Low-Carbon Fuels Policy Working Group

The Low-Carbon Fuels Policy Working Group is one of five Policy Working Groups formed to reflect on the results of the Oregon Energy Strategy technical modeling and help identify policy gaps and opportunities. This group will focus on the role of fuels to help decarbonize Oregon's residential, commercial, industrial, and transportation energy sectors by evaluating fuel options for different end uses, identifying barriers to production and distribution, and developing options to transition end use sectors to other fuels.

Model results provide valuable information on the tradeoffs of different energy choices. This document provides a summary of the modeling results relevant to this working group. It is meant to assist members in processing the results so they can engage in productive policy discussions.

A few of the most fundamental modeling findings for this working group are:

- Fuel use will decrease with the electrification of many applications.
- Low-carbon fuel demand will gradually replace fossil fuel demand.
- New dispatchable capacity from fuel-based generation will likely be needed to maintain a reliable electricity system.
- Low-carbon fuels are most cost-effective when used strategically for the hardest-to-electrify industrial and transportation applications and to maintain a reliable electric grid during net peak periods.

Background: Oregon Energy Strategy Energy Pathways Modeling

Using input from Tribes, the Oregon Energy Strategy's Advisory and Working Groups, staff-to-staff conversations with state agencies and participation in an Inter-Agency Steering Group, and comments from the public, ODOE and its technical contractor developed scenarios that represent different energy pathways the state could take to achieve its energy policy objectives by 2050. The model uses a two-step process:

1) It develops a bottom-up demand model to establish baseline and future energy demand in Oregon's economy from now to 2050.
2) It determines the energy supply needed to meet that demand reliably and at least cost.

The model compares energy pathways from a Reference Scenario to six Alternative Scenarios. The Reference Scenario includes "aggressive but achievable" adoption of demand-side technologies and actions, including energy efficiency and electrification. Assumptions were informed by multiple studies that assessed technology options and strategies to decarbonize the energy sector.[i] The model then selected the least-cost portfolio of supply-side solutions to meet this demand over time. The Alternative Scenarios each change something critical from the Reference Scenario and seek a least-cost pathway across available resources given the new constraint.

[i] ODOE references some studies in the 2022 Biennial Energy Report: *Charting a Course for Oregon's Energy Future*.

For more information on how the modeling works and the key assumptions for the reference and alternative scenarios, see the Energy Strategy Modeling Assumptions and Sources document. Key assumptions refer to specific demand-side inputs or supply-side constraints that were defined as inputs to the model. It is recommended that members of this Working Group review the Reference Scenario assumptions around transportation, buildings, industry, and direct use fuels, and key assumptions for the *Delayed Energy Efficiency and Building Electrification* and the *Alternative Flexible Resources* alternative scenarios.

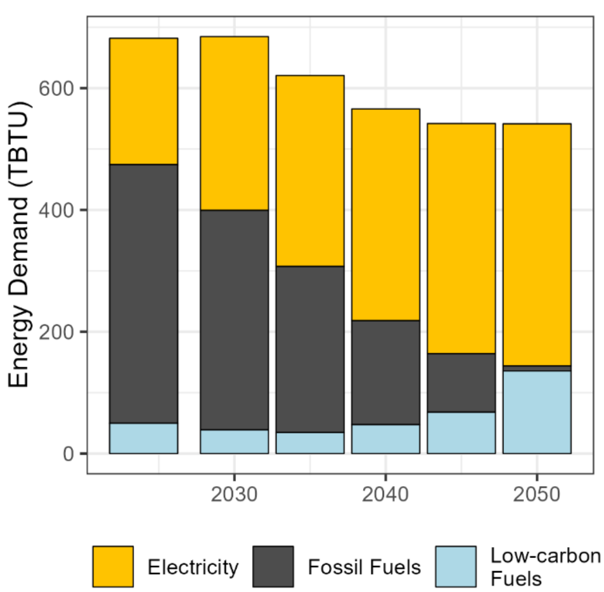
High-level key takeaways relevant for all policy working groups include:

- Oregon has multiple pathways to achieve our energy policy objectives.
- All scenarios indicate a need for low-carbon fuels.
- Existing energy transition policies get us far.
- More action is needed than current policies will deliver.

As you review the key findings below, ask yourself: What policies does the State of Oregon need to maintain or adopt to support low-carbon fuels? What topics need to be better understood before policy choices can be made about low-carbon fuel options?

Key Finding 1: Fuel demand declines but fuel remains a significant component of Oregon's Energy System across all scenarios

Figure 1: Oregon Energy Demand by Fuel in Reference Scenario



Notes: Fossil and low carbon fuels shown here represent end use fuels only. Fuels used to generate electricity are not included.

As more end uses electrify, overall energy demand and fuel demand decrease. All modeled scenarios show a decrease in fuel demand with a corresponding increase in electricity demand, primarily driven by electrification of vehicles and industry and tech load growth, including data centers and chip fabrication. In the Reference Scenario, economy-wide energy demand declines as shown by the decreasing bar size in Figure 1. The proportion of total energy demand from direct use and transportation fuels, represented by the dark gray (middle) and light blue (bottom) sections of each bar, also steadily declines through 2050, dropping from 70 percent of energy demand in 2024 to 26 percent in 2050. By 2050 low carbon fuels account for nearly all fuel use.

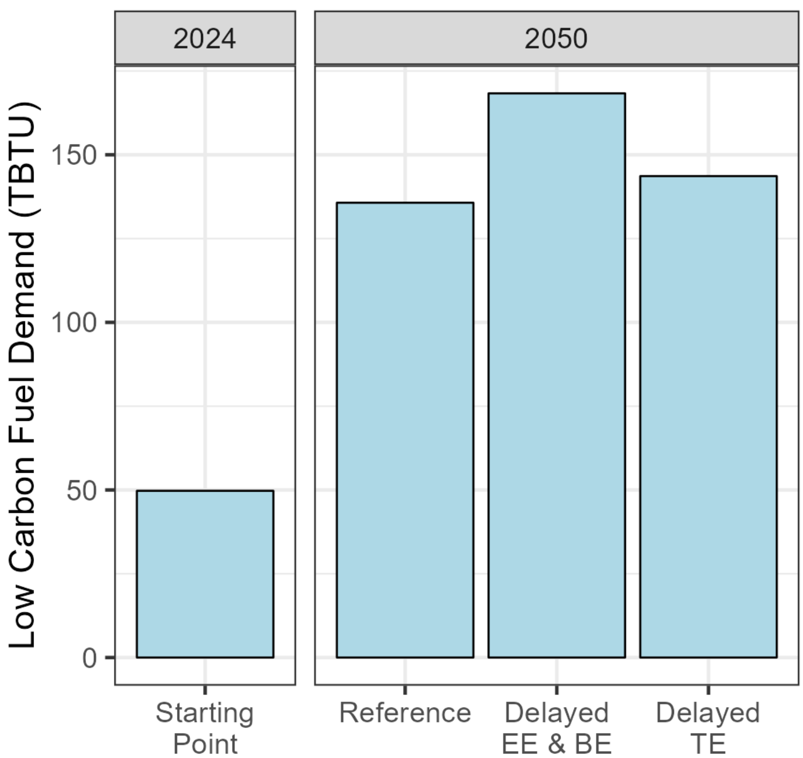
All scenarios modeled show a similar finding to Figure 1, with overall fuel use declining and mostly low-carbon fuels remaining in Oregon's energy resources mix through 2050. In scenarios with slower buildings or transportation electrification trajectories, fuels play a bigger role, though at a greater overall cost. Across all scenarios, fuels are used for the hardest-to-electrify applications across industry, agriculture, transportation, and as a firm resource in the electricity system.

Key Finding 2: Low-carbon fuels are an increasing proportion of Oregon's energy supply across all scenarios

The modeling results indicate that to meet state greenhouse gas reduction goals, most fuels used by 2050 must be low-carbon options. All scenarios show an increase in low-carbon fuel demand by 2050. Beginning in 2040, this demand ramps up rapidly as much of the remaining fossil fuel being used is replaced with lower carbon alternatives. In the reference scenario, low-carbon fuels make up 10 percent of total fuels consumed in 2024, increasing to 94 percent in 2050. Figure 2 shows low-carbon fuel demand for residential, commercial, industrial, and transportation applications. The bar on the left shows consumption in 2024, and the remaining bars show model results for demand in 2050. In 2024, Oregon consumed about 50 trillion Btu[ii] of low-carbon fuels. By 2050, consumption is expected to more than double in all scenarios.

In the *Delayed Energy Efficiency & Building Electrification* and *Delayed Transportation Electrification* scenarios, the delayed electrification leads to higher low-carbon fuel demand than in the reference scenario, with the *Delayed EE & BE* scenario showing the highest increase, about 20 percent more than the Reference Scenario.

Figure 2: Comparison of Changes in Low-Carbon Fuel Consumption in Oregon from 2024 to 2050 Across All Scenarios



[ii] Btu or 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 Btu to more easily evaluate data and show changes over time.

In the model, low-carbon fuels power technologies and operations that are the hardest to electrify, including high-heat industrial applications and vehicles like long-haul trucks, aviation, marine, and rail.

Modeling results indicate that the mix of low-carbon fuels and how they are used will change over time. The most common low-carbon fuels used today are ethanol, biodiesel, renewable diesel, and biogas. These are largely used in the transportation sector, where federal and state programs provide monetary incentives to encourage adoption. As the Climate Protection Program matures and Oregon approaches the economywide 80 percent-below-baseline greenhouse gas goal in 2050, the model selected additional low-carbon fuels to reduce emissions for much of the remaining fossil fuel demand, including renewable hydrogen and biogas. The uses for low-carbon fuels also expand to supplement and replace natural gas and generate electricity, in addition to continuing to power the hardest-to-electrify vehicles.

There is a great deal of interest in hydrogen as an energy resource because it can serve as a resource for electricity generation and storage, for industrial process heating, or as a transportation fuel. However, most of the hydrogen produced today is created from natural gas, and a renewable hydrogen economy is in early stages of development with significant uncertainty about timing and future costs.

Key Finding 3: More capacity from low-carbon fuel gas plants is needed to support the growing electric grid

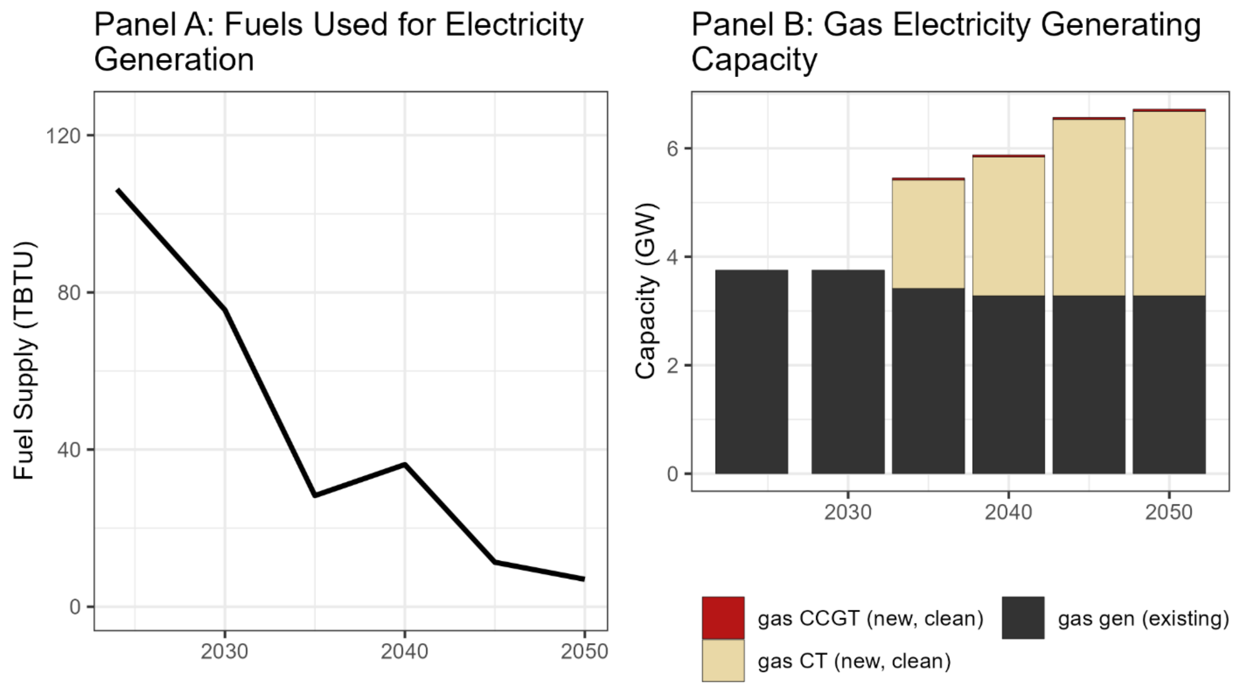
All scenarios modeled showed a decrease in total gas electricity generation through 2050, although both fossil and low-carbon gas electricity generation are still needed in 2050. Results indicate dispatchable capacity from gaseous fuel plants will likely be needed for the electricity system in 2050, but specific resource choices and the amount needed are less certain.

Figure 3, Panel A shows that gas supply used for electricity generation to meet Oregon demand drops from over 106 trillion Btu in 2024 to 7 trillion Btu by 2050 in the Reference Scenario. At the same time, Panel B shows existing gas plant capacity as the dark portion of the bar is essentially flat until 2035, and new, clean gas resources shown in the lighter portions of the bar increase total gas capacity through 2050.

This increase in gas capacity in the model results points to gaseous fuel electricity plants as a key least-cost option for grid flexibility[iii] and reliability, especially in the last 15 years leading up to 2050. Overall fuel demand still declines because these resources are used infrequently, likely for only a few hours in a year to meet seasonal peak load events like heat waves and cold snaps.

[iii] Flexibility refers to the ability to quickly produce, or stop producing, electricity to balance electricity demand and supply. Variable resources like wind and solar are not very flexible because they are not always available, although pairing them with battery storage improves flexibility.

Figure 3: Electricity Generation from Fossil and Low-carbon Fuels in the Reference Scenario



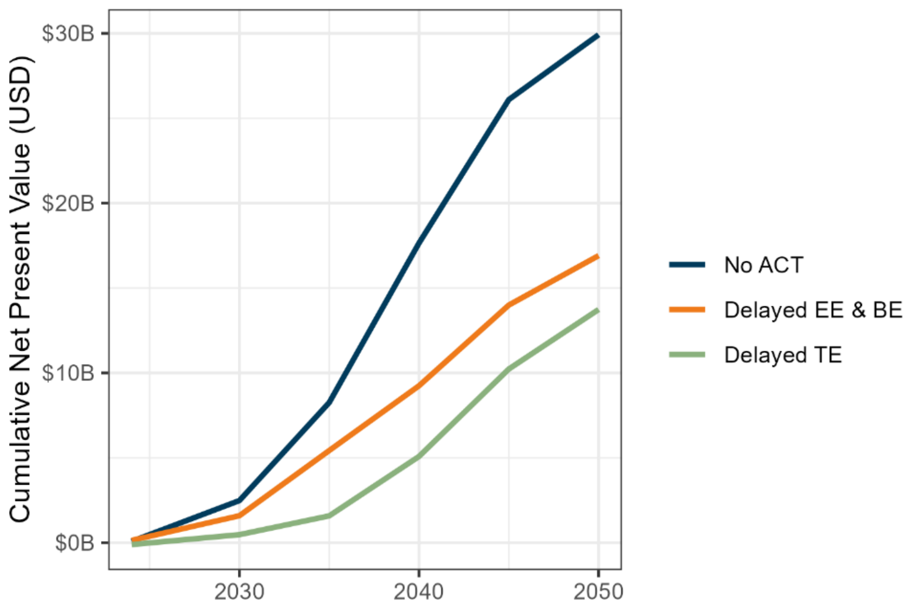
The flexibility of gas resources is critical for grid reliability but also overall cost containment because lacking this flexibility creates higher costs to build sufficient resources to meet grid reliability needs. The *Alternative Flexible Resources* scenario tested this by restricting new fuel electricity generation capacity growth in Oregon. In this scenario, the model built significantly more renewables, largely to create clean hydrogen from electrolysis, which can serve a flexibility role on the system. This scenario had a cumulative net present value cost of over $9 billion greater than the Reference Scenario.

There is a high degree of uncertainty around what technologies and resources will be the least-cost options to provide on demand power in 2035. There are many technological innovations that could change the relative costs of different flexible generation technologies, including batteries, enhanced geothermal, and small modular nuclear reactors. In addition, electric utilities use a diversity of resources to maintain and balance the electric grid today, and the costs for individual resources may vary depending on specific grid needs and regulatory structure.

Key Finding 4: Electrification is more cost effective than adopting low-carbon fuels in many applications

The modeling shows that delaying electrification leads to higher system-wide costs for Oregon to achieve its goals. The Reference Scenario was the least cost of all scenarios modeled, and modeling results with delayed electrification have higher economywide costs. Figure 4 shows a comparison of three different scenarios where electrification is delayed compared to the Reference Scenario. All three show greater overall systemwide costs resulting from increased reliance on fossil and low-carbon fuels. The *Delayed Transportation Electrification*, shown as “Delayed TE” in the chart, resulted in more than $12 billion in cumulative economywide costs, and the *Delayed Energy Efficiency & Building Electrification* scenario, shown as “Delayed EE & BE,” resulted in about $16 billion. The *No Advanced Clean Trucks*, or “No ACT” scenario, produced about $30 billion in additional costs – the highest system-wide costs of any scenario or sensitivity tested by the model.

Figure 4: Costs of Delayed Energy Efficiency and Electrification Compared to Reference Scenario



discount rate.

Findings indicate that delaying electrification or energy efficiency results in increased reliance on fossil fuels and higher economywide costs. Crude oil — and nearly all natural gas — are not extracted or refined in Oregon, meaning most of the money spent on fossil fuels exits the state's economy.[iv] In 2022, Oregon spent $11.2 billion on transportation fuels.[v] Costs for crude oil, and increasingly natural gas, are much more volatile than electricity costs because they are a global commodity that are affected by global demand and geopolitical forces.

Modeling results show that the least cost pathway to achieving Oregon's energy and climate goals is to electrify end uses as early as possible. Building a larger, renewables-based electric grid and developing new low-carbon fuel infrastructure both come with up-front capital costs — but once built, renewable resources like solar, wind, and geothermal energy have no ongoing costs for fuel. Both fossil and low-carbon fuel producers must compete for fuel feedstocks, some of which are subject to global pricing influences.

Model results indicate that low-carbon fuels are most cost-effective when used strategically for the hardest-to-electrify industrial and transportation applications and to maintain a reliable electric grid. Delaying electrification leads to higher economywide costs because low-carbon fuels are currently expensive to produce and are predicted to be significantly more expensive than fossil fuels in the future.

[iv] Oregon Department of Energy. (2024). Oregon Energy Security Plan. https://www.oregon.gov/energy/safety-resiliency/Documents/2024-Oregon-Energy-Security-Plan.pdf

[v] Oregon Department of Energy. 2024 Biennial Energy Report. (2024).https://www.oregon.gov/energy/Data-and-Reports/Documents/2024-Biennial-Energy-Report.pdf#page=42