Oregon Energy Strategy

Reference Scenario
Key Data and Assumptions

Introduction

This document provides the inputs for the Reference Scenario of the Oregon Energy Strategy model. The modeling phase of the Oregon Energy Strategy involves development of a Reference Scenario and several alternative scenarios. The modeled scenarios produce different pathways to meeting Oregon's energy and climate objectives. They provide information on the effects of different energy choices and will serve as foundational information for policy discussions in Phase 2 of the Oregon Energy Strategy process. These discussions are where policy recommendations will be developed. The final Oregon Energy Strategy will be submitted to the Governor and Legislature by November 1, 2025.

The model must solve to meet Oregon's anchor climate and clean energy goals: Executive Order 20-04 (80 percent economy-wide reduction in greenhouse gas emissions by 2050); HB 2021 (100 percent clean electricity for the state's largest investor-owned electric utilities and Electricity Service Suppliers), and the Climate Protection Program (90 percent reduction in greenhouse gas emissions from fuels by 2050). This is a requirement of HB 3630, which directs ODOE to develop the energy strategy and identify pathways to achieving the state's energy policy objectives.

These goals are ambitious, and there are many uncertainties surrounding what combination of technologies and measures will allow Oregon to meet its clean energy and climate goals over time and out to 2050. What is relatively clear based on a range of studies ODOE has evaluated is that: (1) aggressive energy efficiency and electrification are key pillars of cost-effective decarbonization; (2) we have a suite of diverse technologies to choose from to decarbonize the electricity sector; and (3) clean fuels will play a key role.[i]

The modeling exercise requires well-informed, data-driven judgment calls on many of the assumptions relating to energy efficiency and electrification. This is because the transition to economy-wide decarbonization by mid-century requires a pace and scale that is much greater than past trends. And we are still working to understand the combination of consumer behaviors, market forces, and policy supports necessary to accomplish our goals. In order to ensure the Reference Scenario is built on the best available data and aggressive but achievable assumptions, ODOE has collaborated with industry and community experts to inform the modeling inputs. Using that feedback, ODOE and its technical contractor CETI developed a draft Reference Scenario inputs list. ODOE reviewed all feedback received in finalizing the Reference Scenario. The table below represents key data and assumptions in the Reference Scenario.

---

[i] 2022 Biennial Energy Report. *Charting a Course for Oregon's Energy Future*.

How the Model Works

At the highest level, the model uses data on the existing state of energy production and consumption and combines this with forecasts on population growth, load growth, technology evolution, and weather patterns to assess future statewide energy demand. The model then determines the supply of energy resources across the entire energy sector to meet that future demand, considering reliability and cost.[ii]

For the Oregon Energy Strategy, the Reference Scenario is informed by Oregon's energy consumption across its state-wide economy (residential, commercial, industrial, agricultural, fuel, and transportation sectors). To determine energy demand, it looks at energy-consuming technologies across 80 different sub-sectors (space heating, cooking, cars and trucks, and many others), and makes assumptions about how these technologies change over time, including improvements in energy efficiency, when these technologies are expected to turn over, and what they will be replaced with when they reach the end of their useful life.

The Reference Scenario also considers factors like weather, population growth, and industrial load growth (including from industrial data centers and chip manufacturing) to account for how energy demand is changing over time. Through this process, the model comes up with a picture of Oregon's energy needs every 5 years, from now to 2050.

Once we have a picture of how much energy we will need over time, the model searches for the most affordable mix of resources to meet demand across all energy consuming sectors while meeting our key climate and energy goals and maintaining reliability.[iii] It draws on everything from utility-scale resources to smaller-scale and distributed energy resources to do this. The model also considers the availability of energy supply infrastructure (i.e., gas pipes and electricity wires) to deliver that energy to customers.

How Model Results are Used

Model scenarios do not predict the future, rather they provide insights into pathways that meet our clean energy goals by considering differences in costs, energy efficiency, feasibility, and availability. The Reference Scenario will be compared against alternative scenarios that produce different energy pathways that are used to explore "What if?" questions. For example: What if transmission development is further delayed? What if we do not achieve as much electrification as in the Reference Scenario and instead rely more on clean fuels? What does this mean for overall system costs? What does it mean for the mix of resources we'd need to meet our clean energy goals? And most importantly: what do we learn from this exercise on the technologies and measures that are most likely to deliver a lowest-cost, highest-benefits energy transition for our state? The information we gather will provide a basis for analysis and discussion around

---

[ii] 294abc_c5f79e16ca7a470b8168e1bbe7d98c7f.pdf (evolved.energy)

[iii] The model can incorporate some non-energy constraints, such as land use protections. However, much of the analysis on non-energy costs and benefits will happen when we are evaluating the results of the modeling. ODOE will be working with our consultant to evaluate the effects of different scenarios on equity, environmental justice, air quality and public health, and employment.

what policies are needed to achieve our energy objectives while maintaining a resilient and affordable energy system — and create a more equitable energy future for Oregon.

The following are the key data and assumptions for the Reference Scenario of the Oregon Energy Strategy.

While the opportunity to provide comments on the Reference Scenario data and assumptions has passed, ODOE is accepting comments on the alternative scenarios until **5 p.m. on October 11, 2024. You can find the draft alternative scenarios here.**

Key Assumptions for the Reference Scenario

Key Demand-Side Assumptions (Buildings, Industry, Transportation)

1. Buildings

1.1 Buildings: Data sources for stocks

Residential Space Heating	Northeast Energy Efficiency Alliance (NEEA) Residential Building Stock Assessment & Home Energy Score Data*
Commercial Space Heating	NEEA Commercial Building Stock Assessment
Residential Water Heating	NEEA Residential Building Stock Assessment & Home Energy Score Data*
Commercial Water Heating	NEEA Commercial Building Stock Assessment
Residential Building Shells	NEEA Residential Building Stock Assessment & Home Energy Score Data*
Commercial Building Shells	NEEA Commercial Building Stock Assessment
Residential Technology Stock Replacement	Energy Information Administration (EIA) Residential Energy Consumption Survey, potentially supplemented by local/regional data (still in discovery)
Commercial Technology Stock Replacement	EIA Annual Energy Outlook, potentially supplemented by local/regional data (still in discovery)
Residential Cooking & Other Appliances	NEEA Residential Building Stock Assessment
Commercial Cooking & Other Appliances	NEEA Commercial Building Stock Assessment
Residential Lighting	NEEA Residential Building Stock Assessment
Commercial Lighting	NEEA Commercial Building Stock Assessment

**Oregon's Home Energy Score data comes from Earth Advantage*

1.2 Buildings: Key Assumptions

Residential Space Heating	Assume existing policies play out for all space heating technologies 65% heat pump sales by 2030; 90% by 2040

Commercial Space Heating	Weighted average of large and small commercial space heating loads, with the following framing:
	- Small commercial: follow residential
	- Large commercial:
	  ○ 2030: Electric heat pumps 15% of overall sales; other electric + electric hybrid systems (including hybrid heat pumps) 10% of overall sales
	  ○ 2045: Electric heat pumps 50% of overall sales; other electric + electric hybrid systems (including hybrid heat pumps) 40% of overall sales

Residential Water Heating	Incorporate Federal Energy Conservation Standards for Consumer Water Heaters (from May 6, 2029) Electric heat pump sales rising to 95% of overall sales by 2045

Commercial Water Heating	Weighted average of large and small commercial water heating loads, with the following framing:
	- Small commercial: follow residential
	- Large commercial:
	  ○ 2035: Electric heat pumps for water heaters 15% of overall sales, other electric technologies 10% of overall sales
	  ○ 2045: Electric heat pumps for water heaters 50% of overall sales, other electric technologies 40% of overall sales

Cooking	95% sales of new appliances are electric by 2035
Technology stock replacement	Dual gas/electric heat pump systems, differentiated by climate zone, compete with other electric technologies in line with sales shares above
Building shells	ODOE is working through how to apply cost-effective retrofit potentials in Evolved's Enhanced Building Efficiency Modeling
Lighting	100% LED sales by 2025 (HB2531)

2. Industry – Key Assumptions

Industrial Processes	1% process efficiency improvements per year in all sectors Fuel switching measures from fuels to electricity

Electrification	100% of machine drives by 2035 100% of heat by 2050, including in Oregon's largest industrials such as computer and electronics products 50% of integrated steam production, including in food manufacturing, by 2045 100% of refrigeration by 2040 75% of industrial HVAC loads across industrial subsectors by 2050 80% of industrial vehicles including in agriculture by 2050
Switch to Hydrogen	50% of heat in bulk chemicals (not a large industry in OR) 20% of construction energy demand 20% of industrial vehicles by 2050
Cement	Cement process is optimized in the model, including retrofits and new build rotary kilns to include direct separation, oxy-combustion, biomass fuel, and CCS (not a large sector in Oregon)
Thermal Energy Storage	Economic adoption modeled in industrial sector
Hybrid Boilers	Model can invest in dual fuel electric and gas boilers as well as hydrogen boilers

3. Transportation

3.1 Transportation: Data sources for stocks

Light duty vehicle (LDV)current stocks	OR Dept. of Transportation – Driver & Motor Vehicle division (DMV) Data
Medium- and heavy-duty vehicle (MHDV) current stocks	OR Dept. of Transportation – Combination of Commerce and Compliance Division (CCD) and DMV data (depending on vehicle weight) *Note: propose to use Environmental Protection Agency's (EPA's) Motor Vehicle Emission Simulator (MOVES) model if cannot obtain CCD data
Transit Buses current stocks	National Transit Database / EPA MOVES
School Buses current stocks	OR Dept. of Transportation – DMV Data
Fuels current	OR Dept. of Environmental Quality Clean Fuels Program Data
Vehicle Miles Traveled (VMT) current	Dept. of Environmental Quality / EPA MOVES (data comes from Highway Performance Monitoring System)
Fuel Economy current	EPA MOVES, Historical average fuel economy by vintage and vehicle type
LDV sales shares	Advanced Clean Cars I / Advanced Clean Cars II Internation Council on Clean Transportation (ICCT) forecasts based on IRA incentives

MHDV sales shares	Advanced Clean Trucks through 2035 ICCT forecasts based on IRA incentives

3.2 Transportation: Key Assumptions

MDV and HDV sales shares – post 2035	Post 2035: • 100% zero emission vehicle (ZEV) sales by 2040 for Class 2b-8 vehicles (excluding buses) • For long haul: 65% battery electric vehicles (BEVs)/35% hydrogen fuel cell vehicles (FCEVs) All other classes 100% electric
Transit Buses future	100% ZEV sales by 2036 (75% BEV / 25% FCEV by 2040)
School Buses future	100%BEV sales by 2036 (100% electric)
Rail future	20% electric, 70% hydrogen by 2050 (logistic growth starting in 2030)
Maritime Shipping future	Domestic: 10% electric, 20% H2, 50% ammonia by 2050 International: 20% H2, 60% ammonia by 2050
Vehicle Fuels future	Clean Fuels Program + Portland's Renewable Fuel Standard
Vehicle Lifetimes	15 years
Fuel economy: Light duty cars and trucks	EPA SAFE 2022-2026, constant after 2026
Fuel economy: Medium duty & heavy-duty vehicles	EPA Phase 3 standards through MY 2032; Annual Energy Outlook (AEO) projection after 2032
Fuel economy: Buses	Buses: AEO projection of fuel economy
Fuel economy: Aviation	15-20% efficiency gain through 2050, to reflect International Air Transport Association (IATA) Net Zero Roadmap
VMT Assumption	20% reduction in VMT per capita by 2050
Vehicle costs	Light, Medium, and Heavy-Duty Vehicles: International Council on Clean Transportation Report: Analyzing the Impact of the IRA on EV Uptake in the U.S. Transit / School Buses: International Council on Clean Transportation Rail / Aviation / Maritime: Costs assumed to be same as fossil alternatives due to lack of data
Fuel costs	Annual Energy Outlook 2023 Oil and Gas Forecasts
Infrastructure costs	EV Charging: NREL Electrification Futures Study Hydrogen: U.S. Dept. of Energy Technical Targets for H2 Delivery Looking into using NREL's EVI Pro
EV Charging Estimates	NREL's EVI Pro *Note: Propose to use NREL Electrification Futures Study if cannot obtain NREL's EVI Pro data

Key Supply-Side Assumptions (Electricity, Fuels, Pipes & Wires)

4. Direct Use Fuels

Demand Side Assumptions	Modeled residential, commercial, and industrial demand end use using assumptions about sales shares in EnergyPATHWAYS
Supply Side Assumptions	Existing natural gas utility Integrated Resource Plans (IRPs) for near-term investments and operations Survey of peer reviewed and government agency sources of capital and operating costs and performance (ADP Technical Documentation 2023, p. 61)
Fuel supply and price forecasting	Energy Information Administration (EIA) Annual Energy Outlook NW Power and Conservation Council's Fuels Advisory Committee natural gas price forecast Department of Energy Billion Ton Study
Alternative Clean Fuel Investment	DEQ's Climate Protection Program
Alternative Clean Fuels	Biomass-derived fuels, hydrogen, and hydrogen-derived fuels qualify as clean (if green hydrogen used). Imported fuels are counted as zero emissions (credit for negative emissions from processes like BECCS are retained by producing state). Clean Fuel Standard incorporated

5. Energy Efficiency and Load Flexibility

Behind the Meter Photovoltaic (BTM PV)	Northwest Power and Conservation Council March 2024 rooftop solar projections
BTM Storage Adoption	Energy Information Administration's (EIA) June 2024 Survey: 10 MW assumed today (Note: ODOE is also calculating data from the Oregon Solar and Storage Rebate Program (OSSRP) to compare to EIA data. Please share if there is another data source ODOE should consider.) Based on Green Mountain Power adoption, assume 1% of all residential customers have behind the meter storage and participate in a virtual power plant by 2035.
Flexible Load Parameters	Space heating loads can be delayed or advanced by 1 hour Water heating loads can be delayed or advanced by up to 2 hours Air conditioning can be delayed or advanced by 1 hour Residential vehicle charging can be delayed by up to 8 hours and commercial vehicle charging up to 3 hours

V2G	26% V2G for residential EVs, assuming utilities can discharge battery down to 40% capacity (so use 60% of EV battery)
Data Center Load Growth	Northwest Power and Conservation Council Pacific Northwest Power Supply Adequacy Assessment for 2029 mid-higher case, with load differentiated across modeling zones
Demand Response – Households participation	50% of homes with demand response capability are participating in some form of firm demand response program by 2050 (linear growth from 2025) Residential EVs: Start at 0, ramp up to 2/3 of residential EVs participate in managed charging by 2030
Demand Response - Commercial	50% of commercial spaces with demand response capability are participating in some form of firm demand response program (linear growth from 2025) Commercial EVs: Start at 0, ramp up to 1/3 of commercial EVs participate in managed charging by 2030
Demand Response - Industrial	No input. The model will provide insights into the uptake of technologies with flexibility potential over time.

6. Electricity Generation Technologies

Energy Demand	Results from EnergyPATHWAYS model informs Regional Investment and Operations Model (RIO) (both Evolved Energy Research models) Data center and chip fabrication load growth trajectory (see above) Rooftop solar scheduled additions (see above)
Electric Supply	Existing supply minus announced coal/gas retirements Siting restrictions apply to new generation, interconnection, transmission Out-of-state generation requires transmission
Generation Options	Hydropower Solar (photovoltaic and thermal) Wind (onshore, offshore) Biomass (woody, manure, biogas) Biogas, hydrogen, renewable natural gas Geothermal Coal, gas, nuclear (siting restrictions – no new natural gas or nuclear sited in Oregon)
Transmission Availability	The Nature Conservancy Power of Place West (inter-zonal) Bonneville Power Administration (BPA) (for Oregon East-West zones) No new inter-zonal transmission is built until 2035

Inflation Reduction Act Incentives	Supply-side incentives include for hydrogen production, renewable electricity generation, battery storage, carbon capture, clean fuels, out-of-state nuclear

7. Land Use and Natural Resources

7.1 Land Use Screens

The Reference Scenario will restrict the use of legally protected (Level 1) and administratively protected areas (Level 2) in Oregon for energy development using The Nature Conservancy's Power of Place West study as a framework to select land use screens.

Categories of Exclusion	**Definition of Category**	**Examples**	**Biomass**
Level 1	Legally protected: Areas with existing legal restrictions	National Wildlife Refuges, National Parks, Marine Sanctuaries, Military Training Areas	All feedstocks included, exclude potential supply from conservation reserve program land
Level 2	Administratively protected: Level 1 + areas with existing administrative and legal designations where state or federal law requires consultation or review and lands owned by non-governmental organizations (NGOs) on which there are conservation restrictions.	Critical Habitat for Threatened or Endangered Species, Sage Grouse Priority Habitat Management Areas, vernal pools and wetlands, tribal lands	No net expansion of land for purpose-grown herbaceous biomass crops. Specifically, land available for herbaceous biomass crops (miscanthus and switchgrass) is limited to the share of land currently cultivated for corn that is eventually consumed as corn ethanol, which is phased out in all net zero scenarios by 2050.
Level 3	High conservation value: Level 1 + Level 2 + areas with high conservation value as determined through multi-state or ecoregional analysis (e.g., state, federal, academic, NGO) and lands with social, economic, or cultural value.	Prime Farmland, Important Bird Areas, big game priority habitat and corridors, TNC Ecologically Core Areas, "Resilient and Connected Network"	Same as Level 2

7.2 Land Use Key Assumptions

Emissions constraint target accounting	Emissions reduction on anthropogenic emissions, natural climate solutions, and sequestration not eligible
Carbon Capture and Storage (CCS)	CCS included as a carbon reduction option in the model
Non-CO2, non-energy	EPA developed supply curves of measures to reduce non-CO2 and non-energy emissions, e.g. reducing methane (CH4) leakage, reducing f-gasses in industrial processes and products, reducing nitrous oxide (N2O) from soil management. Optimized by the model against energy emissions reduction measures.
Marine Environment	Reflect BOEM limited energy development assumptions

8. Transmission and Distribution

The Transmission and Distribution working group had insufficient time to address all the data and assumptions that will be incorporated into the model. ODOE is posing the following questions for consideration.

Timing of Electricity Transmission Development	No new transmission until 2035, except for certain priority transmission projects that are currently planned and/or under development: New Lines – PAC's Gateway South online by 2025; PAC's Gateway Central and Gateway West online by 2030; IPC's Boardman to Hemingway (B2H) project online in 2030; PAC's Gateway project online in 2035; Snow Goose to Longhorn (Boardman) online in 2035 Reconductoring/Rebuilding Existing Lines - BPA's Big Eddy to Chemawa project and PGE's Round Butte to Bethel project, both expanding East to West transfer capacity from 230 kV to 500 kV and both online in 2035
Electricity Distribution System Cost Assumption	Proxy value based on historic costs from Energy Information Administration (EIA)
Pipeline Infrastructure Assumptions	No new infrastructure development beyond operations and maintenance for interstate natural gas pipelines
Electricity transfer capacity between	Publicly available Bonneville Power Administration (BPA) data on historical path flows. Account for East to West transmission expansion

East and West Oregon	projects noted above (B2H, Big Eddy to Chemawa, and Round Butte to Bethel)