requires a strong understanding of grid conditions and customer behavior. In particular, there remains a significant need for additional research and real-world experience to better understand customer willingness to adopt smart charging technologies, participate in managed charging programs, and adjust charging behavior in ways that support grid needs while still meeting operational requirements.[16]

Infrastructure and Site Design Strategies

Realizing the full flexibility potential of medium- and heavy-duty charging requires more than managed charging programs alone. Infrastructure and site design decisions can determine how charging flexibility is enabled, used, and preserved in practice. Decisions such as how much electrical capacity to install, how chargers are shared across vehicles, whether charging is deployed in phases, and how charging is coordinated with onsite energy resources can affect both the magnitude and timing of grid impacts.

Right-Sizing Interconnection Capacity

One way that fleets can leverage charging flexibility is by "right-sizing" interconnection capacity – aligning electrical service with realistic charging needs rather than the theoretical maximum demand of all chargers operating simultaneously at full power. This can be achieved through appropriate charger power level sizing and managed charging strategies that limit coincident charging demand. Because many fleets do not require every vehicle to charge at maximum power or on the shortest possible timeline, right-sizing can reduce the amount of interconnection capacity required at a site.[19] One study by the National Laboratory of the Rockies found that charging power levels required by electric trucks were often lower than commonly assumed, creating financial benefits for utilities and fleet operators.[20]

Charger-to-Vehicle Ratio

Charger-to-vehicle ratio, or the number of chargers available relative to the number of vehicles served, can also influence how fleets use and preserve charging flexibility. Where vehicle schedules and dwell times allow, fleets may be able to leverage flexibility to support more vehicles with fewer chargers through charger sharing, coordinated charging schedules, and managed charging systems. This can increase charger utilization and potentially reduce the electrical capacity and infrastructure needed at a site. However, lower charger-to-vehicle ratios can also reduce the flexibility that remains available by requiring tighter charging schedules or, in some cases, higher charging power. Rather than assuming every vehicle requires a dedicated charger, lower charger-to-vehicle ratios encourage more active management of charging demand across the fleet.

Phased Infrastructure Deployment

Phased infrastructure deployment involves expanding charging infrastructure and electrical capacity incrementally as fleet electrification needs grow. Rather than building for a fully electrified future fleet upfront, phased deployment aligns investments with actual vehicle adoption and operational experience. This approach allows fleets and utilities to better understand real-world charging behavior, utilization patterns, and the amount of type of charging flexibility available before committing to major infrastructure upgrades. Early phases may leverage that flexibility through lower-power charging equipment, shared charging strategies, or managed charging systems to make more efficient use of limited electrical capacity. As vehicle adoption increases and charging needs become clearer, infrastructure can be expanded in a more targeted and informed manner.

Distributed Energy Resources Integration

Distributed energy resource technologies like battery energy storage, solar generation, and microgrids can enhance the flexibility of MHD charging by increasing the ability of fleets to delay, stagger, or modulate charging while still meeting operational needs. Although DERs are not necessary or cost-effective for every charging project, they may provide significant value at sites facing limited grid capacity, long interconnection timelines, high demand charges, reliability concerns, or concentrated fast-charging demand.

Onsite Battery Energy Storage Systems

Battery energy storage systems are among the most promising DERs for MHD charging because they can help manage the high-power demands associated with fleet charging. Batteries can store

electricity when demand is low and discharge it during periods of heavy charging, reducing short-duration demand spikes – and the associated demand charges – created by high-powered chargers.[21] This peak shaving capability can lower operating costs, reduce coincident peak demand, and decrease the amount of power required from the grid.[22] For large fleet depots, storage can also support phased infrastructure deployment by allowing charging operations to begin before full grid upgrades are completed.

Solar + Storage Integration

Solar generation can support flexible charging strategies, particularly when paired with battery storage. While solar production does not always align with fleet charging needs, especially for fleets that charge overnight, solar can help reduce facility electricity use, support daytime charging, and lower demand on the grid during periods of high electricity use.[23] When combined with battery storage and managed charging, these technologies can increase site flexibility and reduce the need for costly infrastructure upgrades.

Microgrids

Microgrids can further enhance charging flexibility by coordinating onsite generation, storage, and charging loads as a unified system. Acting as an energy management platform, a microgrid can optimize charging in response to grid conditions, electricity prices, onsite generation, and operational priorities. This coordination can improve the ability to shift, limit, or smooth charging demand while also providing resilience and backup charging capability during outages. Many of the flexibility benefits associated with DER integration can be achieved without a full microgrid; however, microgrids may provide additional coordination and resilience benefits in certain applications.

Emerging and Future Grid-Interactive Capabilities: Vehicle-to-X

Vehicle-to-X, or bidirectional charging, allows electric vehicles to discharge electricity from onboard batteries to support buildings, other loads, or the grid during periods of high demand or system stress. Unlike managed charging, which shifts when electricity is consumed, V2X allows EVs to function as distributed energy resources that can provide backup or supplementary power, demand response, and other grid services, creating new revenue and value streams for customers and utilities alike.[24] Some medium- and heavy-duty fleets may be particularly well suited for certain V2X applications due to their large battery capacities, predictable schedules, and long dwell times. As fleet electrification scales, the aggregate battery capacity connected to Oregon's electric grid could become a significant source of flexible load and distributed energy storage, with even limited participation in vehicle-to-grid programs offering substantial system value.[25]

However, V2X applications for MHD vehicles remain at an early stage of development and face ongoing technical, operational, and economic challenges, including higher charger costs, battery warranty considerations, interoperability standards, and uncertain compensation structures.[24] As a result, most near-term flexibility opportunities are likely to come from managed charging, power controls, and DER integration. Still, V2X technologies may play a growing role in future grid-interactive fleet operations as technology and market structures continue to evolve.

Operational Considerations for Flexible Fleet Charging

While the strategies above demonstrate the technical potential of flexible charging, the amount of flexibility available in practice depends on how well charging strategies align with real-world fleet operations. Fleet operators have indicated that business needs require vehicles to be available when needed, leaving little tolerance for disruptions to routes, schedules or service obligations. As a result, the operational characteristics of different fleets play a major role in determining what types of charging flexibility are practical and what grid services fleets may realistically be able to provide. Understanding these constraints is critical to designing programs that fleets are willing to adopt.

Aligning Charging Strategy with Duty Cycles

Charging strategies must reflect how vehicles are actually used, and flexibility will vary significantly across fleet types. Many commercial and municipal fleets – including delivery vehicles, transit buses, refuse trucks, and school buses – operate on repeatable daily schedules and remain parked overnight, making them strong candidates for managed charging. In contrast, long-haul trucking operations or other fleets with highly variable schedules, long operating hours, or limited dwell time may have fewer opportunities for flexible charging.

Fleet Availability and Reliability Constraints

Even when managed charging is technically feasible, fleets may require charging buffers or minimum battery levels to ensure vehicles can reliably complete routes under varying conditions. Successful flexible charging strategies will be those that operate largely in the background, automatically accounting for schedules, departure times, and charging needs without disrupting normal operations.[26] Charging approaches that introduce uncertainty, increase operational risk, or fail to account for operational constraints are unlikely to be adopted.

Range, Charging Speed, and Dwell Time Tradeoffs

The amount of charging flexibility is also influenced by vehicle range requirements, charging speed, and available dwell time. Longer dwell periods can provide fleets with greater flexibility in how charging needs are met – for example, by charging at lower power over a longer period of time or by shifting and staggering charging within the available window in response to grid conditions. Fleets with limited dwell time or high daily mileage may require higher-powered charging or faster charging schedules to maintain operations, reducing opportunities for managed charging.

Delivery Fleets Lead Early Electrification: Amazon's Experience with Depot Charging

Amazon's electric delivery fleet illustrates why last-mile delivery vehicles have emerged as some of the earliest and most successful candidates for electrification. Delivery vans typically operate on predictable routes, return to a central depot each night, and travel relatively modest distances. In addition to making them well suited for electrification, these duty cycles provide regular overnight dwell periods during which vehicles can often meet their charging needs using simpler, lower-cost Level 2 chargers.

Since announcing a commitment in 2019 to deploy 100,000 electric delivery vans by 2030, Amazon has grown its electric delivery fleet to more than 40,000 vehicles in thousands of

communities nationwide, including Portland.[28] To date, Amazon has largely relied on low-powered charging to support these vehicles.[29] At one Amazon delivery station in Seattle, approximately 100 electric vans are supported by roughly 70 charging ports, only three of which are fast chargers.[30] By taking advantage of long vehicle dwell periods to meet charging needs at lower power, this type of charging configuration can limit peak demand and site capacity requirements without relying as heavily on active charge management. Amazon has reported that most depots do not require charge management systems or battery storage.[30]

Even with these favorable operating characteristics, Amazon has found that charging infrastructure deployment – due to utility approvals, construction, and access to electrical capacity – can be more challenging than procuring and deploying vehicles.[30] In some cases, Amazon reportedly prioritized electrification at locations where sufficient electrical capacity was already available, rather than locations where vehicles were most needed operationally.[29] This experience highlights how grid readiness and charging infrastructure can influence the pace and location of fleet electrification.

As Amazon expands electrification beyond last-mile delivery into additional medium- and heavy-duty freight applications, these challenges are likely to become more pronounced. Amazon has already deployed electric drayage trucks at the Ports of Los Angeles and Long Beach and in 2026, the company announced a partnership with Swedish trucking company Einride to deploy 75 electric heavy-duty trucks across five U.S. freight locations.[31] Unlike delivery vans, larger vehicle classes often require significantly more energy, higher-powered charging, and tighter charging windows. While Amazon has been able to electrify much of its delivery fleet using relatively simple, low-powered depot charging approaches, scaling electrification to heavier-duty applications will increasingly require managed charging, greater coordination with utilities, and more sophisticated approaches to load flexibility and grid integration.



Amazon's Growing Lineup of Electric Vehicles[27]

Implications for Utility Planning and Grid Integration

Using Flexibility to Improve Utility Planning

The flexibility of medium- and heavy-duty charging loads has important implications for utility planning. Traditionally, utilities have planned for new demand as relatively inflexible, assuming that loads may be highest at times when the grid is already stressed. Infrastructure investments and interconnection decisions may therefore be based on these conservative, worst-case assumptions. This approach can trigger substantial infrastructure upgrades and long interconnection timelines. However, rather than planning exclusively around worst-case coincident charging assumptions, utilities may increasingly be able to incorporate flexible load behavior into distribution planning, load forecasting, hosting capacity analysis, and infrastructure investment decisions.

Supporting this transition will likely require improved planning tools, forecasting methods, and interconnection processes. Hosting capacity maps, a recommendation of the Oregon Energy Strategy, can help utilities and customers identify locations where existing grid infrastructure may be better able to accommodate new charging load with fewer upgrades or constraints. Improved forecasting methods that incorporate fleet electrification timelines, charging behavior, managed charging assumptions, and geographic clustering of freight activity can also help utilities anticipate where future charging demand is likely to occur. In addition, more standardized and transparent interconnection processes may help reduce uncertainty, improve coordination between utilities and fleet operators, and accelerate deployment timelines for charging infrastructure projects. In this way, medium- and heavy-duty charging flexibility can function not only as an operational tool for managing grid conditions in real time, but also as a planning input that shapes how utilities invest in future grid infrastructure.

Oregon Energy Strategy: Planning for Future Load Growth

The Oregon Energy Strategy provides a long-term framework for ensuring Oregon's energy system remains clean, affordable, reliable, and resilient as the state works toward its climate and energy goals. Recognizing that transportation electrification, building electrification, and other emerging loads will increase demands on the electric system, the strategy highlights the importance of collaborative and proactive planning to maintain reliability, manage costs, and maximize the value of existing grid infrastructure. The recommendations in this report build on that foundation by examining how medium- and heavy-duty charging can serve not only as a source of new electric load but also as a source of flexibility that supports grid operations, informs infrastructure planning, and improves the integration of new electric loads.

Using Flexibility to Improve Grid Integration

The ability to actively manage and shape medium- and heavy-duty charging load may also enable new approaches to grid integration. By treating charging load as controllable, utilities and fleets can

reduce infrastructure constraints and accelerate energization timelines through phased and flexible interconnection and other "bridge-to-wires" approaches,[vii] all while reducing upfront costs for fleets.

Phased Interconnection

Phased service connections provide customers with a temporary capacity limit while utilities build the infrastructure needed to serve a site's full long-term load request.[32] This approach can be particularly useful for fleets that plan to electrify gradually, allowing them to operate within existing grid capacity using managed charging and other operational controls until utility upgrades are completed. Phased interconnection is most effective when the additional EV charging load is incremental relative to the site's existing service rather than transformative, as smaller increases in demand can often be accommodated without major upstream infrastructure investments.[33]

Flexible Interconnection

Conventional utility planning approaches that evaluate new loads based on a site's maximum potential demand during the system's highest-demand hour can trigger costly infrastructure upgrades for large fleet charging depots. While intended to maintain system reliability, this approach can leave much of the grid's existing capacity underutilized most of the time and create a major barrier to transportation electrification. In response, some utilities are exploring flexible interconnection approaches that allow managed or time-varying loads to make use of existing grid capacity while limiting charging during constrained periods.[34] These approaches can help fleets begin operating and charging vehicles sooner, without waiting for full infrastructure upgrades.

Flexible service connections can be either static or dynamic. Under static approaches, available charging capacity is governed by predetermined schedules or fixed limits. Dynamic approaches communicate available capacity in real time based on actual grid conditions, allowing customers to operate at or near full capacity for more hours of the year. Dynamic approaches are more complex and expensive to implement, requiring more advanced communications, monitoring, and control systems.[32]

Flexible Interconnection in Practice – PG&E's Flex Connect Program

As transportation electrification accelerates, charging projects are increasingly encountering grid constraints that can delay energization for months or years while utility upgrades are completed. To address this challenge, Pacific Gas and Electric Company's Flex Connect program allows customers in California to connect and begin operating before full electrical capacity is available. In exchange, customers agree to temporarily limit electricity demand during periods when the local grid is constrained. Flex Connect relies on the ability for customers to actively manage and control their load through strategies such as managed charging, charging schedules, power limits, and onsite battery storage.

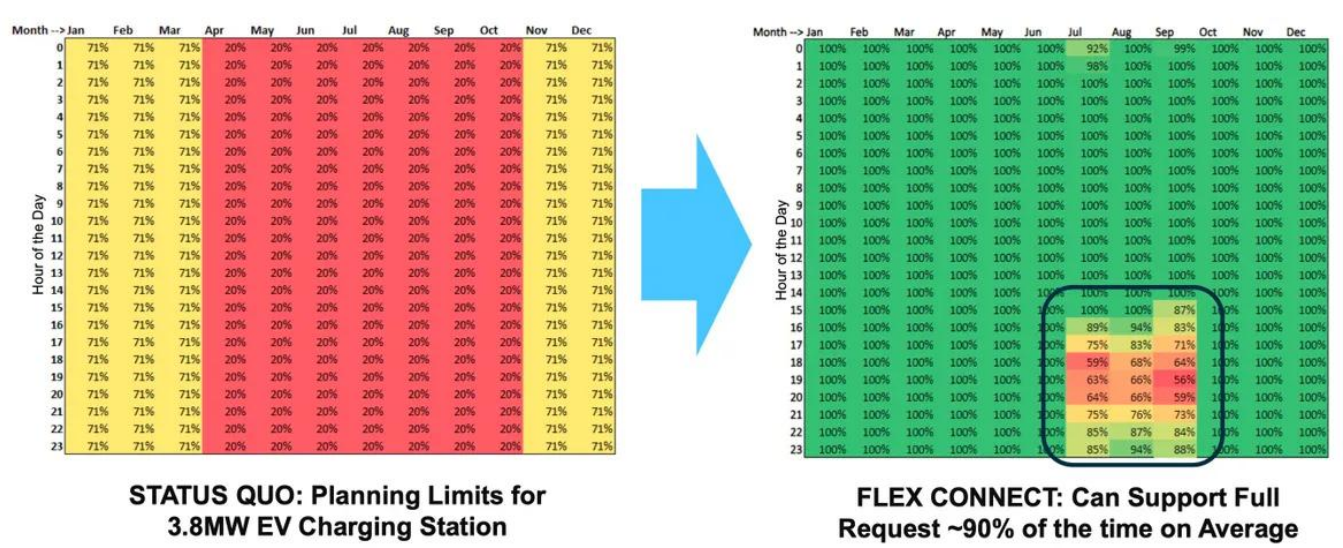
Figure 10 illustrates the concept behind PG&E's Flex Connect program and how flexible load assumptions can change interconnection outcomes for EV charging projects. In this example,

[vii] Bridge-to-wires solutions, sometimes called non-wires alternatives or bridging strategies, are measures that help serve new loads or relieve grid constraints without immediately building new distribution infrastructure.

although the grid can support the customer's full requested load most of the time, a small number of constrained hours limits the site to 3.8 MW of service. Under Flex Connect, the customer can interconnect at its full requested capacity while agreeing to temporarily reduce charging during those constrained periods. As shown, the site can receive its full requested load nearly 90 percent of the time on average, with temporary reductions required only during specific hours and seasons.

Flex Connect demonstrates how load flexibility can accelerate electrification by providing an alternative to traditional "build-first" interconnection approaches.

Figure 10: Flexible Interconnection Can Increase Available Charging Capacity by Leveraging Load Flexibility[35]



Key Considerations for Policymakers

The ability of medium- and heavy-duty vehicle charging to function as a flexible grid resource will depend not only on technology and fleet operations, but also on the policy, regulatory, and planning frameworks that govern how charging infrastructure is deployed and integrated into the grid. Managed charging, distributed energy resources, flexible interconnection, and other load management strategies can improve grid integration outcomes, but realizing these benefits at scale will require coordination among utilities, regulators, fleet operators, and public agencies.

Policymakers can help enable this transition by supporting planning approaches, utility programs, and regulatory frameworks that recognize flexible load as a valuable grid resource. At the same time, flexibility should be viewed as a complement to, not a replacement for, strategic grid investment. While flexible charging can reduce costs, improve asset utilization, and defer some infrastructure upgrades, continued investment in the electric system will still be necessary to support long-term transportation electrification. The following considerations highlight opportunities for Oregon policymakers and utilities to support more flexible, efficient, and scalable medium- and heavy-duty vehicle electrification.

1. Enable and Expand Managed Charging and Flexibility Programs for Fleets that Reflect Grid Conditions

Fleets should be able to select from a portfolio of options – including active managed charging programs, time-of-use rates, demand response programs, and other flexibility mechanisms – that reflect their operational needs, technology readiness, and business objectives.[36] Because fleet operations vary significantly, a one-size-fits-all approach is unlikely to be effective. Programs should be simple, transparent, and designed to integrate seamlessly into fleet operations, with clear expectations and compensation structures. Policymakers and regulators have a role in ensuring that compensation for flexible charging behavior is commensurate with the benefits flexible charging provides to the grid. Well-designed programs can help align utility, ratepayer, and fleet interests while encouraging broad participation.

To date, many of Oregon's consumer-owned utilities have had limited financial or operational incentive to develop EV charging flexibility programs. Unlike larger investor-owned utilities, many COUs have not yet experienced EV adoption levels or system constraints that create a strong business case for managed charging, and some report that existing rate structures provide limited opportunities to capture the value of load shifting. As transportation electrification and other sources of load growth accelerate, however, flexible charging is likely to become increasingly important for managing peak demand and making efficient use of existing infrastructure. Policymakers should consider technical assistance, planning support, and program development resources to help COUs evaluate and implement flexibility programs appropriate for their systems.

Continued support for pilot programs and demonstration projects will also be important for evaluating the grid and operational benefits of managed charging and emerging grid-interactive technologies such as vehicle-to-grid before broader deployment at scale. These efforts can help utilities, regulators, and fleet operators better understand key aspects of program performance, including customer participation, operational constraints, communications requirements, and the potential grid value streams associated with flexible fleet charging.

2. Encourage Early Coordination and Data Sharing between Fleets, Utilities, Charging Providers and Public Agencies

Oregon regulators and policymakers should encourage earlier coordination between utilities, fleet operators, charging providers, and site developers during fleet electrification planning and project development. Early engagement can help reduce uncertainty around infrastructure needs, interconnection timelines, and charging system design while improving utilities' ability to anticipate load growth, identify grid constraints, and evaluate opportunities for managed charging or phased energization. One way to support this is to encourage participation in the Electric Power Research Institute's (EPRI) GridFAST platform, which provides a standardized mechanism for notifying utilities of planned charging projects early in the development process.

Improved data collection and sharing around charging behavior will also become increasingly important as more Oregon fleets invest in medium- and heavy-duty electric vehicles. Utilities currently have limited visibility into how commercial fleets charge, including charging schedules, dwell times, load profiles, operational flexibility, and responsiveness to price or managed charging signals. Supporting the collection and sharing of anonymized charging data can help utilities improve

forecasting, better understand charging flexibility potential, and develop more effective rates, managed charging programs, and interconnection strategies over time. Policymakers should also support common communications standards and data-sharing practices that allow utilities, fleets, and charging providers to coordinate charging more effectively while maintaining appropriate customer privacy protections.

As recommended in the Oregon Energy Strategy, Oregon regulators should require utilities to maintain publicly accessible and regularly updated hosting capacity maps that provide customers and developers with better visibility into available grid capacity and potential distribution system constraints. Improving access to this information can help fleets make more informed siting and infrastructure decisions while supporting earlier coordination between utilities and charging developers.

3. Incorporate Load Flexibility into Utility Planning and Forecasting

As Oregon reduces transportation emissions with increasing numbers of electric vehicles, utilities will need planning approaches that reflect the increasingly flexible nature of electric vehicle charging. Utilities and regulators should incorporate flexible load assumptions and managed charging forecasts into transportation electrification, integrated resource, and distribution system planning processes. Utilities should use information gathered through customer engagement, charging data collection, and transportation electrification planning efforts to improve load forecasting and planning assumptions. Incorporating a range of charging scenarios, including managed charging participation, time-of-use rates, flexible interconnection arrangements, onsite energy resources, and other strategies that may alter charging behavior, can provide a more accurate picture of when and where new capacity will be needed. This approach allows flexible charging to be treated as a planning resource that can help defer, optimize, or right-size infrastructure investments while maintaining reliability and supporting transportation electrification goals. By explicitly accounting for flexible load behavior, utilities can improve forecasting accuracy, make more efficient infrastructure investments, and better align grid planning with the evolving capabilities of EV charging systems.

4. Support Investment in Charging Infrastructure and Flexibility-Enabling Technologies

Deploying MHD charging infrastructure at the scale needed to support transportation electrification will require sustained investment in both charging equipment and the technologies that enable charging flexibility. Consistent with recommendations in the Oregon Energy Strategy, Oregon policymakers should pursue dedicated, sustainable, long-term funding to support the deployment of public and private charging infrastructure, including MHD charging. As these investments are made, state and utility incentive programs should be designed to support charging flexibility as well as infrastructure deployment.

Many flexible charging strategies rely on smart charging technologies, such as networked chargers and energy management software, and may also incorporate onsite energy resources such as battery storage or solar. However, these technologies can increase upfront costs and create additional barriers for fleet operators. Oregon policymakers and utilities can help accelerate adoption by supporting incentives, grants, low-cost loans, or utility programs that reduce the cost of flexibility-enabling technologies and encourage their integration into fleet charging projects. In addition to supporting managed charging and other grid flexibility objectives, some of these technologies also

provide resilience benefits by helping maintain essential fleet operations during outages and providing backup power to homes, businesses, or the grid.

Charging incentive programs should recognize and support technologies that enable charging flexibility, rather than focusing solely on charging hardware installation. Utility make-ready programs, infrastructure incentives, and other funding opportunities should encourage the deployment of networked chargers, charging management systems, communications equipment, onsite energy storage, and other technologies that allow fleets to leverage flexibility. Many of these investments can provide multiple benefits, including enhanced operational reliability and increased resilience when paired with energy storage, microgrids, or other backup power capabilities. Program administrators should consider enhanced incentives for projects that demonstrate controllable load capabilities or provide measurable grid benefits through flexible charging behavior.

5. Support Flexible Interconnection and Phased Service Approaches that Leverage Controllable Load

Providing clear regulatory pathways for flexible interconnection and phased service approaches could help reduce the delays associated with traditional load interconnection processes while improving utilization of existing grid infrastructure and accelerating medium-and heavy-duty vehicle electrification in Oregon. Oregon regulators and utilities should develop formal frameworks for flexible interconnection and phased service connections for MHD charging projects. Regulators should also evaluate whether existing tariffs, interconnection rules, and cost allocation frameworks appropriately support flexible service connection models and other non-traditional approaches to integrating controllable load.

Other states and utilities have already begun piloting flexible service connection and bridge-to-wires approaches.[32] Oregon could build on these efforts by incorporating lessons learned, supporting utility pilot programs, and allowing utilities flexibility to test and refine new approaches with appropriate regulatory oversight. Oregon regulators should support utility investments in the operational capabilities, communications systems, analytical tools, and internal coordination processes needed to successfully implement flexible interconnection at scale. Utilities should also work to develop standardized customer agreements, operational procedures, and program structures compatible with managed charging technologies.

6. Support Proactive Infrastructure Planning and Investment Approaches

While managed charging and load flexibility can help reduce the impact of MHD charging, they are unlikely to eliminate the need for new grid investments altogether. Historically, utilities have taken a relatively conservative approach to investing ahead of anticipated load growth, particularly where the timing, location, or magnitude of new demand is uncertain. This approach reflects concerns that building infrastructure too far in advance of need could result in underutilized or stranded assets if projected demand fails to materialize.[37] As electricity demand grows more rapidly, however, there is increasing interest in more proactive infrastructure investment that plans, upgrades, and deploys grid infrastructure in anticipation of future load growth or system needs. Through enhanced forecasting, scenario analysis that accounts for the uncertainty in the pace and location of load growth, and long-term planning, utilities can identify “least-regrets” investments in areas where electrification and load growth are most likely to occur.[32] This approach, which has been recently authorized by utility

commissions in California, New York, and Massachusetts, can help reduce interconnection delays, avoid piecemeal upgrades, and better align grid infrastructure timelines with the pace of transportation electrification.[32] Studies have found that proactive grid investments can lower long-term system costs for both utilities and ratepayers compared to a purely reactive approach, while providing more timely and predictable service for fleets seeking to electrify.[37]

In Oregon, policymakers and utilities could support this approach by undertaking planning analyses to identify high-priority locations for early grid investment aligned with expected MHD charging demand, particularly along freight corridors, industrial areas, and major fleet hubs. Planning analyses should consider both projected charging demand and the expected impacts of managed charging when identifying infrastructure needs and prioritizing investments. The state could also develop guidance for high-confidence load forecasting methodologies to support strategic early investments and reduce uncertainty around future charging demand. In combination, Oregon could consider enabling utilities to make proactive and flexible infrastructure investments where forecast confidence and site prioritization criteria indicate a strong likelihood of near-term electrification and sustained load growth. Oregon should establish appropriate cost-recovery mechanisms and regulatory frameworks that allow utilities to make strategic early investments while maintaining safeguards for ratepayer protection.

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About the Report

The Oregon Department of Energy is pleased to present the 2026 Biennial Energy Report – the fifth iteration since the inaugural report was published in 2018.

The primary purpose of the report, as directed in ORS 469.059, is to inform local, state, regional, and federal energy policy development, planning, and investments, and to identify opportunities to further the energy policies of the state. To do this, ODOE, the state's dedicated energy office, collects critical energy data and information and analyzes what they mean for Oregon.

The report evolves based on Oregonians' current interests and inquiries about energy resources, policies, trends, and forecasts across the state. The biennial nature of the report provides a "go-to" document and reliable agency process that is timely and responsive to external partners, Tribes, communities, and the public. Ultimately, the Biennial Energy Report is meant to serve as a trusted, data-driven platform for conversations on emerging issues and policies, informing energy goals and strategies for the future.

Scoping & Development

As directed by statute, ODOE "shall seek public input and provide opportunities for public comment during the development of the report." The agency conducts broad outreach to collect feedback from diverse audiences and perspectives, which is intentionally done early in the scoping process to inform content development. In addition, other agency programs and projects reach out and collect feedback that can inform the Biennial Energy Report, allowing for those questions and ideas to be explored through infographics, Energy 101 articles, and more. The development of the Biennial Energy Report process also aligns with ODOE's Strategic Plan strategy to conduct proactive, inclusive collaboration and communication.

Development of the report also includes process objectives:

- Meet statutory requirements while engaging with new people and organizations, including historically and currently underserved populations and communities.
- Focus on content that is relevant and timely to stakeholder interests and responds to questions from Oregonians across the state.
- Ensure collection of stakeholder input and data is integrated with and complementary to other agency engagement and activities.

This year, Oregon Department of Energy developed content for this report bearing in mind the findings and recommendations from recently or soon-to-be-released agency work products. These included the 2025 Oregon Energy Strategy and Energy Security Plan, as well as the development of the most recent Transformative Integrated Greenhouse Gas Emission Reduction, or TIGHGER, forecast. These agency products serve as guiding documents for energy and climate policy development taking

into consideration outcomes for Oregonians and Oregon's economy. In addition to gathering input specifically about what people and organizations wanted to see in the Biennial Energy Report, ODOE leveraged extensive outreach and engagement supporting these other projects to identify key questions about energy policy that informed the topics for the 2026 report.

The 2026 report includes new assessments of emerging clean energy technologies that could support Oregon's transition to a clean energy future. This addition is responsive to Governor Tina Kotek's Executive Order 25-29, which directed ODOE to evaluate opportunities and risks associated with nascent technologies and propose cross-agency frameworks to support technologies that can help Oregon maintain affordable, safe, and reliable resources. The EO designated ODOE to produce this information in this Biennial Energy Report, and to continue to assess progress in emerging energy technologies in future reports.

ODOE used Artificial Intelligence, or AI, as a tool in the development of the report. AI resources were used for research, primarily identifying data and information resources. AI was also used in developing rough drafts of information, which authors used as a starting point for drafting material. ODOE limited its use of energy-intensive AI requests, such as drawing pictures, wherever possible. AI was not used to directly produce any of the content in this report. All written content and numerical data analysis was collected, developed, and validated by ODOE staff.

Drafting & Implementation

Beyond topic selection, the agency's strategic plan informed decisions on content scoping for drafting the report.

Proactive, Inclusive Collaboration and Communication: The project team incorporated stakeholder feedback and inquiries from prior engagement efforts during development, including:

- **Equity considerations**: What unique equity implications arise with each policy topic?
- **Partner needs**: What questions are our agency partners asking about energy policies and potential approaches?
- **Information gaps**: Which energy concepts require foundational context, and which demand deeper policy analysis?
- **Legislative foresight**: What energy policy issues are likely to emerge in the next legislative session?

To answer these, ODOE used targeted outreach and public input, supplemented by insights gathered during legislative hearings, in media coverage, from energy and community experts, and within the energy forums in which the agency participates. These efforts ensured that collaboration was not only proactive and inclusive—but deeply informed by the community's voices.

Reliable, Responsive Data and Analysis: Every biennium, the Biennial Energy Report project team evaluates opportunities to enhance the report's data reliability and analytical rigor. This assessment focuses on ensuring objective reporting and delivering high-quality data, including the adoption of modern data management, analysis, and visualization technologies. To maintain data integrity, the process includes multi-tiered oversight and review:

- Agency narratives undergo **internal accuracy checks** and external review by partner agency and university experts.
- Numerical datasets are **validated against source data**, with internal verification of calculations to uphold report accuracy and quality.
- Any decision to add new data sources or modify inputs is scrutinized by internal data analysts and **approved by the project team**.

Additionally, the report development process strengthens internal capacity—enhancing staff expertise in data management, analytics, and modern reporting methods—with direct benefits for ODOE's organizational resilience.

Resources

Project Website: ODOE hosts a public website for the Biennial Energy Report: https://www.oregon.gov/energy/Data-and-Reports/Pages/Biennial-Energy-Report.aspx. The website includes a link to sign up for email updates, online comment form, and materials from past reports and presentations.

Online Comment Form: ODOE continues to provide a portal to collect feedback on the Biennial Energy Report: https://odoe.powerappsportals.us/en-US/ber-comment. Depending on the type of input and timing, the project team will continue to incorporate comments into report development processes and scoping for future reports.

Webinars and presentations: ODOE staff are available to make presentations in person and virtually on the Biennial Energy Report; an overview or on specific topics and sections. Past webinars are posted on ODOE's website and new materials are provided throughout the year. Organizations and communities interested in specific presentations can submit a request through the online comment form.

energyinfo.oregon.gov/BER

www.oregon.gov/energy/Data-and-Reports/Pages/Biennial-Energy-Report.aspx

About the Data

The Oregon Department of Energy helps Oregonians make informed decisions about their energy choices and advances solutions that will shape an equitable, clean energy transition. ODOE serves as the state's central repository of energy data, information, and analysis, and fulfills this role through rigorous data collection, production standards, and quality assurance protocols. The agency assesses the quality of data based on its relevance to Oregon, its credibility, and its comprehensiveness. In alignment with the statutory requirements for the report, common data and analyses found in the report include:

- Energy consumption, expenditures, and costs
- Generation and transmission
- Production, imports, and exports
- Energy sectors, markets, and jobs
- Technologies and resources, including facilities
- Energy efficiency and conservation
- The effects of energy use, including greenhouse gas emissions

ODOE's preference is for Oregon-specific data, supplemented with national data to fill in gaps or provide context for Oregon's place within a larger energy landscape. For example, Oregon's Electricity Resource Mix and Transportation Sector Fuel Consumption charts were developed from Oregon-specific data sources, rather than using U.S. Department of Energy estimates. ODOE relied on government agencies, academic institutions, and trusted partners with credible and peer-reviewed data and information. Finally, the most thorough and comprehensive datasets from these sources were prioritized, depending on how they could best illuminate specific sectors, markets, resources, and trends.

Common data sources used in development of the report include:

- Federal/National: U.S. Energy Information Administration (EIA); U.S. Department of Energy; the National Labs; U.S. Environmental Protection Agency, U.S. Federal Highways Administration; U.S. Census Bureau; U.S. Department of Health and Human Services; American Council for an Energy-Efficient Economy (ACEEE); Center for Neighborhood Technology (CNT); ASHRAE
- Regional: Northwest Energy Efficiency Alliance; Northwest Power and Conservation Council; Bonneville Power Administration; Energy Trust of Oregon
- State: Oregon Department of Energy; Oregon Department of Transportation; Oregon Housing and Community Services; Oregon Public Utility Commission; Oregon Department of Environmental Quality; Oregon Department of Land Conservation and Development; Oregon Health Authority; Oregon Department of Administrative Services, Oregon Department of Geology, Minerals, and Mining; Portland State University
- Utilities and energy service providers
- Energy associations and organizations

Notable changes have been made to both the methodology and collection of data used in recent iterations of the report.

The biggest change relates to U.S. Energy Information Administration State Energy Data System (often referred to as SEDS), which is the data source behind much of the Energy by the Numbers section. The EIA converts all forms of energy use into British thermal units, or Btu. This conversion helps compare and contrast energy consumption across different energy types, including electricity and fossil fuels. For electricity, this is calculated by comparing the primary fuel combusted – natural gas or coal – with the amount of electricity generated. For noncombustible generation resources, such as hydroelectric, geothermal, solar, and wind, this value must be a proxy or estimated value because there is no fuel combusted to produce the electricity. The EIA instituted a change in how this is calculated in 2023.

Prior to the publication of the 2024 Biennial Energy Report the EIA used a "fossil fuel equivalency" method, which applies a proxy value for Btu for these resources based on a calculation that averages fuel consumption for all fossil-based generating plants. This proxy value represents the energy consumed as if the electricity were generated by fossil fuels. This value changed year-to-year as combustible generation changed. Currently, EIA utilizes a "captured energy approach," which applies a constant conversion factor based on the heat content of electricity itself. This is a static value and is more consistent with international energy calculations. The value of the static captured energy approach proxy is lower than the fossil fuel equivalency value. This change in the data's methodology was first reflected in the 2024 report.

The change created some anomalies in historical renewable energy consumption data presented in the report. This is because it produces significantly lower values for total electric energy consumption, driven by the lower calculated consumption for the noncombustible hydro, solar, wind, and geothermal resources serving Oregon load. In most cases, overall trends in consumption data remain consistent with previous reporting, although anomalies can be seen in some year-to-year comparisons between data presented in the 2020 and 2022 Biennial Energy Reports. Other updates to the data analysis resulted from changes to data sources for two topics in Energy by the Numbers: the County Profiles and Oregon's Electricity Resource Mix.

Prior to the 2024 report, ODOE used Oregon Department of Housing and Community Services' County Profiles Dashboard as the data source for home energy burden costs. The data provided in the OHCS dashboard is necessarily focused on housing accessibility and affordability. Because the purpose of the Biennial Energy Report is to provide key information on the accessibility and affordability of energy services, ODOE analyzed the primary data sources that inform the OHCS dashboard to produce energy-specific information with county-level demographic data. In addition, we previously used the Home Energy Affordability Gap analysis (developed by the public finance & general economics firm, Fisher Sheehan & Colton) to provide data on the estimated number of households experiencing energy burden by county. Fisher Sheehan & Colton discontinued annual updates for this source data, so ODOE developed a similar energy burden analysis using a mix of federal and state data sources. These include: demographic, median income, housing characteristics, and housing tenure data from the U.S. Census Bureau; utility statistics data from the Oregon Public Utility Commission; federal poverty thresholds from the U.S. Department of Health and Human

Services; and the Housing and Transportation Affordability Index from the Center for Neighborhood Technology.

The data presented in Oregon's Electricity Resource Mix also changed, affecting how electricity market purchases are presented. Prior to 2024, ODOE contracted with the State of Washington to assess the electricity generating resources that contribute to wholesale electricity purchases in the region. However, the expansion of west wide wholesale markets in the last several years added a degree of complexity to the analysis, and ODOE determined that the assumptions used previously were no longer viable. Beginning in 2024, ODOE uses data on electricity produced for Oregon consumers from the Oregon Department of Environmental Quality's Greenhouse Gas Reporting Program. This process ensures consistency of energy data across state agencies and eliminates duplicative reporting requests for utilities. While this change to the production of the ERM is more efficient and consistent, it does not include data on a specific resource mix for utility market purchases. Therefore, market purchases are listed as a total amount and labeled as "Unspecified," rather than split into a specific mix of resources.

Data presented on in-state electricity generation facilities continue to be modified and improved. Data were updated to not only include new facilities and remove resources that were retired, but ODOE also conducted an audit of the data and identified several generators serving the same facility that were listed as separate facilities. The data now align with the U.S. EIA in how it identifies generators at the same facility – with unique identifiers assigned based on how the site was permitted and installed. Where ODOE found generators at the same site and with the same unique EIA identifier listed separately, the information was consolidated under a single facility. This process led to a reduction in hydropower sites since the last report.

ODOE does not use EIA data for reporting total electricity generation capacity. Instead, we determined the best available data was our energy facilities database, which includes information on specific resources provided by utilities, developers, and the Energy Facility Siting Council. This information was also used to validate the EIA Power Plant Operations Report for measuring total annual generation of Oregon electricity generation facilities by energy resource and total number of resources. This process provided the most consistency in data availability across the various electricity generating resources used in-state.

Data sources were updated in the production of two summation charts that are featured prominently in Energy By the Numbers: 'Consumption by Sector' and 'Consumption by Source.' In previous reports, we utilized ODOE's internal Transportation Fuels Dashboard total consumption value for the Transportation sector value in the 'Consumption by Sector' chart and the Transportation fuels consumption value in the 'Consumption by Source.' We also used the annual total consumption value from our Electricity Resource Mix to represent Electricity's contribution to the 'Consumption by Source' chart. For this report, we sourced the Transportation consumption values and the Electricity value from the EIA State Energy Database System, which provides the total consumption values for the other energy sectors. This was done to provide consistency between energy consumption sector and end use sector values broadly. However, data presented for more granular breakouts of specific fuels use data from DEQ's Clean Fuels Program and ODOT's Aviation Fuel Tax program. Prior to the

2028 report, ODOE will assess the potential to include the state-provided data into the higher sector-wide data sets.

ODOE chose to report data from 2024 because it is the most recent data available from the EIA, and we attempt to match that year's data for all data sources. However, because 2024 data was not yet available from Oregon DEQ's greenhouse gas emissions inventory, ODOE used the 2023 data from that program. Federal emissions data was used in a small number of places in the report, and in these instances 2024 data was used. These are denoted in the report narrative.

It's important to note that data reported between 2020 and 2022 were influenced by changes in energy consumption resulting from the response to the COVID-19 pandemic. This led to many data points for these years that do not align with prior trends. With this report, more information is known about if and how energy trends have rebounded since the pandemic, which are described in more detail in the narrative.

We are proud of this report and how the data have been presented. ODOE is a steward of accurate, reliable, and credible data, which we achieve through attention to detail, standardized data management practices, and continual efforts to improve and expand our data capabilities. This is crucial to a data-driven report about Oregon's energy resources, activities, trends, and forecasts, and the data and analysis presented is foundational to making energy decisions that affect all Oregonians. If you identify any potential data quality issues or know of more representative or complete data sets that can be used in future reports, please reach out to us: https://odoe.powerappsportals.us/en-US/ber-comment/.

The agency, in collaboration with our many data partners, will continue to strive to be a central resource for sound and objective energy information and ensure the report reflects the most accurate and relevant data for Oregon.

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