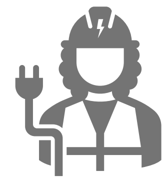
Jobs Analysis

Background: Phase 1 Technical Analysis - Energy Modeling and Jobs Analysis



The jobs analysis is one of several technical analyses undertaken to inform the Oregon Energy Strategy. The Clean Energy Transition Institute and BW Research led the analysis as technical consultants to the Oregon Department of Energy.

The jobs analysis builds on results of the economy-wide energy modeling led by Evolved Energy Research. That modeling evaluated different pathways to achieving Oregon's energy policy objectives. Because the jobs analysis builds on the energy modeling results, it's important to provide some background on the energy model.

The modeling used a two-step process to identify energy needs across the economy, and how those energy needs can be met over time at least-cost:

1) A demand model established a 2024 baseline and future energy demand across Oregon's economy from now to 2050.
2) A supply model determined the energy supply mix that could meet that demand reliably and at least cost.

The model compares energy pathways from a Reference Scenario with six Alternative Scenarios. The Reference Scenario includes "aggressive but achievable" adoption of demand-side technologies and actions, including energy efficiency and electrification. These 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.

Building on the energy modeling results, the jobs analysis evaluates how different future scenarios affect energy sector employment using input-output modeling.[ii] The two input-output models used for the jobs analysis are IMPLAN, short for "impact analysis planning," and JEDI, the National Renewable Energy Laboratory's Jobs and Economic Development Impact Model. The jobs analysis focuses on energy jobs gained or displaced across four primary sectors – electricity, fuels, buildings, and transportation – and 28 subsectors. Table 1 at the end of this document provides an overview of the 28 subsectors analyzed with examples of some of the types of occupations likely to be found in those subsectors.

The jobs analysis modeled employment effects over time from the Reference Scenario and six of the alternative scenarios and sensitivities. While the energy modeling made a distinction between scenarios and sensitivities, for the sake of clarity these will all be referred to as **scenarios** in the jobs analysis:

- No Advanced Clean Trucks (No ACT)

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[i] Oregon Department of Energy. (2022). 2022 Biennial Energy Report, Policy Brief: Charting a Course for Oregon's Energy Future. https://www.oregon.gov/energy/Data-and-Reports/Documents/2022-BER-Policy-Briefs.pdf#page=2

[ii] Input-output models assess how spending in one sector ripples through others. Input-out modeling can be used to estimate the effects of changes in economic activity, such as new investments, on the entire economy in direct, indirect, and induced effects.

- 50 percent Tech Loads
- Delayed Energy Efficiency and Building Electrification (Delayed EE & BE)
- Limited Generation (Ltd Gen)
- High Distributed Energy Resources and Limited Transmission (High DER & Ltd Tx)
- Alternative Flexible Resources (Alt Flex Res)

For more details about the jobs analysis modeling methodology, see the *Jobs Analysis Methodology*. For more information about how the energy model works and the key assumptions used for the reference and alternative scenarios, see the *Energy Strategy Modeling Assumptions and Sources*.

The energy sector accounted for around 5 percent of Oregon jobs in 2023.[iii] These jobs are essential to maintaining and building the critical energy services Oregonians rely on. They are also an important source of employment in communities across the state, from line workers and electricians to installers of energy efficiency technologies and fueling station workers.

One key takeaway from the energy strategy modeling was that significant increases in investment are needed across the energy sector. The goal of the jobs analysis is to understand how that increased investment translates into the types of jobs and skills needed to meet our state's energy policy objectives. While the jobs numbers are not meant to be taken as a forecast, they provide important directional guidance. They serve as a starting point to evaluate existing workforce capabilities and identify workforce training needs. Results from this analysis indicate where growth is expected and where job displacement might occur, providing key information that can help support strategies that address these trends. Finally, this analysis helps highlight the specific occupations most likely to experience growth, as well as average salaries to help inform policies that support living wage jobs and careers.

The jobs results present three levels of employment effects resulting from investment in the energy sector:

1. **Direct effects.** Employment created by the need for workers to implement the measures identified in the energy sector modeling results. Examples include: construction of new power plants, reconductoring or construction of transmission lines, and installation of energy efficiency measures.
2. **Indirect effects.** Employment created in local industries that supply goods and services to support energy sector investment. Examples include: manufacturing jobs assembling components of a home heating appliance to support energy efficiency; accountants hired by motor vehicle manufacturers to support EV sales; and manufacturing a piece of fuel processing equipment that supports adoption of clean fuels.
3. **Induced effects.** Employment supported by direct and indirect energy sector workers spending their wages in the local economy. Examples include employment at restaurants, hospitals, banks, etc. Induced effects are reflected with the sector that has generated them.

Unless otherwise stated, jobs results reflect direct, indirect, and induced effects.

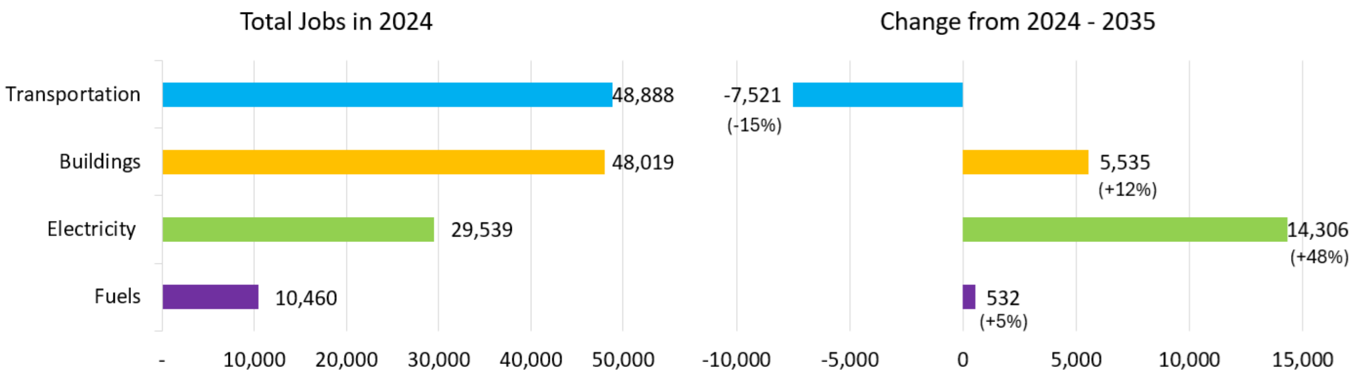
[iii] Calculated using the 2024 baseline direct and indirect employment for the four energy sectors in this analysis and dividing it by the Bureau of Labor Statistics Occupational Employment and Wage Statistics (BLS OEWS) in 2023.

Development of the Oregon Energy Strategy occurred in parallel with significant changes to federal energy policies. Federal policy shifts include elimination of tax credits for energy saving devices and renewable energy systems, weakening product efficiency standards, tariffs on foreign products and termination of energy and climate related federal funding and grant programs. These changes will decrease adoption of consumer products like EVs, heat pumps, solar energy, battery storage, weatherization and home energy audits in Oregon. Development of larger scale solar and wind energy projects will also be affected. Because of their timing, the changes to federal policy were not included in the modelling, jobs analysis or other complimentary analyses completed for the strategy. ODOE will continue to monitor federal energy policies to inform future Oregon Energy Strategy analyses.

Key Finding 1: Achieving Oregon's energy policy objectives is expected to result in substantial net job growth across Oregon's energy sectors.

The jobs analysis suggests that Oregon stands to realize significant net gains in energy jobs by advancing its energy policy objectives. In 2024, Oregon is estimated to have had approximately 137,000 jobs across electricity, fuels, transportation, and buildings. The modeled scenarios estimate that by 2035, jobs could grow to between 9,200 and 16,500 additional energy sector jobs — a 7 to 12 percent increase from 2024. While the precision of longer-term estimates is less certain, by 2050 that number could grow to between 15,300 and 26,200 — an 11 to 19 percent increase from 2024.

Figure 1. Energy Employment by Sector in Oregon2024 - 2035, Reference Scenario



Across these sectors, roughly a quarter of jobs are induced jobs – that is, jobs in the broader economy resulting from direct and indirect energy sector job growth. The remainder are direct and indirect energy sector jobs. The modeling results provide directional insights into potential job growth by sector and occupation, but not the education and training pathways that would be necessary to produce the workforce to meet this demand. If an adequate workforce is unavailable and the pipelines for training and developing the workforce are not sufficient, this could create a significant barrier to meeting our state's energy goals or to ensuring that Oregonians capture those in-state job opportunities. Additional research is necessary to inform a full understanding of workforce needs and to carefully consider how to best ensure a well-trained workforce is established and available at the scale necessary to support Oregon's clean energy transition.

Electricity Sector

Employment gains are most pronounced in the electricity sector. In 2024, the electricity sector supported an estimated 29,500 jobs in Oregon. Across all scenarios, the model estimates net employment growth in the electricity sector by 2035 to be between 10,700 and 18,200 (36 to 62 percent growth from 2024).

This stems from the results of the energy modeling, which show significant near-term electricity load growth and a need to construct more power grid infrastructure and generating capacity inside and outside Oregon across all scenarios and sensitivities, see Key Findings 1 and 4 of the *Developing Clean Electricity Generation and Transmission Key Model Findings*.

Job gains are spread across electricity subsectors. Over the next 5-10 years, the areas of greatest job growth come from new investment in distribution and transmission infrastructure and utility-scale solar. Over the longer term, the model identifies continued growth in distribution and transmission jobs, as well as a shift toward investment in land-based wind, enhanced geothermal energy, and clean gas generation. While there is uncertainty about the exact mix of technologies — and particularly emerging technologies — that will supply future load growth, it is clear that there will be a need for more generation and the infrastructure to interconnect them.

Buildings Sector

The buildings sector also shows net job gains out to 2035 and 2050. In 2024, the sector supported about 48,000 estimated jobs. Across scenarios, job growth in the buildings sector is estimated to be between 4,500 and 5,500 by 2035 (9 to 12 percent growth from 2024). This reflects the high levels of energy efficiency, electrification, and other investments in buildings in the energy modeling (see the *Buildings Efficiency, Electrification, and Distributed Energy Resources Key Model Findings*.[iv]) These job gains are estimated to be primarily in the construction industry, with the largest job growth in the commercial HVAC subsector followed by residential HVAC and other residential and commercial subsectors.[v]

Fuels Sector

In 2024, the fuels sector supported about 10,500 jobs in Oregon. Across all scenarios but one, the jobs analysis shows net job gains in the fuels sector by 2035. This reflects significant increases in the need for low-carbon fuels in the energy modeling (see the *Low-carbon Fuels Key Model Findings*). These gains are more modest in fuels than the electricity or buildings sectors with an estimated net job change by 2035 of between 280 fewer jobs (under the No Advanced Clean Trucks scenario) and 1,300 more jobs (under the Alternative Flexible Resources scenario).

Significant growth in the hydrogen subsector is the primary driver of net job growth in fuels across scenarios; all scenarios reflect growth in hydrogen employment. Jobs in the biofuels subsector remain relatively consistent over time as growth in fuel demand is met by imported biofuels. Upstream natural gas, downstream natural gas distribution, and other fossil fuels subsectors are estimated to experience gradual job displacement due to reduced demand over time. Remaining workers in natural gas and other fossil fuel subsectors remain essential through 2050 to maintain the existing fuel distribution system and meet demand. As in the electricity sector, there is uncertainty over the exact mix of low-carbon fuels and fuel volumes that are likely to be developed to meet Oregon's clean energy goals, and the extent to which those fuels are developed in Oregon.

Transportation Sector

In 2024, the transportation sector in Oregon supported approximately 49,000 jobs. The jobs analysis indicates that the transportation sector is likely to see net job displacement. Across scenarios, the

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[iv] Note that the buildings job findings do not include investments in distributed generation, including PV panels. These jobs numbers are captured under the "electricity" sector.

[v] Jobs are not estimated for the Commercial Shell subsector. The energy modeling from Evolved Energy Research does not include investments from this subsector as a separate category so jobs for this subsector were unable to be estimated in this analysis.

analysis projects that by 2035, between 6,700 and 7,500 transportation sector jobs will be displaced, even after accounting for new job growth within the sector. While employment in the charging stations, vehicle manufacturing, and wholesale trade parts subsectors grows, these gains are outstripped by job losses in fueling stations and vehicle maintenance. Job losses reflect reduced demand for fueling stations as vehicles electrify, as well as lower maintenance needs of electric vehicles. Because EVs have fewer moving parts and key design differences, such as no transmissions, no need for oil changes, and the use of regenerative braking that reduces brake wear, they require less servicing than conventional vehicles.

It is important to note that the energy modeling assumed a 20 percent reduction in per capita light-duty vehicle miles traveled in Oregon by 2050, as well as a sensitivity scenario in which per capita light-duty VMT remains steady over time. The energy modeling did not estimate the level of investment required to achieve VMT reductions, for example, through public transportation, land use planning, or other measures. Other studies, however, have identified significant job growth potential from VMT-reduction strategies, suggesting that this area warrants further exploration.[vi]

While the transportation sector is projected to experience job losses, the jobs analysis shows that electrifying large segments of the transportation sector contributes to substantial net employment gains in the electricity sector. It will be important to consider approaches to mitigate job displacement in the transportation sector, for example by co-locating charging stations at existing gas stations, and to identify opportunities to transition workers to areas of employment growth.

Employment by Subsector

As discussed in each sector narrative above, the shift to clean energy results in net employment growth across energy sector jobs in Oregon. A look at the subsectors provides insights into where, within each sector, the greatest growth is expected and where there may be attrition.

Figure 2 presents employment results by subsector across electricity, buildings, fuels, and transportation for 2024, and Figure 3 presents the expected change over the next decade. Results correspond with the Reference scenario, which is the least-cost scenario modeled. These results illustrate where there are opportunities for jobs in Oregon and a corresponding need to consider workforce training to meet a growing need for workers with key skill sets. Key growing subsectors include electricity distribution, transmission, land-based wind, and other utility-scale generation. Where there is job displacement, it is important to consider mechanisms to mitigate the effects of this displacement and provide opportunities that apply existing skills or provide training in new skills. The most significant displacement in the model is seen in vehicle maintenance, fueling stations, and to a lesser degree, natural gas and other fossil fuels. Employment numbers here reflect direct, indirect, and induced jobs.

[vi] See, e.g., Sustainable Recovery - World energy Outlook Special Report, Figure 2.1, Construction and manufacturing jobs created per million dollars of capital investment and spending by measure.

Figure 2. Energy Employment by Subsector in 2024

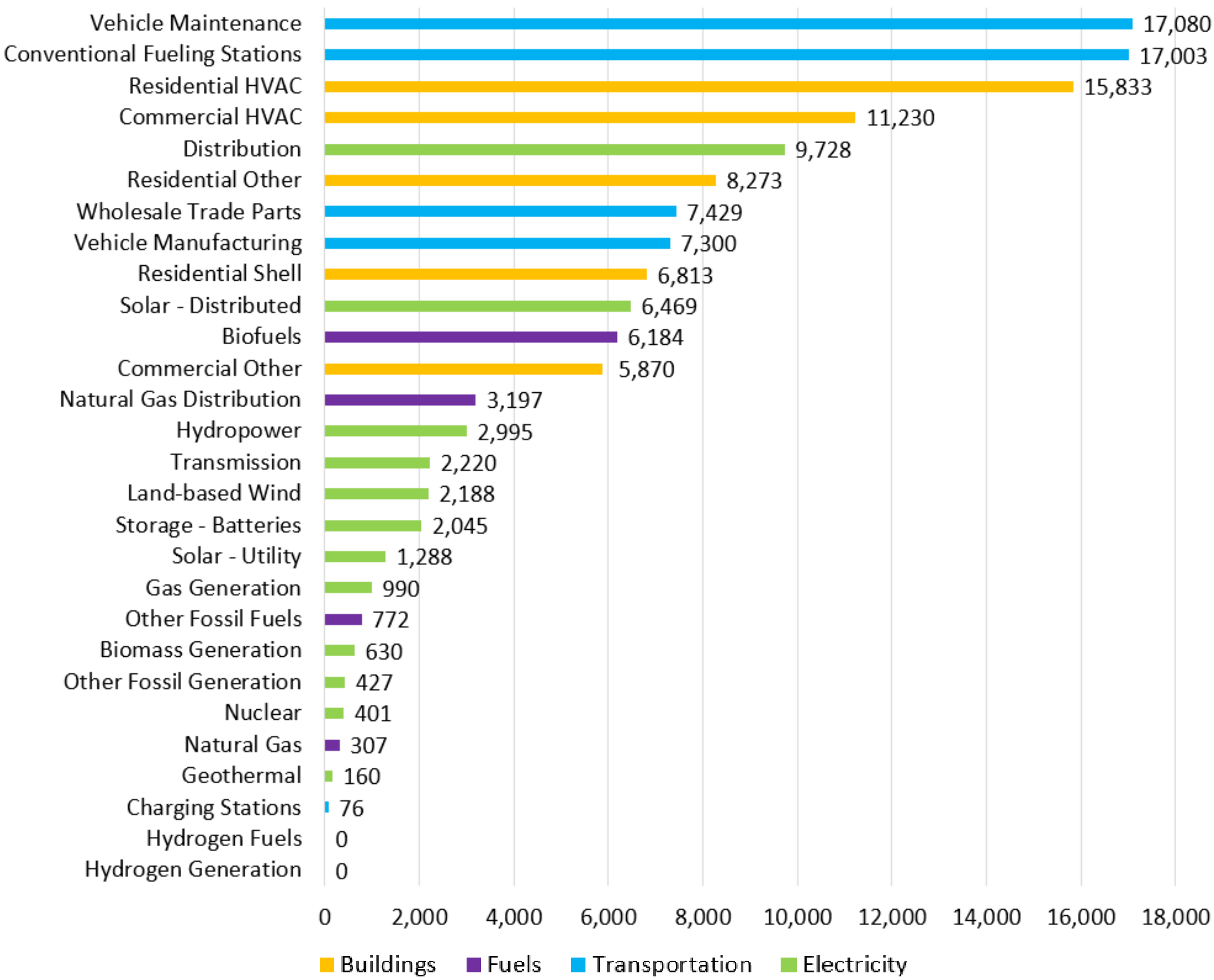
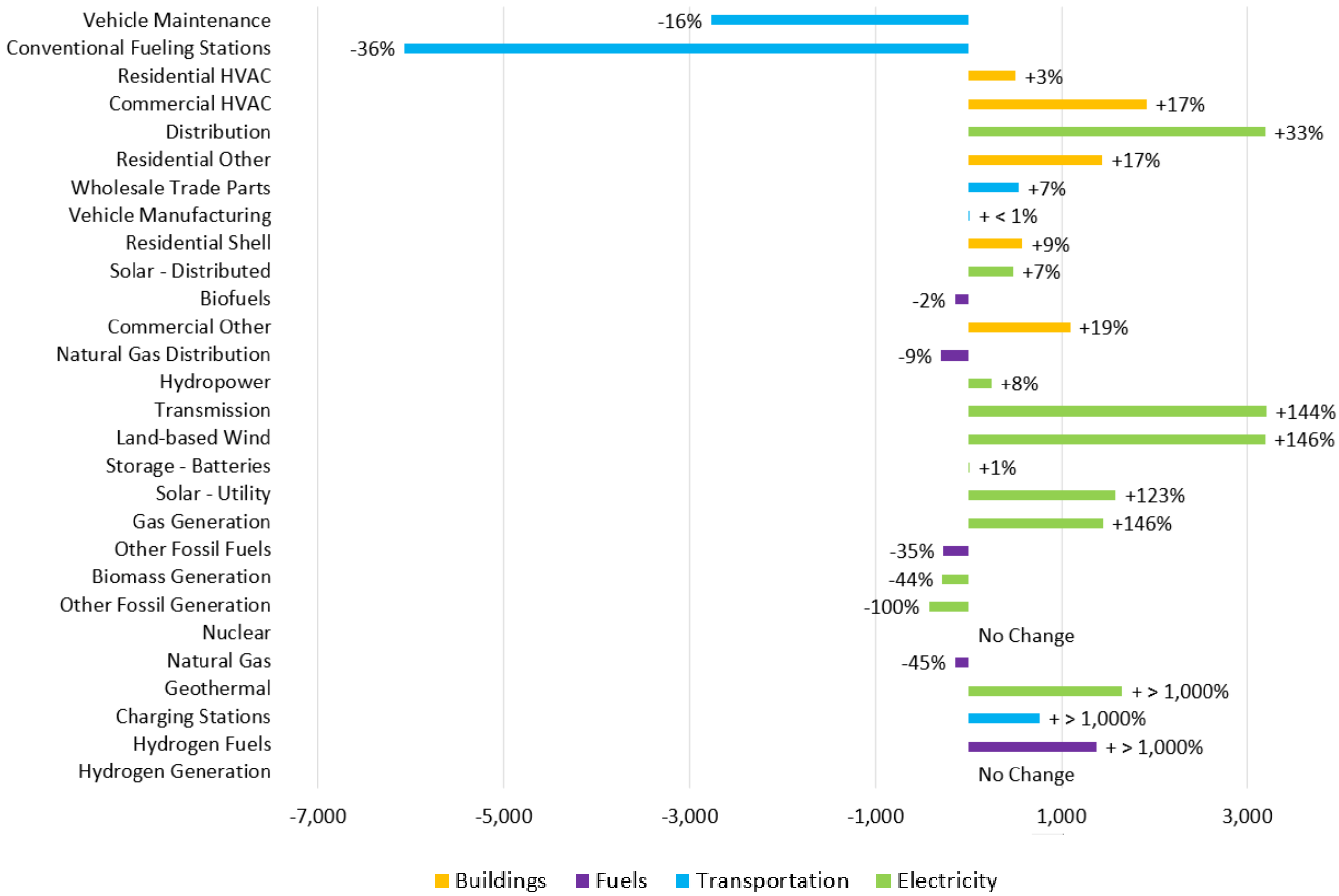


Figure 3. Energy Employment by Subsector 2024-2035, Reference Scenario



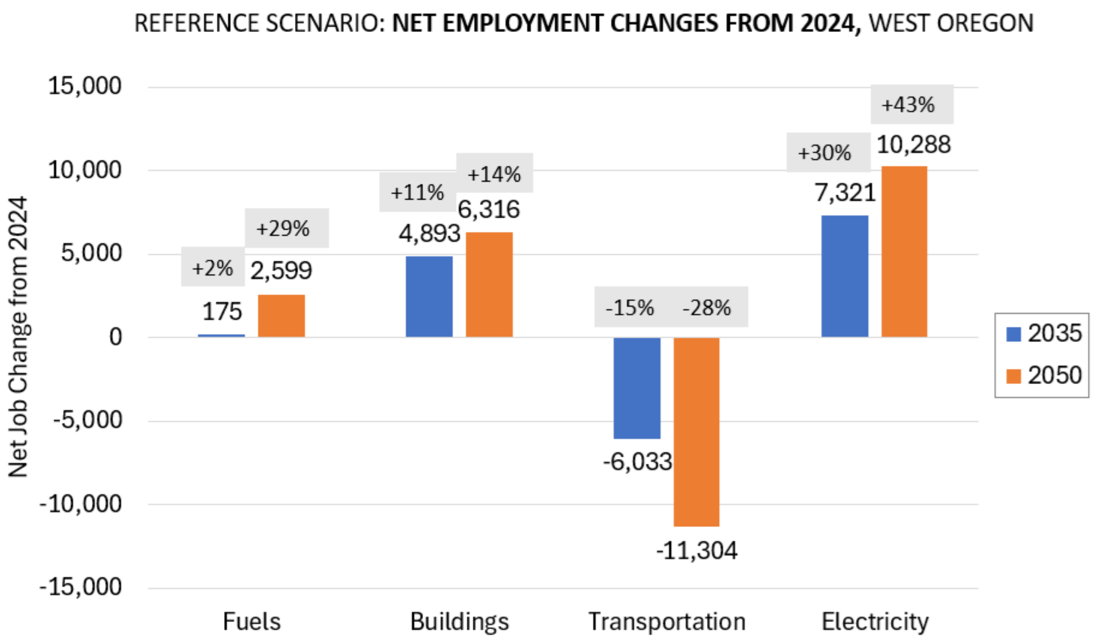
Key Finding 2: Net job growth is expected in both eastern and western Oregon.

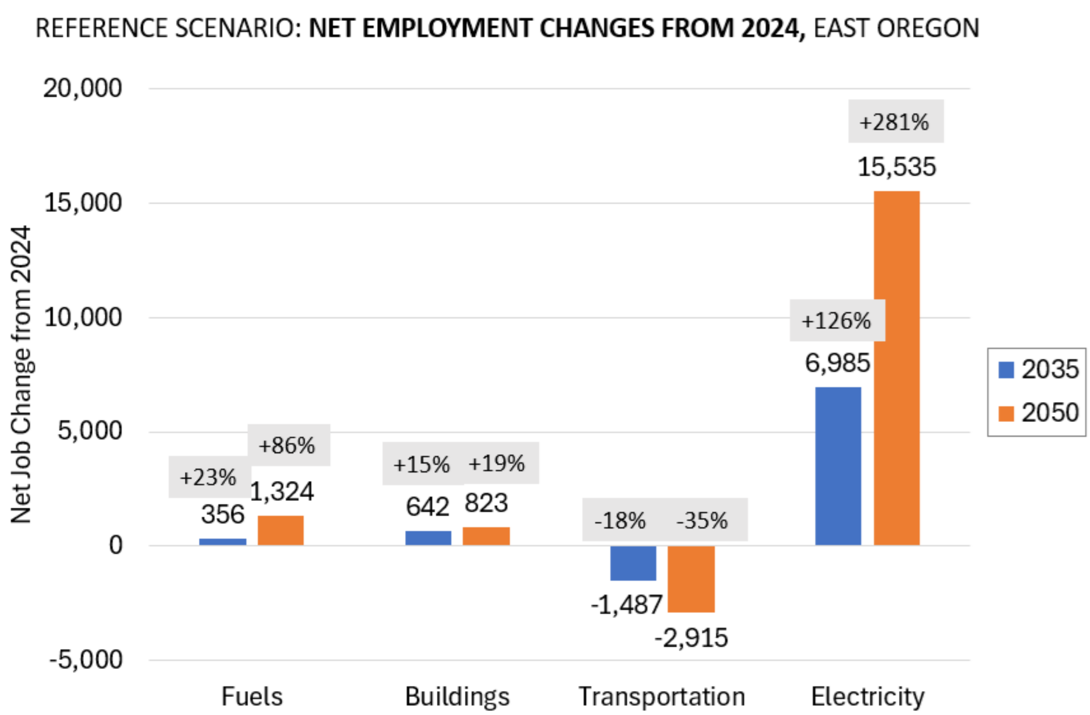
By 2035 in the Reference Scenario, eastern and western Oregon gain nearly the same number of total net jobs across all four energy sectors, about 6,500 jobs to the east of the Cascades and 6,400 jobs to the west. Due to the differences in population and baseline energy employment in the two regions, this translates to a 33 percent job gain in eastern Oregon and a more marginal 5 percent gain in western Oregon. Figure 4 shows the estimated percentage change in net jobs from today's employment out to 2035 by sector for eastern and western Oregon for the reference scenario.

Relative to western Oregon, eastern Oregon is expected to see markedly larger job growth as a percentage of its 2024 baseline employment in the fuels and electricity sectors, highlighting the need for location-based workforce development strategies so eastern Oregon communities, including rural communities, can take full advantage of these employment opportunities. By 2035, eastern Oregon jobs in fuels and electricity grow by 23 and 126 percent respectively, compared to 2 and 30 percent respectively in western Oregon. By 2050, the Reference Scenario shows significantly greater job growth in eastern Oregon than western Oregon in the electricity sector, a 281 percent increase from 2024. This reflects the competitiveness of resources in the energy strategy modeling, which included onshore wind, grid scale solar, and enhanced geothermal electricity.

For buildings and transportation, western Oregon's large population supports a greater number of residential and commercial structures and vehicles than eastern Oregon, and therefore experiences greater net job gains in the buildings sector (approximately 4,900 jobs) and net job losses in the transportation sector (displacement of approximately 6,000 jobs) by 2035. Eastern Oregon's smaller population is forecasted to see job gains in buildings and losses in transportation too, though at smaller magnitudes relative to western Oregon. As a percentage change from their 2024 employment baselines, eastern and western Oregon see roughly equivalent net job growth in buildings and net job loss in transportation.

Figure 4. Net Energy Employment by Sector, Oregon West v East, 2035 and 2050





Key Finding 3: Job growth across different scenarios reflects shifts in investment, and how different choices may affect the skills needed to power Oregon's energy future.

All scenarios modeled found net increases in energy sector jobs for Oregon in 2035 and 2050. This suggests that significant net job growth across the state is likely regardless of the exact pathway taken to meet Oregon's clean energy and climate policy objectives. By 2035, there is only a 1-2 percent difference in energy sector employment across scenarios, though some subsectors experience greater shifts.

Overall job growth across the energy sector is most affected in the two scenarios that limit the in-state investment in electricity infrastructure. The strongest effects occur in the longer term, with 4 percent fewer net jobs in the 50 percent Tech Load scenario by 2050 compared to the Reference, and 5 percent fewer jobs in the Ltd Gen scenario by 2050. The 50 percent Tech Load scenario assumes half of the tech loads in the Reference. This reduces the amount of investment needed in the electricity sector to meet demand and, correspondingly, reduces electricity sector jobs. The Limited Gen scenario assumes that only half of the utility-scale solar, onshore wind, and geothermal resources are built in Oregon, also reducing jobs associated with building electricity infrastructure.

A look at each sector provides additional guidance into how different future paths might affect job growth.

Buildings Sector

The only scenario that affects jobs in buildings is the Delayed EE & BE scenario, which delays energy efficiency and electrification in buildings and industry. In 2035, there are 1,000 fewer jobs than in the Reference, and in 2050, there are 400 fewer jobs. In this scenario, there is job growth over time, but that growth is 1-2 percent lower than the Reference due to the delay in investment in energy efficiency and electric technologies in buildings. The energy modeling suggests that delaying energy efficiency and building electrification could result in greater overall energy consumption and approximately $17 billion in additional total costs (see the *Building Electrification, Efficiency, and Distributed Energy Resources Key Model Findings*).

Transportation Sector

The only scenario that affects the transportation jobs results is the No ACT scenario, which assumes that there are no near-term zero-emission vehicle sales targets for medium- and heavy- duty vehicles. However, the scenario still reaches 100 percent zero-emission vehicle sales by 2050. Under the No ACT scenario parameters, there is a 2-3 percent increase in jobs compared to the Reference Scenario, or 800 fewer jobs displaced by 2035 and 1,000 fewer jobs displaced in 2050. This reflects a slower transition to electric vehicles, which is turn leads to fewer jobs being displaced by the shift to electrification. The Energy Strategy modeling suggests that delaying electrification of medium- and heavy-duty transportation increases overall energy consumption and raises costs by approximately $31 billion by 2050, (see the *Transportation Electrification Key Model Findings document*).

Electricity Sector

This is the sector with the greatest job gains, and there are gains across all scenarios modeled. As already mentioned, the 50 percent Tech Load and Limited Gen scenarios both result in lower electricity sector job growth than the reference (by 8 and 3 percent, respectively, by 2035, and 12 and 13 percent, respectively, by 2050) due to lower investment in in-state electricity generation. The High DER + Ltd Tx scenario, in contrast, significantly increases electricity sector jobs, which are 9 percent greater in 2035 than in the Reference and 5 percent greater in 2050. It's important to keep in mind that in each of these cases, electricity sector jobs are growing significantly, as shown in Figures 5 and 6, which illustrate the net change in electricity jobs across all scenarios evaluated, including the reference.

Figure 5. Net Change in Electricity Jobs in Scenarios, 2024 - 2035

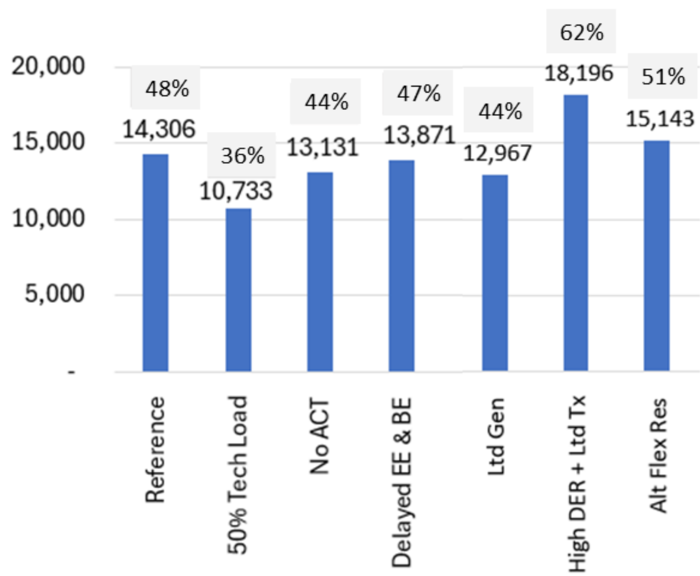
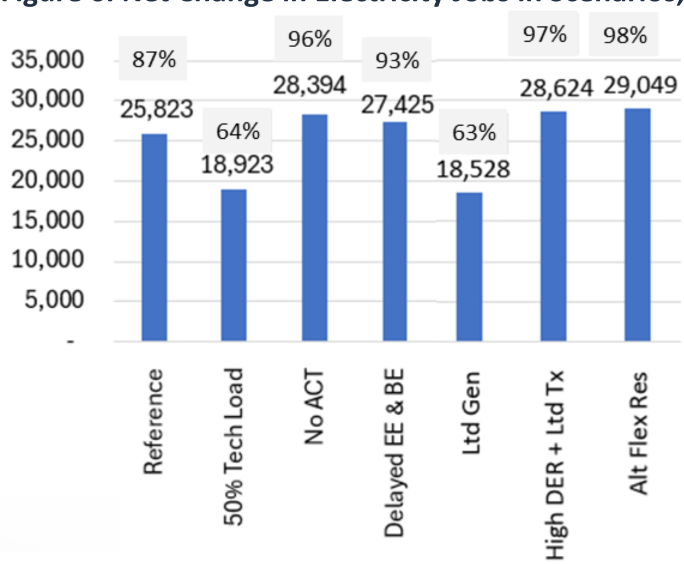


Figure 6. Net Change in Electricity Jobs in Scenarios, 2024 – 2050



Fuels Sector

The two scenarios affecting fuel sector jobs most strongly are the No ACT and Alt Flex Res scenarios. Under the No ACT scenario, there are 7 percent fewer fuels jobs in 2035 compared to the Reference Scenario, and 9 percent fewer by 2050. Under the Alt Flex Res scenario, there are 7 percent more fuels jobs in 2035 and 2 percent more in 2050 than in the Reference. In both cases, the change in jobs compared to the Reference are primarily due to changes in the level of jobs in the hydrogen fuels subsector in Oregon.

Less investment in hydrogen infrastructure in the No ACT scenario leads to about half the job growth in the hydrogen fuels subsector in 2035 and 25 percent less growth by 2050 compared to the Reference

Scenario. Under Alt Flex Res there are 800 more jobs than Reference in 2035 (7 percent increase) and 350 more jobs than the Reference in 2050 (2 percent increase) – driven entirely by hydrogen fuels.

Figures 7 and 8 present the net change in fuels jobs in the Reference, No ACT and Alt Flex Res scenarios. As illustrated, the No ACT scenario is the one scenario with a net job decrease compared to 2024.

Figure 7. Net Change in Fuels Jobs, Select Scenarios, 2024-2035

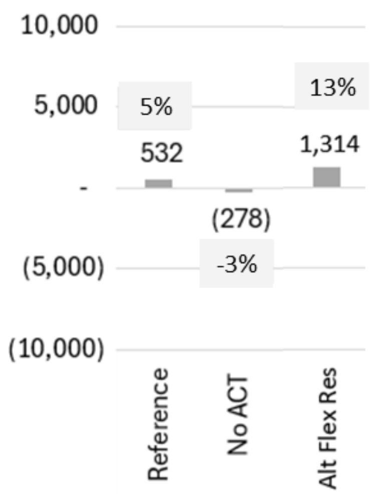
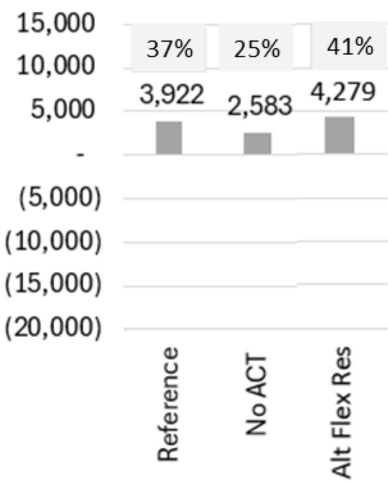


Figure 8. Net Change in Fuels Jobs, Select Scenarios, 2024-2050



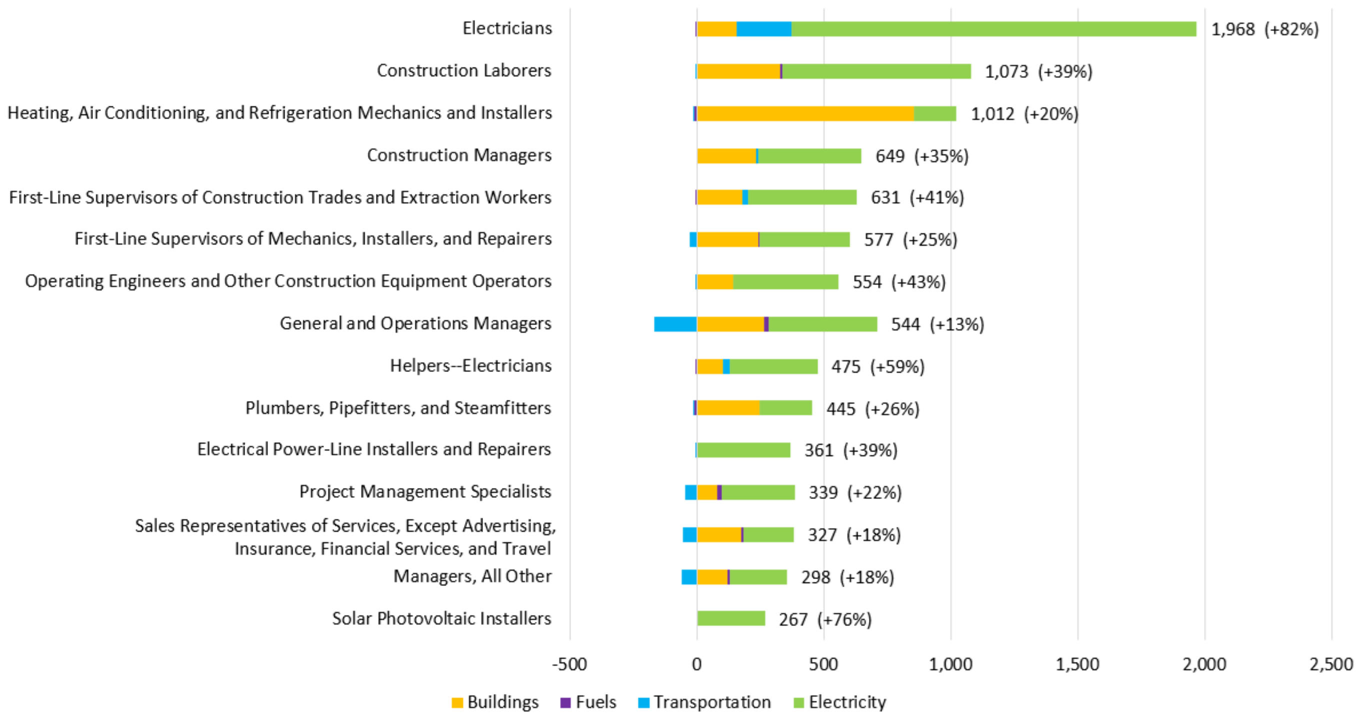
Key Finding 4: Electricians, construction laborers, and heating, air conditioning, and refrigeration mechanics and installers are among the top occupations with expected growth in 2035.

The jobs analysis included occupation-level analysis for the Reference Scenario. As mentioned earlier, the sector and sub-sector employment numbers presented above include induced jobs to reflect the contribution of increased jobs across the energy sector to the broader economy. The occupation-level analysis focuses on **only direct and indirect jobs** to reflect where across the energy sector key skills are needed.

Results from the Reference Scenario indicate a demand for roughly 2,000 more electricians by 2035, 1,000 additional construction laborers, and 1,000 more HVAC and refrigeration mechanics and installers. The analysis also shows increases in related occupations such as: construction managers; general and operations managers; first-line supervisors of construction trades and extraction workers; and first-line supervisors of mechanics, installers, and repairers. Electricians represent the occupation with the largest percentage increase in new employment between now and 2035. Electrician jobs are estimated to increase 80 percent from a baseline of roughly 2,500 electricians currently employed in Oregon.

The occupations that are expected to grow most between now and 2035 differ somewhat between eastern and western Oregon. For example, the jobs analysis estimates a greater percentage growth in HVAC and refrigeration mechanics and installers, and plumbers, pipefitters, and steamfitters in western Oregon, while estimating a greater percentage growth in solar photovoltaic installers and wind turbine service technicians in eastern Oregon. Electricians remain the occupation with the top total job gains across the state, with roughly 600 new jobs in eastern Oregon and 1,400 new jobs in western Oregon.

Figure 9. Net Change in Energy Jobs by Occupation by 2035



Key Finding 5: Net job growth is estimated to occur across wage tiers.

In addition to estimating overall industry and occupation-level job changes, the jobs analysis considered how changes to employment are likely to occur across three wage tiers. These tiers were developed with information from the MIT Living Wage Calculator for Oregon[vii] and are defined for the following ranges: Below a Living Wage: Less than $33/hour; At a Living Wage: $33-$48/hour; Above a Living Wage: More than $48/hour.

The jobs analysis estimates net job growth across all three wage tiers with roughly a 13 percent gain in jobs with earnings above a living wage, a 20 percent gain in jobs with earnings at a living wage, and a 2

[vii] https://livingwage.mit.edu/

percent gain in jobs with earnings below a living wage. Despite these differences, the distribution of total jobs estimated by the model in 2035 across the three wage tiers remains approximately equivalent to the distribution in 2024, with most jobs continuing to be classified as below a living wage. This result is consistent for estimated jobs in both eastern and western Oregon, and is also true across each of the four energy sectors. This underscores a need for early planning and investment in workforce training and development to ensure quality job growth.

Figure 10. Net Change in Total Employment by Wage Tier, Reference Scenario, 2024 vs 2035

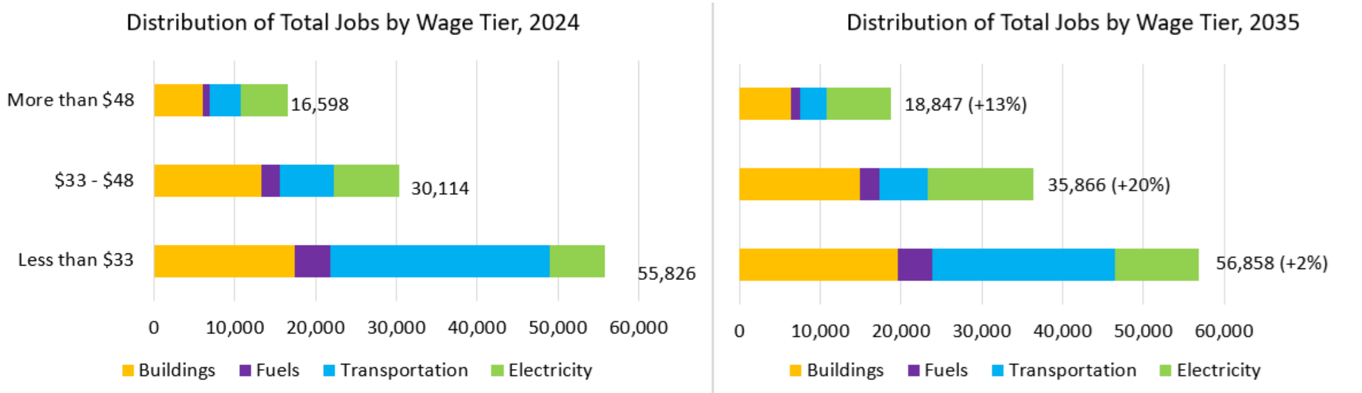


Table 1 provides more detail on the descriptions of each sector, subsector, and examples of jobs that are found in each subsector.

Table 1. Energy Subsector Descriptions and Example Jobs[viii]

Electricity Sector

Subsector	Description	Example Jobs (Direct)
Distribution	*Local power lines, smart grid*	Lineworker, groundperson, cable splicer, service technician, drone pilot, product specialist, software developer, safety manager
Solar (Utility) (Distributed)	*Rooftop solar, utility photovoltaic (PV), concentrated solar power (CSP)*	Solar site assessor, sales representative, PV system designer, installation contractor, structural engineer, power systems engineer, materials scientist
Transmission	*Inter- and intra- zonal transmission*	Substation engineer, power systems engineer, power scheduler (see also: Distribution job areas)
Land-based Wind	*Land-based wind farms*	Survey technician, assembler/fabricator, machinist, blade testing engineer, crane/tower operator, rigger, wind technician, construction manager, plant manager, meteorologist

[viii] Initially produced by the Clean Energy Transition Institute and BW Research Partnership for *Net-Zero Northwest: Workforce Analysis*, *November 2023* and updated for this project. See Net-Zero Northwest *Workforce Analysis Resources* for resources consulted. The list of example jobs is not comprehensive nor ranked in order of importance.

Storage (Batteries)	*Batteries, flywheel, thermal energy, pumped hydro*	Electro-mechanical technician, high voltage reliability specialist, energy storage engineer, production worker, site acquisition specialist, site surveyor, construction manager
Hydropower	*Large-scale and run-of-river hydroelectric power generation*	Plant manager, hydropower biologist, earth scientist, mechanical engineer, compliance specialist
Other Renewable Generation (Geothermal) (Biomass) (Hydrogen)	*Biomass, enhanced geothermal, hydrogen fuel cells*	Power marketer, logistician, industrial engineer, project developer, economist, plant manager, farmers, harvest equipment mechanic
Nuclear	*High-temperature gas-cooled reactors, small module reactors*	Electrician, welder, radiation protection apprentice, power reactor operator, nuclear engineer
Gas Generation	*Natural gas peaker plants, clean gas plants, combustion turbine plants, combined cycle plants*	Power plant operator, electrician, electrical and electronics repairer, industrial machinery mechanic
Other Fossil Generation	*Oil, other fossil fuel burning plants*	Welder, foreman, pipefitter, floorhand, plant operator, petroleum engineer, industrial electrician, landman

Fuels Sector

Subsector	Description	Example Jobs (Direct)
Other Fossil Fuels	*Oil and gas, coal, kerosene*	Welder, driller, foreman, underground miner, pipefitter, floorhand, plant operator, petroleum engineer, landman
Natural Gas Distribution	*Natural gas pipelines, liquefied natural gas (LNG) trucks and tankers*	Pipeline operators, truck drivers, barge operators, pipefitter, other general natural gas jobs (see also: Natural Gas job areas)
Biofuels	*Ethanol, bio-gasification, biomass fast pyrolysis*	Biochemist, farmer, industrial machinery mechanic, chemical and industrial engineers, storage facility operators, construction laborer
Natural Gas	*Natural gas production and transportation*	Driller, above and below ground technician, gas operator, geologist, natural gas scheduler
Hydrogen	*Hydrogen electrolysis and transportation*	Chemical and mechanical engineer, materials scientist, advanced manufacturing technician, lab technician, machinist, plant operator

Buildings Sector

Subsector	Description	Example Jobs (Direct)
Residential HVAC	*Sheet metal, heating, air conditioning*	Residential installer (heat pumps, ventilation, air conditioning, etc.), service technician, residential building code inspector, residential energy auditor
Residential Other	*Laundry, refrigerators, lighting, water heating, cooking, freezing, clothes washing and drying, dishwashing, etc.*	Sales representative and estimator, energy efficiency program assistant, residential energy auditor
Commercial HVAC	*Pipes, sheet metal, heating, air conditioning, refrigeration, power boilers, heat exchangers*	Commercial installer (heat pumps, ventilation, air conditioning, etc.), construction supervisor, refrigeration technician, facilities manager, stationary engineer, commercial energy auditor, building automation systems engineer
Commercial Other[ix]	*Commercial lighting, cooking, refrigeration, water heating, etc.*	Commercial kitchen service technician, commercial energy auditor, lighting designer
Residential Shell	*Paintings, coatings, insulation, windows and doors*	Weatherization technician, sales representative and estimator

Transportation Sector[x]

Subsector	Description	Example Jobs (Direct)
Conventional Fueling Stations	*Fossil fueling stations (to the extent these stations are closed rather than converted to EV charging)*	Cashiers, retail managers, service station attendants
Vehicle Maintenance	*Vehicle repair and maintenance activities*	Tow truck driver, mechanic, tire technician, service technician, detailer, vehicle inspector
Wholesale Trade Parts	*Wholesale of vehicle components*	Parts specialist, product developer, quality testing engineer, process engineer, service manager
Vehicle Manufacturing	*Electric vehicles, conventional vehicles, dual-use technologies (i.e., parts used in both ICE and ZEVs)*	Machinist, equipment assembler, materials scientist, electrical and industrial engineers, mechanical drafter, software engineer, salesperson, quality testing engineer, designer
Charging Stations	*Manufacturing, installation, maintenance*	Electrician, electric power-line installer, urban and regional planner, software engineer, electronics engineer, operations manager, retail salesperson

[ix] Commercial shell subsector not included due to lack of input data from Evolved Energy Research's Energy Pathways modeling.
[x] This analysis focuses on on-road transportation and does not include aviation and maritime shipping.