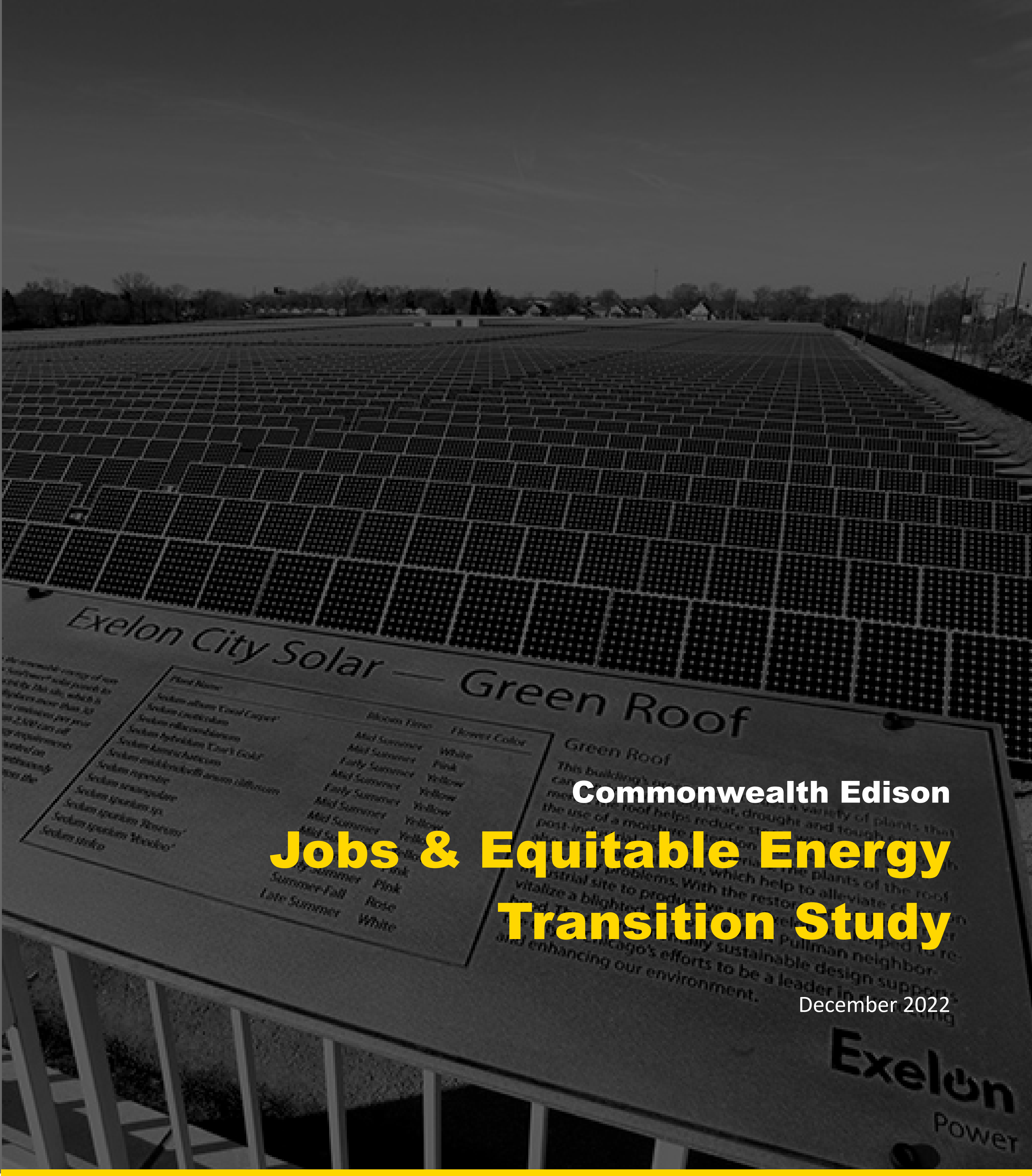

Commonwealth Edison

Jobs & Equitable Energy Transition Study

December 2022

[bw] RESEARCH PARTNERSHIP

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Executive Summary

Introduction

In September of 2021, Illinois signed the Climate and Equitable Jobs Act (CEJA) into law. CEJA provides a framework for eliminating carbon emissions from the energy and transportation sectors. The Jobs and Equitable Energy Transition study (Jobs study) builds upon this framework to examine employment changes under different scenarios related to phasing out carbon emissions in sectors most directly impacted by climate change mitigation strategies.

Foundational Policy

By requiring all private coal-fired and oil-fired electric generating units to reach zero emissions by 2030 with interim goals to achieve 40 percent renewable energy by 2030 and 50 percent renewable energy by 2050, CEJA advances the State of Illinois toward 100 percent decarbonized power generation by 2050. CEJA also sets a state goal of having 1,000,000 electric vehicles on the roads in Illinois by 2030. Additionally, CEJA calls for "expanding equitable access to public health, safety, a cleaner environment, quality jobs, and economic opportunity".[1] As a result, ensuring all Illinoisans have access to good jobs and career opportunities in the clean energy economy is a significant focus for Illinois policymakers. CEJA also focuses on communities and residents facing multiple changes and issues, which include coal plant closures, economic disadvantages, and barriers to employment.[2]

CEJA allocates up to $180 million in funding per year for programming aimed at providing varied education, training, and support services for communities and individuals to succeed in the clean energy sector. Provisions and allocations include the following:

- Clean Jobs Workforce Network Program - a network of career-training and job-matching hubs;[3]
- Illinois Climate Works Pre-apprenticeship Program - a pre-apprenticeship training program;[4]
- Clean Energy Contractor Incubator Program - a network of hubs to provide services (including low-cost capital) to contractor businesses;[5]
- Clean Energy Primes Contractor Accelerator Program - a coaching and mentoring program for contractors;[6] and
- Energy Transition Navigators - an outreach program to ensure eligible individuals are aware of all the Energy Transition Act programs.[7]

Research Objectives

The research phases and objectives for this project were categorized into the following manner:

Phase 1: Develop the structure and framework of the employment impact model.
In the first phase, the team conducted an extensive literature review to understand concepts around modeling employment for different transition pathways from the status quo to a low- or no-carbon

[1] S.B. 2408, 2021-2022, 102nd General Assembly. (Illinois 2022). https://legiscan.com/IL/text/SB2408/id/2433158. Section 5-10
[2] S.B. 2408, Section 5-10
[3] S.B. 2408, Section 5-20
[4] S.B. 2408, Section 5-30
[5] S.B. 2408, Section 5-45
[6] S.B. 2408, Section 5-55
[7] S.B. 2408, Section 5-35

future. The team examined more than 30 studies and employment models to synthesize the literature review findings into the proposed structure and framework of the employment impact model for this study.

Phase 2: Generate outputs from the employment impact model under different transition scenarios.

In the second phase, the team refined the employment impact model by running preliminary iterations of scenarios through the model. The final scenarios modeled and presented in the Jobs Study were taken from the work done by ComEd and E3 to examine a Reference (CEJA) case and a Moderate Electrification scenario.

Phase 3: Examine the initial overall employment, and secondary industry and occupational findings associated with the model outputs.

In the third phase, the team examined the final employment outputs from the models. The study describes how these changes could impact employment in the four sectors (Electricity, Fuels, Buildings, and Transportation) most directly impacted by the transition. The study also presents outputs based on wage categories and regions, i.e., Illinois, the ComEd service area, and Chicago.

Acknowledgments

We would like to acknowledge the stakeholders who graciously spent time with ComEd to answer key questions around the economy, jobs, workforce development, and the energy transition.

We would also like to thank Energy and Environmental Economics, Inc. (E3) and the Center for Climate Resilience and Decision Science at Argonne National Labs for the ongoing collaboration.

Methodology

The team revised and refined the methodology for the Jobs study throughout the project. The methodology was built from two foundations:

1. **Literature review:** To gain a comprehensive view of existing methods in modeling employment scenarios resulting from different climate change mitigation efforts, the team reviewed comparable research and modeling efforts in the early stages of the project.

2. **Modeling experience:** The modeling team refined its project methodology based on what it had learned[8] in similar employment modeling efforts for different economies and varying climate change mitigation scenarios.

The modeling framework was based on examining how different transition related activities impact four primary sectors— Electricity, Fuels, Buildings and Transportation. Each sector was delineated into 11 to five sub-sectors, related to specific technologies or services within each sector, such as Solar, within the Electricity sector. Activities were modeled at the sub-sector level, and they produced initial employment outputs, that measured how employment changed within each sub-sector over time from 2021 to 2050. From the initial employment outputs,

[8] New York State, JTWG Jobs Study, 2021: https://www.bwresearch.com/docs/BWR_NY-JTWG-JobsStudy2021.pdf, ,Massachusetts Clean Energy & Climate Plan, 2022: https://www.mass.gov/doc/clean-energy-and-climate-plan-for-2025-and-2030/download, and World Resources Institute, Federal Policy Building Blocks to Support a Just and Prosperous New Climate Economy in the United States, 2022: https://www.wri.org/research/federal-policy-building-blocks-support-just-prosperous-new-climate-economy-united-states.

more granular modeling was completed in a secondary phase, which provided information on how occupations, wages, and regional employment would change from 2021 (baseline year) to 2030.

Modeled Scenarios

For the Jobs study, the BW research team modeled two transition scenarios based on E3's *Illinois Decarbonization Study*.[9]

- **The Reference scenario** was also described as the baseline CEJA scenario. This scenario is a business-as-usual vision of the future that includes existing state and federal policies— i.e., CEJA and the Inflation Reduction Act respectively— enacted into law by September 2022.

- **The Moderate Electrification scenario** would achieve Illinois' target of economy-wide net zero GHG emissions by 2050 with aggressive action in all sectors, with high levels of electrification, and with a significant role for hydrogen and gas backup for heating.

For both scenarios the baseline year of comparison was 2021, with overall employment modeling outputs developed for 2025, 2030, 2035, 2040, 2045, and finally 2050. Industry employment was modeled for each of the output years, with more detailed occupational, wage, and geographic outputs completed for 2030.

Key Findings & Conclusions

BW Research offers the following key findings and conclusions for the Jobs study based on an analysis of the model outputs.

Employment Impacts from 2021 to 2030

Both the Reference and Moderate Electrification scenarios show a net increase in employment, when examining employment from all four sectors, from 2021 to 2030. The Reference scenario shows an overall increase of approximately 15,000 jobs, with over half of the increase (8,900 jobs) coming from the Electricity sector. The Moderate Electrification scenario shows a much larger increase in jobs, over the same period, to almost 41,000 new jobs in the four sectors. Just over half of the increase (20,800 jobs) for the Moderate Electrification scenario is attributed to the Buildings sector, as the Moderate Electrification scenario takes a more aggressive investment in electrifying buildings.

In the reference scenario, three of the four sectors, Electricity (8,900 jobs), Transportation (5,000 jobs), and Buildings (2,800 jobs) show a net increase in jobs from 2021 to 2030, while the Fuels sector (-1,600 jobs) shows a net decline in employment over the same period. In the Moderate Electrification scenario, all the sectors, Buildings (20,800 jobs), Electricity (11,100 jobs), Fuels (4,600 jobs), and Transportation (4,300 jobs) showed a net increase in employment from 2021 to 2030.

An examination of the employment growth by sub-sectors from 2021 to 2030, shows the greatest increase in employment from the Reference scenario, in Solar (12,100 jobs), Charging & Hydrogen Fuel Stations (8,000 jobs), Residential HVAC (3,400 jobs), and Land-Based Wind (3,400 jobs). The largest employment declines in the Reference scenario were found in Conventional Fueling Stations (-5,600 jobs), Natural Gas Generation (-3,800 jobs), and Vehicle Manufacturing (-3,700 jobs). For the Moderate Electrification scenario, the largest employment increases were found in Solar (12,800 jobs), Charging & Hydrogen Fuel Stations (10,700 jobs), Residential Shell (7,700 jobs), Residential HVAC (6,600 jobs) and Bioenergy (5,600 jobs). The largest employment declines were found in Conventional Fueling Stations (-7,200 jobs), Petroleum Fuels (-4,500 jobs), and Vehicle Manufacturing (-3,800 jobs).

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[9] Illinois Decarbonization Study, Energy and Environmental Economics Inc., 2022.

Job quality improved considerably for the four sectors from 2021 to 2030. Job quality can be measured many ways, but for this study, jobs were categorized into one of three tiers based on data from the MIT Living Wage Calculator[10]. Tier 1 jobs— i.e., the highest paying jobs— in the Reference case increase by 9 percent by 2030, the same tier under the Moderate Electrification scenario will increase by 17 percent. Occupations in Tier 2— i.e., the moderate paying wage category— increase by 7 percent in 2030, compared to 17 percent under Moderate Electrification. Under the Reference case, Tier 3 jobs— i.e., the lowest paying jobs— decreased by 2 percent compared to a 0 percent increase under the Moderate Electrification scenario.

Employment Impacts from 2021 to 2050

The longer-term employment picture from 2021 to 2050 continues to show an overall increase in jobs from the four sectors, for a net increase of 38,000 jobs in the Reference scenario to almost 151,000 additional jobs in the Moderate Electrification scenario. In the Reference scenario, Buildings (24,400 jobs) and Electricity (20,800 jobs) experience considerable employment growth over the long run, while Fuels (-6,300 jobs) and Transportation (-1,000 jobs) experience a smaller decline in employment, over the same period. In the Moderate Electrification scenario, Buildings (63,900 jobs), Electricity (54,400 jobs), and Fuels (45,500 jobs) all experience strong employment growth, while Transportation (-13,000 jobs) experiences an employment decline in the 2021 to 2050 timeframe.

An examination of the employment growth by sub-sectors from 2021 to 2050, shows the greatest increase in employment from the Reference scenario, in Solar (14,700 jobs), Land-Based Wind (13,000 jobs), Residential HVAC (10,000 jobs), and Charging & Hydrogen Fuel Stations (9,200 jobs). The largest employment declines in the Reference scenario were found in Conventional Fueling Stations (-17,600 jobs), Petroleum Fuels (-10,000 jobs), and Natural Gas Generation (-7,100 jobs). For the Moderate Electrification scenario, the largest employment increases were found in Bioenergy (48,900 jobs), Solar (37,400 jobs), Hydrogen Fuels (35,400 jobs), Commercial HVAC (25,500 jobs), and Residential HVAC (16,600 jobs). The largest employment declines were found in Conventional Fueling Stations (-25,800 jobs), Petroleum Fuels (-20,900 jobs), and Natural Gas Distribution (-15,700 jobs).

Conclusions

The following conclusions are based on the key findings from this study:

1. **Total jobs are increasing in the four primary sectors**, both in the short-run (through 2030) and in the long-run (through 2050).

2. **Job composition and job quality is changing in the transition to clean energy**. The employment churn— i.e., an increase in jobs in specific categories and displacement of jobs in others— will require active support for individuals transitioning from declining industries and occupations. Workforce development investments and programs will be vital in supporting transitioning workers, and workers in search of new or better opportunities. Effective workforce development interventions will be critical if Illinois is to provide these emerging high-quality employment opportunities to all residents, particularly those from under-resourced communities. This employment churn can also be seen in the occupational categories, where Installation and Repair occupations are growing by 12 to 25 percent, depending on the scenario, and Management and Professional positions are growing by 5 to 9 percent while Administrative positions decline by 5 to 8 percent with smaller declines seen in Production and Manufacturing occupations. The opportunity arising from all this employment churn is more high-quality jobs, as Tier 1 (high-paying jobs) and Tier 2 (middle wage jobs) employment, experience strong growth and Tier 3 employment (lower-

[10] The MIT Living Wage Calculator (https://livingwage.mit.edu/). The categories were created based on living wage data for Illinois.

paying jobs) is flat or declining. The challenge is these growing positions in Management and Professional occupations, as well as those in Installation and Repair will likely require more training and education.[11]

3. **The scenario matters and will considerably impact Illinois's workforce and economic development plans**. The differences between the Reference case (CEJA, baseline scenario) and the Moderate Electrification scenario show considerable variation in their net employment impacts. Both the Fuels and Buildings sectors are highly sensitive to the scenario. For example, while the Fuels sector will lose 1,500 jobs by 2030 in the Reference case, it will grow by more than 4,500 jobs by 2030 under Moderate Electrification. Additionally, the Buildings sector will experience less than 3,000 added net jobs under the Reference case or more than 20,000 added net jobs under Moderate Electrification by 2030. As a result, Illinois decision-makers will need to make timely choices on the pathway to adopt in transitioning from the status quo to be more effective in workforce development planning.

Stakeholder Insights and Next Steps

Concurrent with employment impact modeling, ComEd engaged stakeholders to share perspectives on the current state of the economy and workforce in Illinois. ComEd conducted stakeholder engagement to understand workforce readiness and preparedness for the future of no-carbon economies. ComEd conducted 15 interviews with stakeholders in economic & workforce development, educational institutions, community-based & non-profit organizations, municipal and regional planning organizations, industry, and labor, among others.

The following key themes emerged from the engagements:

1. **Finding, hiring, and developing talent** will be a challenge as total jobs will increase in most sub-sectors, with employers already facing challenges in hiring.

2. Stakeholders expressed support for **more aligned, coordinated training efforts across education, labor, workforce development organizations, governmental entities, utilities, including ComEd, and other key stakeholders, throughout the region** to ensure best use of resources and ability to help more individuals and communities. Stakeholders consistently indicated the need for ComEd to support workforce development as the state continues its clean energy transition.

3. Providing **high quality employment opportunities for all Illinois residents**, particularly those from under-resourced communities who have been left out in the past, will be crucial for the clean energy transition.

Additional anonymized insights collected via these interviews are available under the C. Stakeholder Engagement section of the Appendix.

Understanding the expected shifts in jobs across sectors and occupations is only the first step. To build upon the research findings in this study, interested stakeholders across the state may consider pursuing the following potential next steps:

1. **Identify the regional and statewide opportunities to support workforce and economic development to connect emerging opportunities and pathways for those in under-resourced communities**. The research findings provide multiple workforce and economic development pathways for employment growth and increased business activity. Additional research and analysis should look to identify and find consensus around those opportunities that are most relevant to under-resourced communities and/or cohorts within Illinois.

[11] While the team only focused on the Reference and Moderate Electrification cases, there is an additional high electrification scenario from the E3 study which would likely result in greater changes in employment profiles across the four sectors.

2. **Develop and communicate employment and training pathways to those in declining occupations and/or industries**. The research findings identify employment pathways that are both growing and declining due to the climate change mitigation transition scenarios. Additional research and analysis should look to identify, develop, and communicate those growing employment pathways that are most relevant to individuals in declining occupations and/or industries.

3. **Align the growing industry and occupational employment expectations with the education and training infrastructure of Illinois**. The research findings can be connected to more traditional labor market models to better understand how the overall demand for jobs and employment will change the demand for education, training, and skills in Illinois over the next three to 28 years. Additional research and analysis should examine the current capacity in Illinois to develop education, training, skills for workers both now and into the future, and the most relevant gaps in that capacity as the demand for workers evolves.

4. **Examine and identify the business and entrepreneurship support mechanisms that can be provided for those in declining businesses and/or industries**. The research findings identify those industries and technologies that are most likely to be negatively impacted by the transition to a low to no carbon economy. Additional research and analysis should be done to determine the best mechanisms to support businesses and those individuals that are most likely to be negatively impacted and provide opportunities to transition out of declining industries and occupations or adapt to the changing environment to thrive within the low to no carbon reality.

Review of Comparable Research

The following review summarizes findings from studies modeling the impacts of energy transition scenarios from the status quo to low carbon across the United States. The research team formulated and calibrated the models based on understanding the different methodologies and frameworks used to study job impacts in specific areas of the energy economy over time.

The research team conducted an extensive review of state-specific and national resources, works, and literature related to job forecasts and modeling for energy economy sectors that will be directly impacted by the transition. To guide the review and comparison, the team developed five categories of questions:

1.	**Structure**	How will sectors, industries, and occupational categories identified and defined in parts of the energy economy be directly affected by the transition to low- or no-carbon?
2.	**Modeling Approaches**	What methods were used to estimate current or future job impacts?
3.	**Transition Scenarios**	What transition scenarios do comparable studies model?
4.	**Workforce Implications**	How do different transition scenarios impact the evolving employment landscape?
5.	**Equitable Transition and Policies**	What special considerations were given in the literature to including under-resourced groups and communities? What benefits and challenges were identified in the literature, and what solutions were proposed?

The following is a discussion of specific reviews related to answering the outlined questions. Through reviewing national and regional approaches to the questions above, the team identified and adopted best practices to conduct a robust analysis of parts of the energy economy that will be directly impacted by the transition from the status quo. More detailed write-ups can be found in section E. Review of Comparable Research: Detailed of the Appendix. A complete list of reviewed literature can be found under section D. Review of Comparable Research: Bibliography of the Appendix.

Structure

Sectoral Categorization

Typical analyses of the economic impact of transitions to a low-carbon economy are performed at the sectoral level (see Table 20 for specific reports). While the literature review revealed inconsistent naming and categorization practices, three universal sectors emerged from the research:

1. **Electricity/Energy:** renewable and traditional Electric Power Generation; Transmission, Distribution and Storage (TDS); and Grid Modernization
2. **Buildings:** including Energy Efficiency, Electrification, and Building Appliances
3. **Transportation:** including Alternative Vehicles, Infrastructure for Alternative Vehicles, and Mass Transit

Three additional sectors— namely, **Industry**, **Working Lands** and **Water**— emerged in the research but were less consistently defined. Other sectors include **Option Creation, District Heating**, and **Hydrogen.**

Occupational Categorization

Most studies do not use occupational categories consistently to study employment impacts in the energy economy (see Table 21)**.** Studies either categorized occupations using activity progression for project life cycles, i.e., value chain (namely Construction, Installation, Utilities, Agriculture and Forestry, Manufacturing, Trade, Professional Services and Operations and Maintenance), or work settings (i.e., Blue Collar, White Collar, Professional and Managerial). Some reports delineate employment impacts by value chain but rarely provide definitions. While some studies defined and grouped similar occupations together by major Standard Occupation Classification (SOC) codes to come up with occupational categories, others differentiated workers by skill specialization while others used SOC codes to identify the affected energy economy jobs. The research team adopted the latter approach to identify priority occupations that will be most affected by the energy transition.

Modeling Approaches

Different models are used for different purposes in reviewed studies. Previous research on estimating the employment impacts of transitioning to a low-carbon economy has typically utilized one of the four following modelling approaches:

1. **General IMPLAN**
   This approach is built around the proprietary input-output (I/O) modeling software package developed initially by the University of Minnesota and now operated by the IMPLAN group. It uses a variety of economic datasets—with information that includes employment, employee compensation, industry expenditures, commodity demands, relationships between industries, and other relevant data—to generate expected employment and economic impacts. The following studies used General IMPLAN:
   - *2035 The Report*
   - *The Economic Impacts of California's Major Climate Programs on the San Joaquin Valley*
   - *California Building Decarbonization: Workforce Needs and Recommendations* (for all sectors except Electricity)

2. **Custom IMPLAN**
   This approach uses IMPLAN; however, it modifies and customizes some of the inputs and assumptions that go into the I/O model. The Custom IMPLAN approach uses existing data to modify inputs for Analysis-by-Parts IMPLAN modeling and some multipliers in IMPLAN for both direct and indirect job counts. Specifically, the custom IMPLAN model adjusts the allocations by supply chain and multipliers based on data on overall cost—including the labor costs associated with each category—and existing supply chain data to determine the percentage of domestic and in-State content. The following studies used Custom IMPLAN:
   - *Putting California on the High Road*
   - *America's Zero Carbon Action Plan*

3. **Proprietary Model**
   While this approach is also generally built around I/O economic models, it uses models that were developed specifically to estimate employment and/or economic activity in energy industries and/or the

broader economy. Instead of using IMPLAN, researchers have developed their own internal models; for example, JEDI models were developed and supported by NREL, and they are the proprietary model most often used for estimating the economic impacts of constructing and operating power plants, fuel production facilities, and related energy projects. The following studies employed proprietary models:

- *Employment Impacts of the Clean Power Plan*
- *A Road Map to Decarbonization in the Midcontinent*
- *Advancing Equity in California Climate Policy*

4. **Investment Multipliers**

This approach is based on estimating the impact of how a dollar spent or invested in each sector, or technology, will generate an employment multiplier effect. Researchers used this approach to estimate the relationship between investment and corresponding employment impact by sector or related technology. The following studies used investment multipliers:

- *Build Back Better, Faster*
- *Reversing Inequality, Combatting Climate Change*
- *The Economic Impacts of California's Major Climate Programs on the San Joaquin Valley*

Proprietary models are most often used for estimating the economic impacts of constructing and operating power plants, fuel production facilities, and related energy projects while investment multiplier models are used to estimate the relationship between investment and corresponding employment impact by sector or related technology. See Table 22 for detailed breakdown on the modelling approaches utilized in different studies.

Transition Scenarios

Transition scenarios examine the impact of decarbonization at a sectoral level, not the entire economy**.** The primary sectors are energy, transportation, and buildings. The use of occupations and industries for modeled transition scenarios are much more inconsistent.

Detailed write-ups of studies with a national focus can be found under Appendix E. Review of Comparable Research: Detailed. The following sub-sections summarize the modeling specific to Chicago and the Midcontinent region and were particularly relevant to this study because of their geographic focus.

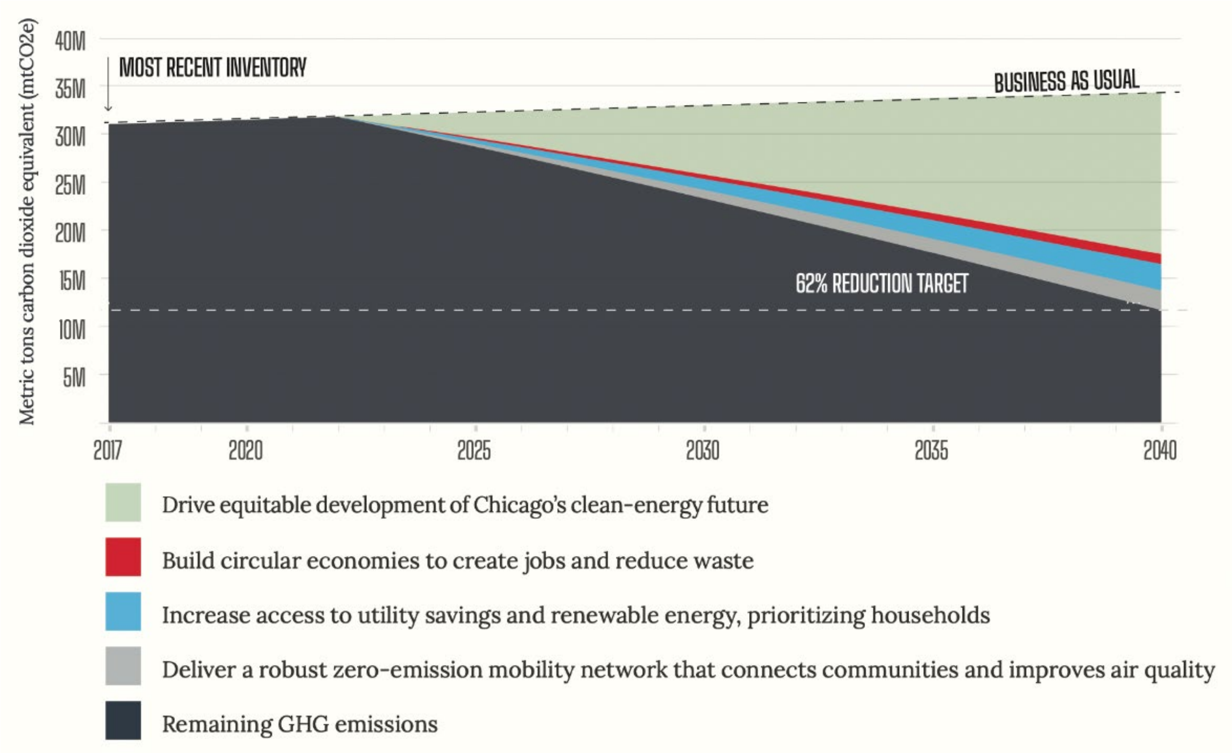
The 2022 Chicago Climate Action Plan

The City of Chicago: Office of the Mayor published an action plan with the goal of a 62 percent greenhouse gas emissions reduction by 2040. To meet this goal, the climate action plan uses 2017 as a baseline to chart a single GHG emissions reduction pathway which centers the following five pillars:

1. Drive equitable development of Chicago's clean energy future
2. Build circular economies to create jobs and reduce waste
3. Increase access to utility savings and renewable energy, prioritizing households
4. Deliver a robust zero-emission mobility network that connects communities and improves air quality
5. Strengthen communities and protect health

Pillars are broken down into strategies, and strategies are broken down into actions. The actions for each strategy are specific and measurable. For example, one action for the strategy "retrofit buildings" under the pillar "increase access to utility savings and renewable energy, prioritizing households" is "retrofit 20 percent of total 5+ unit residential buildings by 2030".

Figure 1. Greenhouse Gas Inventory Summary (2021-2040)[12]



A Road Map to Decarbonization in the Midcontinent

The Great Plains Institute's *A Road Map to Decarbonization in the Midcontinent* explores decarbonization within three sectors: electricity, buildings, and transportation.

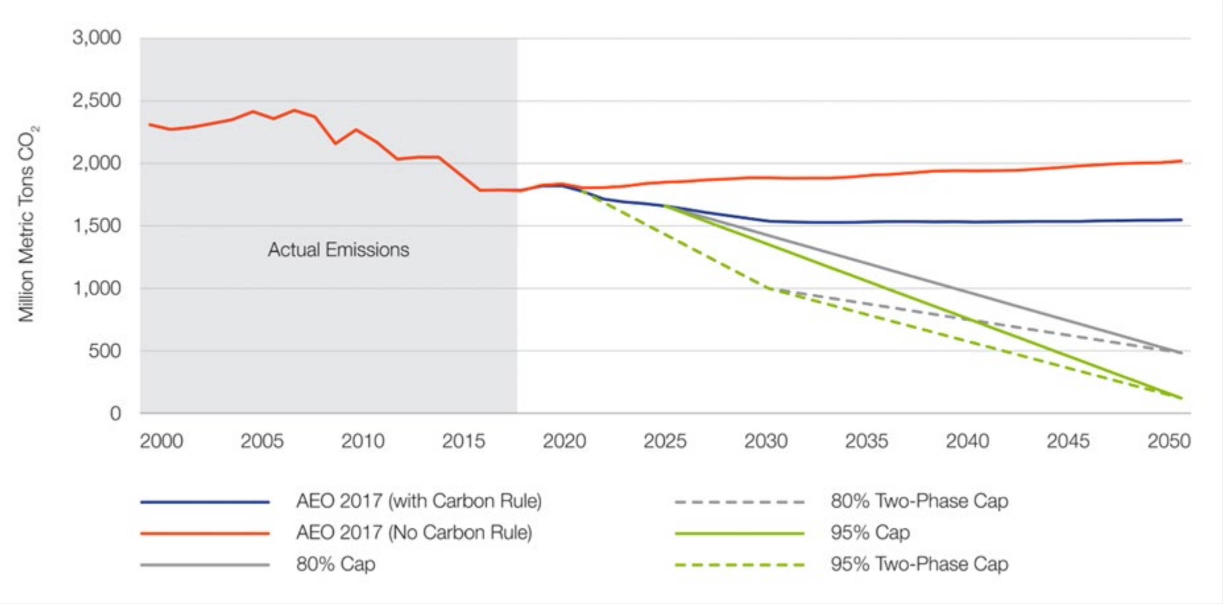
Electricity

The electricity report uses 2005 as a baseline and imposes carbon constraints on the electricity sector to find low-cost pathways to decarbonization in the midcontinent. The two main scenarios considered in the report are a cap beginning in 2025 and decreasing on a linear path to 80 percent below 2005 levels in 2050, and a cap beginning in 2025 and decreasing on a linear path to 95 percent below 2005 levels in 2050. Two additional scenarios are also modeled: a two-stage cap requiring a decrease to 60 percent below 2005 levels by 2030, then decreasing on a linear path to 80 percent below 2005 levels in 2050, and a two-stage cap requiring a decrease to 60 percent below 2005 levels by 2030, then decreasing on a linear path to 95 percent below 2005 levels in 2050.

For the one-cap scenarios, emissions reductions are inexpensive through 2030 and then increase in cost until 2050. The pathway aiming to reduce emissions to 95 percent below 2005 levels in 2050 is more expensive than the pathway reducing emissions to 80 percent below 2005 levels in 2050. This cost barrier, along with technological limitations like a greater need for renewable energy and natural gas with carbon capture, make reaching 95 percent decarbonization more challenging.

[12] City of Chicago: Office of the Mayor. 2022 Chicago Climate Action Plan.

Figure 2. Modeled Cap Scenarios with Historical Emissions and Federal Projections[13]



Buildings

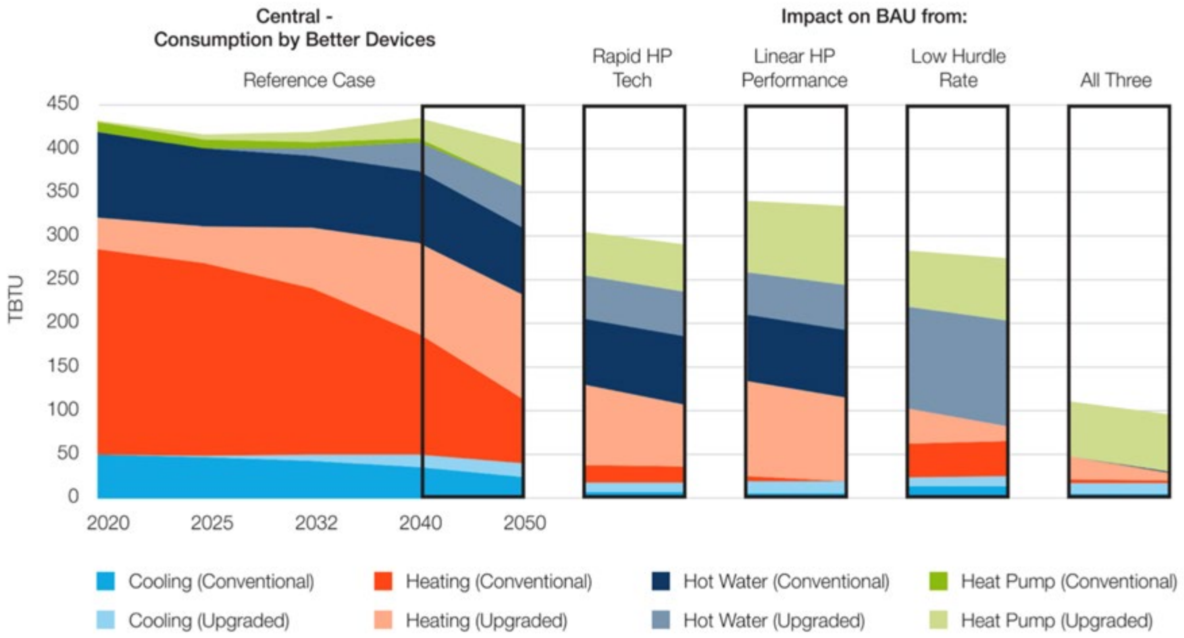
The direct emissions created by the commercial and residential Buildings sector in the U.S are attributed mainly to space and water heating. The buildings report finds that heat pump adoption is a crucial step in reducing emissions created by buildings in the midcontinent.

The report models five scenarios for heat pump adoption and energy consumption between 2020 and 2050. The first scenario is business-as-usual, meaning modest advancement in heat pump technology, backup heat required when temperatures fall below 10 degrees Fahrenheit, and a 20 percent hurdle rate. The second is rapid advancement in heat pump technology. The third scenario is advancement in linear heat pump performance to negative 20 degrees Fahrenheit. The fourth is reduced hurdle rate from 20 percent to 7.5 percent.[14] The fifth scenario modeled the previous three scenarios simultaneously, meaning rapid heat pump technology, increased linear heat pump performance, and a reduced hurdle rate from 20 percent to 7.5 percent.

Figure 3 displays projected energy consumption between 2020 and 2050 for the central part of the midcontinent region across the five scenarios listed above. This region includes much of Illinois, but specifically excludes the northern part of the state. While each individual improvement in heat pump technology, performance, and hurdle rate results in decreased energy consumption between 2020 and 2050, the scenario including all three simultaneously results in the largest reduction in energy consumption for the region.

[13] The Great Plains Institute. A Road Map to Decarbonization in the Midcontinent: Electricity Sector. July 2018.
[14] The hurdle rate is used as a proxy for efforts to reduce hurdles to adopting initiatives and technology which reduce carbon emissions. A 20 percent hurdle rate reflects the current conditions for heat pump adoption while the 7.5 percent hurdle rate reflects conditions if policies are implemented to reduce the barriers to heat pump adoption, such as financial incentives or consumer education.

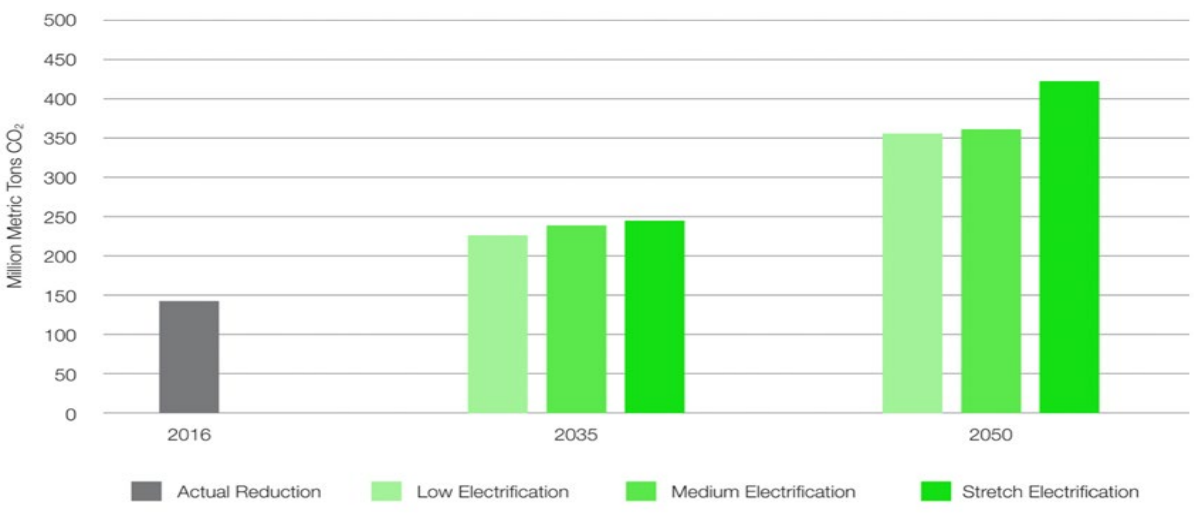
Figure 3. Energy Consumption by End Use and Device Efficiency in Central Part of Region[15]



Transportation

The transportation report uses 2005 as a baseline to explore three scenarios for emissions reductions in the Transportation sector: low electrification, medium electrification, and stretch electrification. Under all three scenarios, emissions in the midcontinent region are expected to decrease in 2035 and 2050.

Figure 4.Millions of Metric Tons Reduced in Electricity and Transportation from 2005 Baseline[16]



[15] The Great Plains Institute. A Road Map to Decarbonization in the Midcontinent: Buildings. February 2021.
[16] The Great Plains Institute. A Road Map to Decarbonization in the Midcontinent: Transportation Electrification. January 2019.

Workforce Implications

Overall, the literature revealed a focus on overall employment as the unit of measurement for job creation. Not much granularity about the types and quality of jobs emerged. While most discussions of potential employment impacts did not feature changes in job type or quality, some comparable studies explored current and future job changes by occupation and reported on labor standards and unionization.

It is also worth noting that the research team for this study did not follow the same methodology as the Energy Infrastructure Modernization Act (EIMA) jobs study because of the differences in project scope. The EIMA jobs study looks at impacts from a specific ComEd smart grid and grid modernization program on ComEd and ComEd contractor employment. This study looks at energy-wide employment impacts of policies and goals across sectors (Electricity, Fuels, Buildings, Transportation) from 2025 to 2050.

Job Creation

The United States Energy Employment Report[17] (USEER) provides both national and statewide measures of employment in energy and energy-related industries and technologies. USEER provides a valuable starting point for understanding the size of energy-related employment across the nation or within a given state. For this study, baseline employment numbers for 2021 were derived from the USEER 2022 report and dataset.

As of 2021, USEER estimates total energy industry jobs in the United States at approximately 7.4M and approximately 2.7M of those workers are in clean energy sectors (Table 1). In Illinois, energy efficiency workers make up the largest percentage of energy workers and with the passage of the Climate and Equitable Jobs Act (CEJA), investments are meant to expand these jobs and others in renewable energy industries and sectors.

Table 1. United States Energy & Employment Report: 2021 Energy Job Estimates

	Electric Power Generation	Fuels	Transmission, Distribution & Storage	Motor Vehicles	Energy Efficiency
Total	857,579	908,422	1.20M	2.44M	2.16M
Clean Energy	568,277	107,586	146,410	339,291	2.16M

An Analysis of Decarbonization Methods in Vermont reports labor demand outputs instead of employment estimates. The study finds that carbon pricing policies that decrease outputs relative to business as usual (BAU) will decrease labor demand, and policies that increase relative output—i.e., revenue used for cuts in other taxes or reductions in electricity rates— will increase labor demand.

The *Employment Impacts of the Clean Power Plan* report found that the Clean Power Plan would create a net increase of the total annual employment by approximately 74,000 jobs in 2020 and 196,000 by 2025. By 2040, this figure would be 273,000 jobs.

Net-Zero America reports net economy-wide employment changes for each of their scenarios. Their high electrification scenario predicts the following changes: 0.6M jobs in the 2020s, 1.4M jobs in the 2030s and 2.2M jobs in the 2040s.

For full details on job creation estimates, see Table 23- Table 25 in Appendix Review of Comparable Research: Tables.

[17] https://www.energy.gov/policy/us-energy-employment-jobs-report-useer

Job Quality, Labor Standards and Unionization

The literature review revealed an overall rise in wages and benefits available to workers in a transitioning economy; the rise is despite the current high wages and unionization rates in some fossil fuel activities. The *Reversing Inequality, Combatting Climate Change: A Climate Jobs Program for New York State* report indicates that most of utility-scale solar construction organized under collectively bargained contracts or project labor agreements in California resulted in jobs with higher wages and better benefits. *Net-Zero America* finds that their high electrification scenarios resulted in faster overall wage growth compared to the Reference scenario. *The Climate and Community Act: A Big Win for New York State on Jobs and the Economy* reports that workers involved in renewables and energy efficiency—delineated by those with and without a college degree, and those in direct and indirect jobs—receive high wages overall.

Most studies indicate that increased unionization within the energy industry will support a rise in job quality. The energy industry already has higher unionization rates than other industries; except for Fuels, all sectors have overall unionization rates higher than the national average of six percent (refer to Table 9). The Energy Policy Solutions Simulator projects that unionized workers will make up a large percentage of workers in the jobs needed to achieve net-zero emissions by 2050. *Reversing Inequality, Combatting Climate Change: A Climate Jobs Program for New York State* indicates jobs created through transportation investments will be forty percent more likely to be unionized compared to other industries.

Equitable Transitions

There is ample qualitative consideration of the impact of transitioning on under-resourced communities; however, none of the studies quantitively modeled transition impacts in specific communities. The literature, in addition to racially and ethnically under-resourced communities, considered fossil-fuel workers who will be most affected by the transition away from carbon-intensive economies. Studies suggested a range of policies focused on workforce training and job creation opportunities as methods to facilitate an equitable transition.

In *A Comparative Review of National and Regional Just Transition Initiatives*, the research team notes different pathways available within an equitable transition approach: distributional (how different groups stand to benefit or be impacted by changes), recognitional (identifying groups of interest) and procedural (who is included in governance and how). The literature discussed job, environmental and societal interpretations to the above pathways; these three have implications in where governments focus their decision-making around policy support and investments. The studies identified below employ all three interpretations; however, the "job-focused" lens tends to take precedence as studies advocate for workers primarily impacted by climate goals and policies.

In *Workers and Communities in Transition: Report of the Just Transition Listening Project*, participants identified the need to support job creation for fossil-fuel workers and building tradespersons. The National Climate Jobs campaign's Illinois work was highlighted to demonstrate the optimism for the opportunity to create union jobs through renewable energy developments. Participants also identified the importance of trust building between different stakeholders and the importance of coalitions with different lenses in the effort to ensure equitable transition away from carbon-intensive economies.

Putting California on the High Road offers a high road framework to aid California's decision makers in prioritizing job quality, job access, and job growth throughout the transition to a carbon-neutral economy. The study argues that demand-side labor market strategies must be used in conjunction with supply-side strategies to aid in the equitable transition.

The *Advancing Equity in California Climate Policy* report presents a Climate Policy Equity Framework as a new social contract that promotes environmental justice, economic equity, and public accountability in policy design and evaluation. The study advocates for pre-apprenticeship job training, weatherization assistance, and solar energy deployment to close the climate gap and promote career track employment in renewable energy.

Forest Carbon Strategies in Climate Change Mitigation explores scenarios in which climate change mitigation, community development, and biodiversity conservation can be scaled nationally. The study also highlights case studies that demonstrate the feasibility of community forest carbon projects.

America's Zero Carbon Action Plan recommends state- and federal-level support for land repurposing and reclamation in fossil-fuel-dependent communities; the study also recommends new investments in renewable energy projects within those communities. Additionally, recommendations include relocation support for displaced workers, pension and employment guarantees, wage insurance and training support to help fossil fuel workers transition to carbon-neutral economies.

The Economic Impacts of California's Major Climate Programs on the San Joaquin Valley suggests an increase in access to career-track jobs for workers from disadvantaged communities. The study identifies project labor agreements or community workforce agreements to make provisions for target hires as approaches most likely to succeed in supporting this goal.

The *California Building Decarbonization: Workforce Needs and Recommendations* identifies an orderly transition as key to successful equitable transition. The study suggests decision-makers develop a fund to offer transition assistance and retain workers through upskilling and retraining workers. Additionally, the study also recommends making investments to ensure we pursue aggregated community-scale decarbonization.

Conclusions from the Literature Review

The literature review provided the research team a deeper understanding of the information that is available on employment transitions to a clean energy economy as well as some of the strengths and weaknesses of different approaches that have been used to generate those employment impacts. Some of the key lessons that were applied in this study from the literature review include:

1. **The identification and categorization of sectors and sub-sectors used for this study** was based upon what was learned in the literature review. Energy, Buildings, and Transportation were the three universal sectors, that were identified in just about all the comparable studies that were examined. By splitting energy into two sectors, electricity and fuels, we were able to develop a more robust list of sub-sectors.

2. **The decision to use different economic impact models within the same study** was based on what was learned in the literature review around supply chain assessments and the strengths and weaknesses of different models. The literature review gave us a deeper understanding of evolving supply chains in different industries and technologies and the need to continually evaluate which assumptions are most appropriate for each sub-sector and/or technology.

3. **The initial employment outputs and secondary employment output process** was created as a two-step approach, based on some of the challenges comparable studies have shown in providing labor market data that is comparable to current North American Industry Classification System (NAICS) and Standard Occupational Classification (SOC) categories. It is worth noting that the industry and occupational classifications that were used in this study were chosen because they were consistent with traditional labor market classification categories.

Methodology & Forecast Approach

The following section discusses the framework used to model transition scenarios to generate employment outputs.

The two foundations guided the development of the framework for modeling transition scenarios:

1. **Literature review**
   To gain a comprehensive view of existing methods in modeling transition scenarios resulting from different climate change mitigation efforts, the team reviewed comparable research and modeling efforts in the early stages of the project.

2. **The combined experience of the BW Research team**
   The modeling team refined the project methodology based on what they had learned in similar employment modeling efforts for different economies and varying climate change mitigation scenarios.

This Jobs and Equitable Energy Transition study is a first step in understanding how the transition to a low or no carbon future will impact regional and statewide employment. However, it is important to note that the transition modeling in this study does not factor in the entire economy. Instead, the focus of the study is on sectors of the economy that had the most sizeable impact on greenhouse gas emissions and were most directly impacted by strategies to combat climate change.

The research team focuses on two transition scenarios developed for this analysis by the ComEd and E3 teams[18]—the Reference and the Moderate Electrification scenarios. The Reference scenario is a business-as-usual vision of the future that includes existing state and federal policies, that is, CEJA and the Inflation Reduction Act. The Moderate Electrification scenario would achieve the Illinois target of economy-wide net zero GHG emissions by 2050 with aggressive action in all sectors, with high levels of electrification, and with a significant role for hydrogen and gas backup for heating. Employment outputs are generated for both transition scenarios using input-output (I/O) modeling.

The research team uses IMPLAN and the National Renewable Energy Laboratory's (NREL) Jobs and Economic Development Impact (JEDI) model software for this purpose. IMPLAN is used to focus on the overall employment impacts of inputs in Illinois; it is not an energy-specific industry analysis. JEDI tools estimate the local economic impacts of the construction and operation of power generation and biofuel plants.[19] User inputs of project location facility size, and year of construction, are run in combination with the built-in model defaults and economic multipliers. JEDI is used in the Electricity and Fuels sectors as a technical data source to split investments into industries and to generate initial employment outputs for the Land-Based Wind Electricity sub-sector.

Input-output models illustrate the interdependent relationships between different sectors of a region's economy—Illinois, in this case. Investments or activities in a given sector are used as inputs into the model to estimate the ripple or multiplier effect on business, household, and government expenditures and industry employment. This study reports on employment outputs in two ways: the Initial Employment Outputs (IEOs) and the Secondary Employment Outputs (SEOs).

[18] Illinois Decarbonization Study, Energy and Environmental Economics Inc., 2022.

[19] NREL provides JEDI models for various energy sub-sectors, including Land-Based and Offshore Wind, Biomass, and Hydropower.

Initial Employment Output (IEOs)

An initial step in the methodology for this study was to determine the categories that would best reflect the differences between sectors and sub-sectors in modeling the transition scenarios (Table 2). Employment modeling is split into Energy Supply (i.e., Electricity and Fuels sectors) and Energy Demand (i.e., Buildings and Transportation). The four primary sectors— i.e., Electricity, Fuels, Buildings and Transportation) are further split into 26 sub-sectors. The study reports on overall sector IEOs in addition to sub-sector outputs that delineate employment according to activities, i.e., industries. The industries found in each sub-sector are Construction, Professional Services, Manufacturing, Other Supply Chain, and Induced.

The sectors chosen from this study, Electricity, Fuels, Buildings and Transportation are responsible for a sizeable majority of Illinois's greenhouse gas emissions and are largely consistent with the universal sectors that were identified in the literature review. The industries found in each sub-sector were chosen to be consistent with labor market data categorized by the 2-digit NAICS (North American Industry Classification System) as well as separate out the induced employment impacts.

Table 2. Categorization of Sectors and Sub-Sectors

Category	Sector	Sub-Sector
Energy Supply	Electricity	Solar
		Land-Based Wind
		Hydrogen
		Distribution
		Transmission
		Storage
		Hydropower
		Biomass
		Nuclear
		Other Fossil Generation
		Natural Gas Generation
	Fuels	Hydrogen
		Bioenergy
		Natural Gas
		Natural Gas Distribution
		Petroleum
Energy Demand	Buildings	Residential HVAC
		Residential Shell
		Residential Other
		Commercial HVAC
		Commercial Other

	Transportation	Wholesale Trade Parts
		Charging Stations
		Vehicle Manufacturing
		Vehicle Maintenance
		Conventional Fueling Stations

The methodological approach to generating Initial Employment Outputs (IEOs) in both transition scenarios is generally the same across the four primary sectors— i.e., Electricity, Fuels, Buildings and Transportation. While the assumptions made within specific sub-sectors vary due to the nature of the different activities, the general structure remains consistent.[20]

The IEO methodology follows six steps:

1. **The research team determines the unit inputs for the model.** Unit inputs— i.e., device stocks and sales, electric capacity (in MW), and fuel demand— typically come from the E3 PATHWAYS and RESOLVE model outputs.
2. **The research team determines the unit and total investments**. Investment inputs come from the E3 PATHWAYS and RESOLVE model outputs where provided, and any additional investments are assumed from secondary sources.
3. **The research team then processes the investment data** to reduce inter-annual variation as needed.
4. **The research team allocates the input data into the relevant industry categories** based on the activities associated with the investments by using technical cost data from secondary sources.
5. **The research team then applies IMPLAN/JEDI industry employment multipliers** based on the allocation described in step 4 to calculate employment outputs.
6. **Employment outputs are reported by industry activities, termed industries in this study.** IEOs are reported across the following industry categories: Construction, Professional Services, Manufacturing, Other Supply Chain, and Induced.[21]

Secondary Employment Outputs (SEOs)

Direct and indirect employment figures generated under the Initial Employment Outputs (IEOs) are used as input data to generate Secondary Employment Outputs (SEOs) in 2021 and 2030 in both the Reference and the Moderate Electrification transition scenarios. While the Initial Employment Outputs (IEOs) provide estimates of the changes in job quantity in five-year increments for both transition scenarios, the Secondary Employment Outputs (SEOs) offer insights into the occupational changes which occur in growing and displaced sub-sectors. Both primary (2021 Illinois USEER employment) and secondary (IMPLAN, BLS OEWS, etc.) data sources are used in modelling the SEOs.

An initial step was to determine the best categorization of occupations to reflect the differences in the transition models for the Secondary Employment Outputs (Table 3). Occupational categories are defined according to the Bureau of Labor Statistics (BLS) Standard Occupational Classification (SOC) codes. Occupations are delineated into the following categories:

[20] Refer to Appendix B. Model Inputs & Data Sources for detailed modelling assumptions.

[21] The 2021 baseline employment is derived from the 2021 U.S. Energy and Employment Report (USEER) unless otherwise stated.

1. Production/Manufacturing
2. Installation/Repair
3. Administrative
4. Management/Professional
5. Sales
6. Other

Table 3. Categorization of Occupations

Occupational Category	Occupations
Administrative	Office and Administrative Support Occupations
Installation or Repair	Building and Grounds Cleaning and Maintenance Occupations
	Construction and Extraction Occupations
	Installation, Maintenance, and Repair Occupations
Management/Professional	Management Occupations
	Business and Financial Operations Occupations
	Computer and Mathematical Occupations
	Architecture and Engineering Occupations
	Life, Physical, and Social Science Occupations
	Legal Occupations
Production/Manufacturing	Production Occupations
Sales	Sales and Related Occupations
Other	Community and Social Service Occupations
	Educational Instruction and Library Occupations
	Arts, Design, Entertainment, Sports, and Media Occupations
	Healthcare Practitioners and Technical Occupations
	Healthcare Support Occupations
	Protective Service Occupations
	Food Preparation and Serving Related Occupations
	Personal Care and Service Occupations
	Farming, Fishing, and Forestry Occupations
	Transportation and Material Moving Occupations

The methodology for converting IEO data to SEO outputs includes the following steps:

1. **Complete an IMPLAN to NAICS crosswalk**. IMPLAN industry categories are converted to 6-digit codes that fall under the North American Industry Classification System (NAICS). For each of the 26 sub-sectors, crosswalks are completed by the outlined industry categories.
2. **Run 2021 staffing patterns in Illinois for each occupation within each sub-sector**. Staffing patterns determine the highest employment numbers in each NAICS code and delineate them by 6-digit SOC codes. 2021 staffing patterns are then used to augment staffing patterns for 2030. Occupations are then aggregated into the occupational categories shown in Table 3.
3. **Model SEOs from finalized staffing patterns and proportional employment for each transition scenario**. Outputs show employment growth and displacement— with specific industry and occupational profiles— at the sectoral level for both transition scenarios.

Workforce Implications

The team also performed additional regional and job quality analyses for both the Reference and Moderate Electrification Transition scenarios.

1. The **Regional Analysis** considers the employment impacts across three Illinois regions: Chicago, the remaining ComEd Service Areas, and the rest of Illinois. Adding outputs from all three regions gives the overall output for Illinois.
2. The **Job Quality (Wage) Analysis** considers the employment impacts across three wage categories— Tier 1 (highest pay), Tier 2 (moderate pay) and Tier 3 (lowest pay). Jobs in 2021 and 2030 are split into these wage categories and compared against each other. Occupational categories are used to report on expected employment changes.

Regional Analysis

The regional analysis estimates employment figures based on 2021 regional-level data defined by county as shown below (Table 4):

Table 4. Regional Analysis Definitions

Chicago	Employment figures for Chicago are estimated based on industry-level comparisons to employment in Illinois; the E3 RESOLVE analysis does not provide this level of geographic detail. The IMPLAN multipliers used to estimate employment effects across the Chicago economy are the ones for Cook County.
ComEd Service Areas	The ComEd Service Area was defined using data from the ComEd team, to determine the counties where the effects of the mitigation strategies take place. Employment figures for this region are estimated based on industry-level comparisons to employment in Illinois. The IMPLAN multipliers used to estimate employment effects in the ComEd Service Area, are the ones for the combined region created from the list of counties within the ComEd Service Area.
Illinois	The Illinois region follows the industry employment proportions from the 2022 USEER and uses statewide multipliers from IMPLAN. The region considers all the territory of the state of Illinois that is not included in the definitions of Chicago or the rest of the ComEd service areas.

Wages

The analysis of job quality based on three wage categories or tiers provides outputs, in 2021 dollars, of employment within each wage tier (Table 5). Living wage data from the Massachusetts Institute of Technology (MIT) Living Wage Calculator are used to define three wage categories based on 2 adults (1 working) with 1 child in the state of Illinois.[22]

Table 5. Wage Tier Categorizations[23]

Tier 1 (highest paying jobs)	Above sustainable wage	Over $37/hour
Tier 2 (moderate paying jobs)	Sustainable wage	$27 - $37 per hour
Tier 3 (lowest paying jobs)	Below sustainable wage	Less than $27/hour

[22] The outlined living wage for this assumption is $32.72 per hour in Illinois.

[23] Since the technical documentation included with the MIT Living Wage Calculator data advises against reporting specific wage data at the state level, the research team devised a margin around the $32.72 figure to allow for differences in living conditions and costs.

Initial Employment Outputs (2021-2050)

The following section is a discussion of the inputs and Initial Employment Outputs (IEOs) generated up to 2050, using 2021 as the baseline. Employment outputs are reported in five-year increments for sectors and sub-sectors for the period of analysis.

A discussion of overall IEOs, highlighting the growth and displacement in both transition scenarios, is followed by sector- and sub-sector- specific inputs and outputs for both the Reference and Moderate Electrification transition scenarios.

Key Findings

Table 6 shows the expected growth and displacement across sub-sectors through 2050. Electricity sub-sectors largely experience growth or remain neutral. Fuels sub-sector outcomes are variable across scenarios. Buildings sub-sectors largely experience growth whereas Transportation sub-sectors are nearly equally likely to grow or be displaced.

Table 6. Growth & Displacement (2021-2050) – Combined Reference & Moderate Electrification

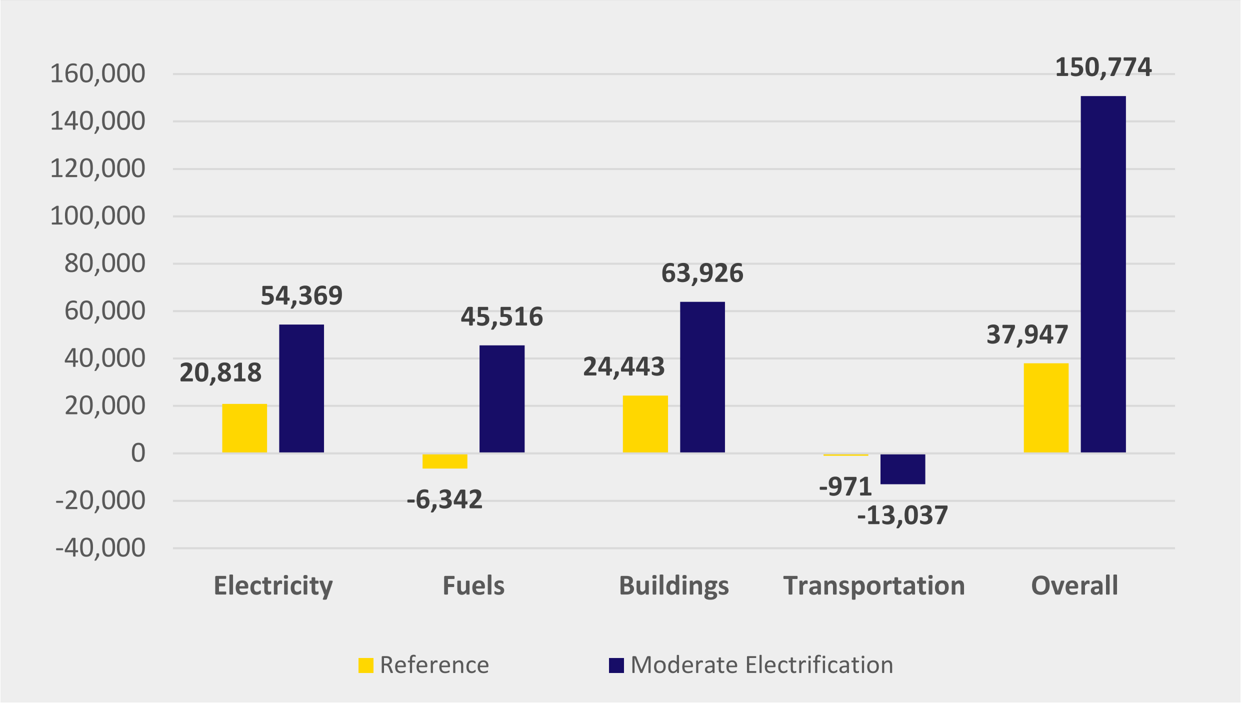
Sector	Sub-Sector	Growth or Displaced
Electricity	Solar	Growth
	Land-Based Wind	Growth
	Hydrogen	Growth
	Distribution	Growth
	Transmission	Growth
	Storage	Growth
	Hydropower	Neutral
	Biomass	Neutral
	Nuclear	Neutral
	Other Fossil Generation	Displaced
	Natural Gas Generation	Displaced
Fuels	Hydrogen	Growth
	Bioenergy	Varies Across Scenarios
	Natural Gas	Varies Across Scenarios
	Natural Gas Distribution	Varies Across Scenarios
	Petroleum	Displaced
Buildings	Residential HVAC	Growth

	Residential Shell	Growth
	Residential Other	Growth
	Commercial HVAC	Growth
	Commercial Other	Displaced
Transportation	Wholesale Trade Parts	Growth
	Charging Stations	Growth
	Vehicle Manufacturing	Displaced
	Vehicle Maintenance	Displaced
	Conventional Fueling Stations	Displaced

Overall

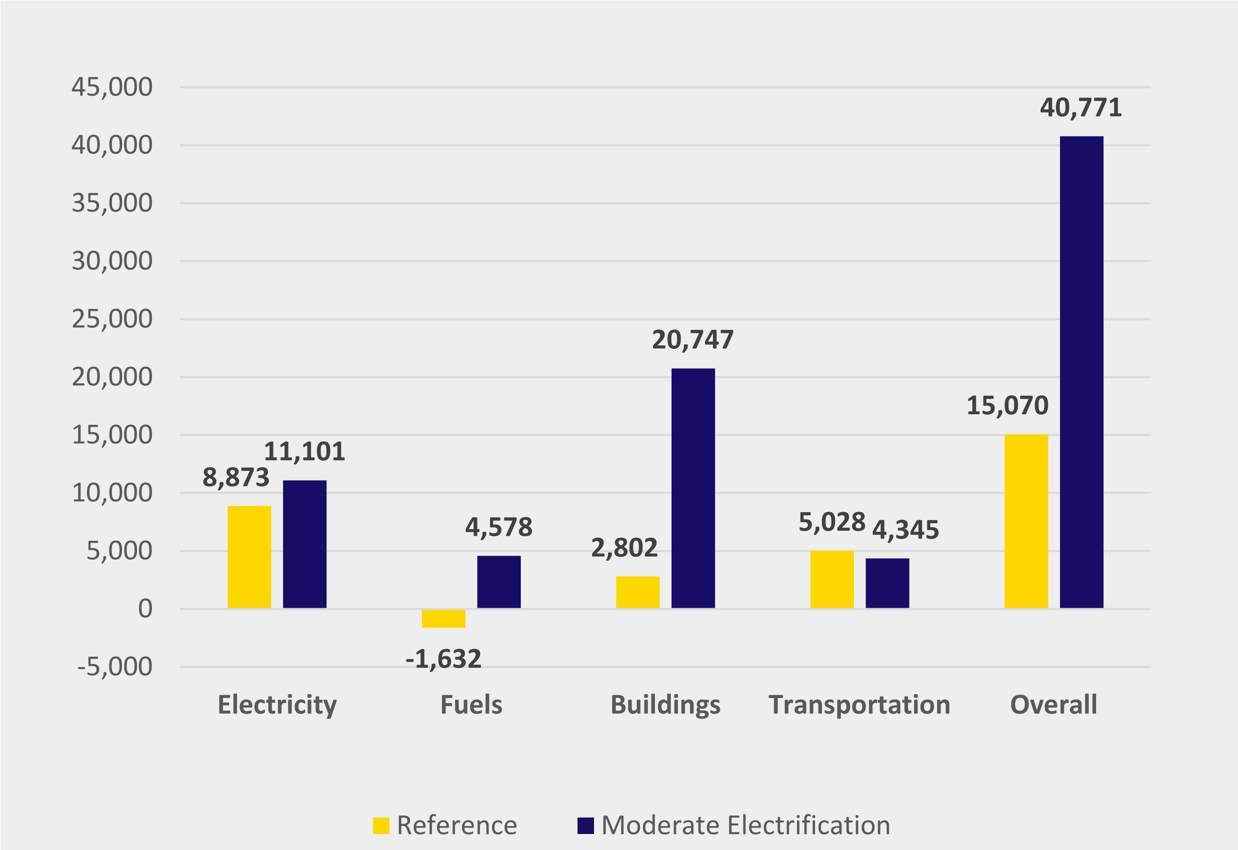
Overall, the Moderate Electrification scenario leads to higher net growth compared to the Reference scenario in 2050 (Figure 5)**.** There will be 150,700 net growth under Moderate Electrification and 37,900 net growth under the Reference scenario by 2050. Net employment changes in the Electricity sector are positive in both the Moderate Electrification (54,300 jobs) and Reference (20,800 jobs) scenarios. The net employment change for the Fuels sector is negative in the Reference scenario (-6,300 jobs) and positive under Moderate Electrification (45,500 jobs). Net employment changes in the Buildings sector are positive in both the Moderate Electrification (63,900 jobs) and Reference (24,400 jobs) scenarios. Net employment changes in the Transportation sector are negative in both the Moderate Electrification (-13,000 jobs) and Reference (-900 jobs) scenarios.

Figure 5. Net Employment Changes (2021– 2050) – Reference vs. Moderate Electrification



Overall, the Moderate Electrification scenario leads to higher net growth compared to the Reference scenario in 2030 (Figure 6). On net, the Moderate Electrification and Reference scenarios respectively grow by 40,700 and 15,000 jobs. Net employment changes in the Electricity sector are positive in both the Moderate Electrification (11,100 jobs) and Reference (8,800 jobs) scenarios. The net employment change for the Fuels sector is negative in the Reference scenario (-1,600 jobs) and positive under Moderate Electrification (4,500 jobs). Net employment changes in the Buildings sector are positive in both the Moderate Electrification (20,700 jobs) and Reference (2,800 jobs) scenarios. Net employment changes in the Transportation sector are positive under Moderate Electrification (5,000 jobs) and the Reference scenario (4,300 jobs).

Figure 6. Net Employment Changes (2021– 2030) – Reference vs. Moderate Electrification



Buildings jobs under Moderate Electrification experience the most growth in 2030 whereas Transportation jobs under Moderate Electrification experience the most displacement (see Figure 7 and Figure 8). Under the Reference scenario, 14,900 jobs are added to the Electricity sector and 6,100 jobs are displaced in 2030. In the Moderate Electrification scenario, 15,900 jobs are gained in the Electricity sector and 6,100 jobs are displaced. Under the Reference scenario for the Fuels sector, 2,300 jobs are added, and 3,900 jobs are displaced which leads to a net negative change (-1,600 jobs). In the Moderate Electrification scenario for the Fuels sector, 10,600 jobs are gained in the sector and 6,000 jobs are displaced by 2030. Under the Reference scenario for the Buildings sector, 4,100 jobs are added, and 1,300 jobs are displaced. In the Moderate Electrification scenario for the Buildings sector, 22,700 jobs are gained in the sector and 1,900 jobs are displaced by 2030. The Moderate Electrification scenario in Buildings leads to the highest net positive change across sectors. Under the Reference scenario for the Transportation sector, 10,300 jobs are added, and 5,300 jobs are displaced. In the Moderate Electrification scenario for the Fuels sector, 13,000 jobs are gained in the sector and 8,600 jobs are displaced by 2030.

Figure 7. Sector Growth (2021– 2030) – Reference vs. Moderate Electrification

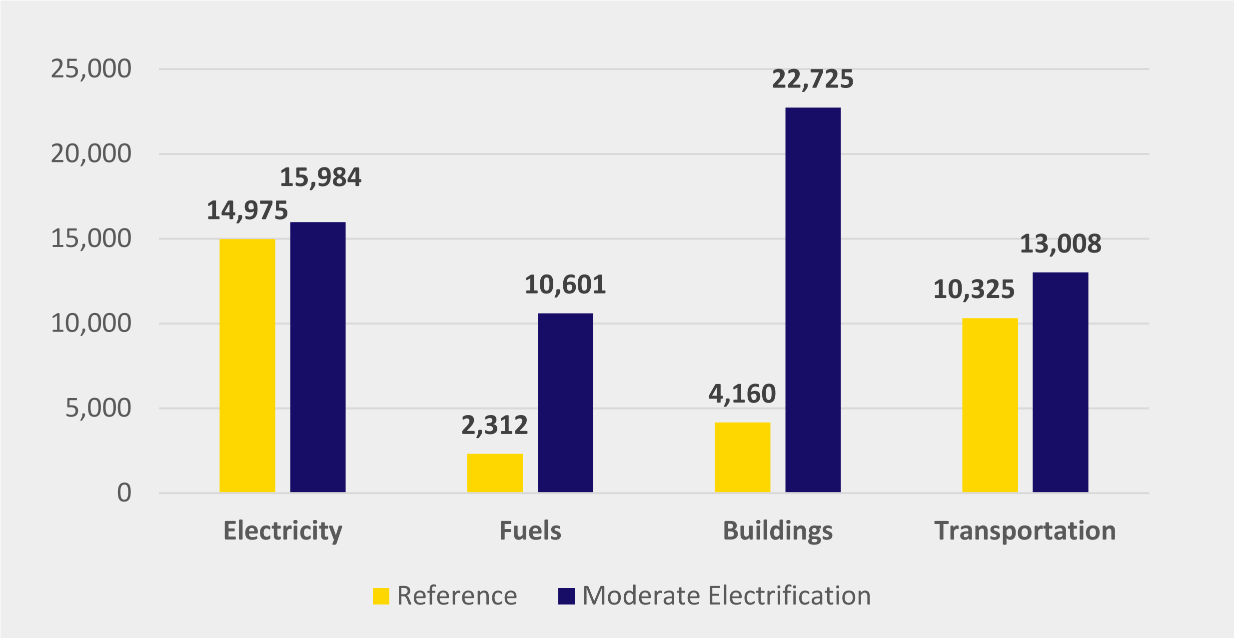
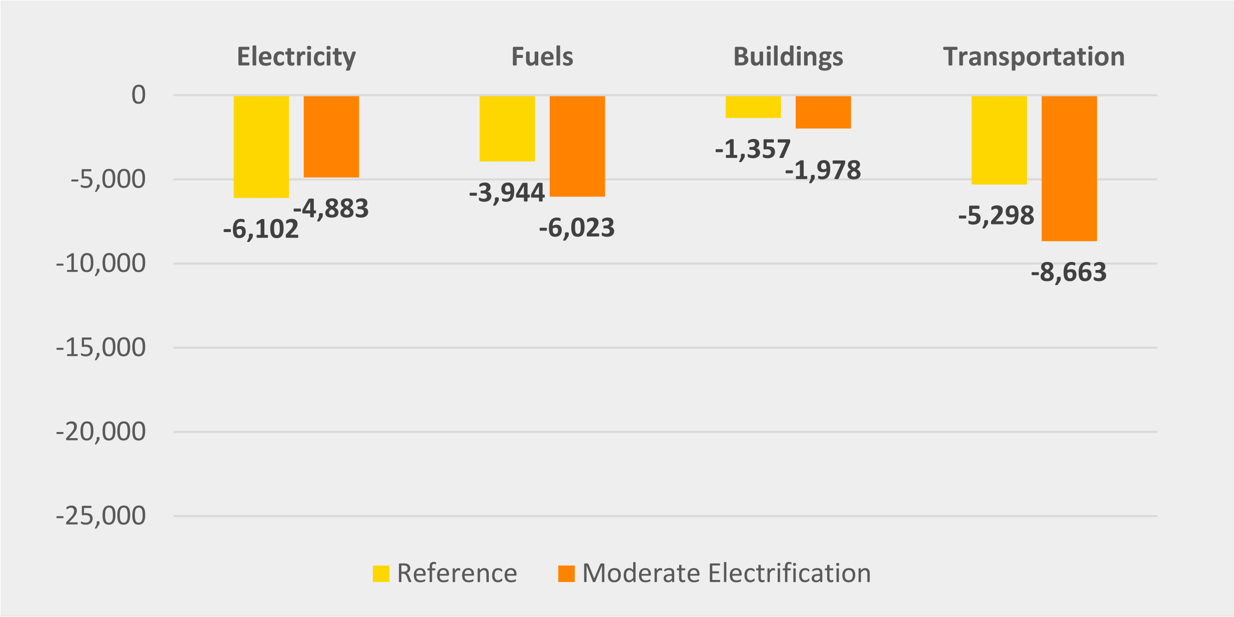


Figure 8. Sector Displacement (2021– 2030) – Reference vs. Moderate Electrification



Fuels jobs experience the highest growth and displacement under the Moderate Electrification scenario by 2050 (see Figure 9 and Figure 10). Under the Reference scenario, 32,100 jobs are added to the Electricity sector and 11,300 jobs are displaced by 2050. In the Moderate Electrification scenario, 65,700 jobs are gained in the Electricity sector and 11,300 jobs are displaced. Under the Reference scenario for the Fuels sector, 2,300 jobs are added, and 3,900 jobs are displaced which leads to a net negative change (-1,600 jobs). In the Moderate Electrification scenario for the Fuels sector, 10,600 jobs are gained in the sector and 6,000 jobs are displaced by 2050. Under the Reference scenario for the Buildings sector, 4,100 jobs are added, and 1,300 jobs are displaced. In the Moderate Electrification scenario for the Buildings sector, 22,700 jobs are gained in the sector and 1,900 jobs are displaced by 2050. The Moderate Electrification scenario in Buildings leads to the highest net positive change across sectors. Under the Reference scenario for the Transportation sector, 10,300 jobs are added, and 5,300 jobs are displaced. In the Moderate Electrification scenario for the Fuels sector, 13,000 jobs are gained in the sector and 8,600 jobs are displaced by 2050.

Figure 9. Sector Growth (2021– 2050) – Reference vs. Moderate Electrification

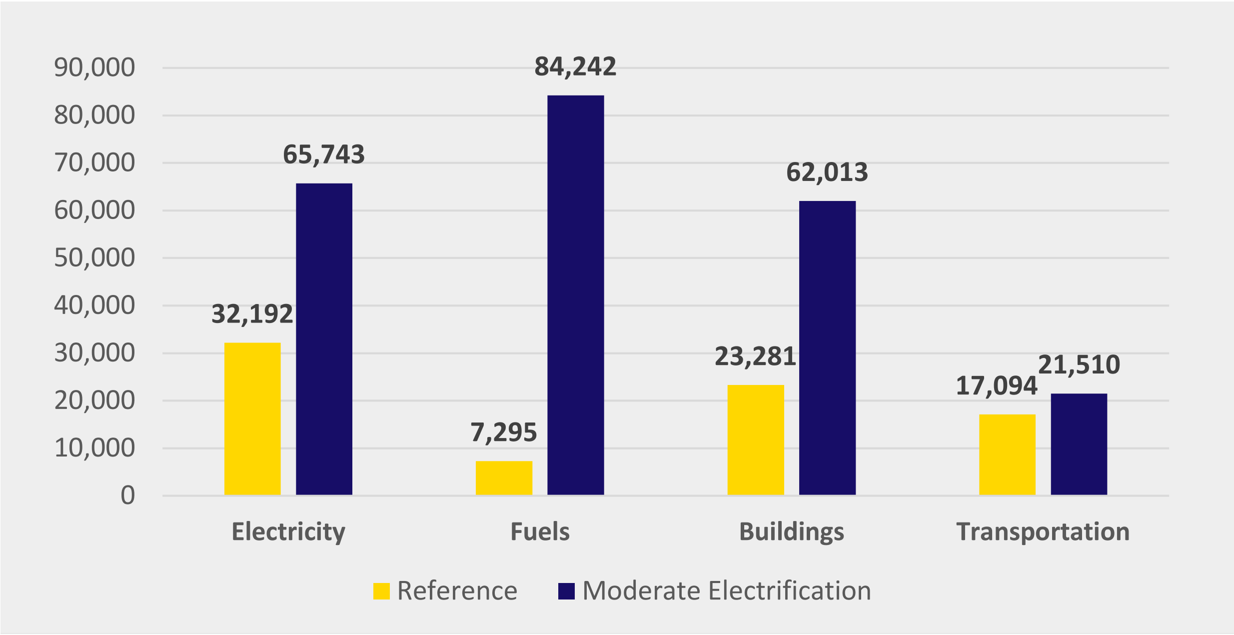
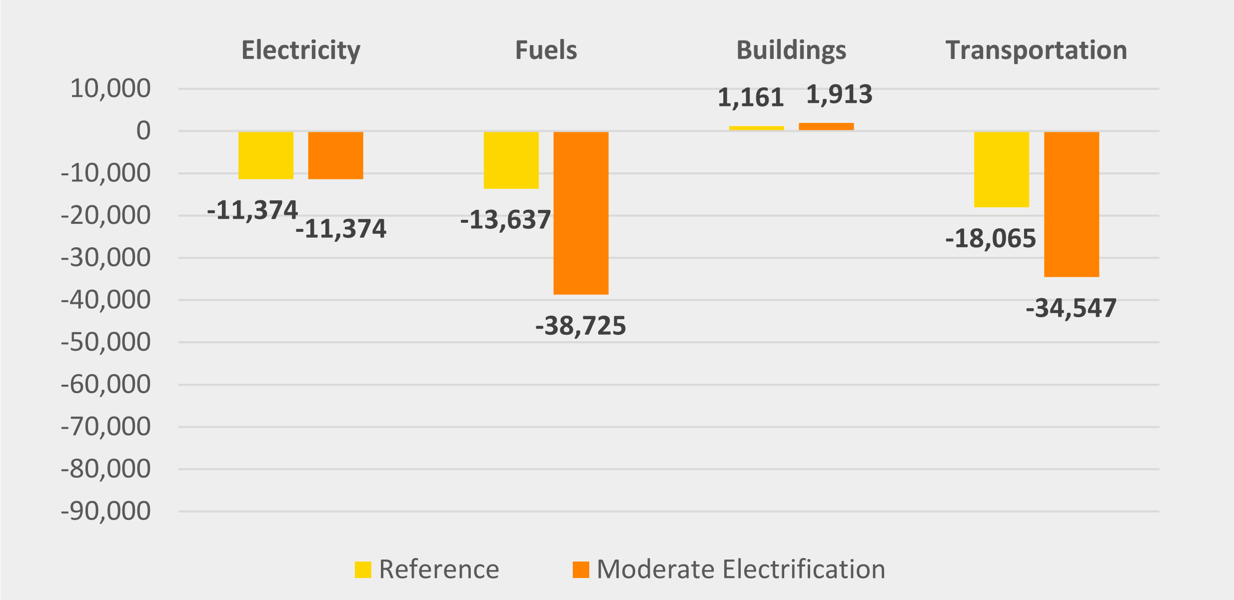


Figure 10. Sector Displacement (2021– 2050) – Reference vs. Moderate Electrification



Electricity

The Electricity sector is composed of eleven sub-sectors: Solar, Land-Based Wind, Hydropower, Hydrogen, Biomass, Distribution, Transmission, Storage, Natural Gas Generation, Other Fossil Generation and Nuclear. In 2021, Electricity was responsible for 25.1 percent of total GHG emissions in Illinois.[24] The Offshore Wind sub-sector, which is responsible for electric generation in some states, is not included in this analysis since Illinois has no Offshore Wind generation, and investment inputs did not project any future investments into this sub-sector.[25]

Over half of the Electricity sub-sectors experience growth between 2021 and 2050 in the Reference and Moderate Electrification scenarios. Solar, Land-Based Wind, Hydrogen, Distribution, Transmission, and Storage are sub-sectors that will experience growth. Other Fossil Generation and Natural Gas Generation are the two sub-sectors that will experience displaced jobs. Hydropower, Biomass and Nuclear sub-sectors will remain neutral.

By 2030, the Electricity sector is set to experience a net increase of 8,873 jobs in the Reference scenario, and a net increase of 11,101 jobs in the Moderate Electrification scenario (see Table 7 and Table 8). By 2050, the Electricity sector will experience a net increase of 20,818 jobs in the Reference scenario, and a net increase of 54,369 jobs in the Moderate Electrification scenario. Solar, Land-Based Wind, Hydrogen, Distribution, Transmission, and Storage will grow to 88,900 jobs in 2040, an additional 18,000 jobs to the 2021 baseline. Other Fossil Generation and Natural Gas Generation will only generate 2,615 jobs in 2040, which represents a job displacement close to 8,700 jobs from the 2021 baseline. Job additions in the displaced sub-sectors will eventually stop in 2045 for both sub-sectors, which leads to a total of 11,300 displaced jobs in 2045 and 2050.

[24] U.S Energy Information Administration (EIA). "Energy-Related C02 Emission Data Tables", Table 3. https://www.eia.gov/environment/emissions/state/

[25] Refer to Detailed Modeling Assumptions: in Appendix A. Model Inputs & Data Sources.

Table 7. Electricity: Overall Employment Output - Reference

SUB-SECTOR	YEAR						
	2021	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Solar	8,504	22,595	20,609	15,751	17,516	22,942	23,253
Land-Based Wind	15,153	15,153	17,653	18,793	21,521	25,367	28,135
Hydrogen	0	0	0	1,448	1,318	1,155	1,218
Distribution	42,700	42,700	42,969	43,384	43,019	42,914	42,963
Transmission	939	939	1,039	1,192	1,057	1,018	1,036
Storage	3,425	3,425	3,425	3,687	4,473	5,521	6,307
Total Growth	70,720	84,810	85,695	84,255	88,903	98,916	102,912
Change in Growth		+14,091	+14,975	+13,535	+18,184	+28,196	+32,192
Neutral Sub-Sectors							
Hydropower	2,190	2,190	2,190	2,190	2,190	2,190	2,190
Biomass	3,256	3,256	3,256	3,256	3,256	3,256	3,256
Nuclear	7,834	7,834	7,834	7,834	7,834	7,834	7,834
Total Neutral	13,280	13,280	13,280	13,280	13,280	13,280	13,280
Displacement Sub-Sectors							
Other Fossil Generation	4,276	3,858	2,013	0	0	0	0
Natural Gas Generation	7,098	4,484	3,258	2,615	2,615	0	0
Total Displaced	11,374	8,341	5,272	2,615	2,615	0	0
Change in Displaced		-3,033	-6,102	-8,759	-8,759	-11,374	-11,374
Electricity OVERALL	**95,374**	**106,432**	**104,246**	**100,150**	**104,799**	**112,196**	**116,192**
Net Change from 2021		**+11,058**	**+8,873**	**+4,777**	**+9,425**	**+16,822**	**+20,818**

In the Moderate Electrification scenario, net employment in the Electricity sector will grow to at least 121,800 jobs in 2040, which represents a total of 26,400 jobs added to the 2021 baseline (Table 8). The growth sub-sectors will add to at least 33,300 jobs to total 104,000 jobs in 2040. Conversely, displaced sub-sectors will lose at least 6,000 jobs in 2040, and will eventually stop producing new jobs in 2045, which will result in a total displacement of 11,300 jobs by 2050.

Table 8 Electricity: Overall Employment Output – Moderate Electrification

SUB-SECTOR	YEAR						
	2021	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Solar	8,504	22,795	21,329	16,713	26,817	45,265	45,942
Land-Based Wind	15,153	15,153	17,653	18,793	22,820	25,959	28,727
Hydrogen	0	0	0	3,051	2,583	1,701	5,679
Distribution	42,700	42,700	43,180	43,781	44,126	43,898	43,606
Transmission	939	939	1,117	1,339	1,467	1,382	1,274
Storage	3,425	3,425	3,425	4,134	6,264	9,103	11,233
Total Growth	70,720	85,010	86,704	87,811	104,078	127,308	136,462
Change in Growth		+14,291	+15,984	+17,092	+33,358	+56,588	+65,743
Neutral Sub-Sectors							
Hydropower	2,190	2,190	2,190	2,190	2,190	2,190	2,190
Biomass	3,256	3,256	3,256	3,256	3,256	3,256	3,256
Nuclear	7,834	7,834	7,834	7,834	7,834	7,834	7,834
Total Neutral	13,280	13,280	13,280	13,280	13,280	13,280	13,280
Displacement Sub-Sectors							
Other Fossil Generation	4,276	3,858	2,013	0	0	0	0
Natural Gas Generation	7,098	5,702	4,478	4,478	4,478	0	0
Total Displaced	11,374	9,559	6,491	4,478	4,478	0	0
Change in Displaced		-1,815	-4,883	-6,896	-6,896	-11,374	-11,374
Electricity OVERALL	**95,374**	**107,850**	**106,475**	**105,569**	**121,836**	**140,588**	**149,743**
Net Change from 2021		**+12,476**	**+11,101**	**+10,196**	**+26,462**	**+45,214**	**+54,369**

Solar

The Solar sub-sector, a growth sub-sector, includes technologies such as photovoltaics, solar heating & cooling, and concentrating solar power.

Investments in both the Reference and the Moderate Electrification scenarios trend upwards from 2021 to 2050 (see Figure 11 and Figure 12). However, investments made in the Moderate Electrification scenario trend much higher than in the Reference scenario. In the Reference scenario, total expenditure in Solar would reach $1,562M by 2045, while it would reach $4,025M by 2045 in the Moderate Electrification scenario. The investments made in both scenarios lead to job increases in the Solar sub-sector.

Figure 11. Solar Inputs (2021-2050): Investments ($M) – Reference

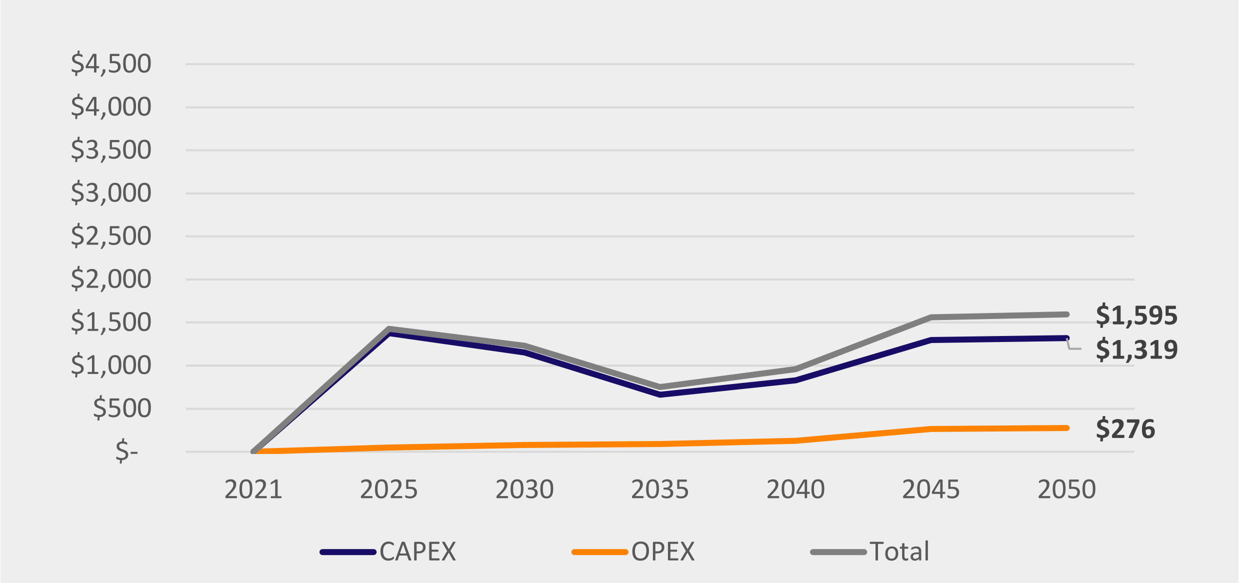
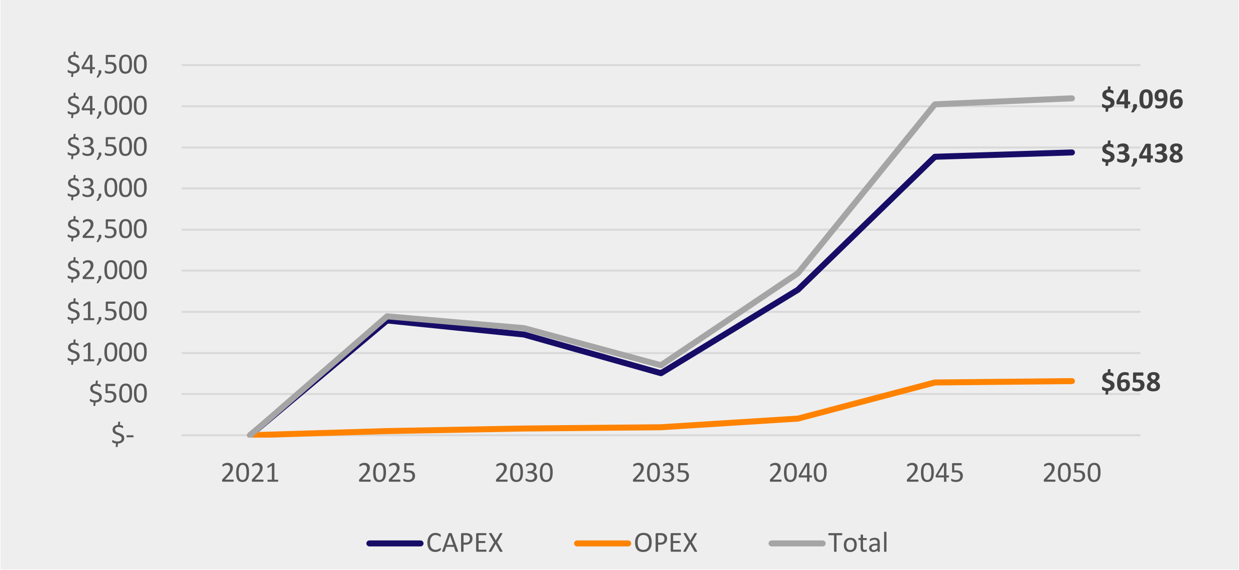
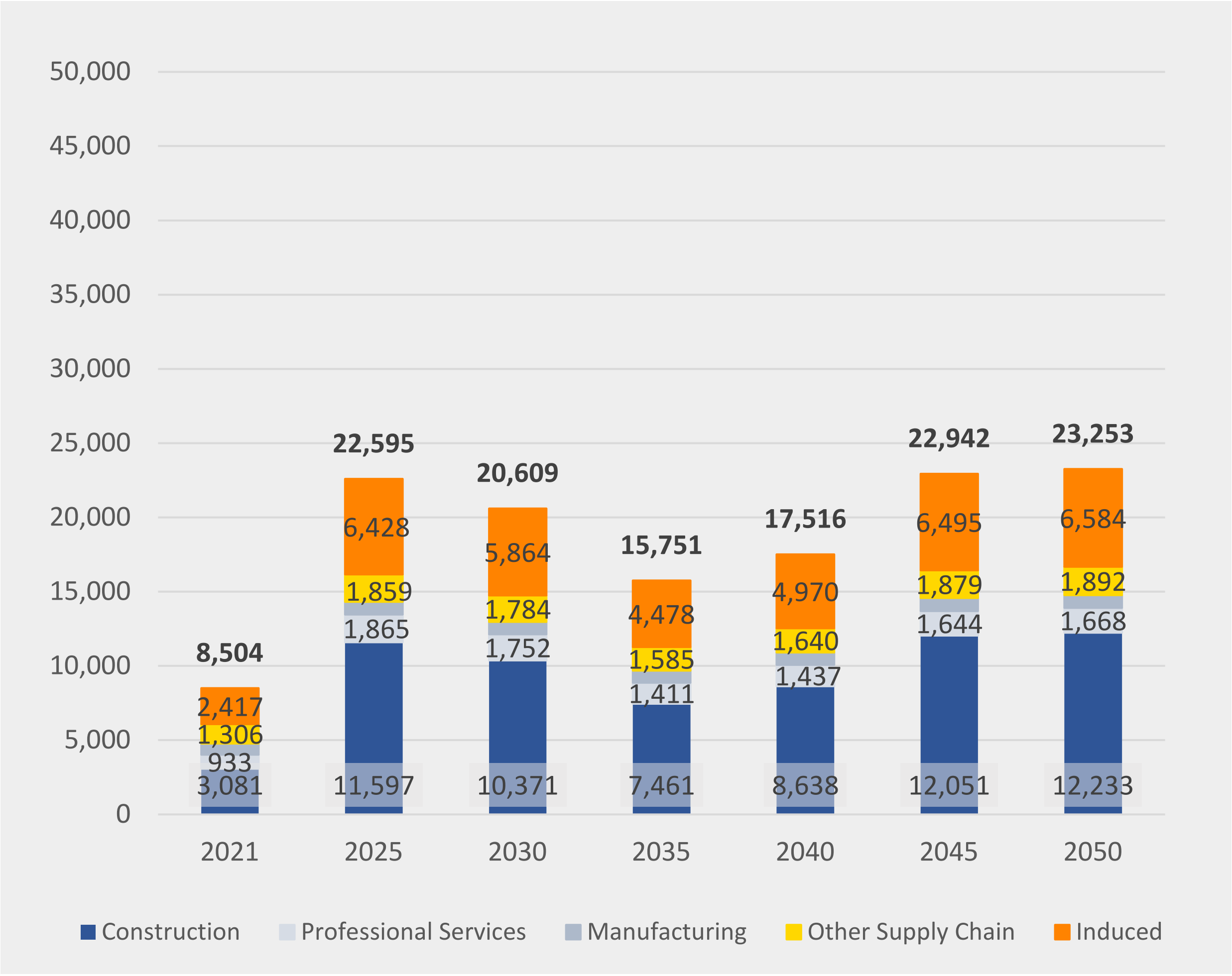


Figure 12. Solar Inputs (2021-2050): Investments ($M) – Moderate Electrification



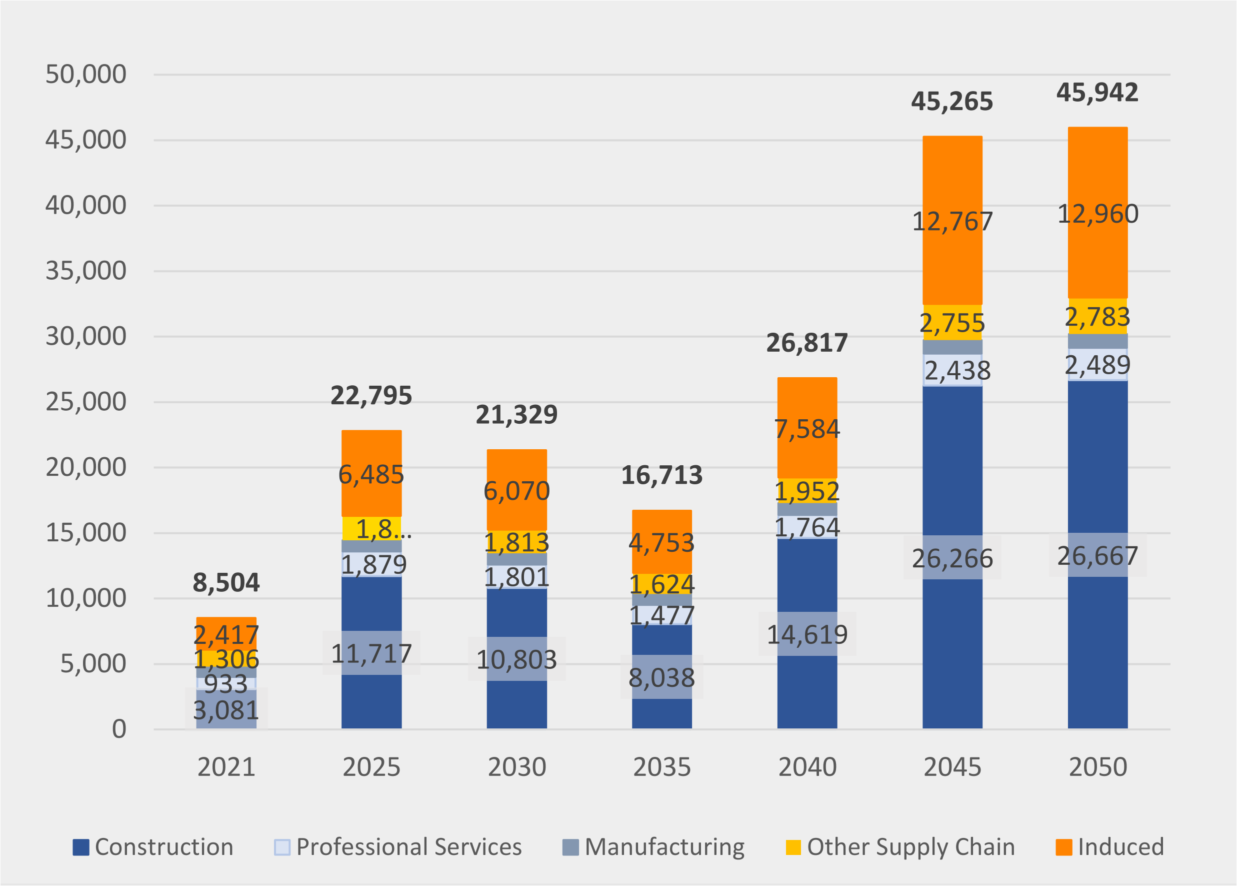
In the Reference scenario, the $1,595M change in investment between 2021 and 2050 leads to a change of over 14,000 jobs (Figure 13). By the final year of analysis, Construction (12,200 jobs) and Induced (6,500 jobs) experience the highest growth. Other Supply Chain industries will add 1,800 jobs, followed by Professional Services (1,600 jobs), and Manufacturing (800 jobs). In the Reference scenario, Construction increases fourfold from its 2021 baseline of 3,000 jobs. Induced employment triples from its 2021 baseline of 2,400 jobs.

Figure 13. Solar Outputs (2021-2050) – Reference



The investments made in the Moderate Electrification scenario led to similar, yet more pronounced growth in jobs across industries, adding more than 37,000 jobs in 2050 (Figure 14). The Induced (4,000 jobs) and Construction (9,000 jobs) industries experience the greatest growth rate by 2050. By contrast, Professional Services (700 jobs), Other Supply Chain (500 jobs) and Manufacturing experience a modest growth between 2021 and 2050.

Figure 14. Solar Outputs (2021-2050) – Moderate Electrification



Land-Based Wind

The Land-Based Wind sub-sector is comprised of distributed or small-scale wind, and utility-scale wind.

Land-based wind capacity in Illinois will increase in both the Reference and Moderate Electrification scenarios (see Figure 15 and Figure 16). While the capacity installed is similar in both scenarios until 2035, the Moderate Electrification scenario promises a higher capacity installed in 2040 (10,285MW) than the Reference scenario (8,671MW). Capacity installed will reach 11,132MW by 2050 in both scenarios.

For this sub-sector, the Reference and Moderate Electrification scenarios assumed the same or a similar investment schedule. Charts were included for both scenarios to be consistent with those sub-sectors where the investment schedules differed.

Figure 15. Land-Based Wind Inputs (2021-2050): Total Installed Capacity (MW) – Reference

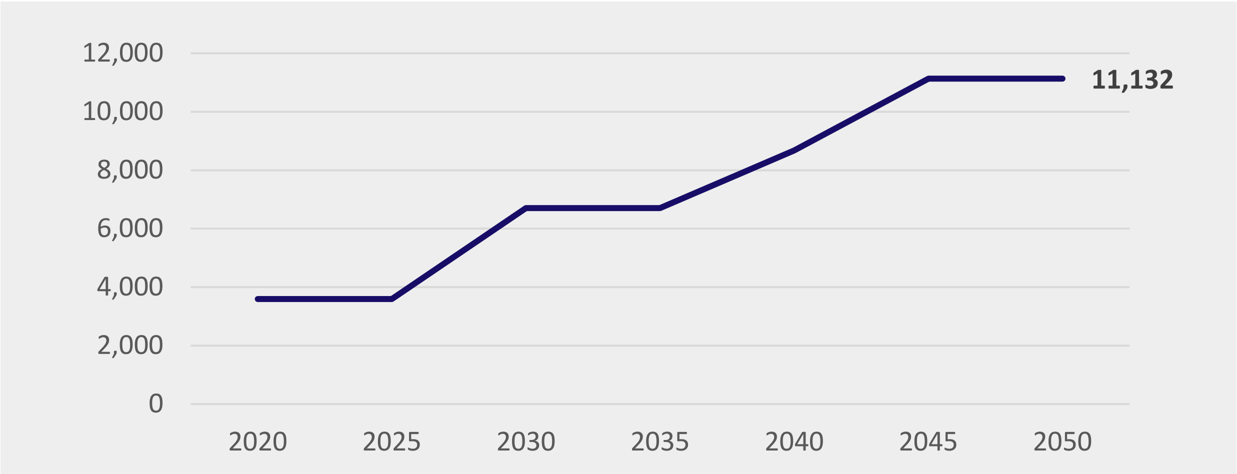
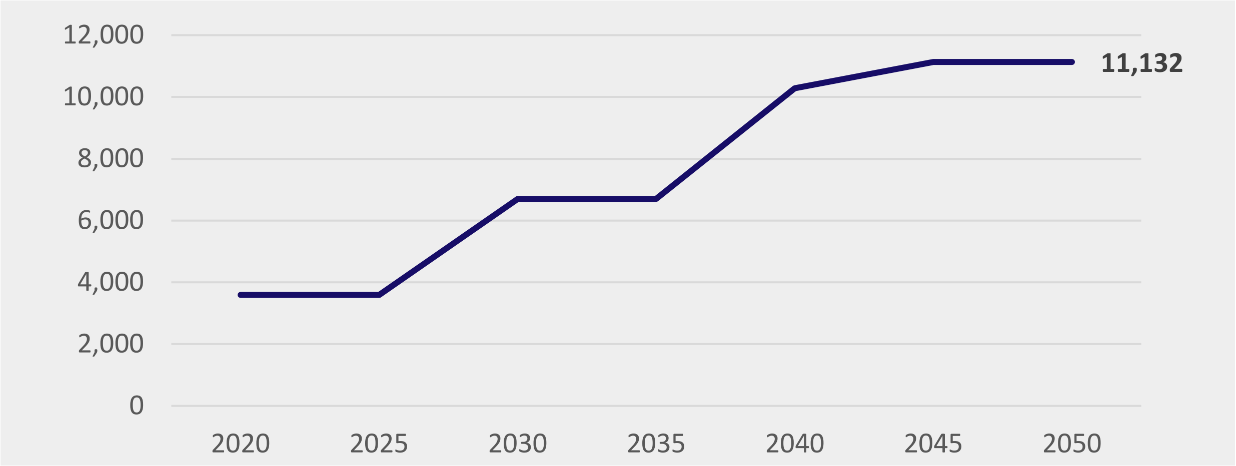
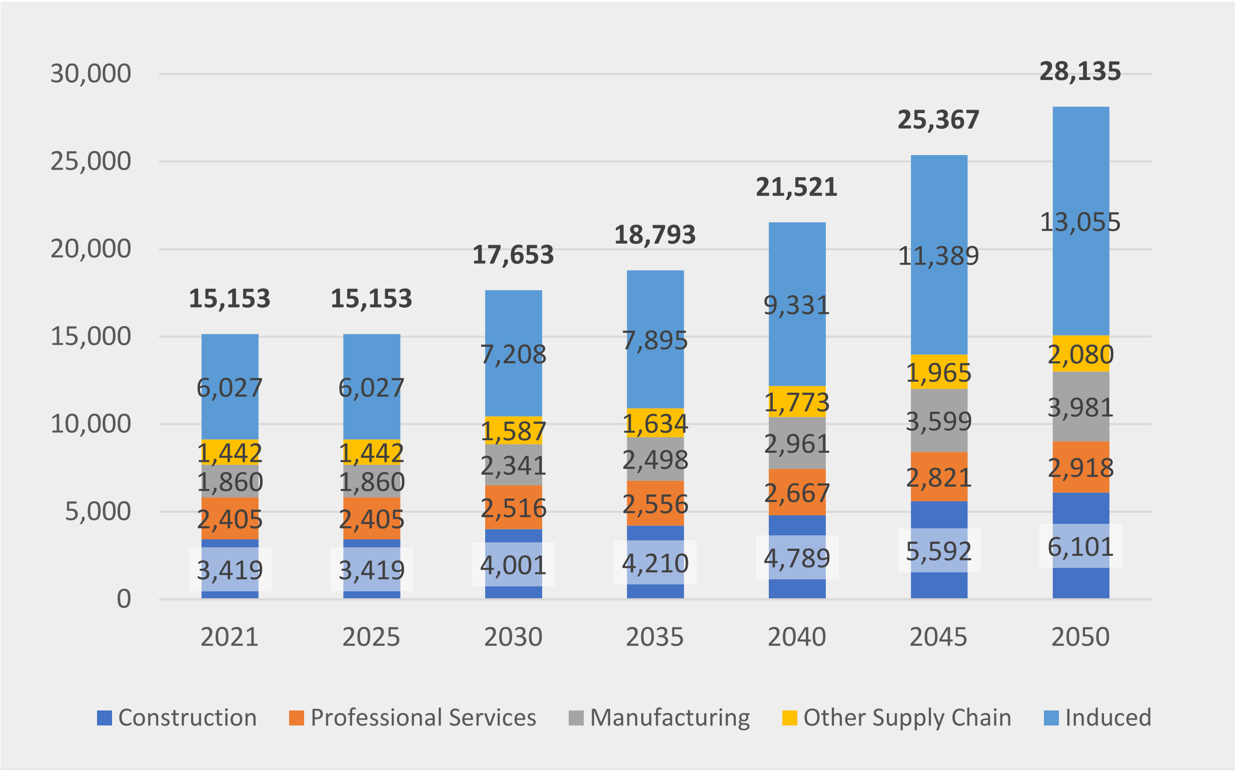


Figure 16. Land-Based Wind Inputs (2021-2050): Total Installed Capacity (MW) – Moderate Electrification



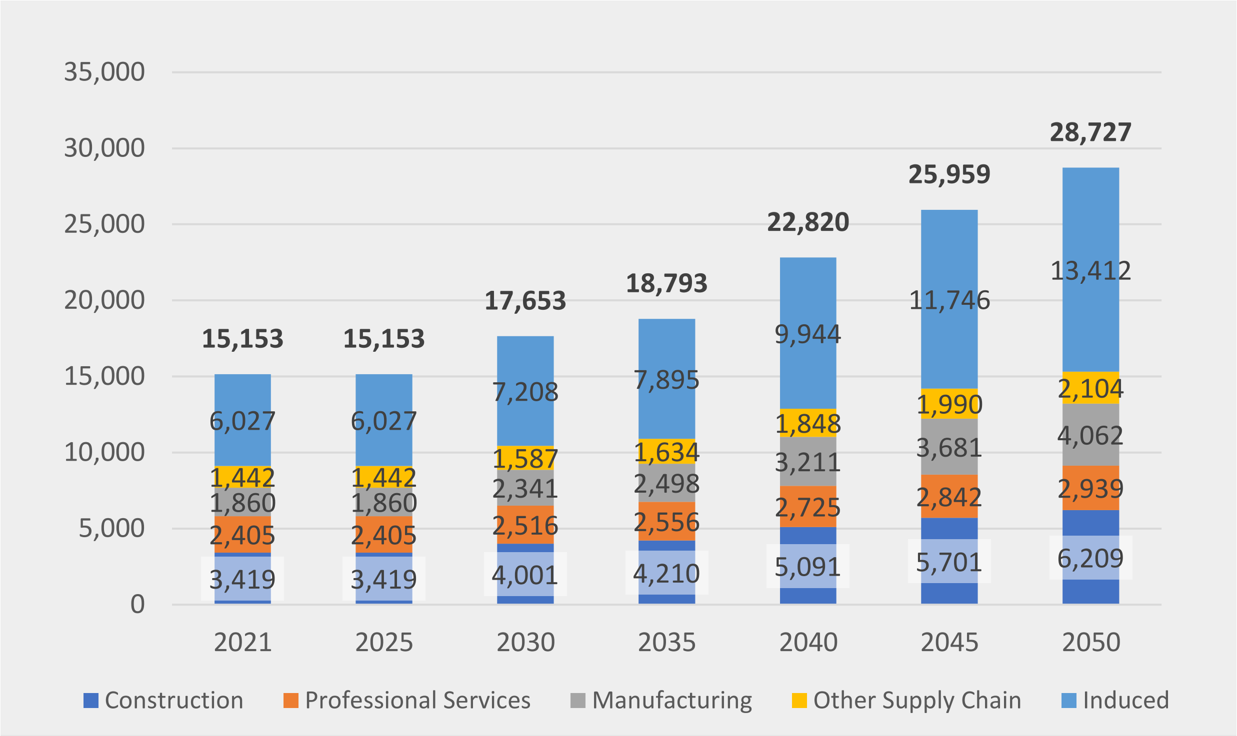
The Induced and Construction industries experience the most growth, as the number of jobs in both industries double in both the Reference and Moderate Electrification cases. By 2050, the Reference scenario adds 12,900 jobs to the 2021 baseline (Figure 17). While most of the industries – Manufacturing, Construction, Professional Services, and Other Supply Chain – are experiencing incremental linear growth, Induced employment more than doubles in the timeframe of analysis.

Figure 17. Land-Based Wind Outputs (2021-2050) – Reference



Job creation under the Moderate Electrification scenario yields similar results (Figure 18). Induced (7,000 jobs), Construction (3,000 jobs), and Manufacturing (2,000 jobs) employment at least doubled from their respective 2021 baseline numbers in 2050. Professional Services and Manufacturing only experienced modest growth in comparison.

Figure 18. Land-Based Wind Outputs (2021-2050) – Moderate Electrification

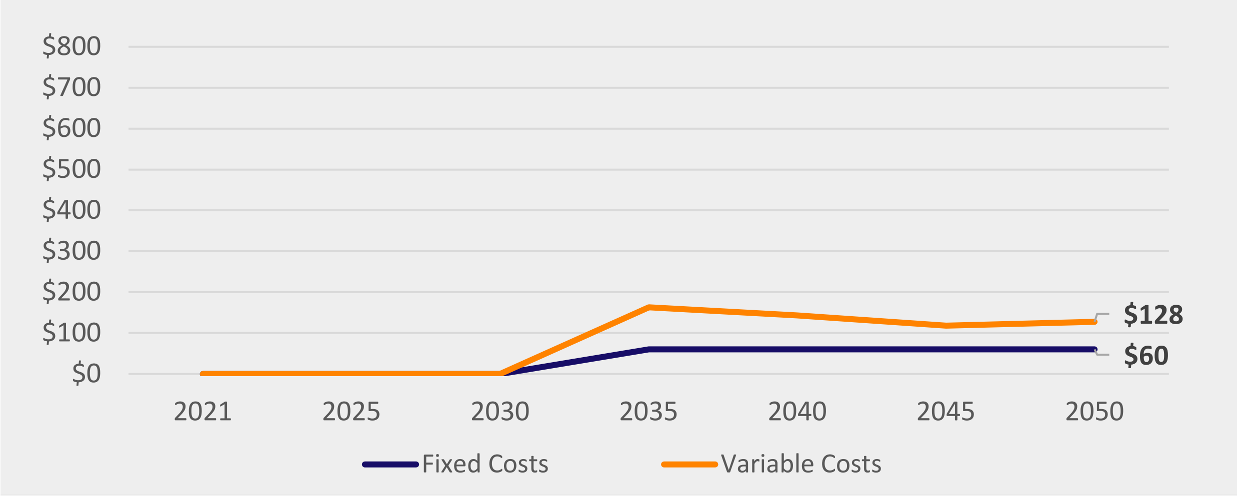


Hydrogen

The Hydrogen sub-sector is comprised of technologies such as thermal processes and electrolytic processes.

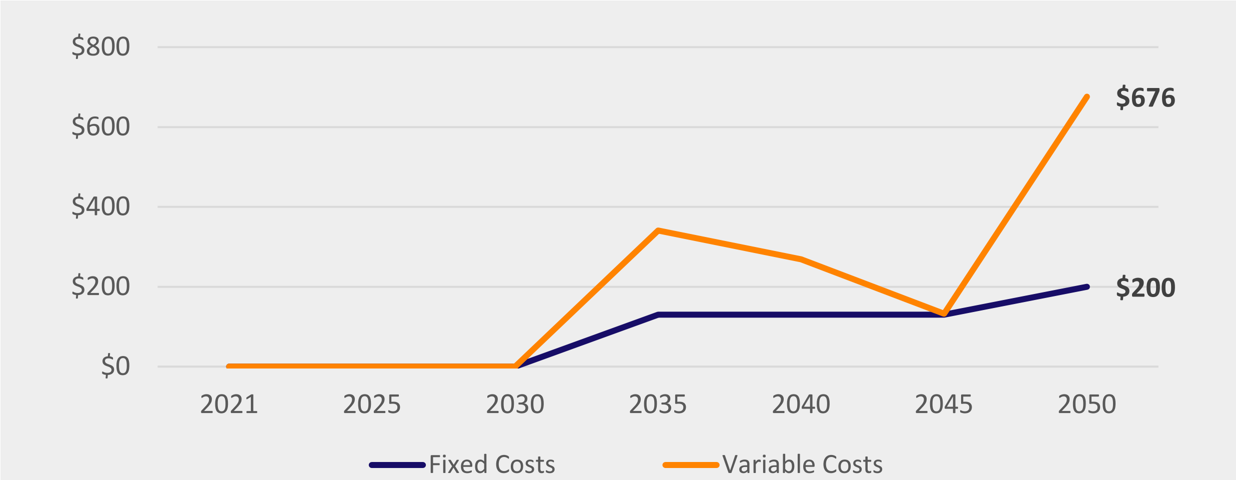
Both the Reference and Moderate Electrification scenarios start off with $0M in investments, from the baseline year of 2021 until 2030 (see Figure 19 and Figure 20). In the Reference scenario, investments peak in 2035, reaching $193M total investments, before dipping down to $178M in the final year of analysis.

Figure 19. Hydrogen Inputs (2021-2050): Investments ($M) – Reference



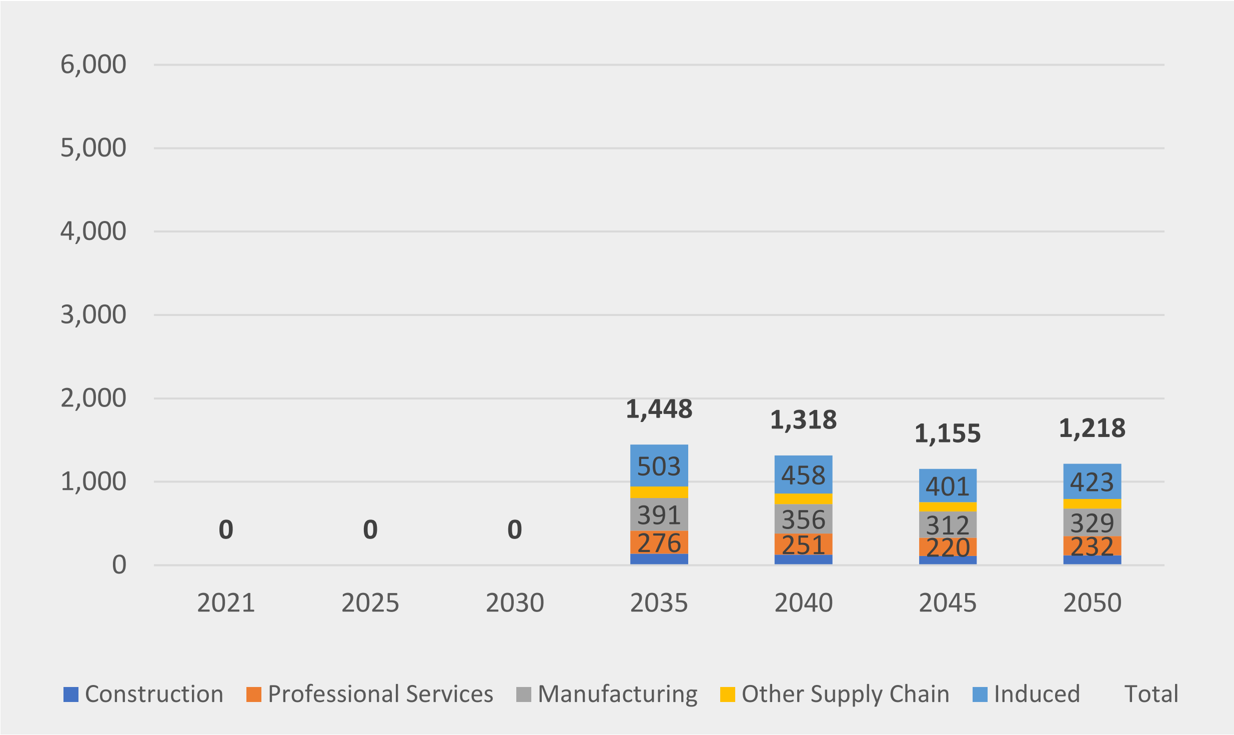
In the Moderate Electrification scenario, investments reach an initial peak in 2035, totaling $471M, before dipping down and reaching a new peak in 2050, at $876M. As there are no investments made in Hydrogen until after 2030 in both scenarios, zero jobs in 2021, 2025 and 2030.

Figure 20. Hydrogen Inputs (2021-2050): Investments ($M) – Moderate Electrification



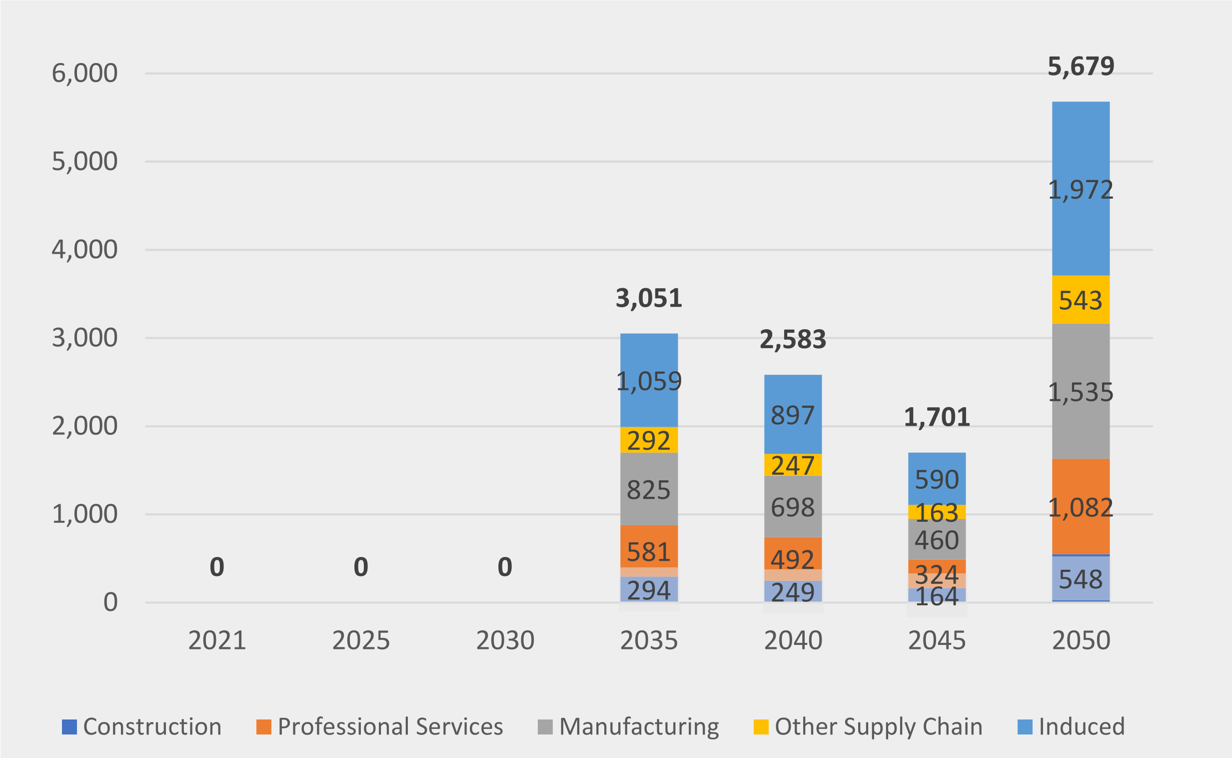
After 2030, the Reference scenario leads to more jobs created in Induced employment, and Manufacturing than the other industries, generating more than half of projected employment (Figure 21). Professional Services account for roughly 20 percent of projected employment, while the rest comes from Construction and Other supply chain. Job growth across all industries peaks in 2035 and slowly declines until the final year of analysis.

Figure 21. Hydrogen Outputs (2021-2050) – Reference



Induced employment and Manufacturing are also the leading industries in terms of job-creation in the Moderate Electrification scenario (Figure 22). By 2050, these industries are closely followed by Professional Services. In this scenario, more than 2,000 jobs are created between 2035 and 2050.

Figure 22. Hydrogen Outputs (2021-2050) – Moderate Electrification



Hydropower

The Hydropower sub-sector uses hydroelectric power, achieved by converting gravitational potential of a water source to produce power.

In both the Reference and Moderate Electrification scenarios in Illinois, the total installed capacity is capped at 27MW from 2021 to 2050 (see Figure 23 and Figure 24).

For this sub-sector, the Reference and Moderate Electrification scenarios assumed the same or a similar investment schedule. Charts were included for both scenarios to be consistent with those sub-sectors where the investment schedules differed.

Figure 23. Hydropower Inputs (2021-2050): Total Installed Capacity (MW) – Reference

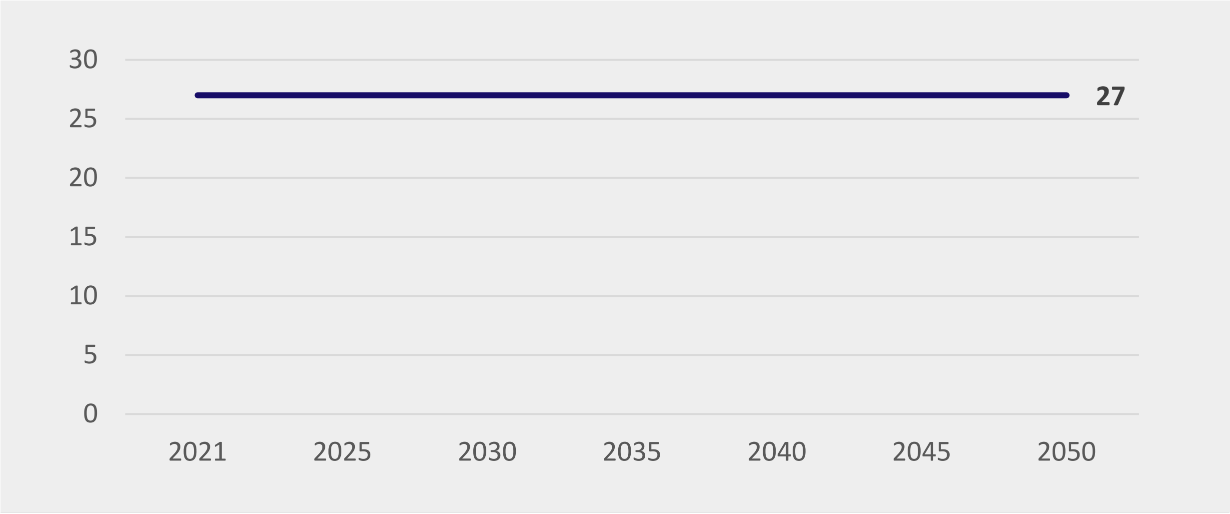
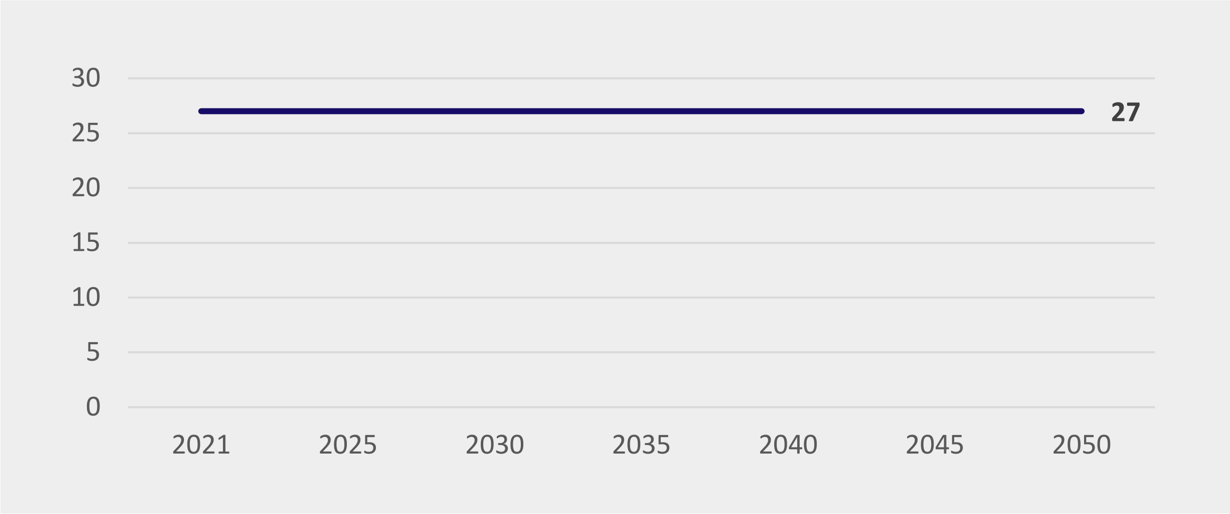


Figure 24. Hydropower Inputs (2021-2050): Total Installed Capacity (MW) – Moderate Electrification



Employment numbers remain constant for Hydropower employment throughout the period of analysis for both scenarios (see Figure 25 and Figure 26). Induced employment (900 jobs) constitutes the largest share of Hydropower jobs at 44 percent, followed by Other Supply Chain (500 jobs), which accounts for 27 percent of Hydropower jobs.

Figure 25. Hydropower Outputs (2021-2050) – Reference

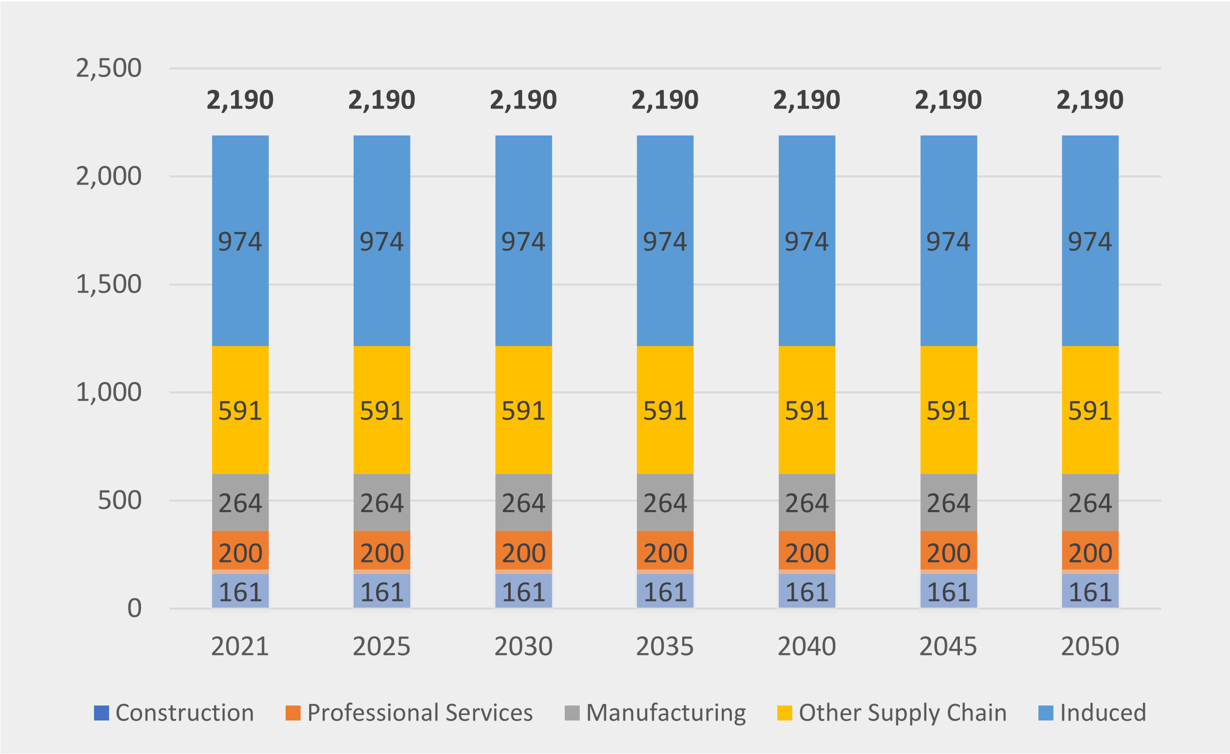
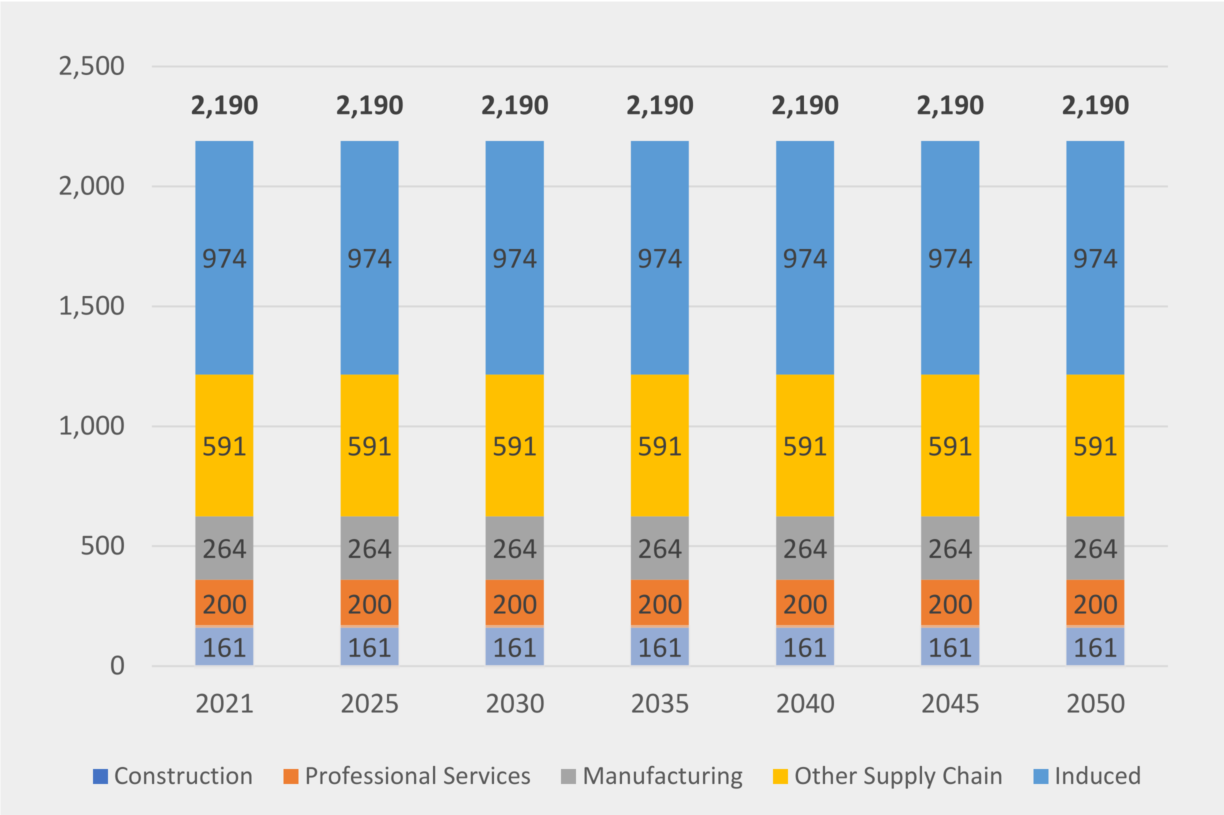


Figure 26. Hydropower Outputs (2021-2050) – Moderate Electrification



Biomass

The Biomass sub-sector includes a wide range of technologies that use phytomass to produce biofuels or used as a heat and electricity-producing energy source.

In both the Reference and Moderate Electrification transition scenarios, there are no capital expenditure (CAPEX) investments made in the Biomass sub-sector (see Figure 27 and Figure 28). Operations and Maintenance (O&M) appropriations are capped at $62M from the baseline year until the final year of analysis.

For this sub-sector, the Reference and Moderate Electrification scenarios assumed the same or a similar investment schedule. Charts were included for both scenarios to be consistent with those sub-sectors where the investment schedules differed.

Figure 27. Biomass Inputs (2021-2050): Investments ($M) – Reference

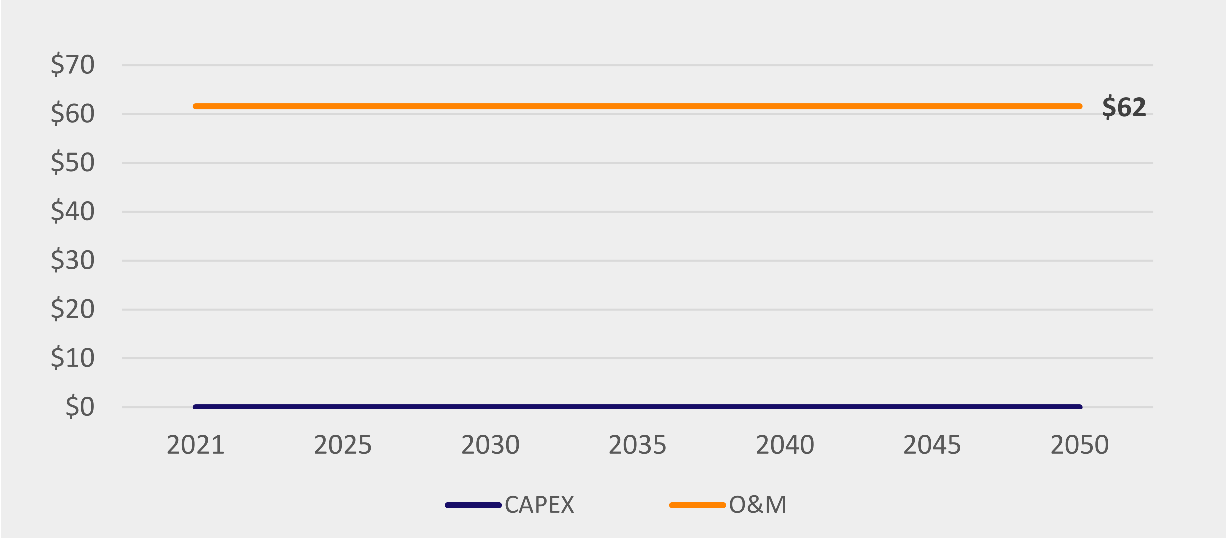
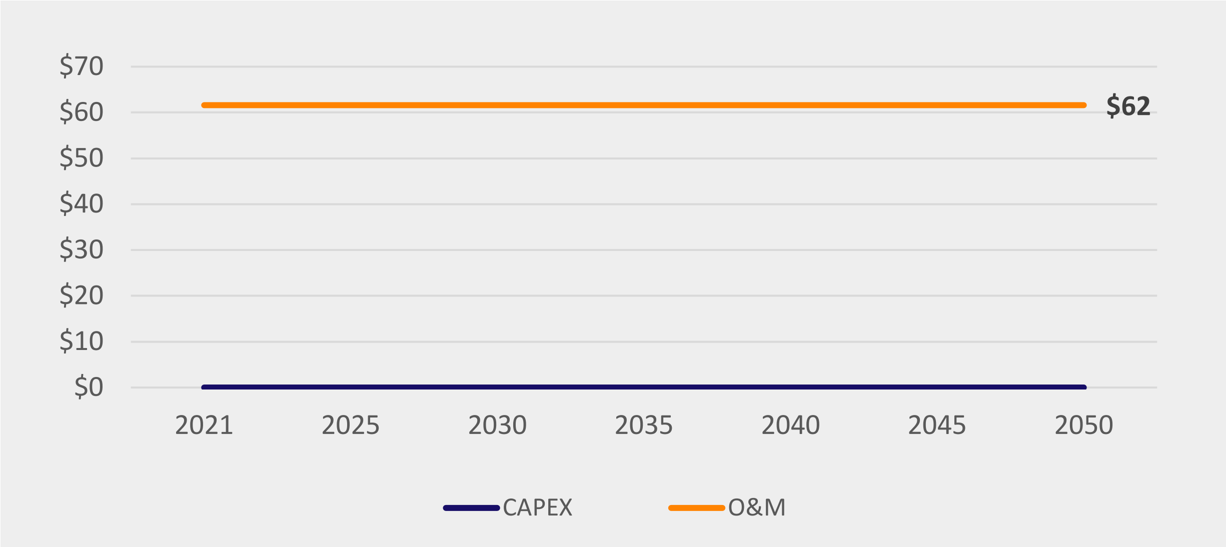


Figure 28. Biomass Inputs (2021-2050): Investments ($M) – Moderate Electrification



Employment numbers remain constant between 2021 and 2050 for both scenarios (see Figure 29 and Figure 30). Induced and Construction jobs make up the largest share of the Biomass sub-sector at 34 percent and 33 percent respectively. Manufacturing and Other Supply Chain jobs make up the lowest share of the Biomass sub-sector, each respectively contributing 200 jobs between 2021 and 2050.

Figure 29. Biomass Outputs (2021-2050) – Reference

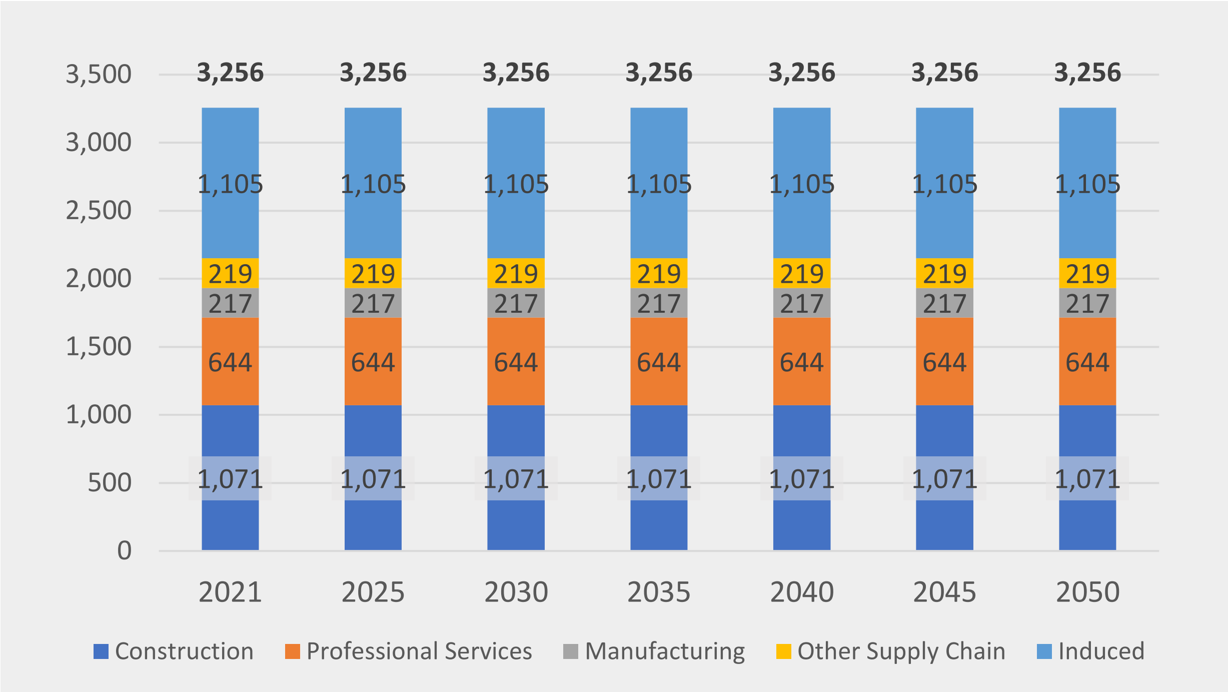
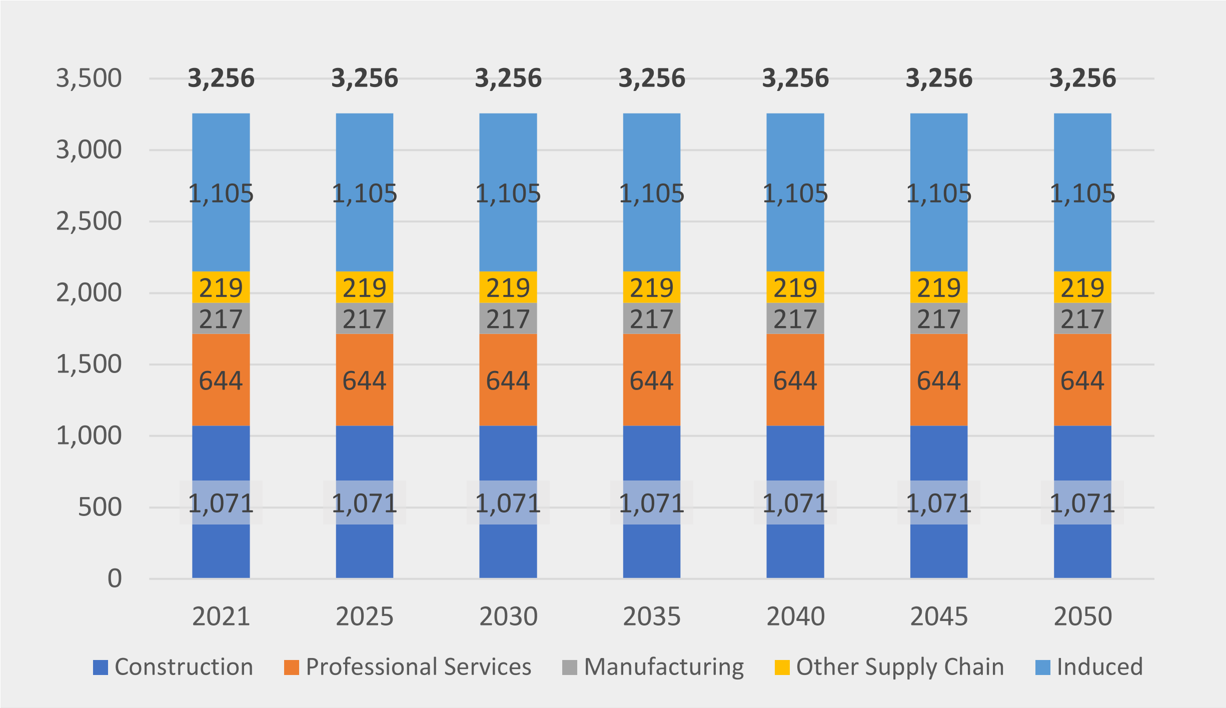


Figure 30. Biomass Outputs (2021-2050) – Moderate Electrification

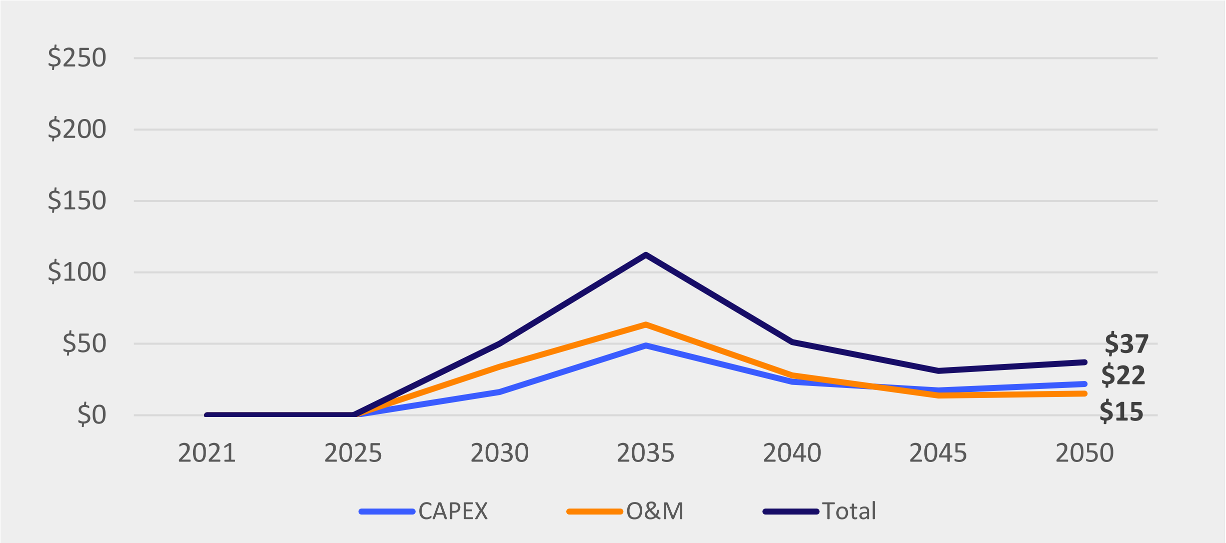


Distribution

The Distribution sub-sector is made up of technologies such as power lines and local smart grids.

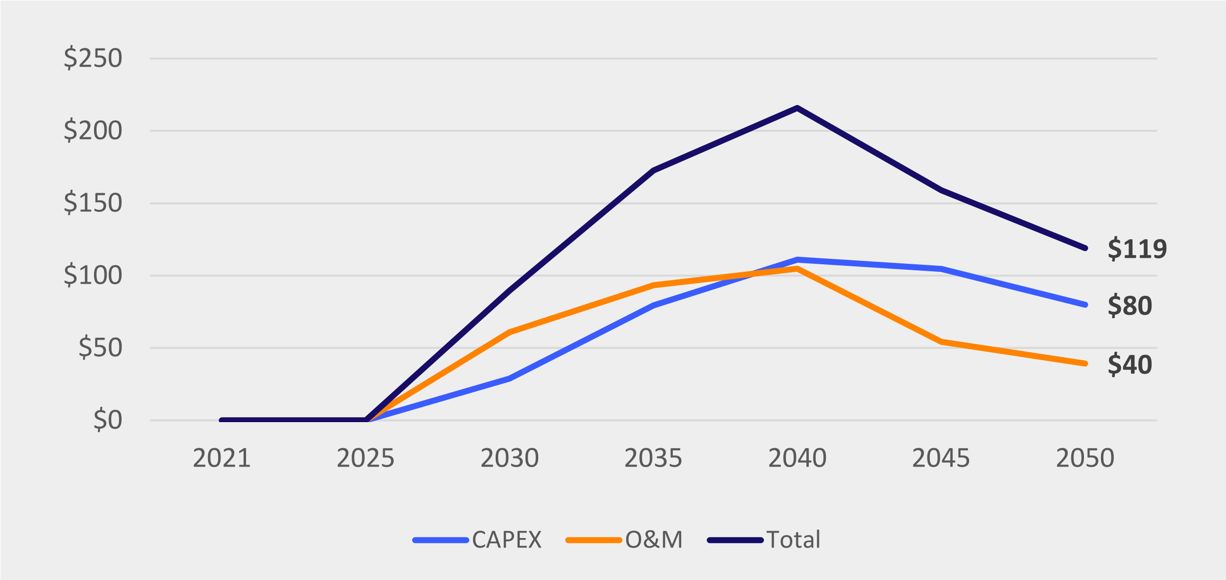
Under the Reference scenario, no CAPEX or O&M investments are made in Distribution until 2025 (Figure 31). Both CAPEX and O&M investments peak in 2035, leading to a total of $112M in Distribution investments. Investments begin to decline in 2040, reaching a $37M total in 2050.

Figure 31. Distribution Inputs (2021-2050): Investments ($M) – Reference



Under the Moderate Electrification scenario, investments in Distribution also begin in 2025 (Figure 32). However, both CAPEX and O&M investments peak in 2040, a total of $216M in Distribution investments. After 2040, O&M investments decline more rapidly than CAPEX investments. By 2050, total Distribution investments will reach $119M.

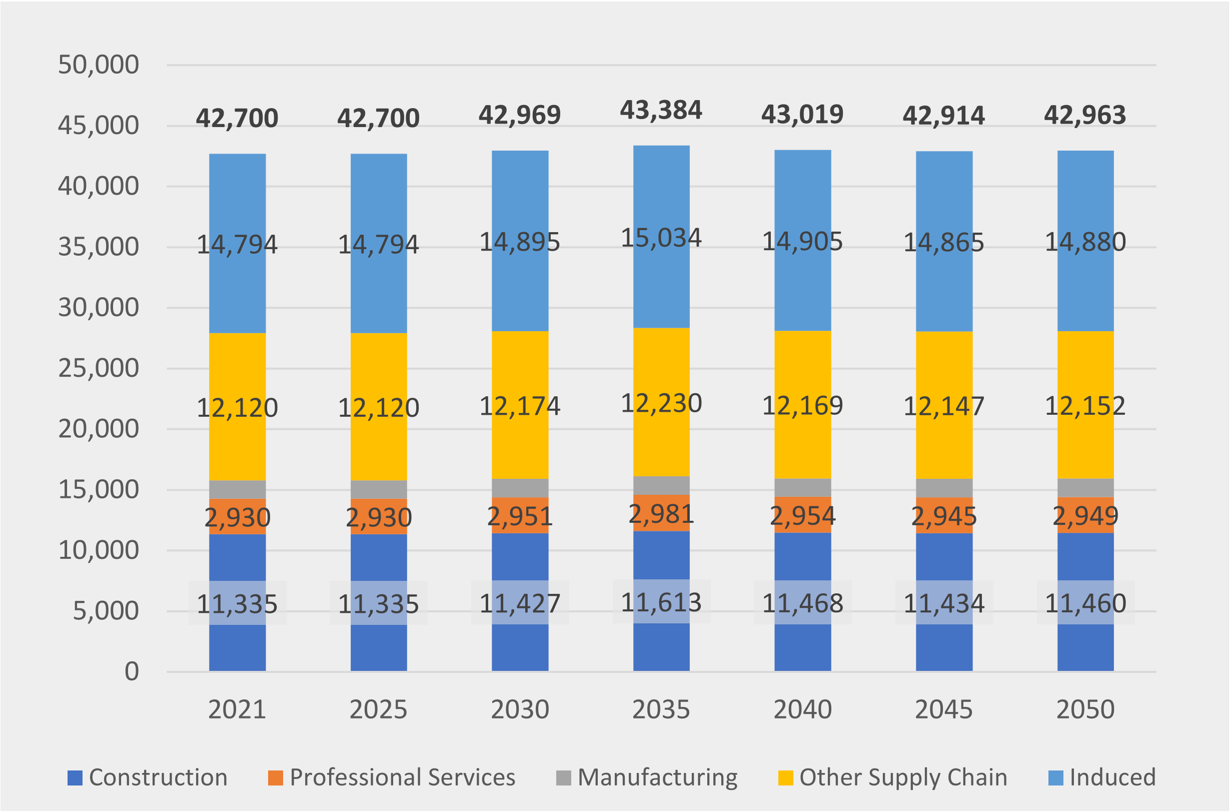
Figure 32. Distribution Inputs (2021-2050): Investments ($M) – Moderate Electrification



While both scenarios showcase a modest increase in total employment, the composition of industry jobs changes over time. In both scenarios, most jobs are provided through Induced employment, Other Supply Chain and Construction. Jobs added in the Reference and Moderate Electrification scenarios peak in 2035 and 2040, respectively, which corresponds to the highest levels of investment in both scenarios. The decrease in investments from 2040 to 2050 lead to a decrease in jobs in both scenarios.

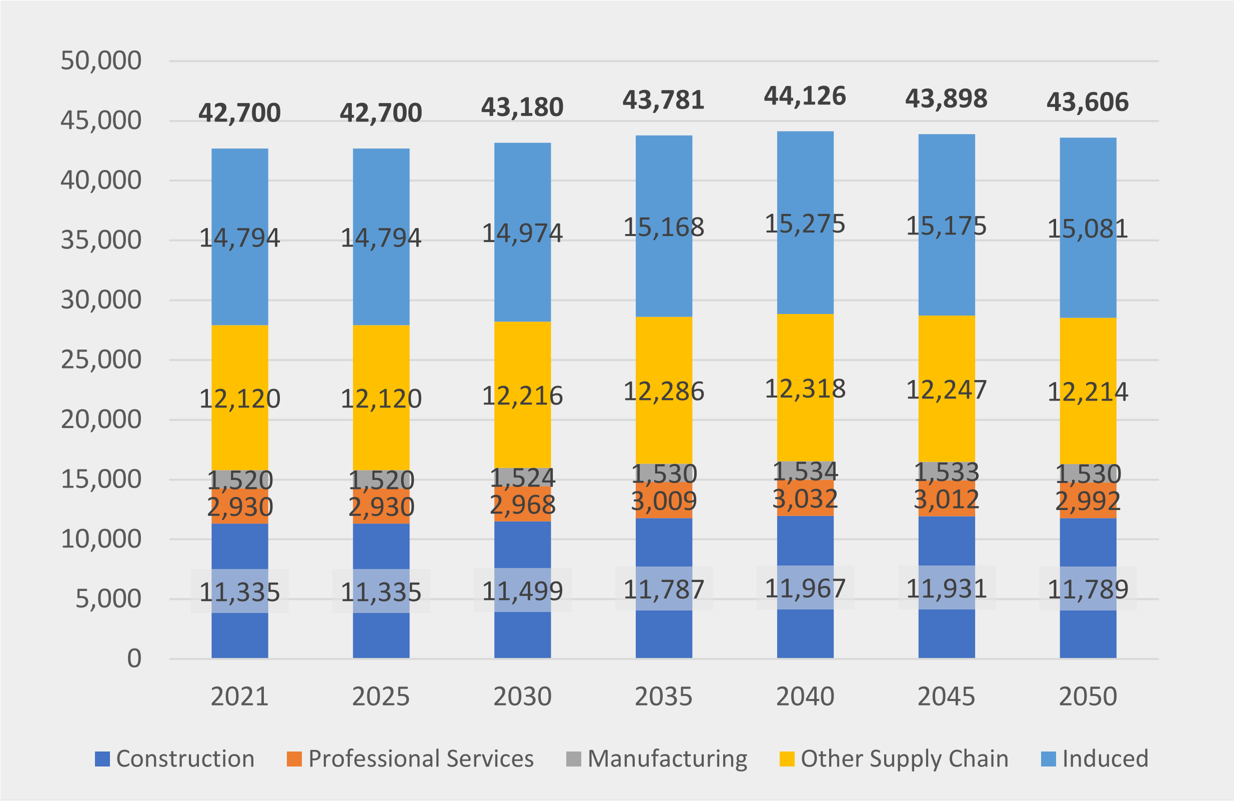
Under the Reference scenario, 263 additional jobs are created between 2021 and 2050 (Figure 33). Close to 300 jobs are added by 2030, mostly in Induced, Other Supply Chain, and Construction industries. By 2040, close to 200 additional jobs are created, with these industries still occupying the largest shares of employment.

Figure 33. Distribution Outputs (2021-2050) – Reference



Under the Moderate Electrification scenario, almost one thousand additional jobs are created between 2021 and 2050 (Figure 34). Close to 500 jobs are added by 2030, and almost 1,500 additional jobs are created by 2040. The Induced, Other Supply Chain, and Construction industries still occupy the largest share of employment in the Moderate Electrification case.

Figure 34. Distribution Outputs (2021-2050) – Moderate Electrification

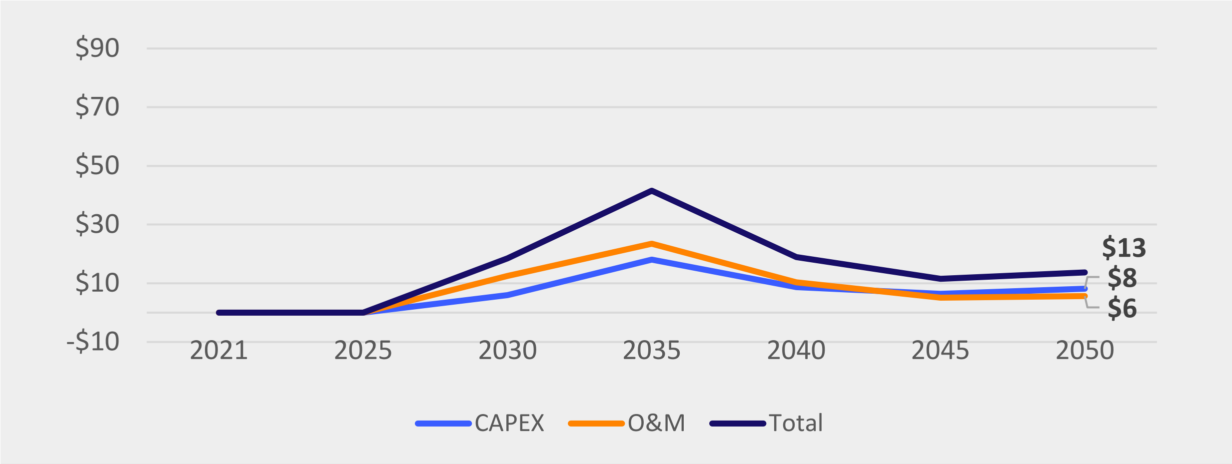


Transmission

The Transmission sub-sector is comprised of technologies such as overhead lines, HVAC cables, HDVC power transmission, and HVAC/HVDC Hybrid overhead lines.

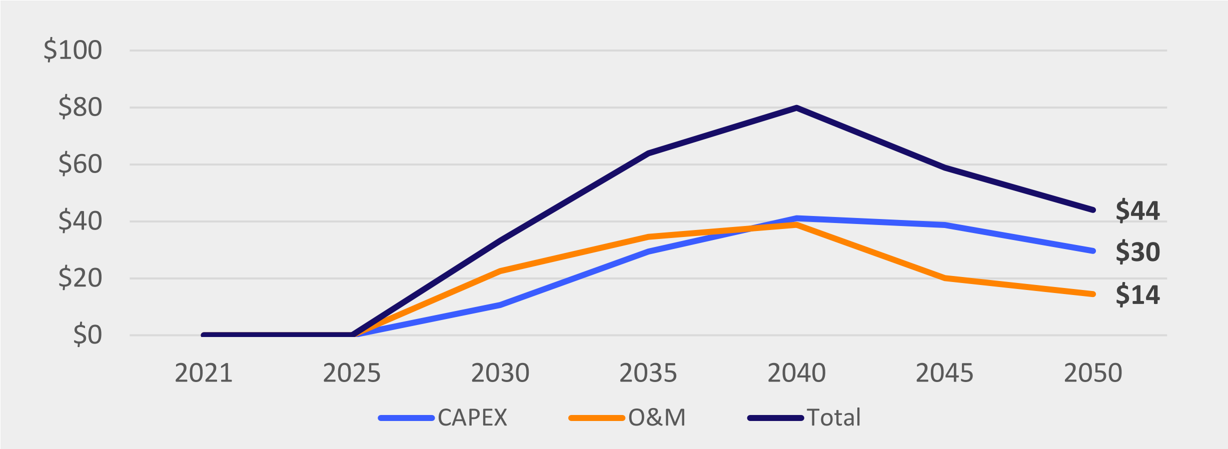
Under the Reference scenario, there are no investments into the Transmission sub-sector in 2021 and 2025 (Figure 35). By 2030, however, investments reach a total of $18.5M and peak at $42M in 2035 Both CAPEX and O&M investments decline for the remainder of the period of analysis, reaching a combined total of $14M by 2050.

Figure 35. Transmission Inputs (2021-2050): Investments ($M) – Reference



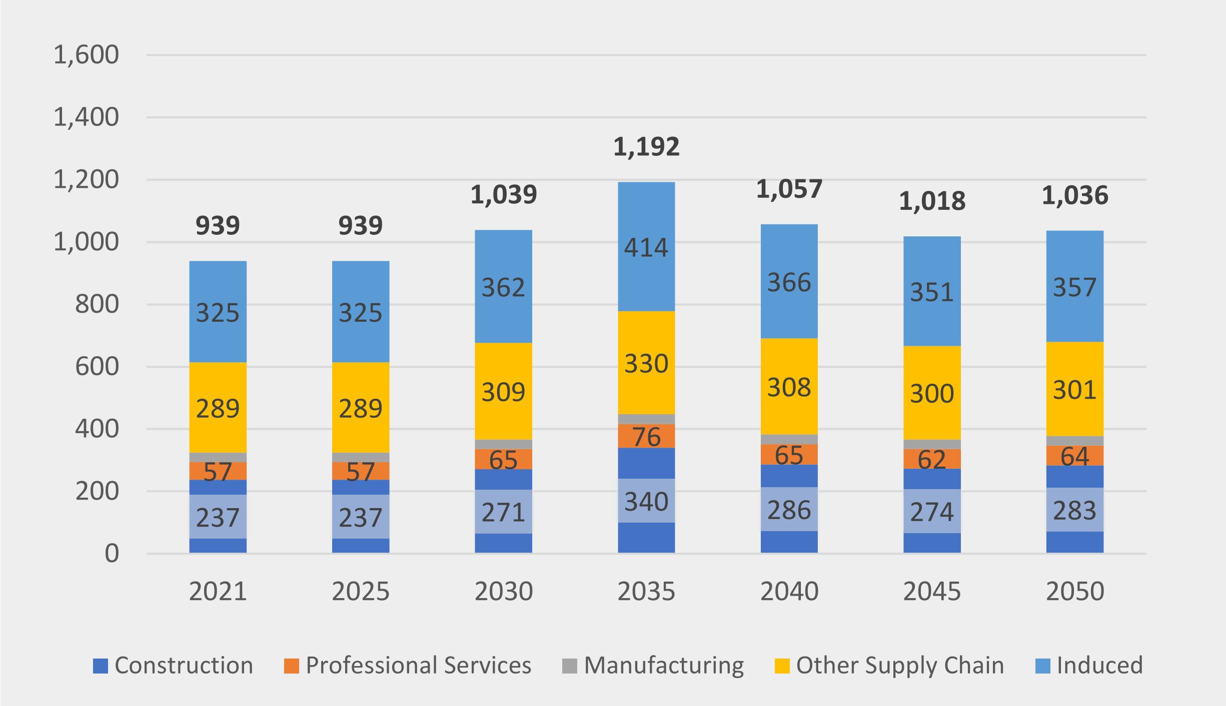
Under the Moderate Electrification scenario, investments also begin increasing after 2025 (Figure 36). Both CAPEX and O&M investments increase steadily until peaking in 2040 at a combined total of $80M. Investments decline after 2040, with O&M investments declining at a higher rate than CAPEX investments. By the end of the period of analysis, total investments in the Transmission sub-sector reach a total of $44M.

Figure 36. Transmission Inputs (2021-2050): Investments ($M) – Moderate Electrification



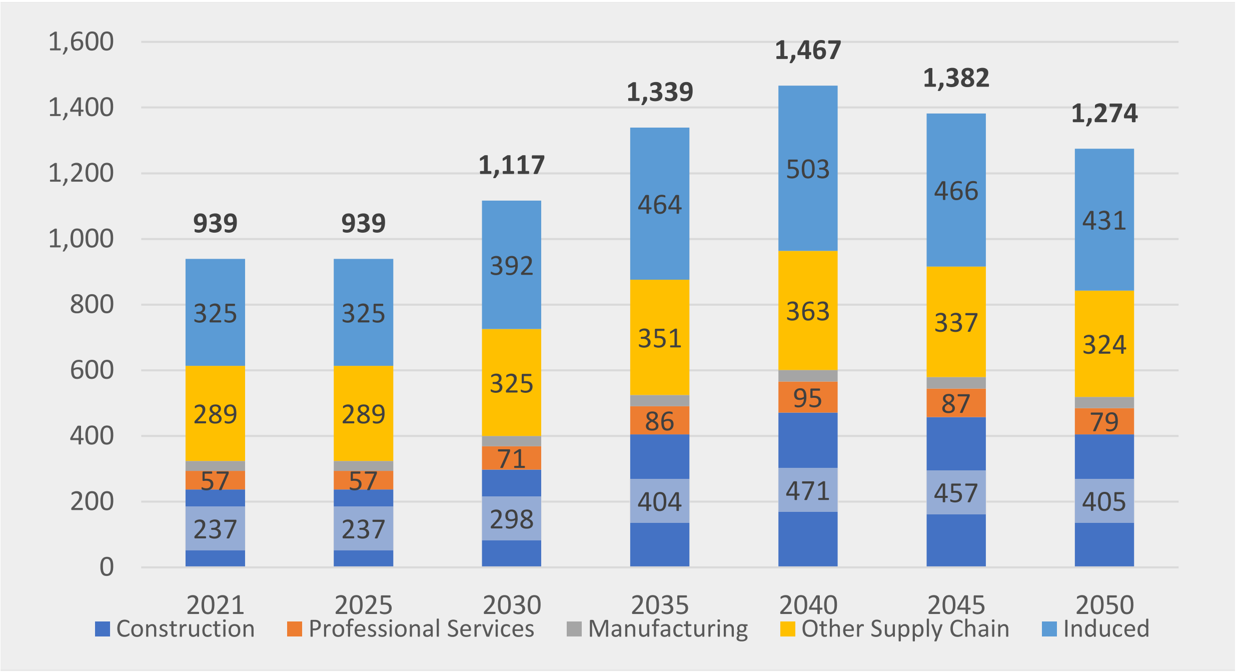
In the Reference scenario, less than one hundred jobs are created in Transmission between 2021 and 2050 (Figure 37). Manufacturing and Professional Services occupy the lowest share in the sub-sector, while Induced Employment, Other Supply Chain, and Construction account for over half of employment**.** Employment growth peaks in 2035 at 1,100 jobs, reflecting the peak investments into Transmission in the same year in the Reference scenario. The number of jobs declines after 2035, reaching a total of 1,000 jobs by 2050.

Figure 37. Transmission Outputs (2021-2050) – Reference



In the Moderate Electrification scenario, more than 300 jobs are created between 2021 and 2050 (Figure 38). In the Moderate Electrification case, as in the Reference scenario, the Induced, Other Supply Chain and Construction industries generate the most jobs. Employment growth peaks in 2040 at 1,400 jobs, reflecting the peak investments in Transmission in the same year under the Moderate Electrification scenario. The number of jobs declines after 2040, reaching a total of 1,200 jobs by 2050.

Figure 38. Transmission Outputs (2021-2050) – Moderate Electrification

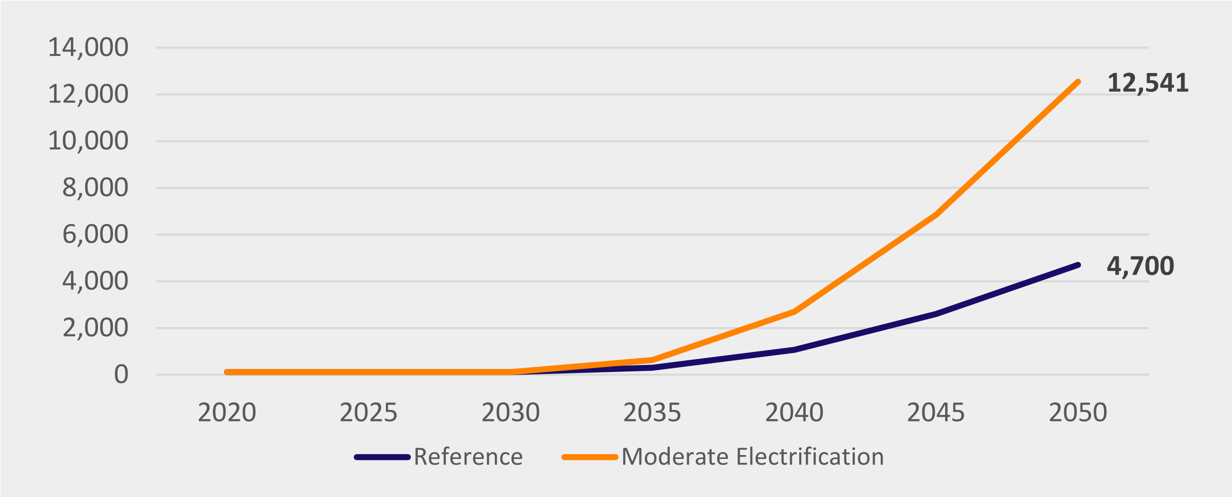


Storage

The Storage sub-sector is comprised of technologies such as batteries, thermal energy, flywheels, and pumped storage hydropower.

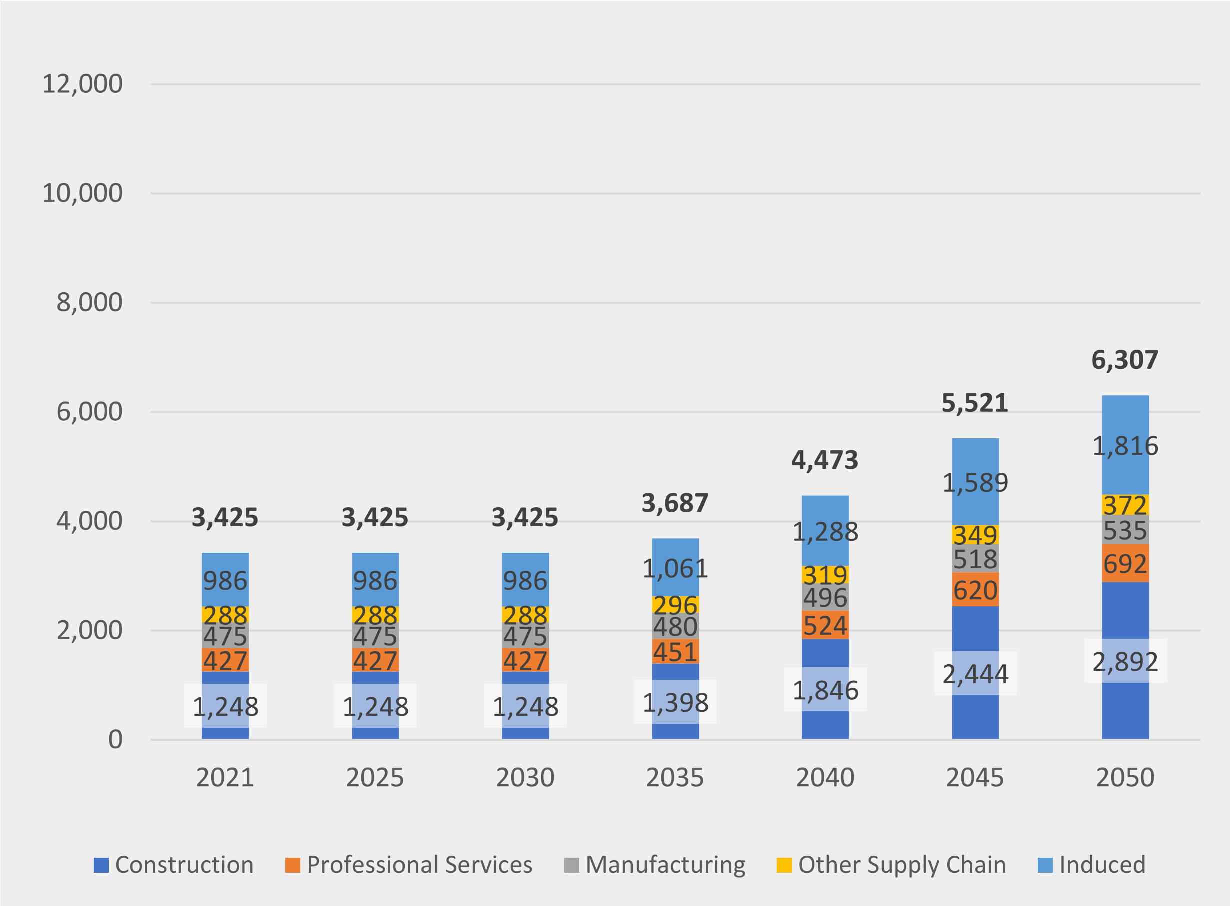
Under both scenarios, Storage total capacity installed is capped at 112MW until 2035, after which it grows in a linear fashion under the Reference scenario, and exponentially under the Moderate Electrification scenario (see Figure 39). In the Reference case, the total capacity installed reaches its peak by the final year of analysis, as it reaches 4,700MW. In the Moderate Electrification case, total installed capacity also peaks in 2050, and reaches 12,541MW, and therefore, quadruples the capacity reached in the Reference scenario.

Figure 39. Storage Inputs (2021-2050): Total Installed Capacity (MW) - Reference vs. Moderate Electrification



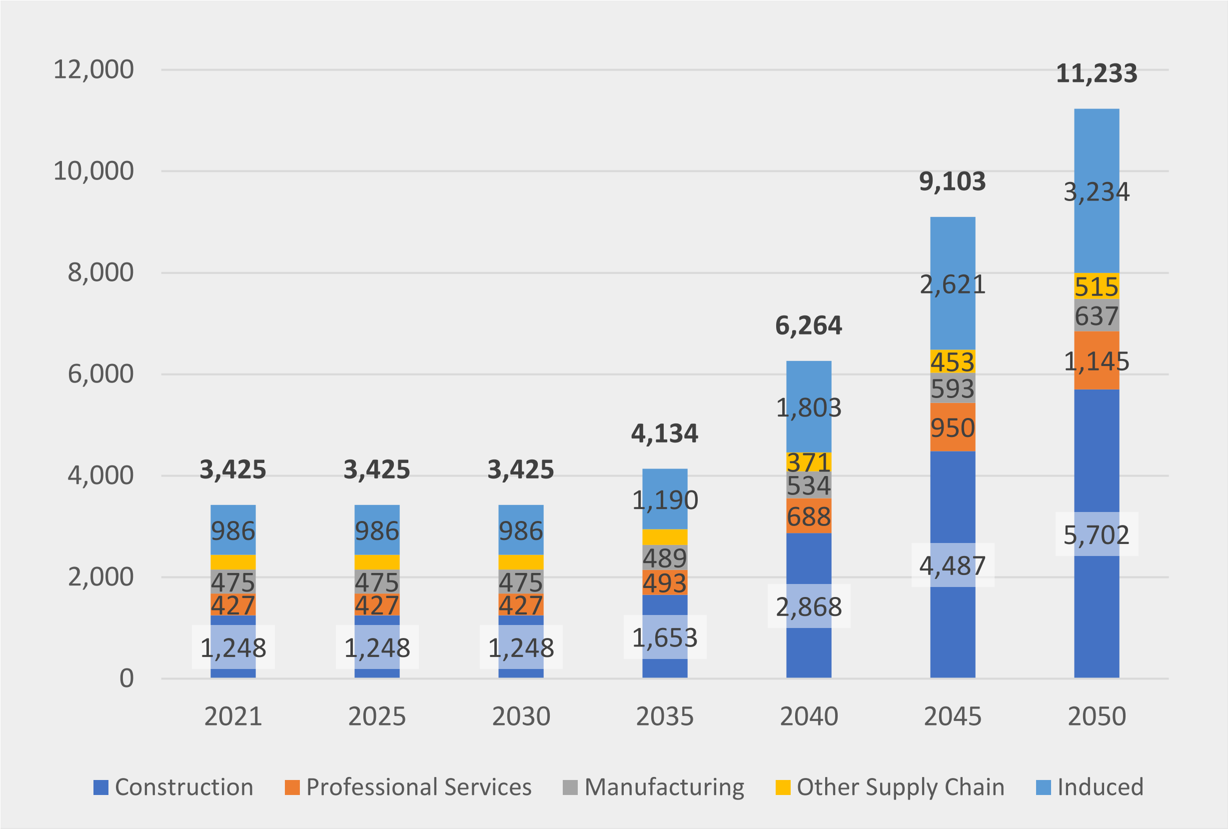
As total capacity increases so does job creation under the Reference scenario (Figure 40). In the Reference scenario, there are almost 3,000 additional jobs created between 2021 and 2050. Construction and Induced employment represent most of the jobs in the sub-sector, while Professional Services, Manufacturing, and Other Supply Chain generate the smallest number of jobs.

Figure 40. Storage Outputs (2021-2050) – Reference



Under the Moderate Electrification scenario, more than 7,000 jobs are added in the same time frame, with Construction and Induced employment still representing most of the jobs created in that sub-sector (Figure 41).

Figure 41. Storage Outputs (2021-2050) – Moderate Electrification



Natural Gas

Natural Gas, a displaced sub-sector, is composed of technologies such as natural gas-fueled power plants.

Both the Reference and Moderate Electrification scenarios start with a total capacity installed of 10,757MW at the baseline year (see Figure 42 and Figure 43). Under the Reference scenario (-5,000MW) there is a steep decline from 2020 to 2025, before complete retirement 0MW in 2045. Under the Moderate Electrification scenario (-3,585MW), the initial decline from 2020 to 2025 is less pronounced and total capacity remains steady around 7,400MW until complete retirement in 2045.

Figure 42. Natural Gas Inputs (2021-2050): Total Installed Capacity (MW) – Reference

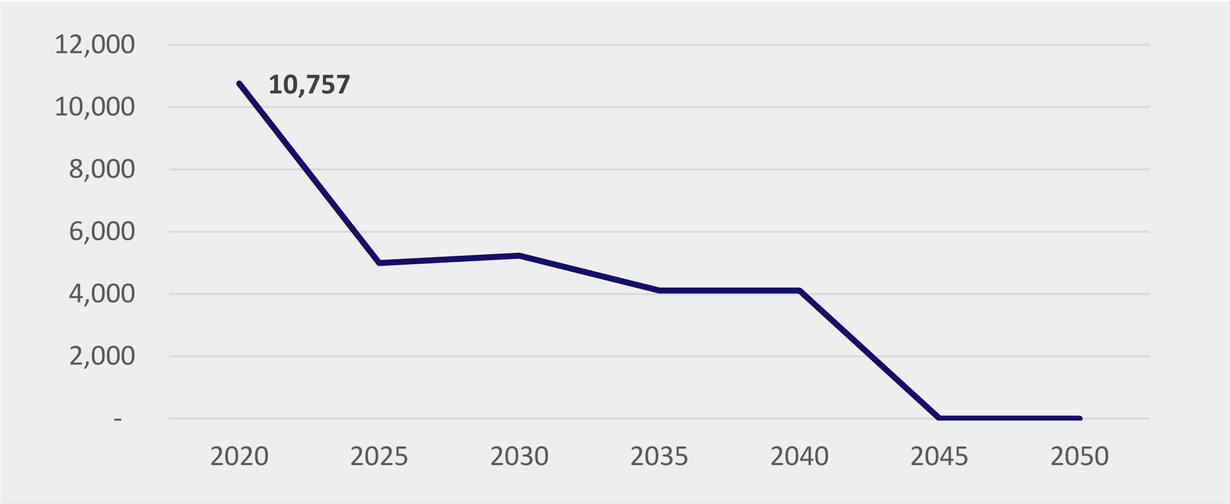
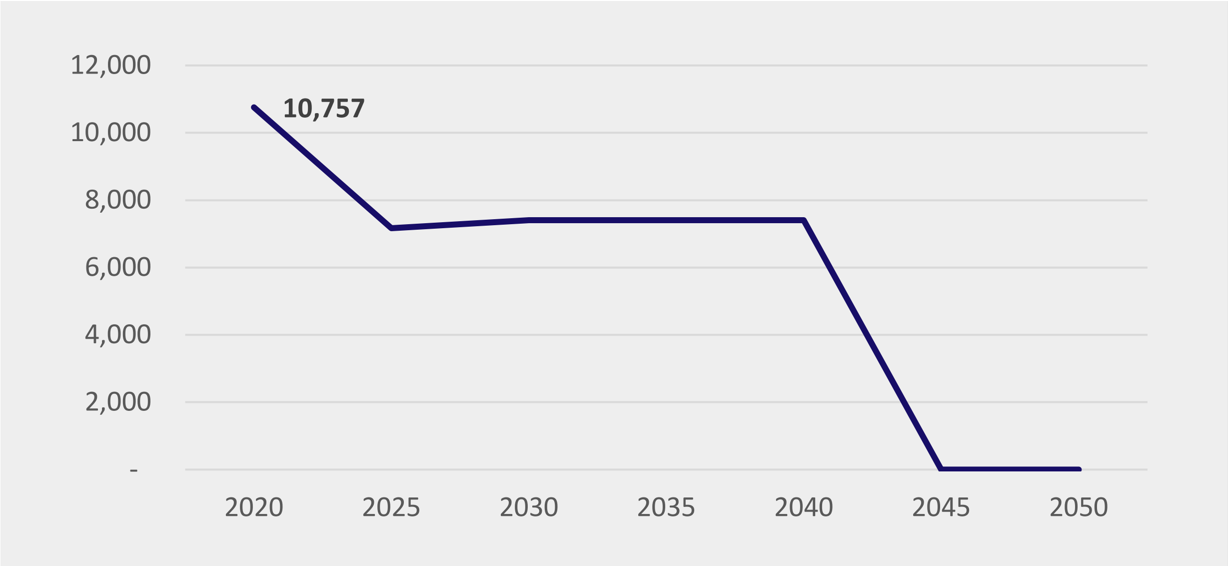


Figure 43. Natural Gas Inputs (2021-2050): Total Installed Capacity (MW)– Moderate Electrification



Under both scenarios, the decline in capacity installed leads to a decline in additional jobs (see Figure 44 and Figure 45). Under the Reference scenario, more than 4,000 jobs are lost between 2021 and 2040, totaling 2,615 by

2040 and reaching 0 new jobs by 2045. Under the Moderate Electrification scenario, the decline in additional jobs is more gradual, with a loss of jobs (-2,620 jobs) by 2040. However, this scenario also shows 0 new jobs by 2045. These job losses are mostly driven by Induced employment and Construction, which occupy more than half of the sub-sector throughout the period of analysis under both scenarios.

Figure 44. Natural Gas Outputs (2021-2050) – Reference

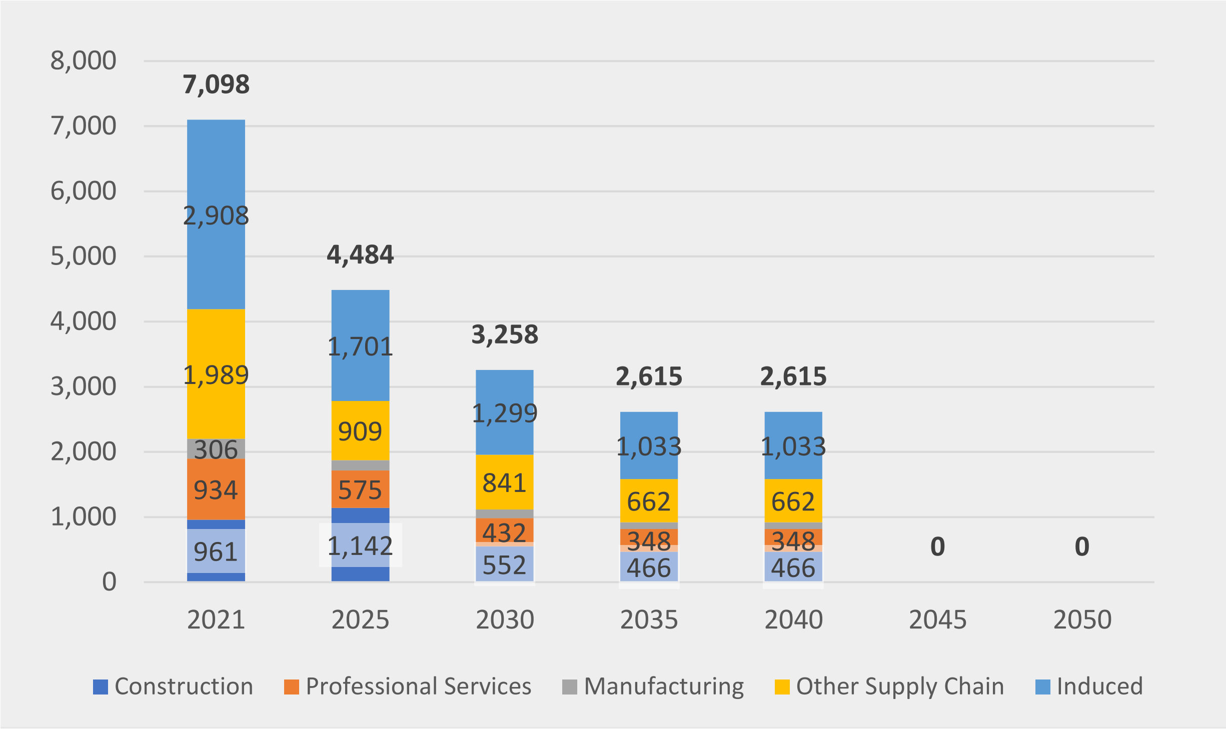
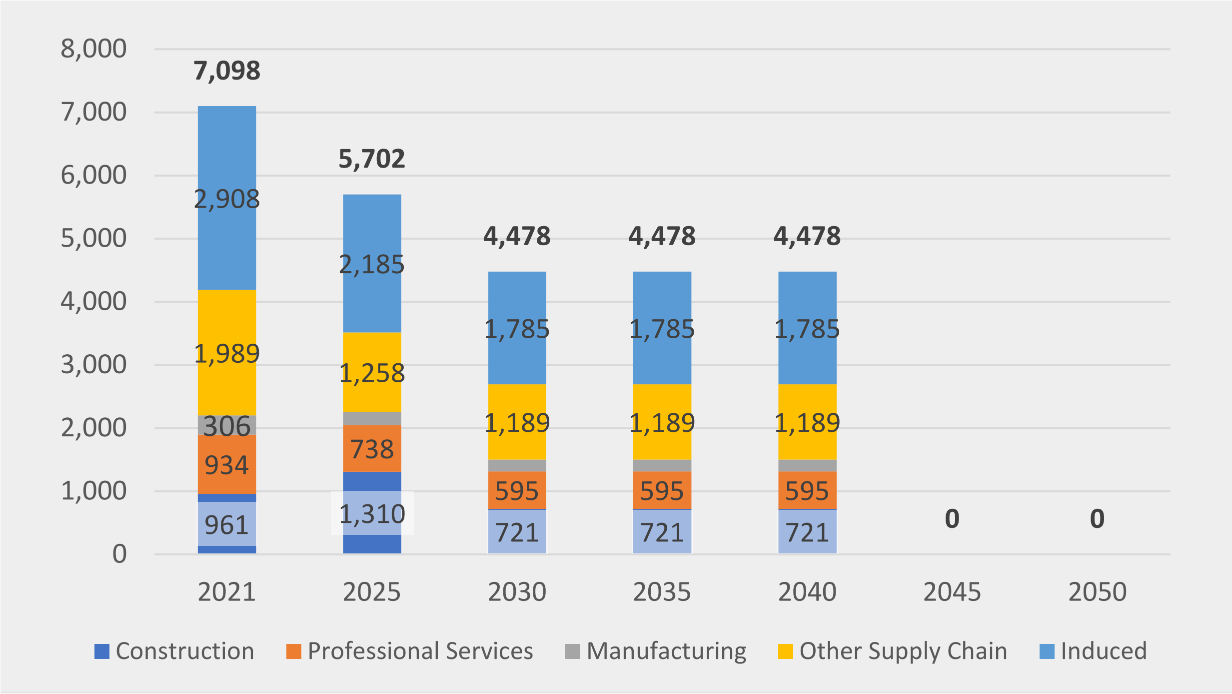


Figure 45. Natural Gas Outputs (2021-2050) – Moderate Electrification



Other Fossil Generation

The Other Fossil Generation sub-sector, also a displaced sub-sector, is comprised of technologies such as coil, oil, and other fossil fuel-burning power plants.

Under both Reference and Moderate Electrification scenarios, Other Fossil Generation's total capacity begins at 5,639MW, and reaches complete retirement by 2030 (see Figure 46 and Figure 47).

For this sub-sector, the Reference and Moderate Electrification scenarios assumed the same or a similar investment schedule. Charts were included for both scenarios to be consistent with those sub-sectors where the investment schedules differed.

Figure 46. Other Fossil Generation Inputs (2021-2050): Total Installed Capacity (MW) – Reference

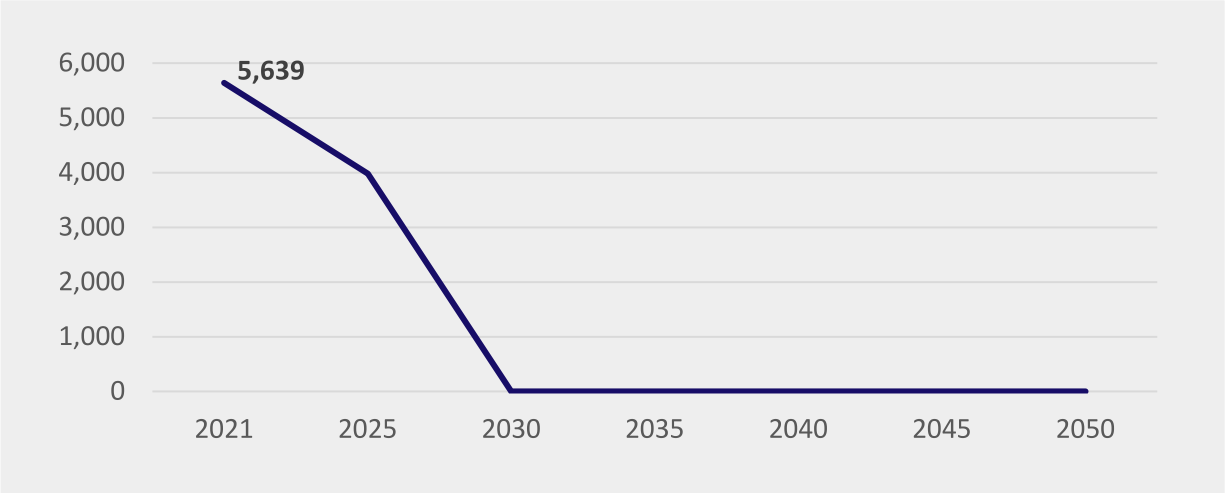
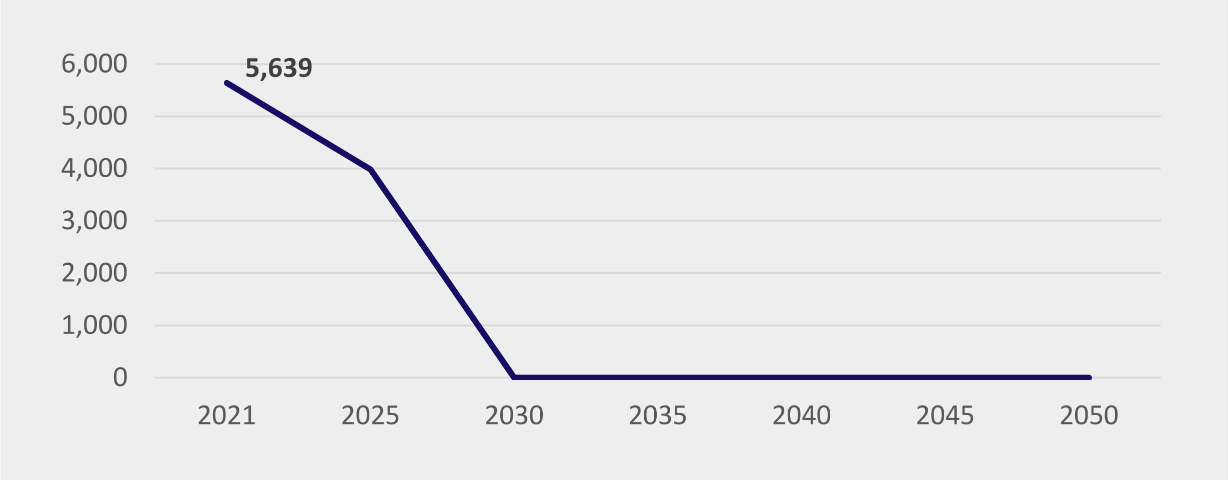


Figure 47. Other Fossil Generation Inputs (2021-2050): Total Installed Capacity (MW) – Moderate Electrification



The sharp decline in total capacity installed in both scenarios leads to identical results in additional jobs (Figure 48 and Figure 49). By 2030, there will be (-2,200 jobs) jobs lost in this sub-sector, before reaching a complete halt in 2035. Between 2021 and 2030, these changes will mostly be driven by Induced employment, Construction, and Professional Services, which occupy the largest share of employment in the Fossil Generation sub-sector.

Figure 48. Other Fossil Generation Outputs (2021-2050) – Reference

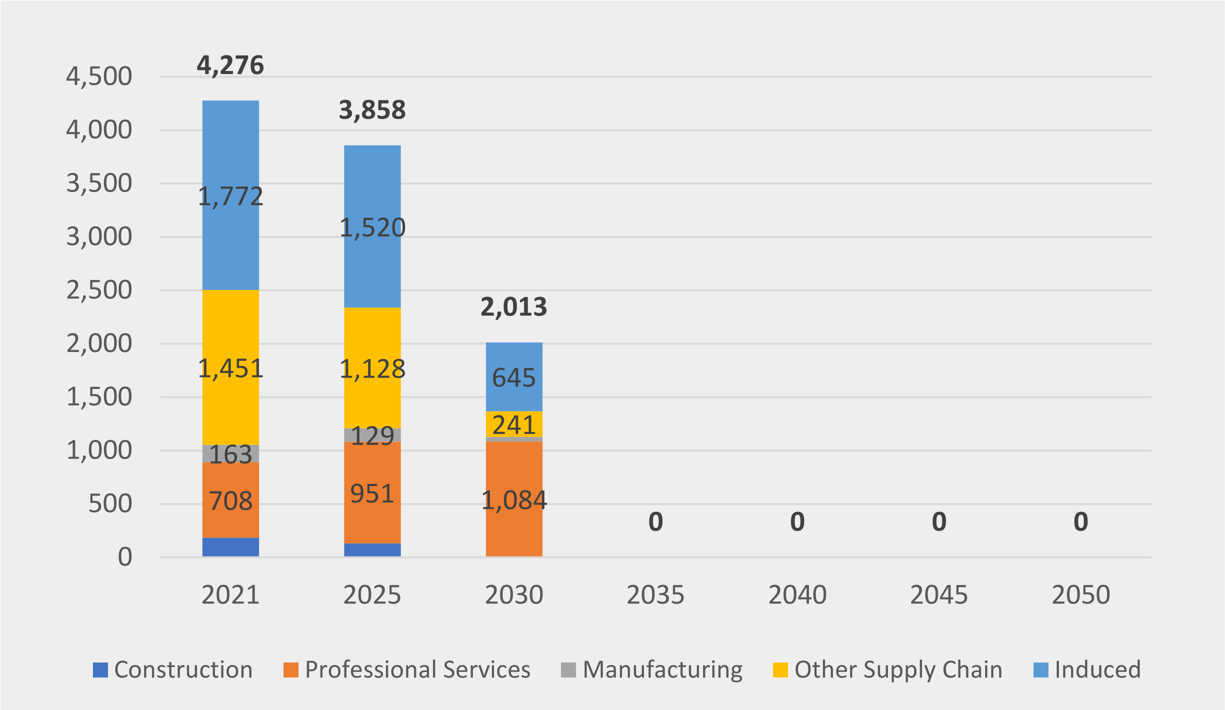
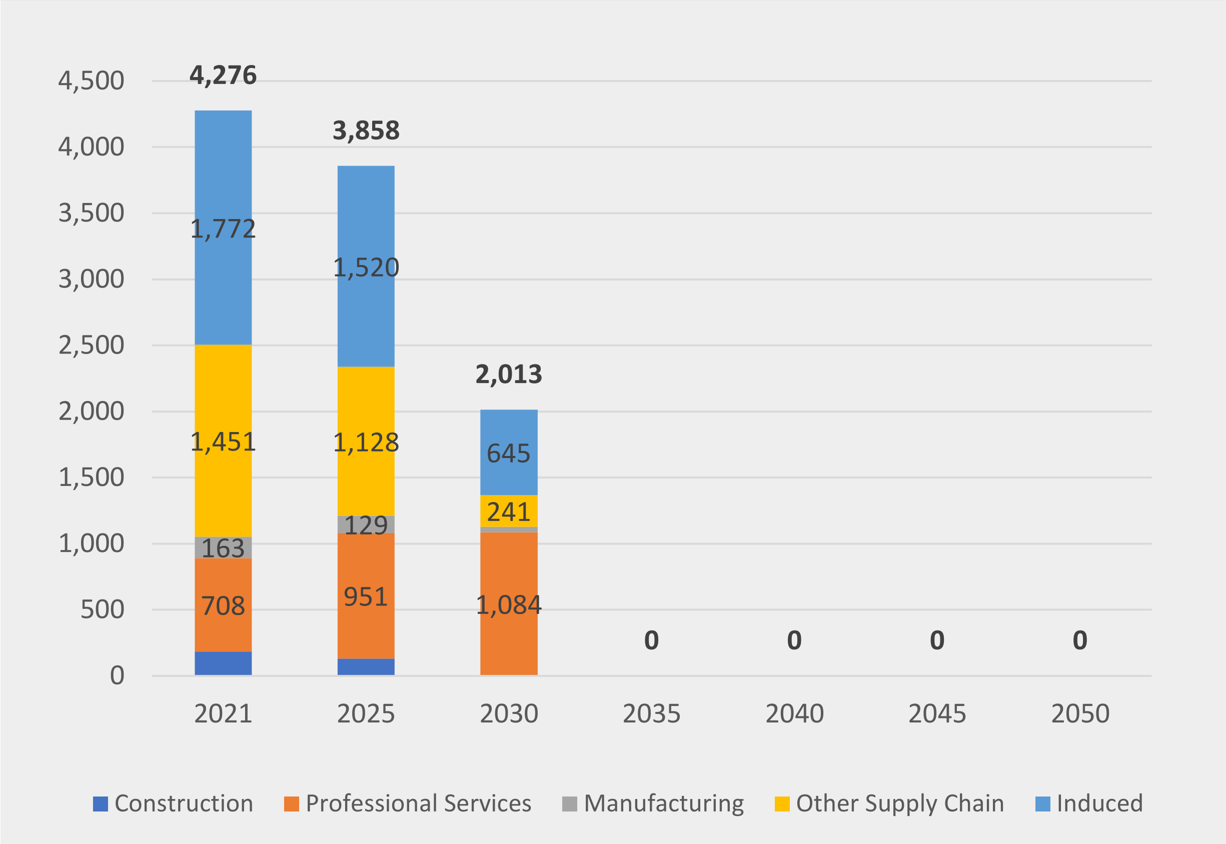


Figure 49. Other Fossil Generation Outputs (2021-2050) – Moderate Electrification



Nuclear

The Nuclear sub-sector is comprised of technologies such as nuclear power plants.

In both the Reference and Moderate Electrification scenarios, Nuclear total installed capacity is capped at 10,656MW from the baseline year until the final year of analysis (see Figure 50 and Figure 51).

For this sub-sector, the Reference and Moderate Electrification scenarios assumed the same or a similar investment schedule. Charts were included for both scenarios to be consistent with those sub-sectors where the investment schedules differed.

Figure 50. Nuclear Inputs (2021-2050): Total Installed Capacity (MW) – Reference

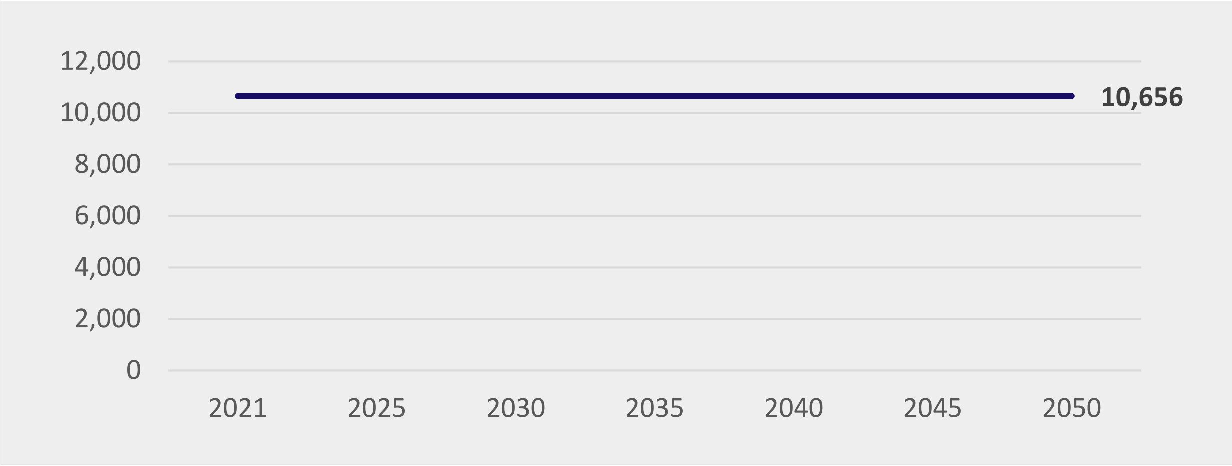
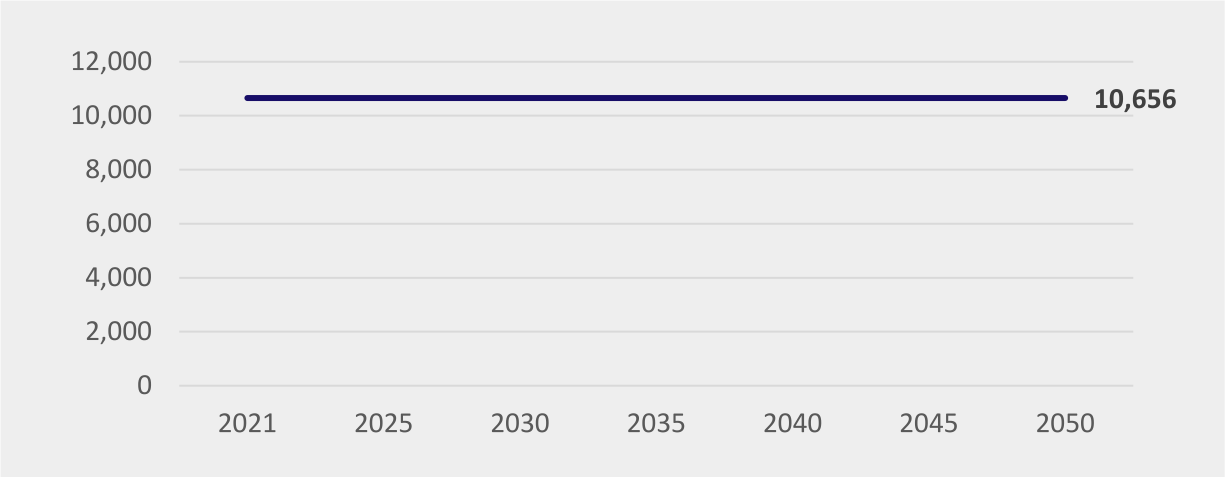


Figure 51. Nuclear Inputs (2021-2050): Total Installed Capacity (MW) – Moderate Electrification



No additional jobs are created throughout the period of analysis (see Figure 52 and Figure 53). Employment remains constant at approximately 7,800 jobs in both scenarios. Here, Induced employment and Construction occupy the largest share of the Nuclear sub-sector, accounting for about 92 percent of employment.

Figure 52. Nuclear Outputs (2021-2050) – Reference

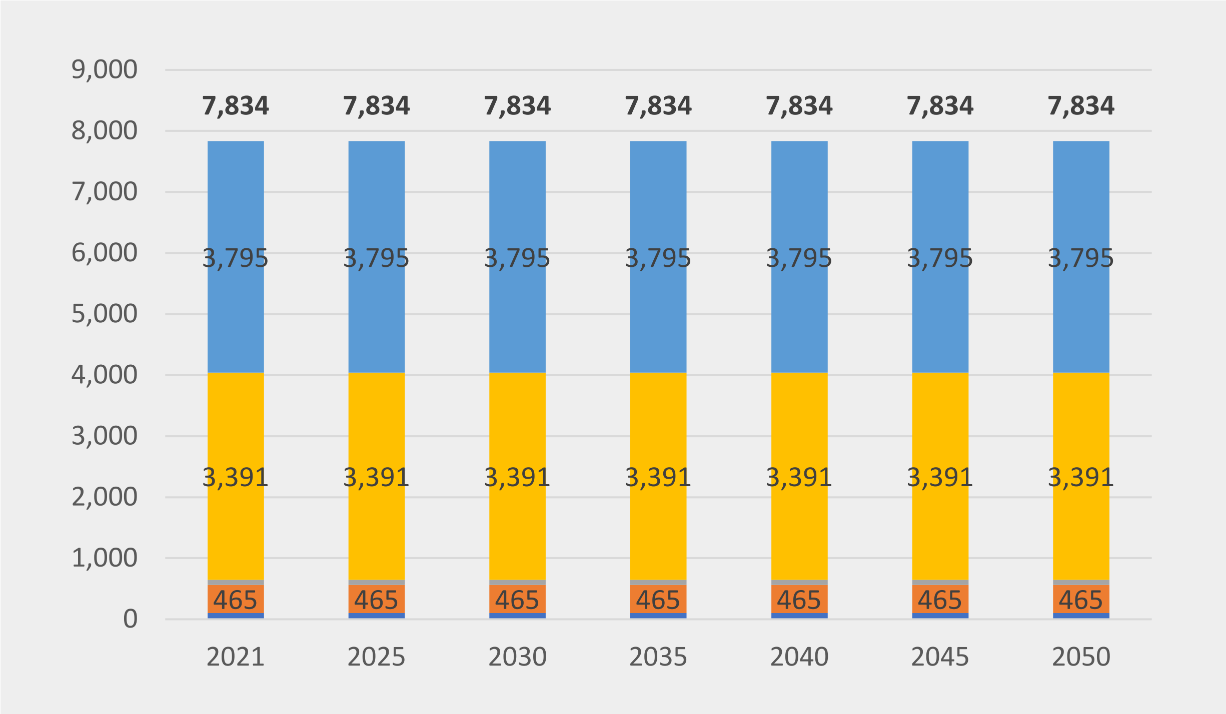
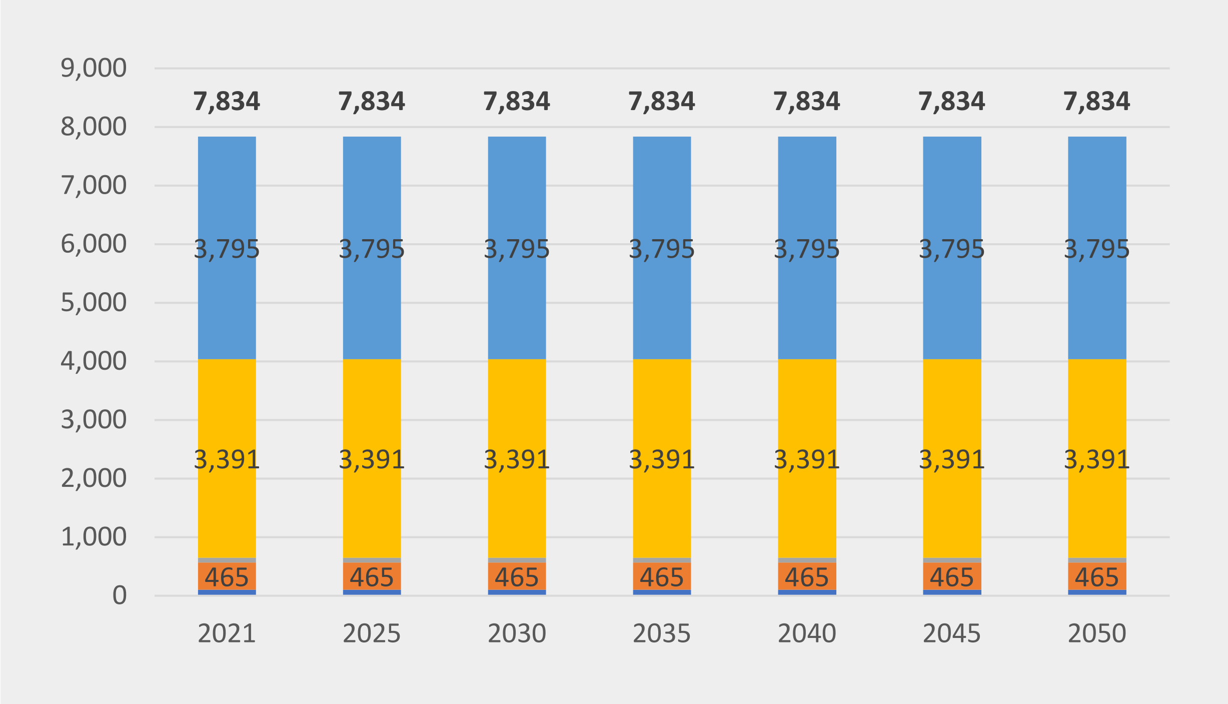


Figure 53. Nuclear Outputs (2021-2050) – Moderate Electrification



Fuels

The Fuels sector is composed of five sub-sectors: Hydrogen Fuel, Bioenergy, Natural Gas, Natural Gas Distribution, and Petroleum Fuels. BW Research has identified Natural Gas, Natural Gas Distribution and Hydrogen as growing sub-sectors. Conversely, Bioenergy and Petroleum were identified as displaced sub-sectors.

Table 9 and Table 10 show the overall— as well as the sector- and sub-sector-specific— initial employment outputs for the Reference and Moderate Electrification scenarios. By 2030, the Fuel sector will experience a net decrease (-1,632 jobs) in jobs in the Reference scenario, and a net increase (4,578 jobs) in the Moderate Electrification scenario. By 2050, the Fuel sector will experience a net decrease (-6,342 jobs) in the Reference scenario, and a net increase (45, 516 jobs) in the Moderate Electrification scenario.

The declines in the Reference case are caused by considerable displacement in both the Bioenergy and Petroleum sub-sectors, that results in a displacement of over 13,000 jobs by 2050. However, although the net change in employment is driven by this considerable decline in displaced sub-sectors, it is noteworthy to mention that the growing sub-sectors are generating a total growth of at least 29,000 jobs by 2050, with more than 7,000 additional jobs than the 2021 baseline figure.

Table 9. Fuels: Overall Employment Output - Reference

SUB-SECTOR	YEAR						
	2021	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Natural Gas	2,701	2,872	2,911	2,952	3,000	3,049	3,099
Natural Gas Distribution	19,236	20,592	20,952	21,314	21,701	22,074	22,422
Hydrogen	0	110	386	920	1,613	2,546	3,710
Total Growth	21,937	23,574	24,249	25,186	26,314	27,669	29,231
Change in Growth		+1,637	+2,312	+3,249	+4,377	+5,732	+7,295
Displacement Sub-Sectors							
Bioenergy	7,171	6,907	5,995	5,069	4,335	3,846	3,544
Petroleum	25,980	26,142	23,212	20,259	18,074	16,714	15,970
Total Displaced	33,151	33,049	29,207	25,328	22,409	20,560	19,514
Change in Displaced		-102	-3,944	-7,823	-10,742	-12,591	-13,637
Fuels OVERALL	**55,088**	**56,623**	**53,456**	**50,514**	**48,723**	**48,229**	**48,745**
Net Change from 2021		**+1,535**	**-1,632**	**-4,574**	**-6,365**	**-6,859**	**-6,342**

Table 10 shows the overall as well as the sector- and sub-sector-specific initial employment outputs for the Moderate Electrification scenario. Overall employment in the Fuels sector shows growth of at least 69,000 jobs, with more than 14,000 jobs added in 2040 in comparison to the 2021 baseline figure. Displaced sub-sectors will also be declining in this scenario, with over 38,000 displaced jobs by 2050 in the Petroleum, Natural Gas, and Natural Gas Distribution sub-sectors. However, Bioenergy and Hydrogen will significantly offset this displacement, as these sub-sectors will add more than 84,000 jobs by the final year of analysis.

Table 10. Fuels: Overall Employment Output – Moderate Electrification

SUB-SECTOR	YEAR						
	2021	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Bioenergy	7,171	7,304	12,762	19,899	27,887	40,094	56,057
Hydrogen	0	1,186	5,010	11,976	19,373	27,237	35,355
Total Growth	7,171	8,490	17,772	31,875	47,260	67,331	91,412
Change in Growth		+1,320	+10,601	+24,705	+40,090	+60,160	+84,242
Displacement Sub-Sectors							
Petroleum	25,980	25,630	21,519	15,646	10,928	7,056	5,088
Natural Gas	2,701	2,786	2,487	1,926	1,367	857	567
Natural Gas Distribution	19,236	19,857	17,888	13,826	9,646	5,778	3,537
Total Displaced	47,917	48,225	41,894	31,398	21,941	13,691	9,192
Change in Displaced		+388	-6,023	-16,519	-25,976	-34,226	-38,725
Fuels OVERALL	**55,088**	**56,745**	**59,666**	**63,273**	**69,201**	**81,022**	**100,604**
Net Change from 2021		**+1,657**	**+4,578**	**+8,186**	**+14,114**	**+25,934**	**+45,516**

Hydrogen Fuel

The Hydrogen Fuel sub-sector, a growing sub-sector, is comprised of technologies such as hydrogen fuel cells.

Hydrogen Fuel is a growing sub-sector under both the Reference and Moderate Electrification scenarios, although growth it is more pronounced in the latter (Figure 54). In the Reference scenario, initial annual investments start at $1M in the baseline year, and reach $589M by the final year of analysis. In the Moderate Electrification scenario, the annual investments are much higher, as the initial investment made during the baseline year totals $31M, reaching $5,609M by 2050. Annual investments are ten times higher in the Moderate Electrification case ($5,609M) than in the Reference case ($589M), which should result in proportional job changes. By the final year, almost 4,000 jobs are created under the Reference scenario.

Figure 54. Hydrogen Fuel Inputs (2021-2050): Annual Investment ($M) - Reference vs. Moderate Electrification

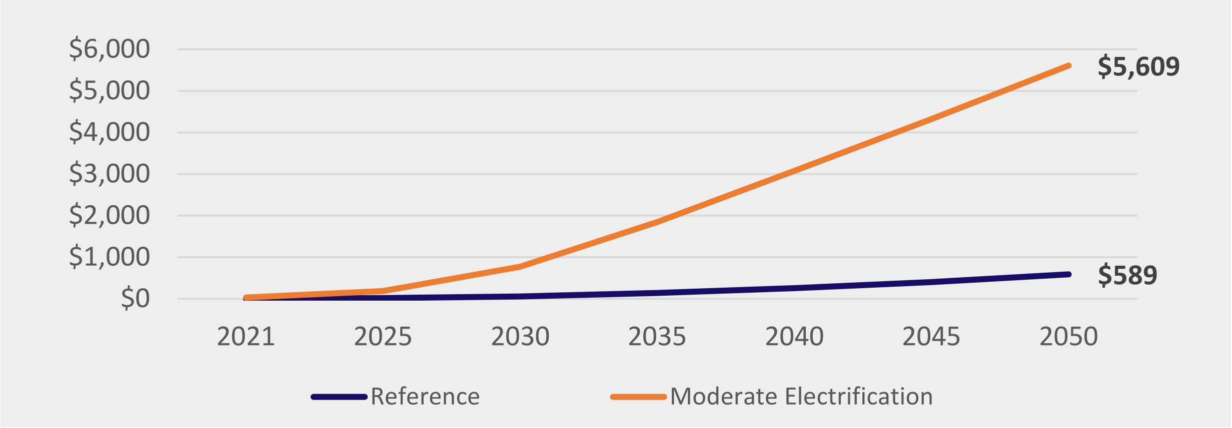
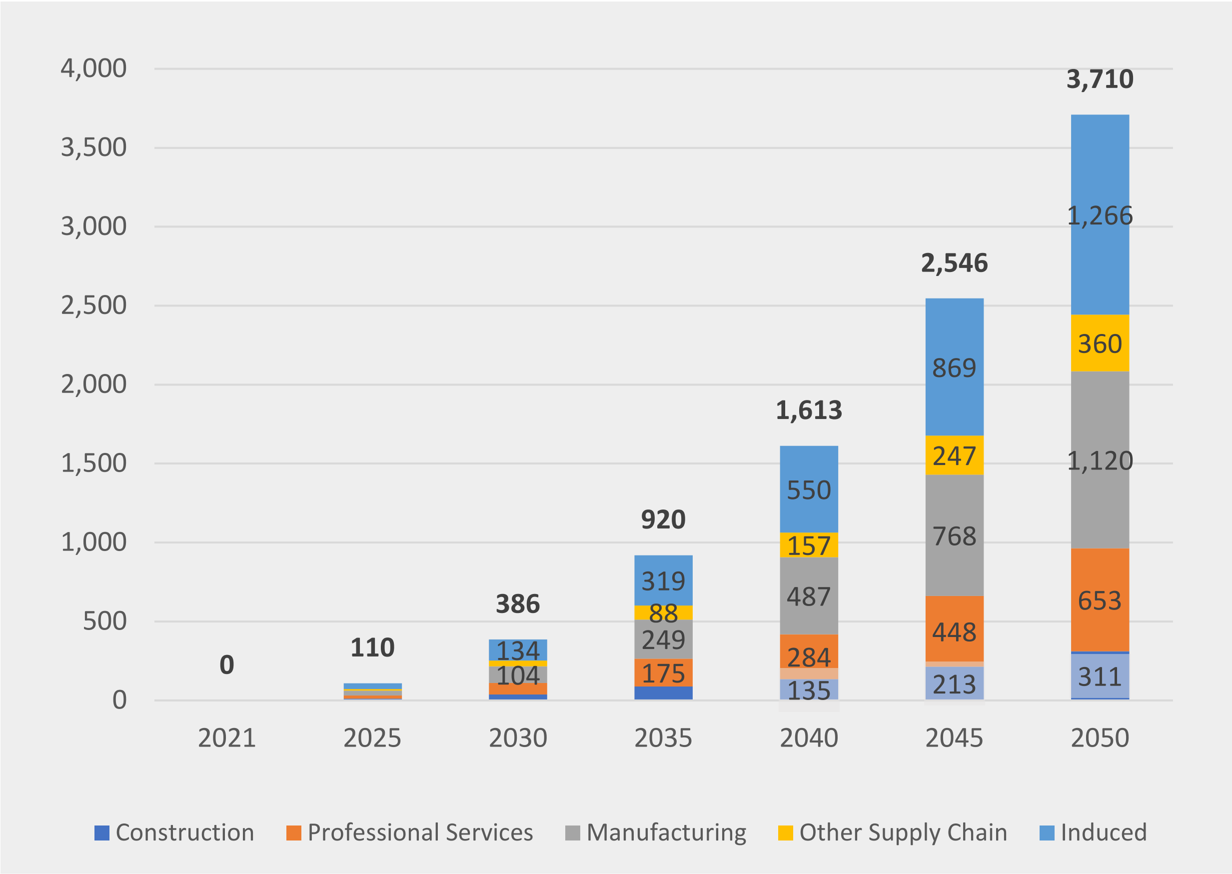
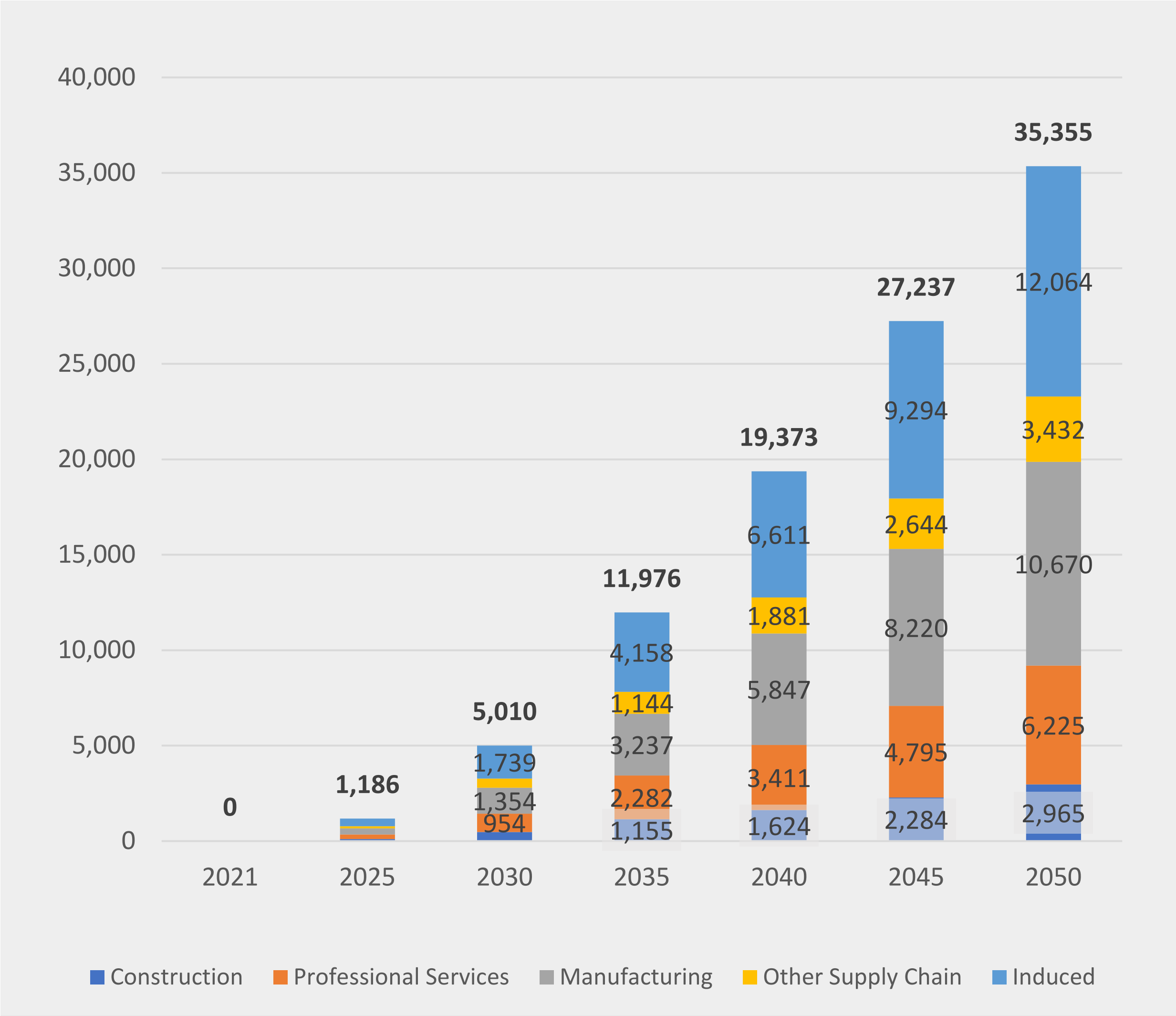


Figure 55. Hydrogen Fuel Outputs (2021-2050) – Reference



In comparison, the Moderate Electrification scenario provides more than 35, 000 additional jobs (Figure 56). Nevertheless, the trends are similar in both instances, as Induced employment, Manufacturing, and Professional Services occupy the largest share of employment in both scenarios.

Figure 56. Hydrogen Fuel Outputs (2021-2050) – Moderate Electrification

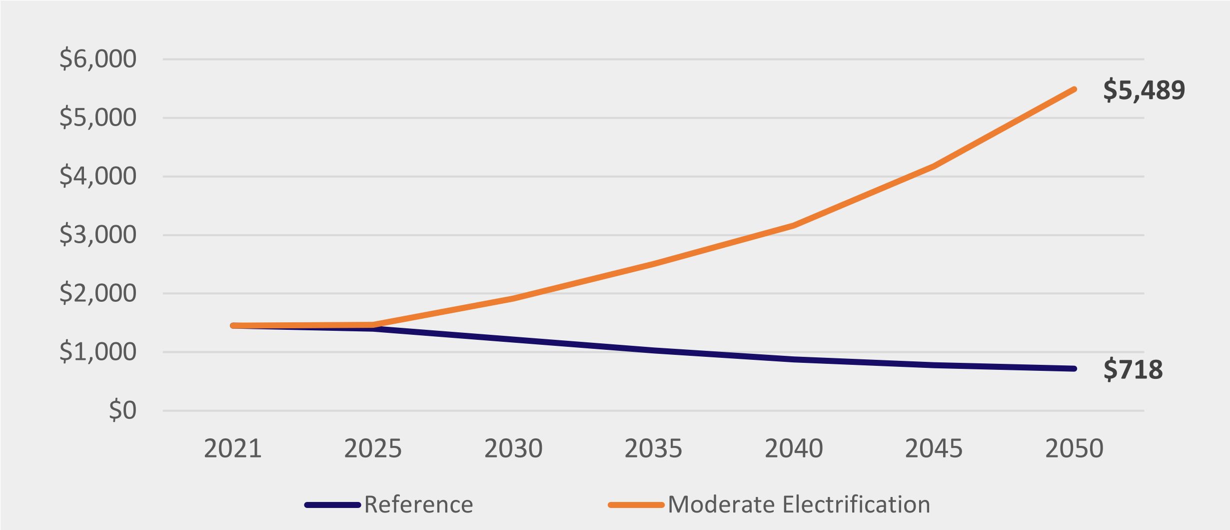


Bioenergy

The Bioenergy sub-sector, a growing sub-sector, is comprised of technologies such as renewable diesel, ethanol, biodiesel, renewable gasoline, renewable natural gas, renewable jet fuel, and jet kerosene.

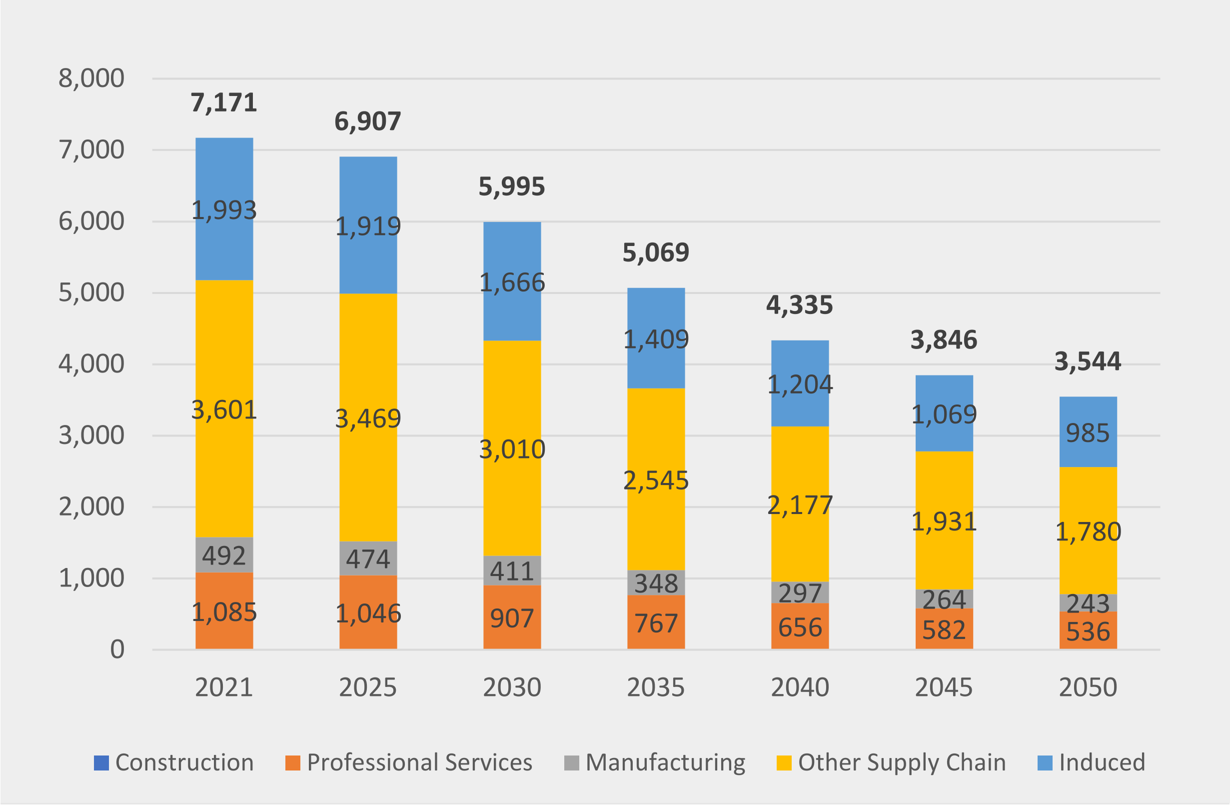
The Reference and Moderate Electrification scenarios are following opposing trends in this sub-sector (see Figure 57). In the Reference scenario, annual investments start at $1,453M in 2021, slowly declining until they reach $718M by the final year of analysis. Meanwhile, the Moderate Electrification scenario starts with a low annual investment in the baseline year, totaling $545M, eventually increasing to $5,653M by 2050.

Figure 57. Bioenergy Inputs (2021-2050): Annual Investment ($M) – Reference vs. Moderate Electrification



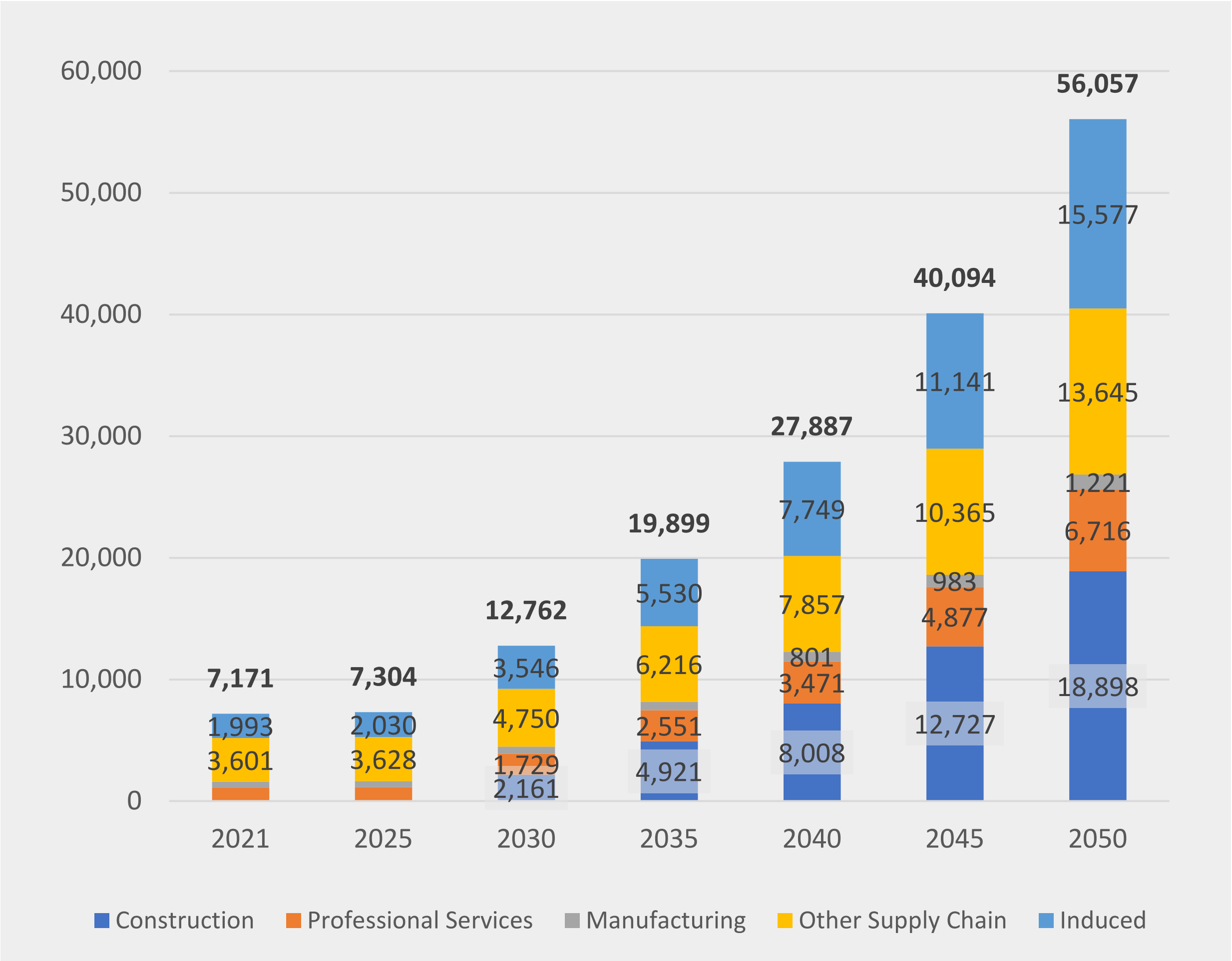
These opposing trends are further reflected in the associated changes in additional jobs in the Reference scenario (Figure 58). Under the Reference scenario, more than 3,600 jobs are lost between 2021 and 2050. Those changes are largely due to Induced employment and Other Supply Chain, which drive the sub-sector under this scenario.

Figure 58. Bioenergy Outputs (2021-2050) – Reference



In the Moderate Electrification scenario, more than 48,000 additional jobs are created by the final year of analysis (Figure 59). Here, changes in additional jobs are mostly driven by Construction (18,800 jobs), Induced employment (13,500 jobs) and Other Supply Chain (10,000 jobs) by 2050.

Figure 59. Bioenergy Outputs (2021-2050) – Moderate Electrification

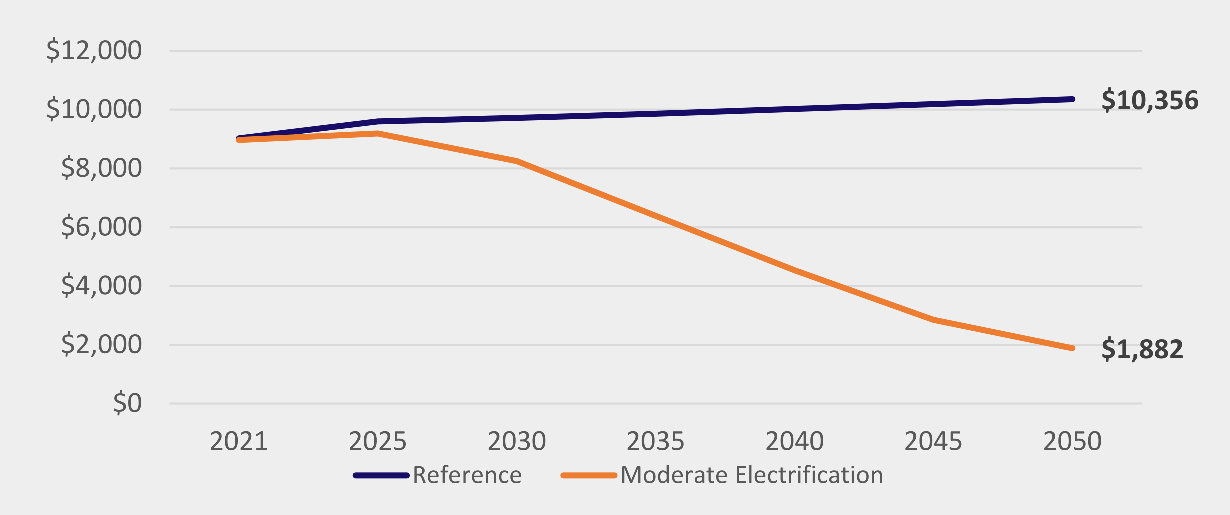


Natural Gas

Natural Gas, a displaced sub-sector, is comprised of technologies such as natural gas fuels.

Here, investments made under the Reference and Moderate Electrification scenarios follow opposite trends (see Figure 60). Under the Reference scenario, annual investments start at $9,024M in 2021 and increase slightly until they reach $10,356M by the final year of analysis. Under the Moderate Electrification scenario, annual investments total $8,965M in the baseline year, progressively declining to $1,882M in 2050. The differences in investments in both scenarios lead to differences in job changes.

Figure 60. Natural Gas Inputs (2021-2050): Annual Investment ($M) - Reference and Moderate Electrification



Overall, the Reference scenario shows a slight increase in additional jobs by the final year of analysis, that is mostly driven by Induced employment and Other Supply Chain (Figure 61). The Moderate Electrification scenario shows a steady decrease in additional jobs, with an exception in 2025 that corresponds to a peak in investments, where more than 2,000 jobs are displaced, mostly in Induced employment, Other Supply Chain and Manufacturing (Figure 62).

Figure 61. Natural Gas Outputs (2021-2050) – Reference

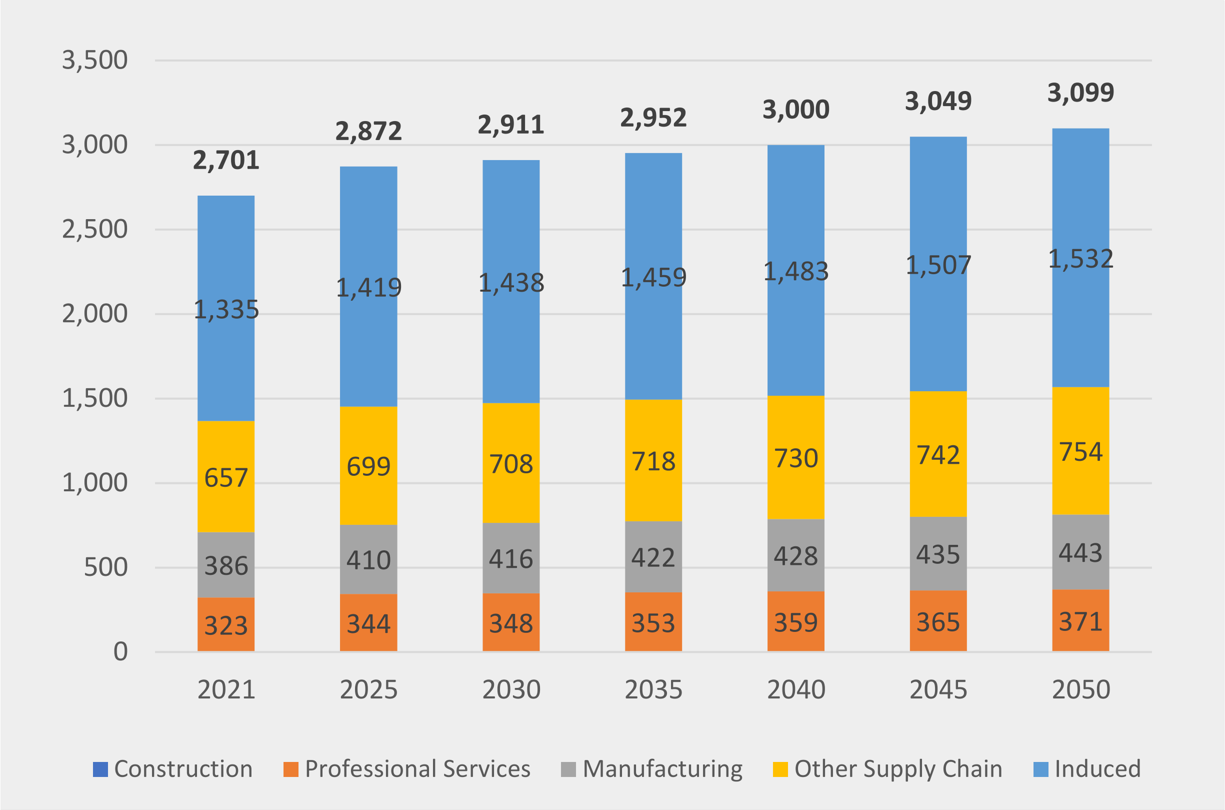
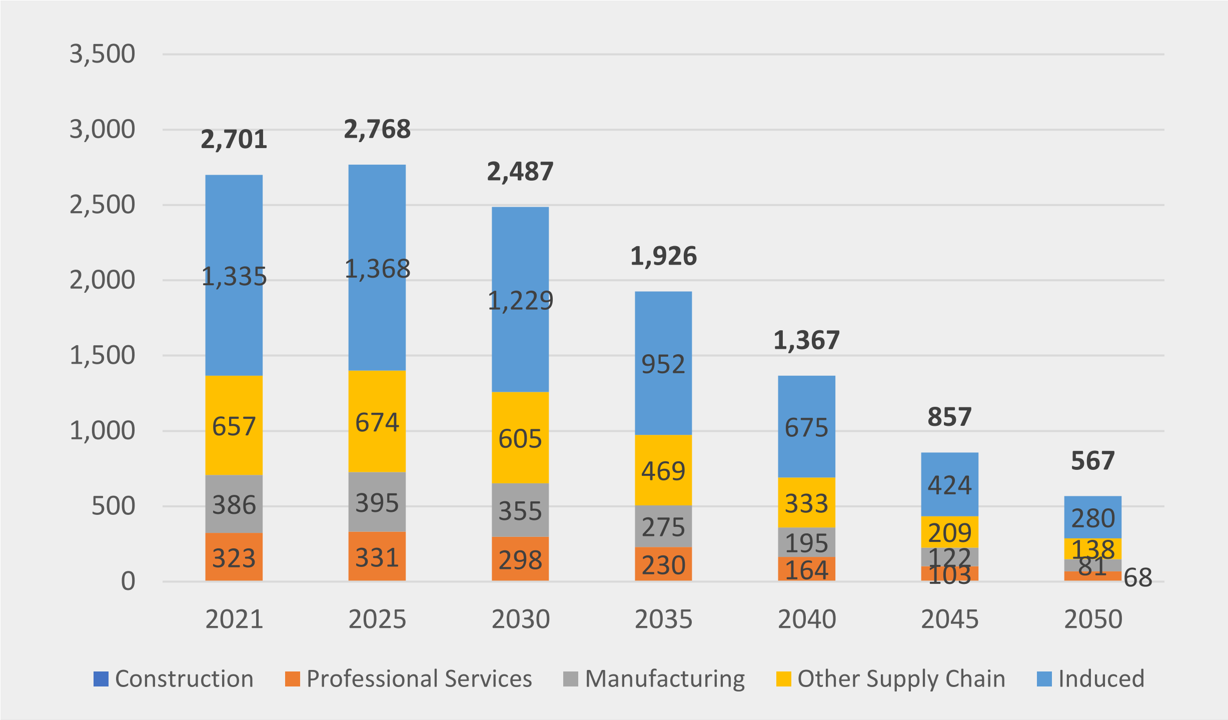


Figure 62. Natural Gas Outputs (2021-2050) – Moderate Electrification



Natural Gas Distribution

The Natural Gas Distribution sub-sector, a displaced sub-sector, is comprised of technologies such as natural gas pipelines and liquified natural gas trucks and tankers.

Fuel demand in both the Reference and Moderate Electrification scenarios begins at 100 percent (see Figure 63 and Figure 64). However, fuel demand will steadily increase in the Reference scenario whereas fuel demand will decrease significantly under Moderate Electrification. The Reference scenario calls for a steady increase in demand, reaching 117 percent by the final year of analysis. The Moderate Electrification scenario shows a decrease by half in 2040, before decreasing to 18 percent demand in the final year of analysis.

Figure 63. Natural Gas Distribution Inputs (2021-2050): Fuel Demand – Reference

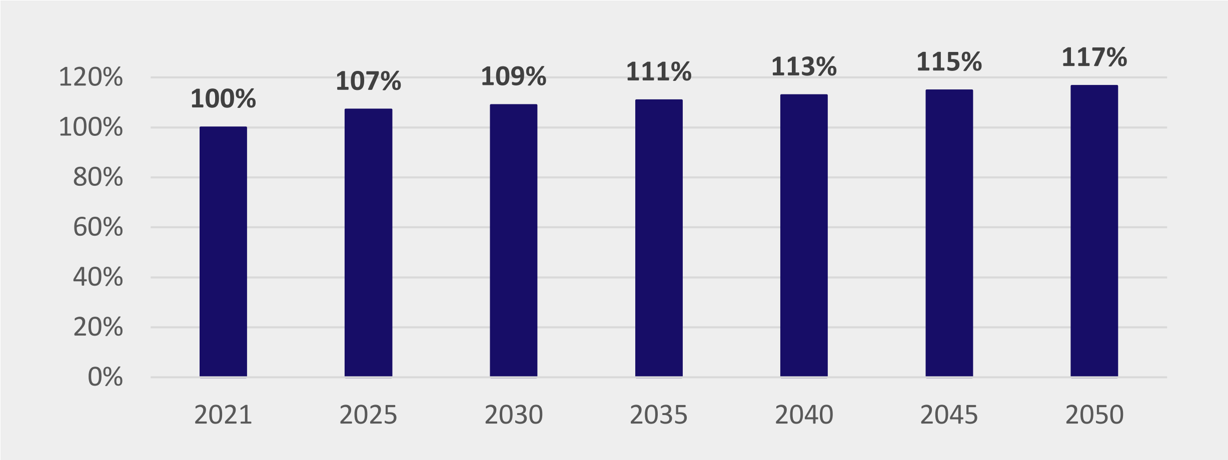
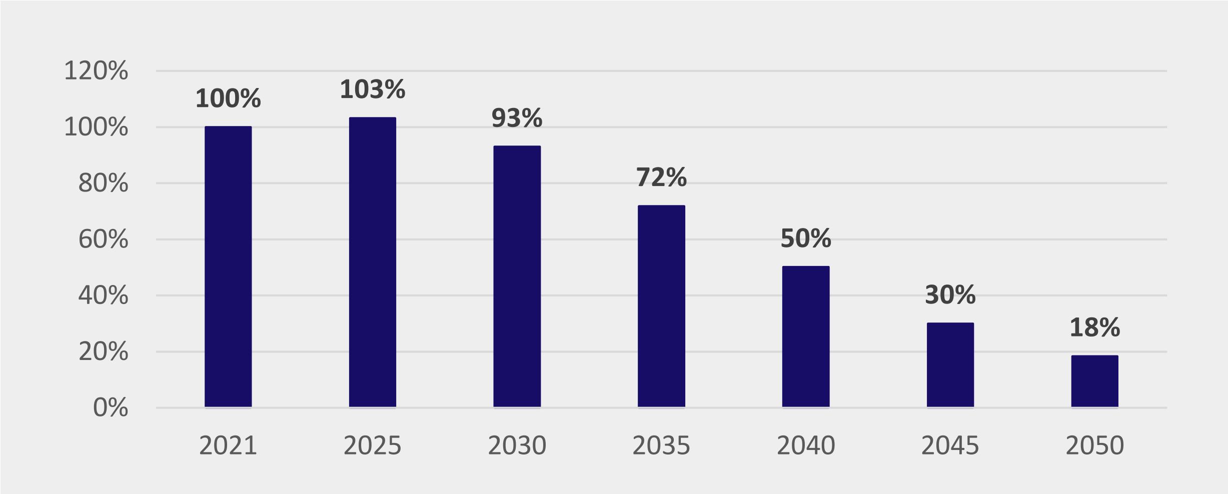
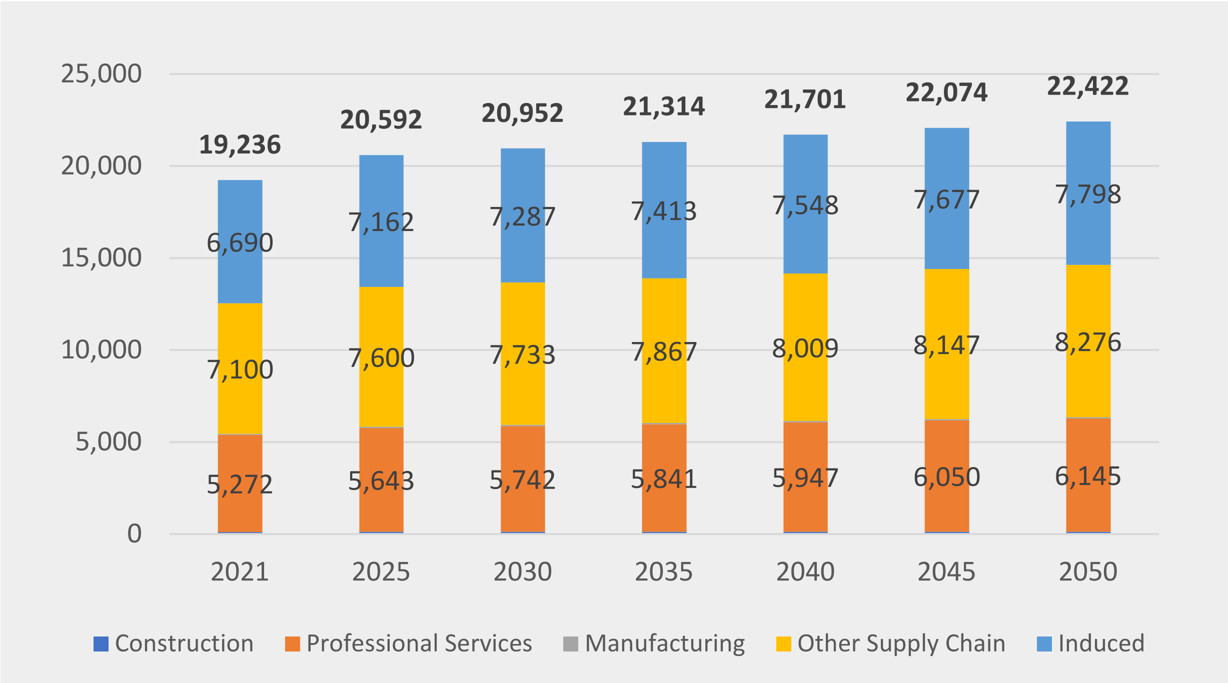


Figure 64. Natural Gas Distribution Inputs (2021-2050): Fuel Demand – Moderate Electrification



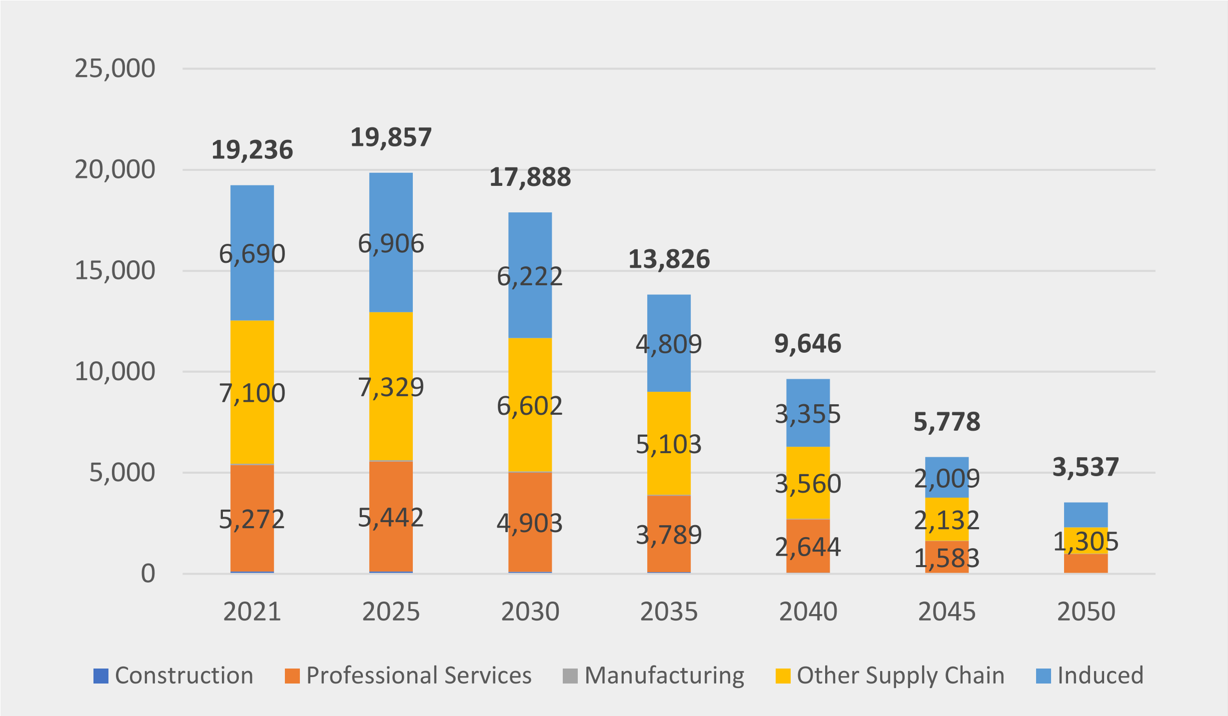
Given increasing fuel demand in the Reference scenario between 2021 and 2050, employment numbers increase in the same time frame (Figure 65). The sub-sector gains more than 3,000 jobs under the Reference scenario, which is driven by Other Supply Chain, Induced employment, and Professional Services.

Figure 65. Natural Gas Distribution Outputs (2021-2050) – Reference



By contrast, more than 15,000 jobs are displaced under the Moderate Electrification scenario (Figure 66). Other Supply Chain, Induced employment, and Professional Services shrink proportionally to the decreased demand between 2021 and 2050.

Figure 66. Natural Gas Distribution Outputs (2021-2050) – Moderate Electrification

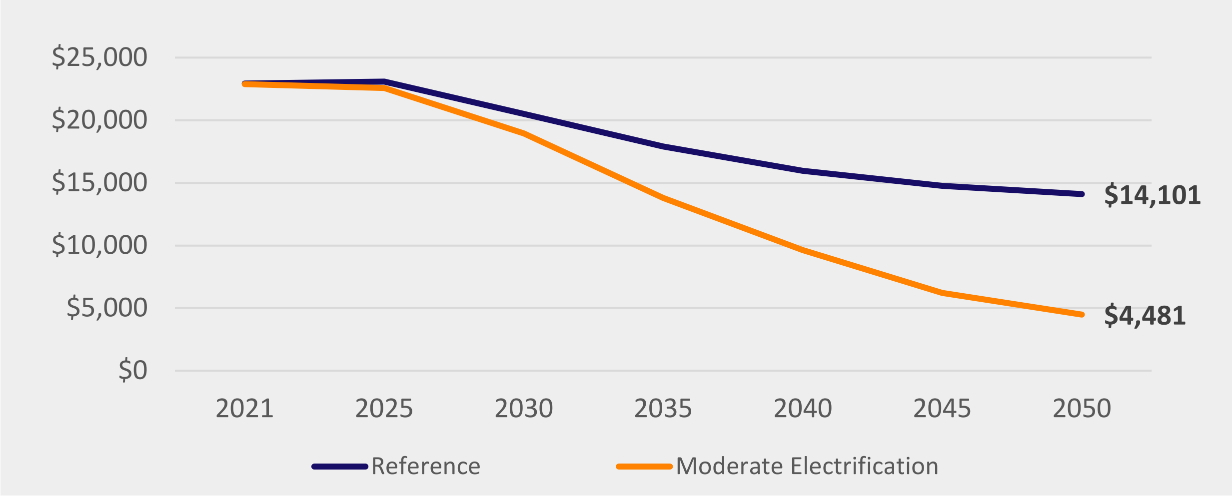


Petroleum Fuels

The Petroleum Fuel sub-sector, a displaced sub-sector, is comprised of technologies such as oil and gas pipelines, kerosene, and oil and fuel trucks and tankers.

Both the Reference and Moderate Electrification scenarios predict a decrease in annual investments (see Figure 67). The Reference scenario starts at $22,941M in the baseline year, steadily decreasing until it reaches $14,101M by the final year of analysis. The Moderate Electrification scenario starts at $22,881M in the baseline year, with a pronounced decrease that will leave investments at $4,481M by 2050. Thus, the change in additional jobs in each scenario is proportional to the change in annual investments made over the full period of analysis.

Figure 67. Petroleum Fuel Inputs (2021-2050): Annual Investment ($M) – Reference vs. Moderate Electrification



In the Reference scenario, about 10,000 jobs are displaced by 2050, which can be attributed to Induced employment and Other Supply Chain (Figure 68). In the Moderate Electrification scenario, almost 21,000 jobs are displaced by 2050 (Figure 69). This is mostly due to a shrinkage in Induced employment and Other Supply Chain as demand decreases dramatically.

Figure 68. Petroleum Fuel Outputs (2021-2050) – Reference

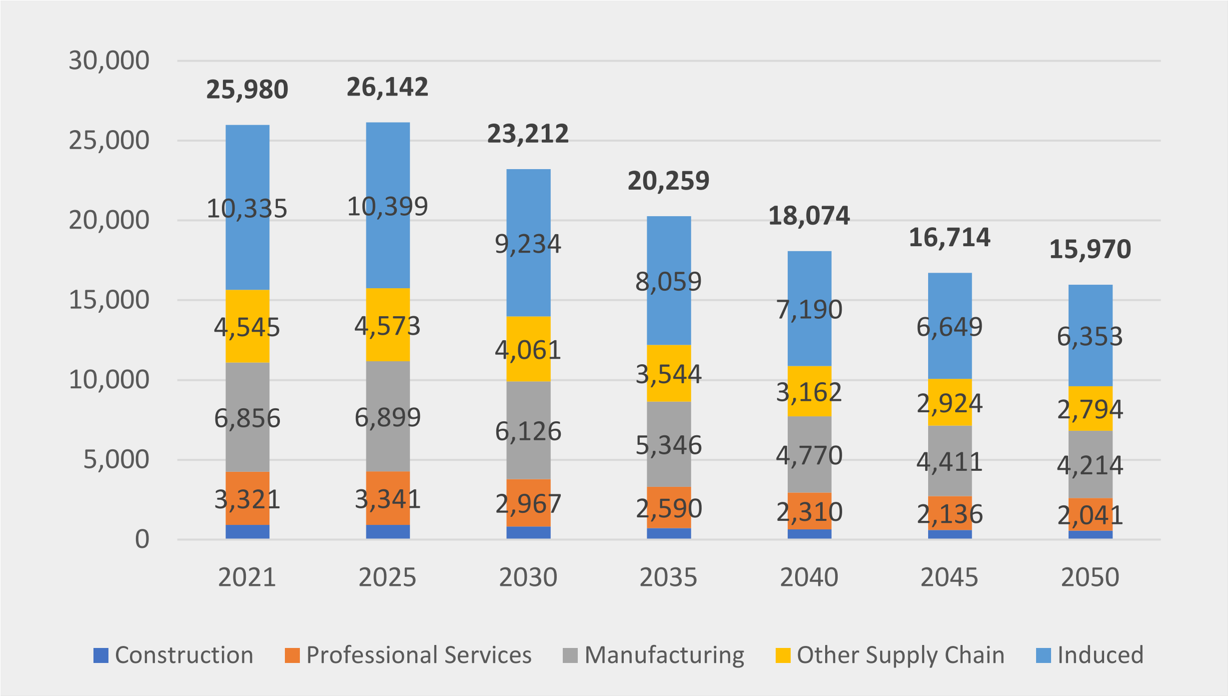
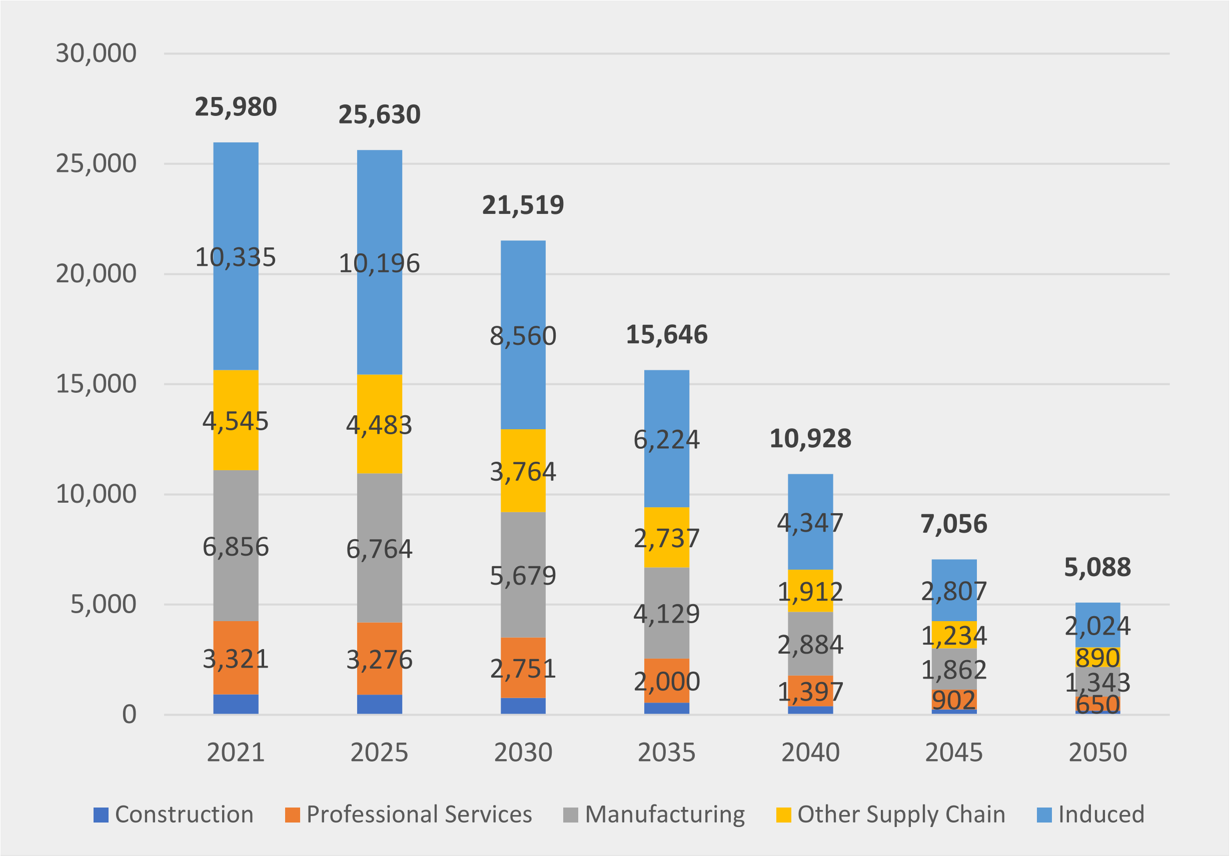


Figure 69. Petroleum Fuel Outputs (2021-2050) – Moderate Electrification



Buildings

In 2020, the Buildings sector was responsible for 42.8 percent of total greenhouse gas emissions in Illinois.[26] The Buildings sector is composed of five sub-sectors: Residential HVAC, Residential Shell, Residential Other, Commercial HVAC, and Commercial Other.[27]

In both the Reference and Moderate Electrification scenarios, the sub-sectors expected to experience growth are Commercial HVAC, Residential HVAC, and Residential Shell (see Table 11 and Table 12). Commercial Other is expected to be displaced in 2030 but grow by 2050 in both the Reference and Moderate Electrification scenario.

By 2030, the Buildings sector is expected to see a net increase of 2,800 jobs under the Reference scenario and 20,700 jobs under the Moderate Electrification scenario. By 2050, the Buildings sector sees a net gain of 24,400 jobs under the Reference scenario and 63,900 jobs under the Moderate Electrification scenario. The rapid increase in net jobs between 2030 and 2050 under the Moderate Electrification scenario is largely driven by job growth in the Commercial HVAC and Residential HVAC sub-sectors, which are expected to grow by 20,900 jobs and 10,000 jobs, respectively.

[26] U.S. Energy Information Industry (EIA). Energy-Related CO_2 Emission Data Tables. Table 3. State energy-related carbon dioxide emissions by sector. https://www.eia.gov/environment/emissions/state/.
[27] Commercial Shell is not included in this analysis because Commercial Shell investments are not generated by the PATHWAYS model.

Table 11. Buildings: Overall Employment Output – Reference

SUB-SECTOR	YEAR						
	2021	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Residential Shell	5,778	5,987	6,365	6,729	7,117	7,514	7,912
Residential HVAC	40,006	44,257	43,388	43,210	46,250	49,233	50,017
Residential Other	15,629	15,385	15,556	16,710	18,204	18,945	19,855
Commercial HVAC	33,468	34,065	33,731	34,880	36,885	38,063	40,378
Total Growth	94,881	99,694	99,040	101,529	108,456	113,755	118,162
Change in Growth		+4,813	+4,160	+6,649	+13,575	+18,874	+23,281
Displacement Sub-Sectors							
Commercial Other	13,061	12,172	11,704	11,704	12,103	12,946	14,223
Change in Displaced		-889	-1,357	-1,357	-958	-115	+1,161
Buildings OVERALL	**107,942**	**111,866**	**110,744**	**113,233**	**120,558**	**126,701**	**132,385**
Net Change from 2021		**+3,924**	**+2,802**	**+5,291**	**+12,616**	**+18,759**	**+24,443**

Table 12. Buildings: Overall Employment Output – Moderate Electrification

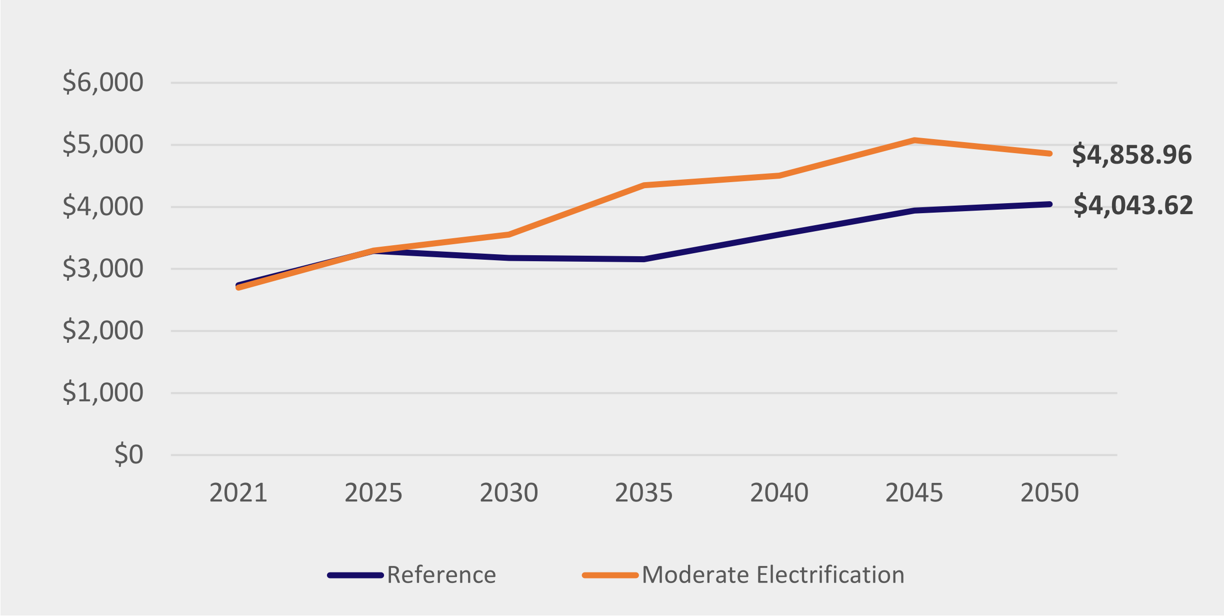
SUB-SECTOR	YEAR						
	2021	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Residential Shell	5,778	8,935	13,484	14,881	16,377	16,492	16,589
Residential HVAC	40,006	44,585	46,564	52,651	53,840	58,223	56,566
Residential Other	15,629	17,731	19,463	21,018	22,613	23,592	24,734
Commercial HVAC	33,468	34,899	38,095	50,523	55,176	56,850	59,005
Total Growth	94,881	106,149	117,606	139,073	148,005	155,158	156,894
Change in Growth		+11,269	+22,725	+44,192	+53,125	+60,277	+62,013
Displacement Sub-Sectors							
Commercial Other	13,061	11,748	11,083	11,083	11,724	13,023	14,974
Change in Displaced		-1,314	-1,978	-1,978	-1,337	-39	+1,913
Buildings OVERALL	**107,942**	**117,897**	**128,689**	**150,156**	**159,730**	**168,181**	**171,868**
Net Change from 2021		**+9,955**	**+20,747**	**+42,214**	**+51,788**	**+60,239**	**+63,926**

Residential HVAC

Residential HVAC, a growth sub-sector, consists of technologies such as residential central air conditioning, residential room air conditioning, and residential single and multi-family space heating.

In both the Reference and Moderate Electrification scenarios, investment in Residential HVAC increases between 2021 and 2050 (see Figure 70). Residential HVAC receives fewer investment dollars under the Reference scenario—peaking in 2050 with an investment of about $4M. Residential HVAC investment under the Moderate Electrification scenario reaches about $5M at its peak, which comes in 2045 rather than 2050.

Figure 70. Residential HVAC Inputs (2021-2050): Investments ($M) – Reference vs. Moderate Electrification



Residential HVAC employment outputs follow the same pattern as Residential HVAC investment for both the Reference and Moderate Electrification scenarios (see Figure 71 and Figure 72). Employment increases between 2021 and 2025, decreases between 2025 and 2035, and increases until 2050 under the Reference scenario and slowly increases between 2021 and 2045 before decreasing in 2050 under the Moderate Electrification scenario. Between 2021 and 2050, 10,000 jobs are created in the Residential Shell sub-sector under the Reference scenario and 16,500 jobs are created under the Moderate Electrification scenario. Much of the job growth under both scenarios is driven by increased Construction and Induced employment.

Figure 71. Residential HVAC Outputs (2021-2050) – Reference

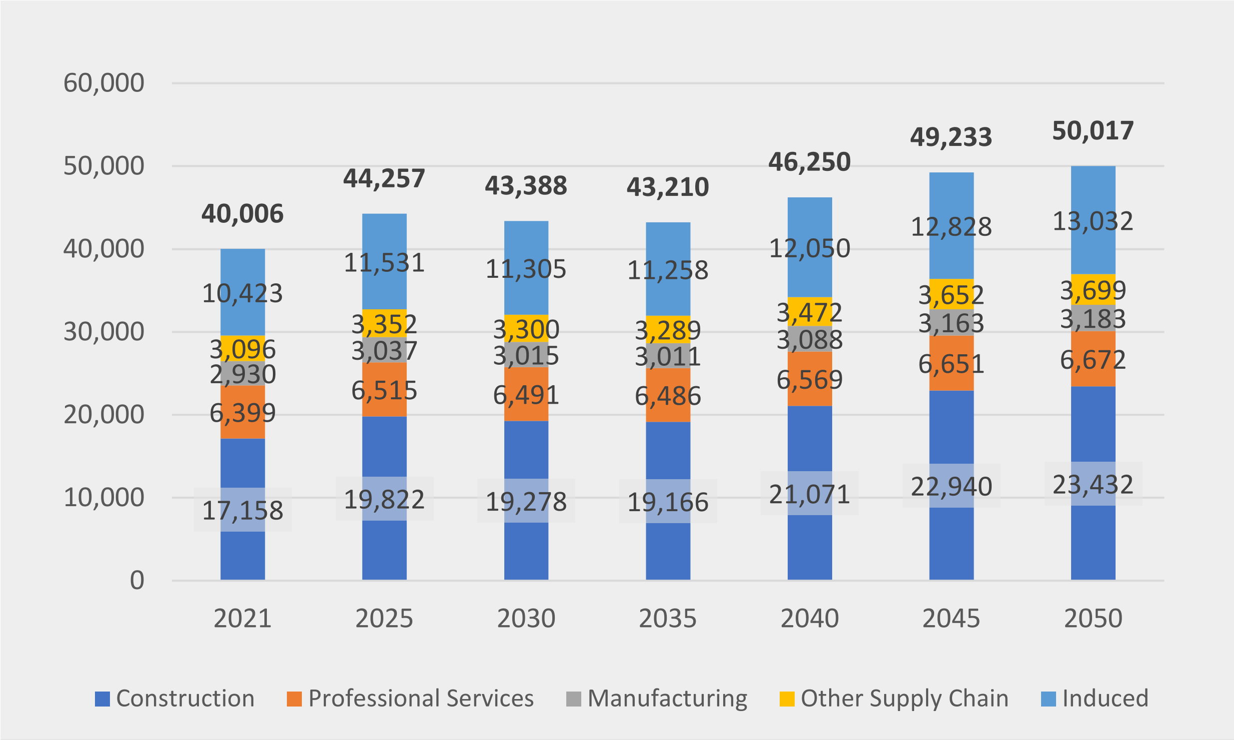
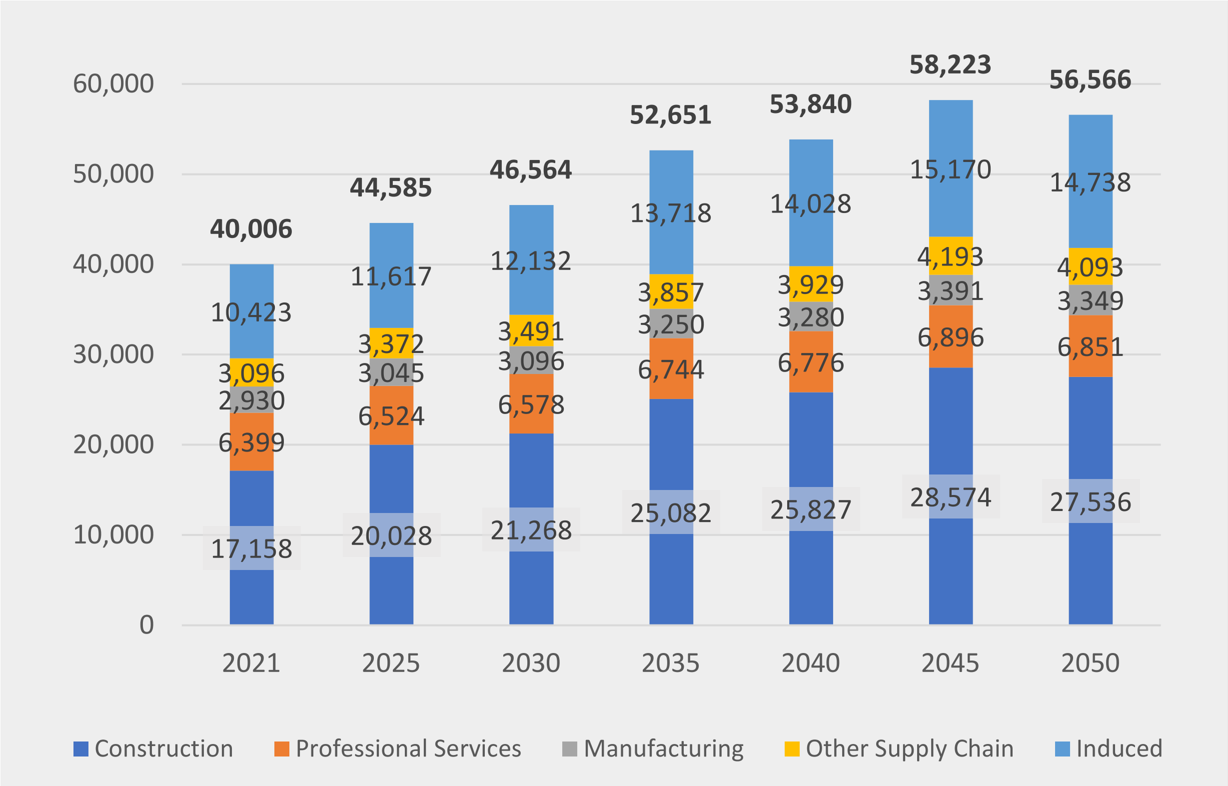


Figure 72. Residential HVAC Outputs (2021-2050) – Moderate Electrification

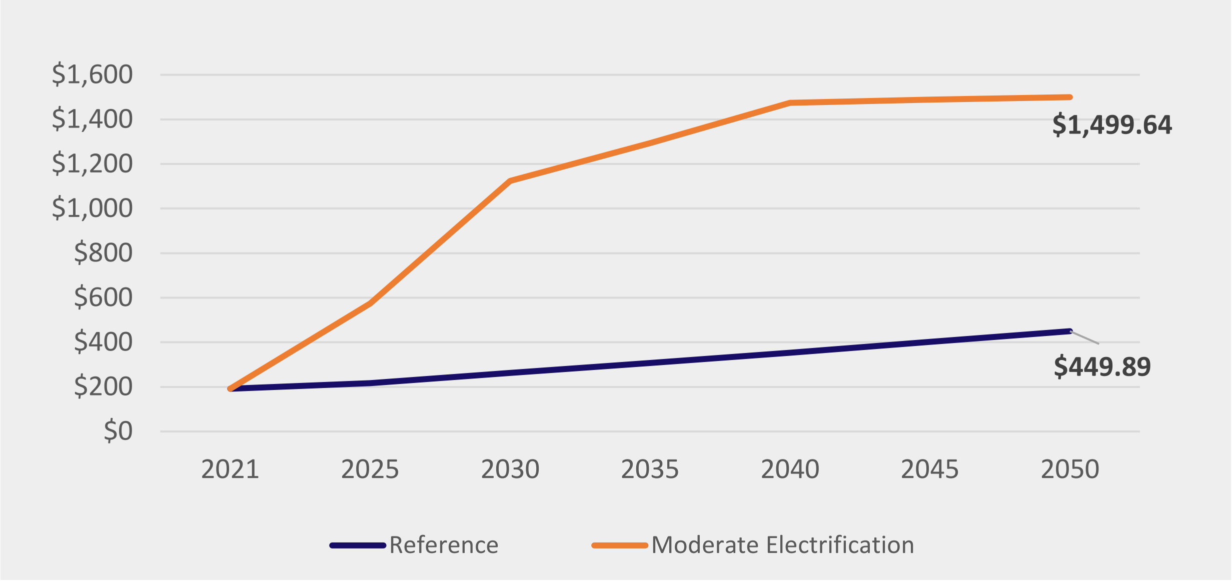


Residential Shell

Residential Shell, a growth sub-sector, consists of technologies such as insulation, glazing, paints, films, and windows.

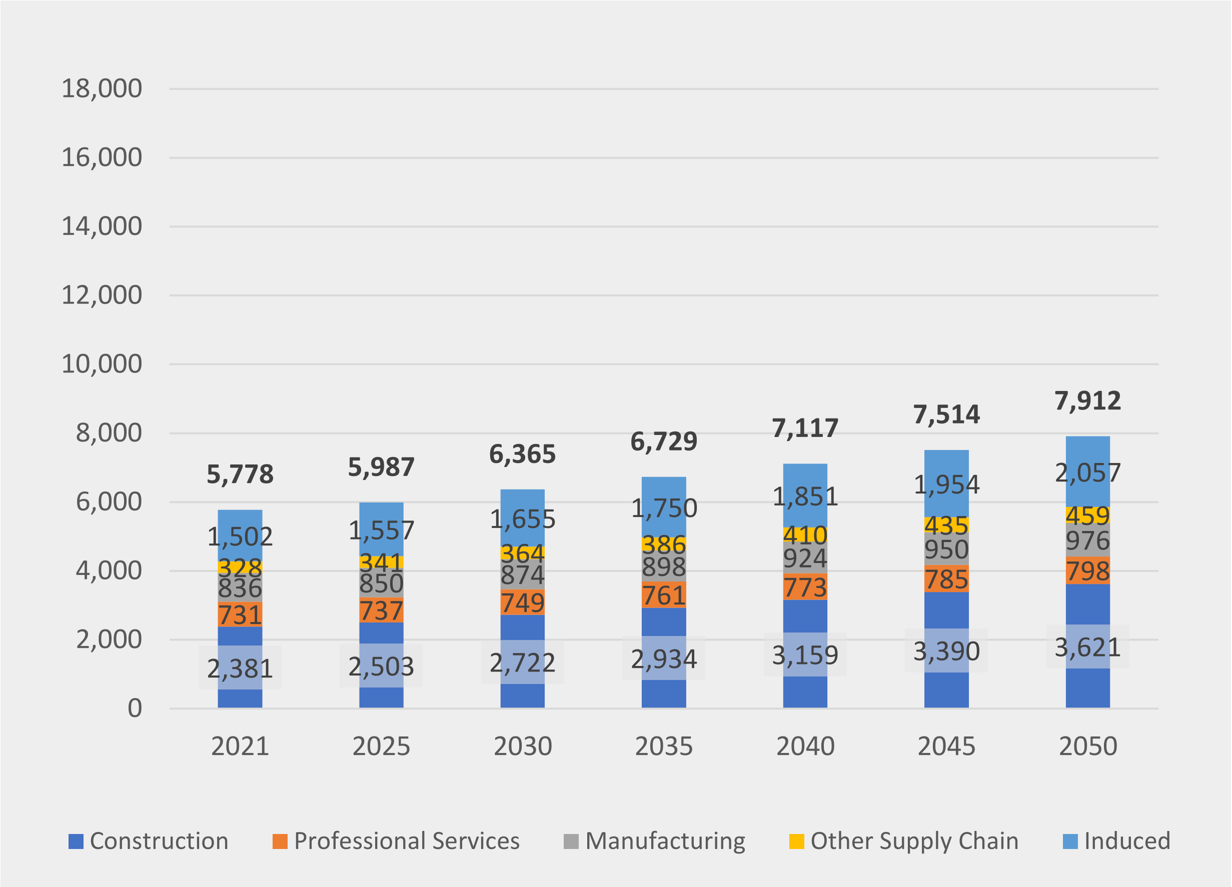
In both the Reference and Moderate Electrification scenarios, investment in Residential Shell increases between 2021 and 2050 (see Figure 73). Investment in Residential Shell under the Reference scenario is lower and increases more slowly than in the Moderate Electrification scenario. Investment under the Reference scenario increases steadily from about $191M in 2021 to nearly $450M in 2050. Under the Moderate Electrification scenario, Residential Shell investment spikes from $191M to $1,124M between 2021 and 2030, spikes again to reach $1,473M in 2040, and then steadily increases to nearly $1,500M in 2050.

Figure 73. Residential Shell Inputs (2021-2050): Investments ($M) – Reference vs. Moderate Electrification



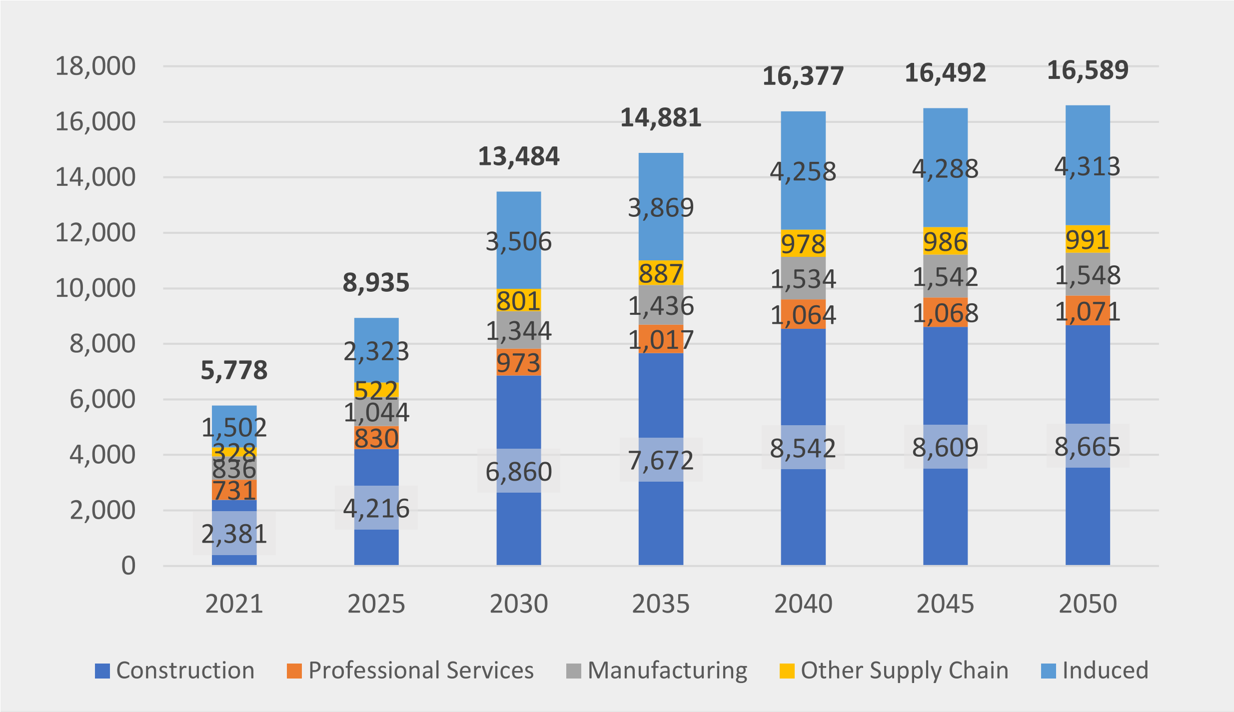
Residential Shell employment outputs follow the same pattern as Residential Shell investment (see Figure 74 and Figure 75). Residential Shell employment under the Reference scenario increases more steadily and is consistently lower than employment under Moderate Electrification. Residential Shell employment steadily increases from 5,700 jobs in 2021 to 7,912 jobs in 2050 under the Reference scenario, adding 2,100 jobs in total. Under the Moderate Electrification scenario, employment in the Residential Shell sub-sector rapidly increases from 5,700 jobs in 2021 to 13,400 jobs in 2030, after which employment growth slows until reaching 16,500 jobs in 2050—adding 10,800 jobs in total.

Figure 74. Residential Shell Outputs (2021-2050) – Reference



Under both scenarios, job growth is largely driven by increased Construction and Induced employment. In the Reference scenario, 1,240 jobs are added to Construction, and Induced employment increases by 555 jobs by 2050. Under Moderate Electrification, 6,284 jobs are added to Construction, and Induced employment increases by 2,811 jobs by 2050.

Figure 75. Residential Shell Outputs (2021-2050) – Moderate Electrification

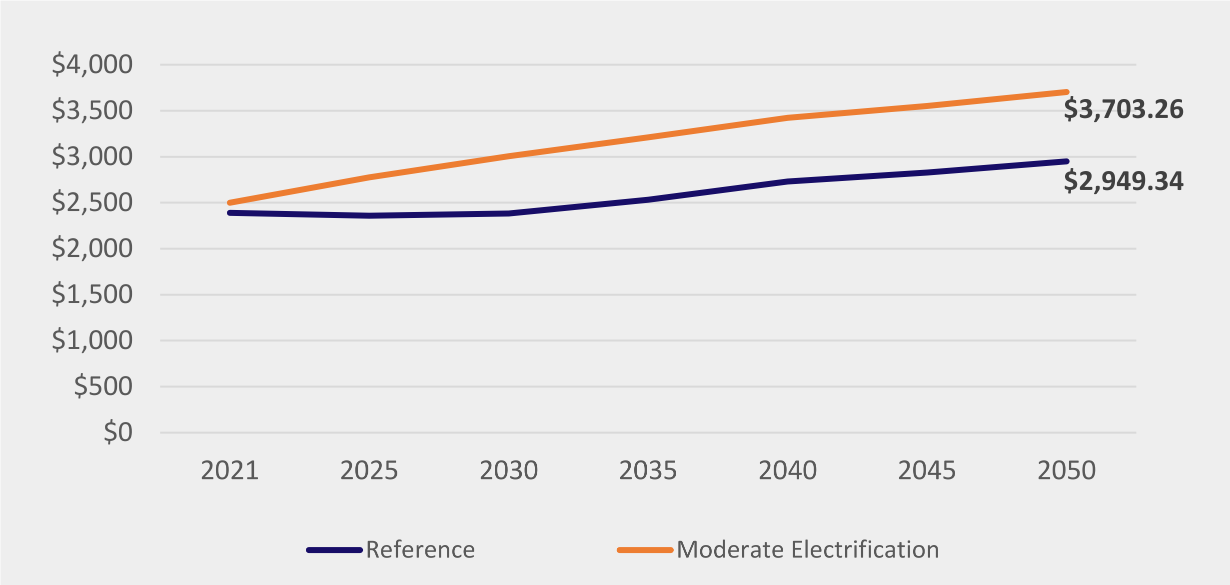


Residential Other

Residential Other, a growth sub-sector, consists of technologies such as refrigerators and freezers, clothes washers and dryers, water heaters, and stoves.

Residential Other investment under the Moderate Electrification scenario is consistently higher than investment under the Reference scenario (see Figure 76). In the Reference scenario, Residential Other investment remains fairly steady at around $2,390M between 2021 and 2030 before slowly increasing to reach nearly $2,950M in 2050. In the Moderate Electrification scenario, investment steadily increases from nearly $2,500M in 2021 until it reaches $3,700M in 2050.

Figure 76. Residential Other (2021-2050): Annual Investment ($M) - Reference vs. Moderate Electrification



Residential Other employment growth follows the same pattern as Residential Other investment (see Figure 77 and Figure 78). Residential Other employment remains fairly steady between 2021 and 2030 and then slowly increases until 2050 under the Reference scenario while employment steadily increases from 2021 to 2050 under Moderate Electrification. Residential Other employment is also consistently higher under the Moderate Electrification scenario than under the Reference scenario; 4,200 jobs are added to the sub-sector by 2050 under the Reference scenario while over twice as many jobs (9,100 jobs) are added under Moderate Electrification.

Figure 77. Residential Other Outputs (2021-2050) – Reference

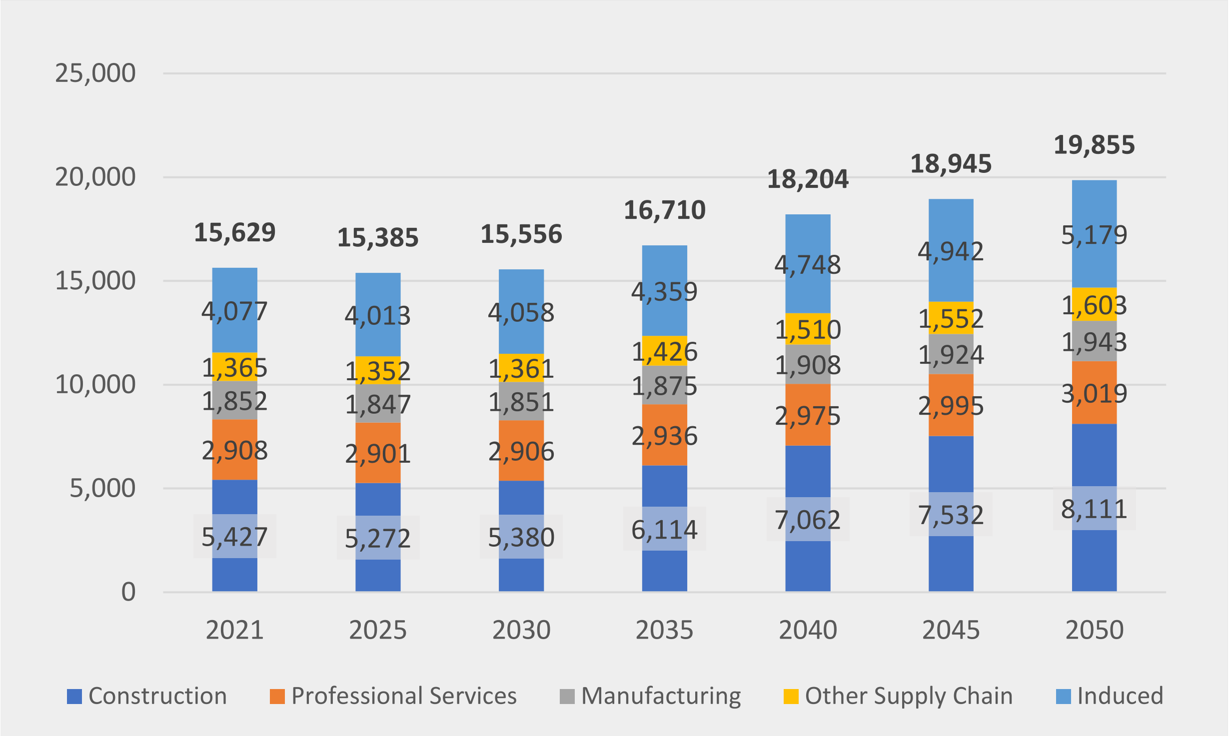
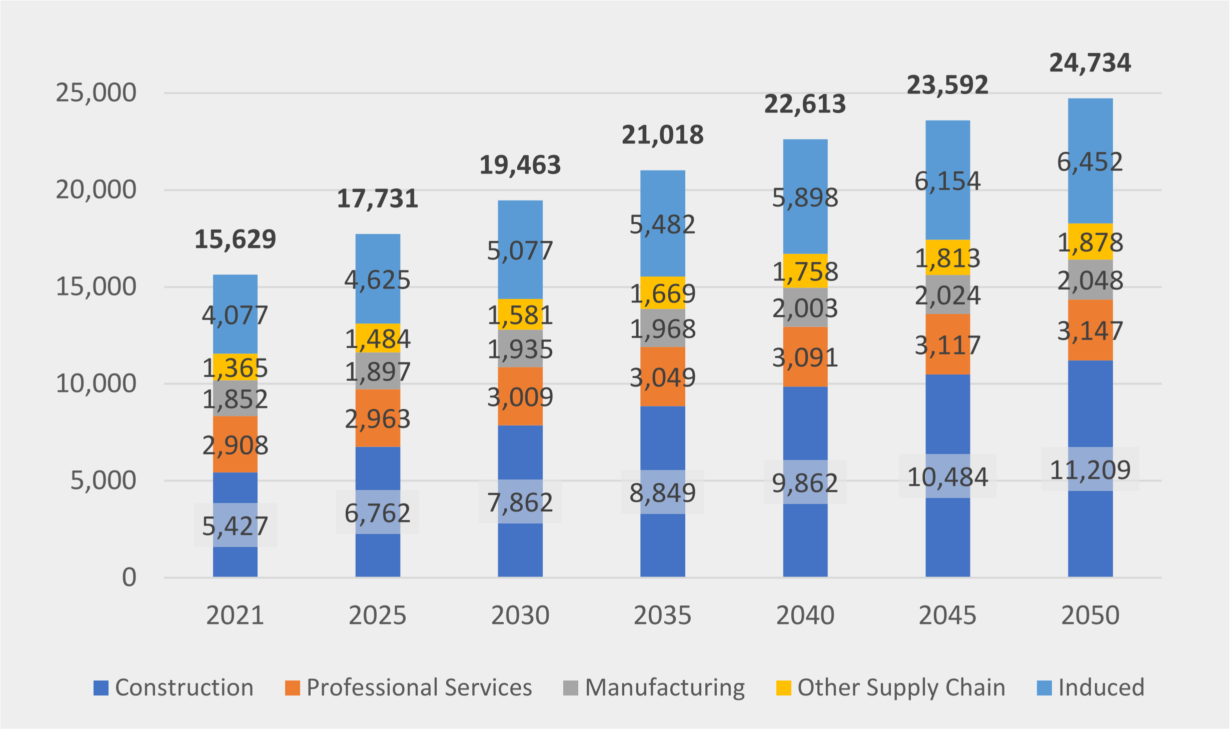


Figure 78. Residential Other Outputs (2021-2050) – Moderate Electrification

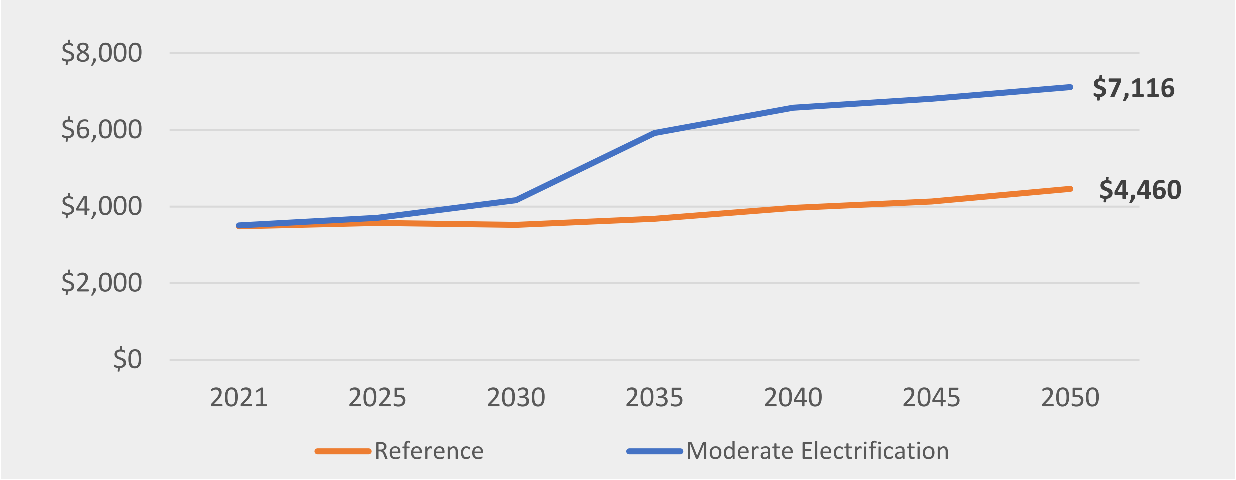


Commercial HVAC

Commercial HVAC, a growth sub-sector, consists of technologies such as commercial air conditioning, space heating, and ventilation.

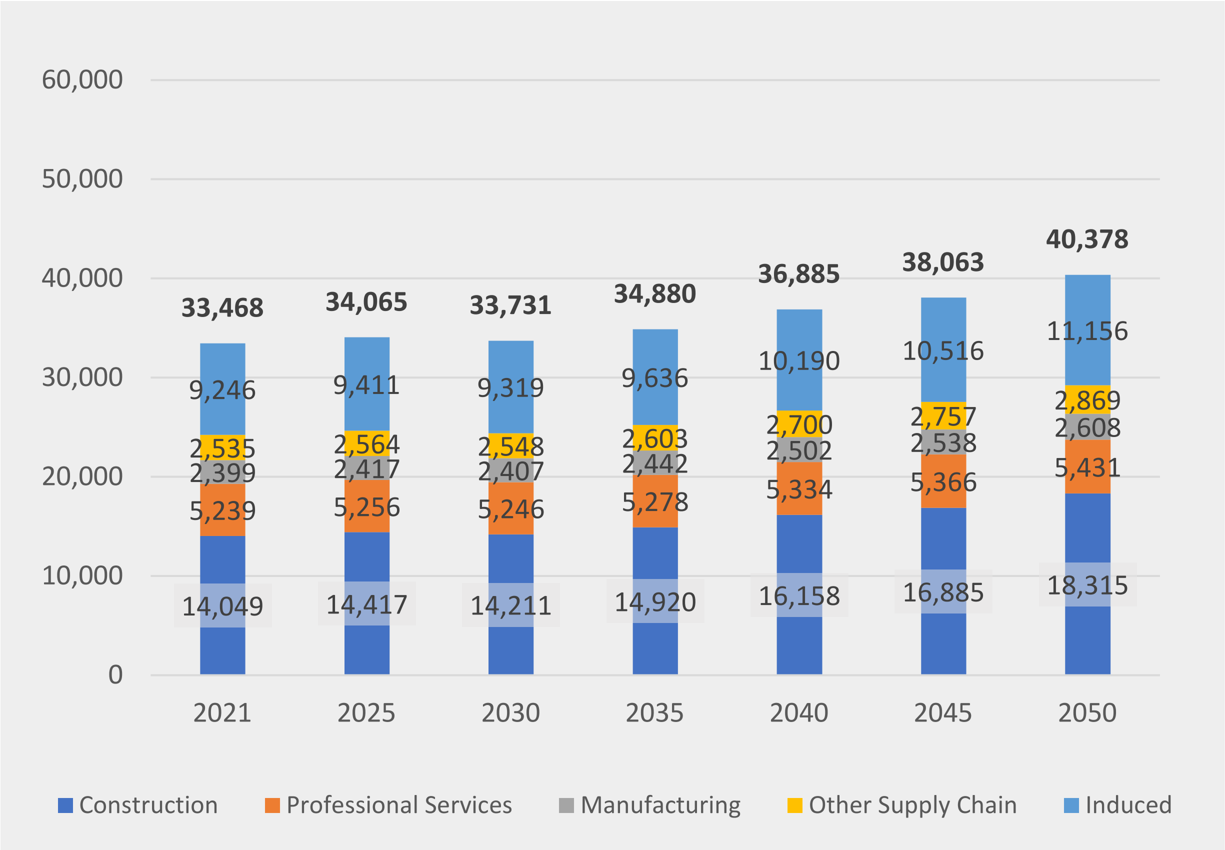
Investments in Commercial HVAC in the Moderate Electrification scenario increase more aggressively than they do in the Reference scenario (see Figure 79). Commercial HVAC investment remains stable at around $3,500M through 2030 under the Reference scenario and then steadily increases to reach $4,460M in 2050. Under the Moderate Electrification scenario, Commercial HVAC investment steadily increases from $3,500M in 2021 to $4,160M in 2030 before spiking to reach nearly $5,920M in 2035 and increasing to $7,120M by 2050.

Figure 79. Commercial HVAC Inputs (2021-2050): Investments ($M) – Reference vs. Moderate Electrification



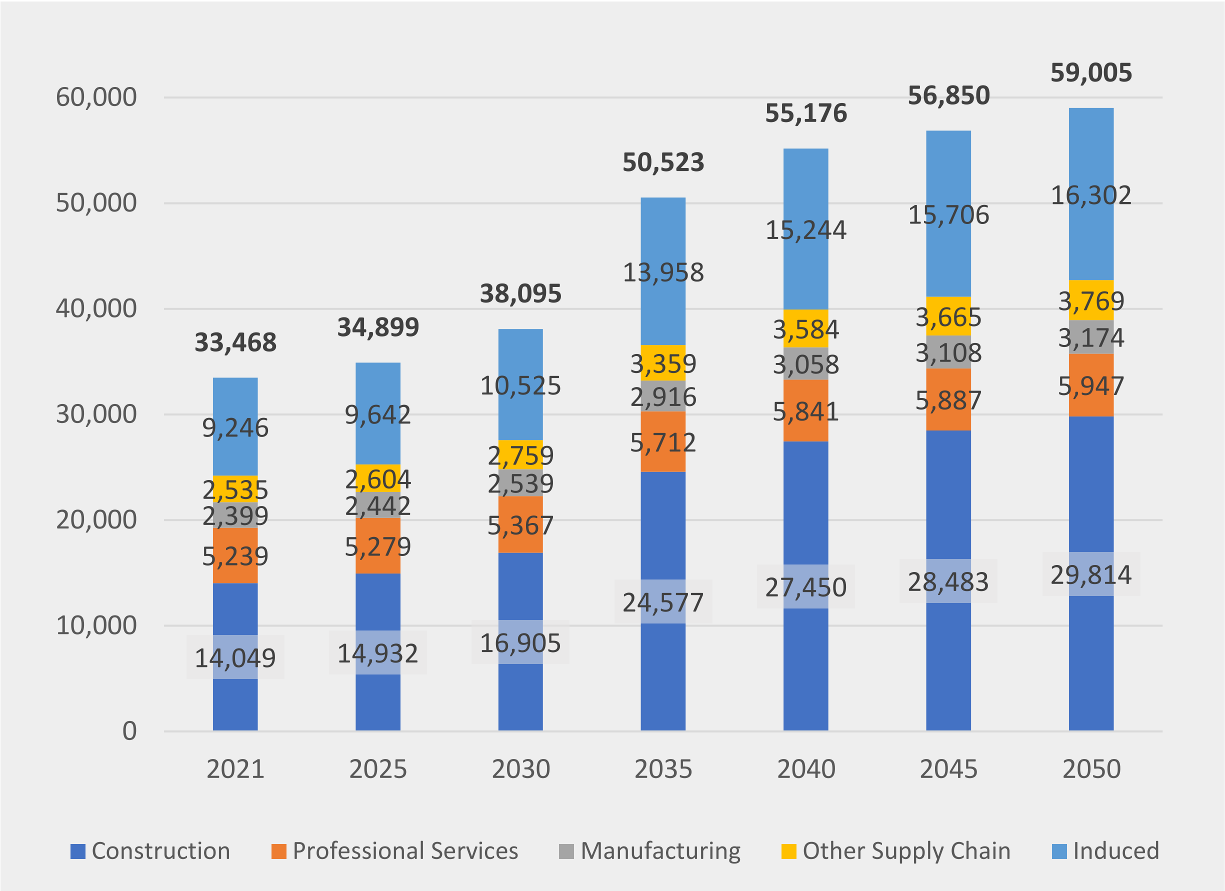
Commercial HVAC employment growth follows the same pattern as Commercial HVAC investment (Figure 80). Commercial HVAC remains largely unchanged in the Reference scenario between 2021 and 2030 before slowly increasing up to 2050 while employment increases slowly between 2021 and 2030 under the Moderate Electrification scenario and then spikes in 2035 and continues growing slowly until 2050.

Figure 80. Commercial HVAC Outputs (2021-2050) – Reference



Between 2021 and 2050, 6,910 jobs are added to the Commercial HVAC sub-sector under the Reference scenario while over three times as many jobs (25,500 jobs) are added under the Moderate Electrification scenario (Figure 81). Under both scenarios, most of the job growth is driven by increased employment in Construction and Induced employment, though job growth in these two categories spikes in 2035 under the Moderate Electrification scenario.

Figure 81. Commercial HVAC Outputs (2021-2050) – Moderate Electrification

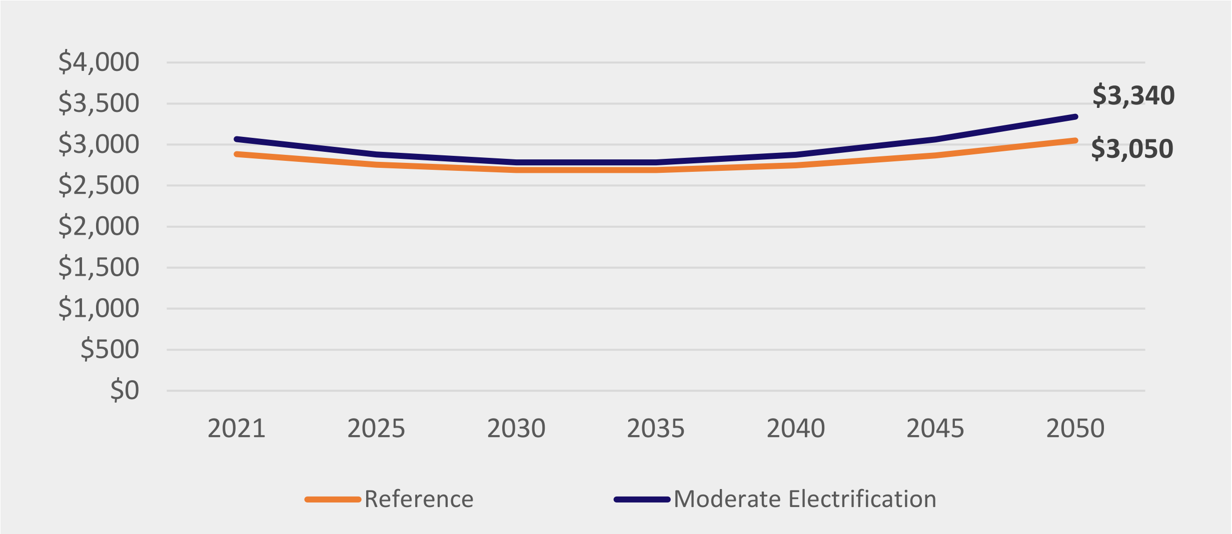


Commercial Other

Commercial Other, a displaced sub-sector, consists of technologies such as water heating, general service lighting, high intensity discharge lighting, linear fluorescent lighting, and refrigeration.

Commercial Other investment in the Moderate Electrification scenario is consistently higher than investment under the Reference scenario (see Figure 82). In both the Reference and Moderate Electrification scenario, Commercial Other investment decreases between 2021 and 2030, remains constant between 2030 and 2035, and then increases between 2035 and 2050.

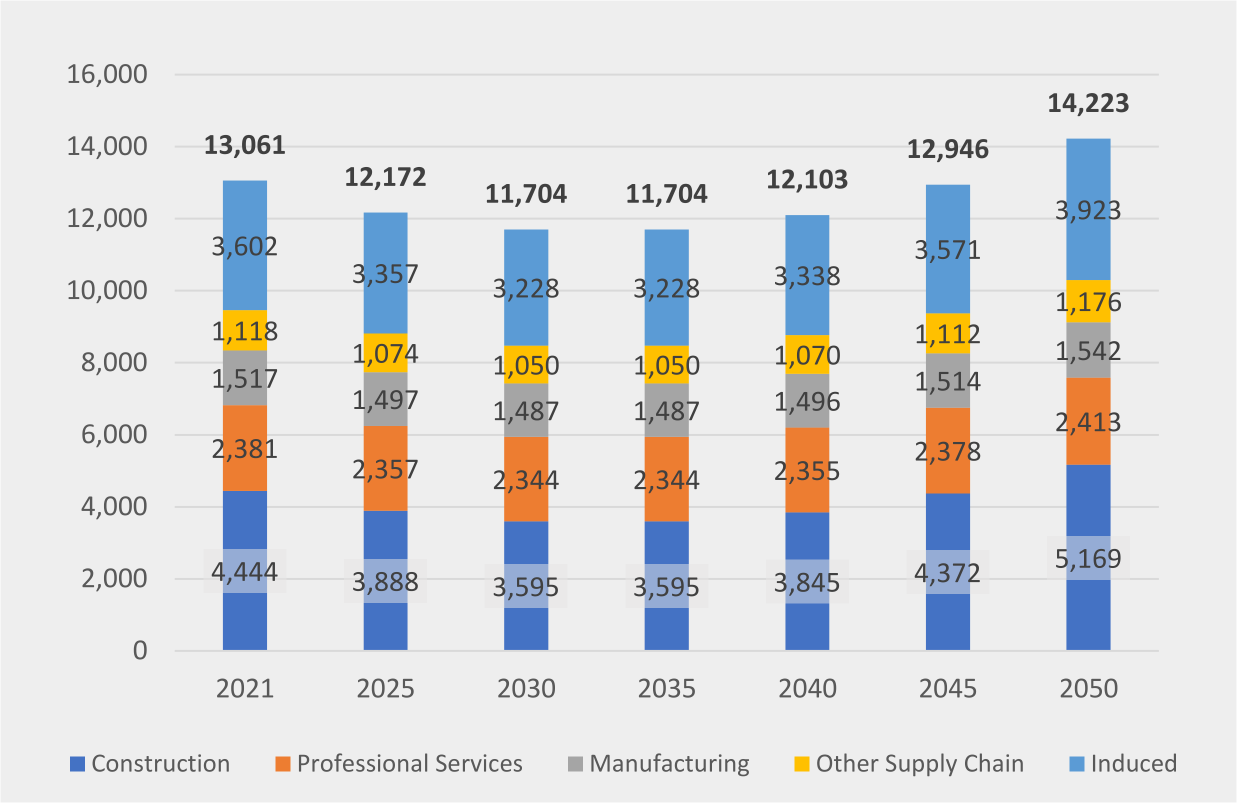
Figure 82. Commercial Other Inputs (2021-2050): Investments ($M) – Reference vs. Moderate Electrification



Commercial Other investment under the Moderate Electrification scenario starts at around $3,050M in 2021, decreases to $2,800M by 2030, and then increases to reach $3,340M by 2050. Commercial Other investment under the Reference scenario, however, starts at around $2,880M in 2021, decreases to $2,690M by 2030, and then increases to reach $3,050M by 2050.

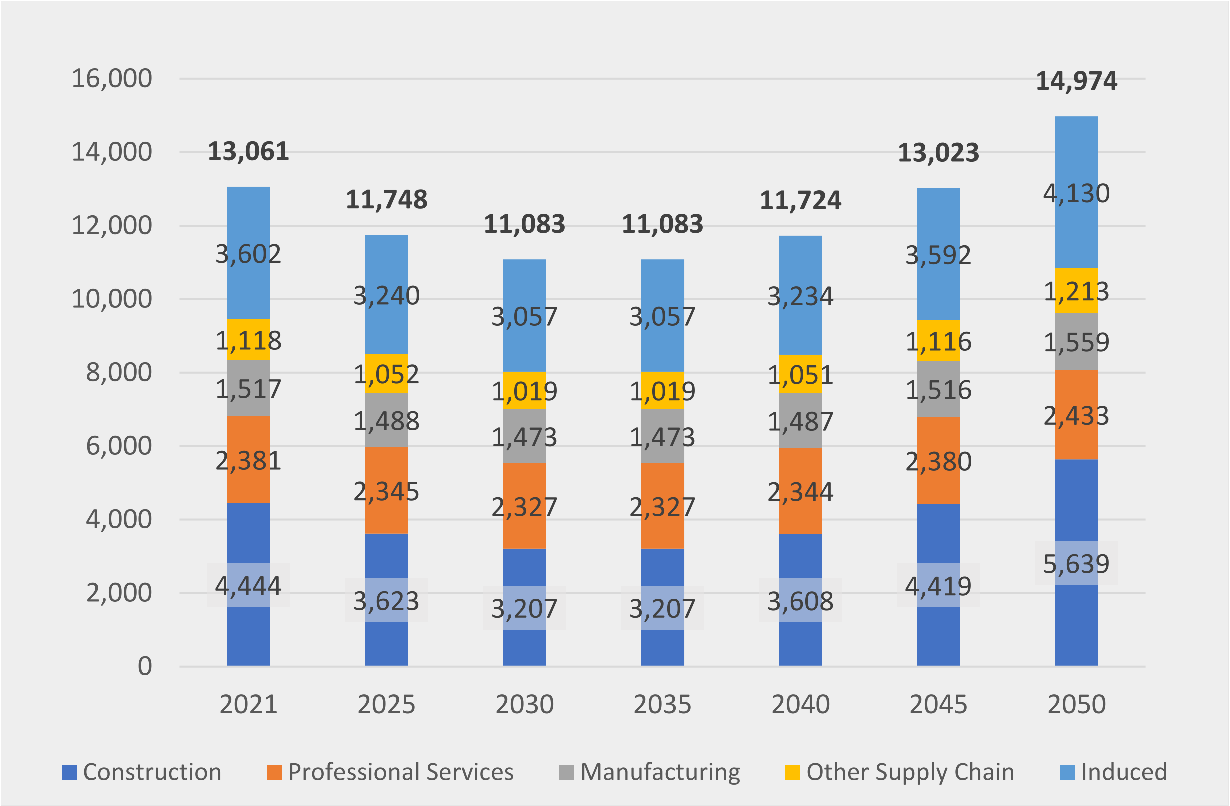
Commercial Other investment patterns result in corresponding employment growth (see Figure 83and Figure 84). Under both Reference and Moderate Electrification scenarios, Commercial Other employment is expected to decrease from 2021 to 2030, remain constant from 2030 to 2035, and then increase between 2035 and 2050. Under the Reference scenario, employment in the Commercial Other sub-sector decreases from 13,000 in 2021 to 11,704 in 2030 and then increases to reach 14,200 in 2050. Under Moderate Electrification, employment decreases from 13,000 in 2021 to 11,083 in 2030 and increases to reach 14,900 in 2050. By 2050, the Commercial Other sub-sector is slated to gain 1,100 jobs compared to 2021 under the Reference scenario and 1,900 jobs compared to 2021 under Moderate Electrification.

Figure 83. Commercial Other Outputs (2021-2050) – Reference



While Commercial Other investment is consistently higher under Moderate Electrification, Commercial Other employment under Moderate Electrification falls below employment under the Reference scenario between 2025 and 2040. This is largely caused by increased job displacement in Construction under the Moderate Electrification scenario; between 2021 and 2030, Construction decreases by 840 jobs under the Reference scenario and 1,200 jobs under Moderate Electrification.

Figure 84. Commercial Other Outputs (2021-2050) – Moderate Electrification



Transportation

In 2020, the Transportation sector in Illinois was responsible for 32.1 percent of total greenhouse gas emissions.[28] The Transportation sector is composed of five sub-sectors: Vehicle Manufacturing, Vehicle Maintenance, Wholesale Trade Parts, Fueling Stations, and Charging and Hydrogen Fuel Stations.

Under both the Reference and Moderate Electrification scenarios, the sub-sectors expected to experience growth are Wholesale Trade Parts and Charging and Hydrogen Fuel Stations (see Table 13 and Table 14). Conventional Fuel Stations, Vehicle Manufacturing, and Vehicle Maintenance are expected to be displaced in both scenarios.

By 2030, the Transportation sector is expected to see a net increase of 5,000 jobs under the Reference scenario and 4,300 jobs under the Moderate Electrification scenario. Job growth between 2021 and 2030 is driven by the Charging Stations sub-sector, which gains 8,000 jobs by 2030 under the Reference scenario and 10,700 under Moderate Electrification.

[28] U.S. Energy Information Industry (EIA). Energy-Related CO_2 Emission Data Tables. Table 3. State energy-related carbon dioxide emissions by sector. https://www.eia.gov/environment/emissions/state/.

Table 13. Transportation: Overall Employment Output – Reference

SUB-SECTOR	YEAR						
	2021	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Wholesale Trade Parts	45,098	46,103	47,394	48,727	50,102	51,521	52,985
Charging Stations	616	2,172	8,645	9,718	10,347	9,882	9,823
Total Growth	45,714	48,275	56,040	58,444	60,449	61,403	62,809
Change in Growth		+2,560	+10,325	+12,730	+14,734	+15,689	+17,094
Displacement Sub-Sectors							
Vehicle Manufacturing	109,787	106,963	106,043	107,703	108,600	108,706	109,755
Vehicle Maintenance	56,824	61,445	60,846	58,822	56,953	56,071	56,379
Fueling Stations	50,389	49,366	44,814	40,223	36,604	34,228	32,801
Total Displaced	217,000	217,773	211,702	206,748	202,157	199,005	198,935
Change in Displaced		+773	-5,298	-10,252	-14,843	-17,995	-18,065
Transportation OVERALL	**262,715**	**266,048**	**267,742**	**265,192**	**262,606**	**260,408**	**261,744**
Net Change from 2021		**+3,334**	**+5,028**	**+2,478**	**-109**	**-2,306**	**-971**

By 2050, however, the Transportation sector is expected to see a net decrease (-970 jobs) under the Reference scenario and (-13,000 jobs) under the Moderate Electrification scenario. Under both scenarios, job displacement is largely driven by Conventional Fueling Stations; employment in the Fueling Stations sub-sector decreases by 17,500 between 2021 and 2050 under the Reference scenario and 25,800 under the Moderate Electrification scenario. With slowing growth in the Charging Stations sub-sector between 2030 and 2050, job displacement in the Fueling Stations sub-sector leads to a net decrease in jobs by 2050 under both scenarios.

Table 14. Transportation: Overall Employment Output – Moderate Electrification

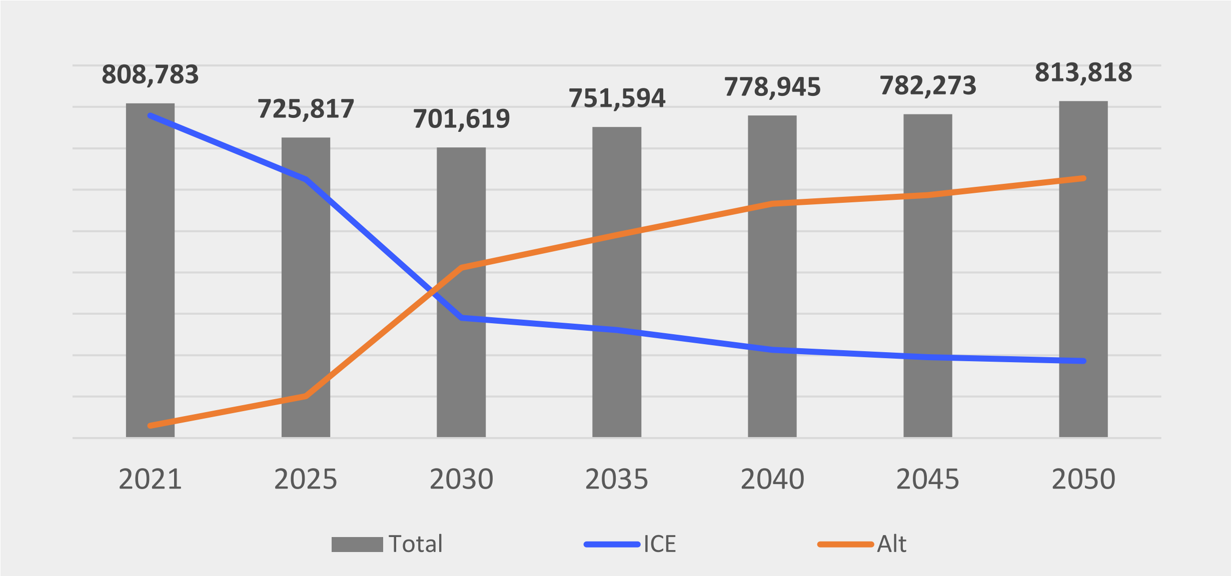
SUB-SECTOR	YEAR						
	2021	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Wholesale Trade Parts	45,098	46,103	47,394	48,727	50,102	51,521	52,985
Charging Stations	616	5,767	11,328	16,119	15,764	14,925	14,239
Total Growth	45,714	51,870	58,722	64,846	65,866	66,446	67,224
Change in Growth		+6,156	+13,008	+19,132	+20,151	+20,732	+21,510
Displacement Sub-Sectors							
Vehicle Manufacturing	109,787	106,914	106,015	107,620	108,529	108,642	109,694
Vehicle Maintenance	56,824	60,584	59,106	54,730	50,726	48,543	48,214
Fueling Stations	50,389	48,787	43,216	36,450	30,774	26,943	24,546
Total Displaced	217,000	216,284	208,337	198,800	190,030	184,127	182,453
Change in Displaced		-716	-8,663	-18,200	-26,970	-32,873	-34,547
Transportation OVERALL	**262,715**	**268,154**	**267,060**	**263,646**	**255,896**	**250,573**	**249,677**
Net Change from 2021		**+5,440**	**+4,345**	**+931**	**-6,819**	**-12,141**	**-13,037**

Vehicle Manufacturing

Vehicle Manufacturing, a displaced sub-sector, is largely made up of automobile, tire, brake system, body, and steering and suspension component manufacturing.

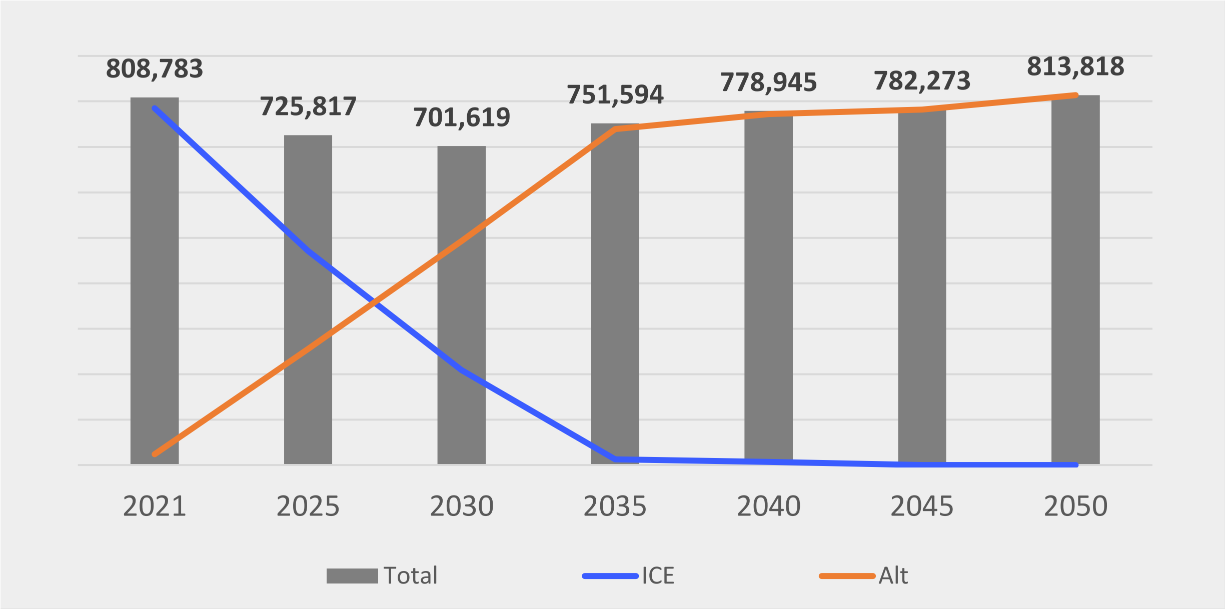
In both the Reference and Moderate Electrification scenario, vehicle sales are expected to decrease between 2021 and 2030—from 808,783 vehicles in 2021 to 701,619 vehicles in 2030—before increasing to reach 813,818 vehicles by 2050 (see Figure 85 and Figure 86). However, internal combustion engine (ICE) vehicle sales decrease more slowly, and alternative (Alt) vehicle sales increase more slowly under the Reference scenario than under the Moderate Electrification scenario. And while ICE vehicle sales reach 0 by 2045 under Moderate Electrification, nearly 200,000 ICE vehicles are expected to be sold per year through 2050 under the Reference scenario.

Figure 85. Vehicle Manufacturing Inputs (2021-2050): Vehicle Sales – Reference



Under the Moderate Electrification scenario, ICE vehicle sales decrease rapidly from 785,058 vehicles in 2021 to 12,470 in 2035 and then slowly decrease until reaching 0 in 2045. Inversely, Alt sales increase rapidly from 23,725 vehicles in 2021 to 739,124 in 2035 and then slowly increases until Alt vehicles make up all vehicle sales in 2045. Under the Reference scenario, ICE vehicle sales decrease from 778,974 vehicles in 2021 to 289,971 in 2030. ICE vehicle sales decrease slowly between 2030 and 2050, reaching 186,219 vehicles in 2050.

Figure 86. Vehicle Manufacturing Inputs (2021-2050): Vehicle Sales – Moderate Electrification



Under both scenarios, employment in the Vehicle Manufacturing sub-sector remains largely unchanged between 2021 and 2050 (see Figure 87 and Figure 88). While the composition of ICE and Alt sales trends as a fraction of total sales is expected to change between 2021 and 2050, total vehicle sales grow by only 5,000 vehicles. Employment decreases between 2021 and 2030 and then increases again to near 2021 employment levels again in

2050. Most of the jobs displaced between 2021 and 2030 under both scenarios are from Manufacturing, though most of these jobs are regained by 2050.

Figure 87. Vehicle Manufacturing Outputs (2021-2050) – Reference

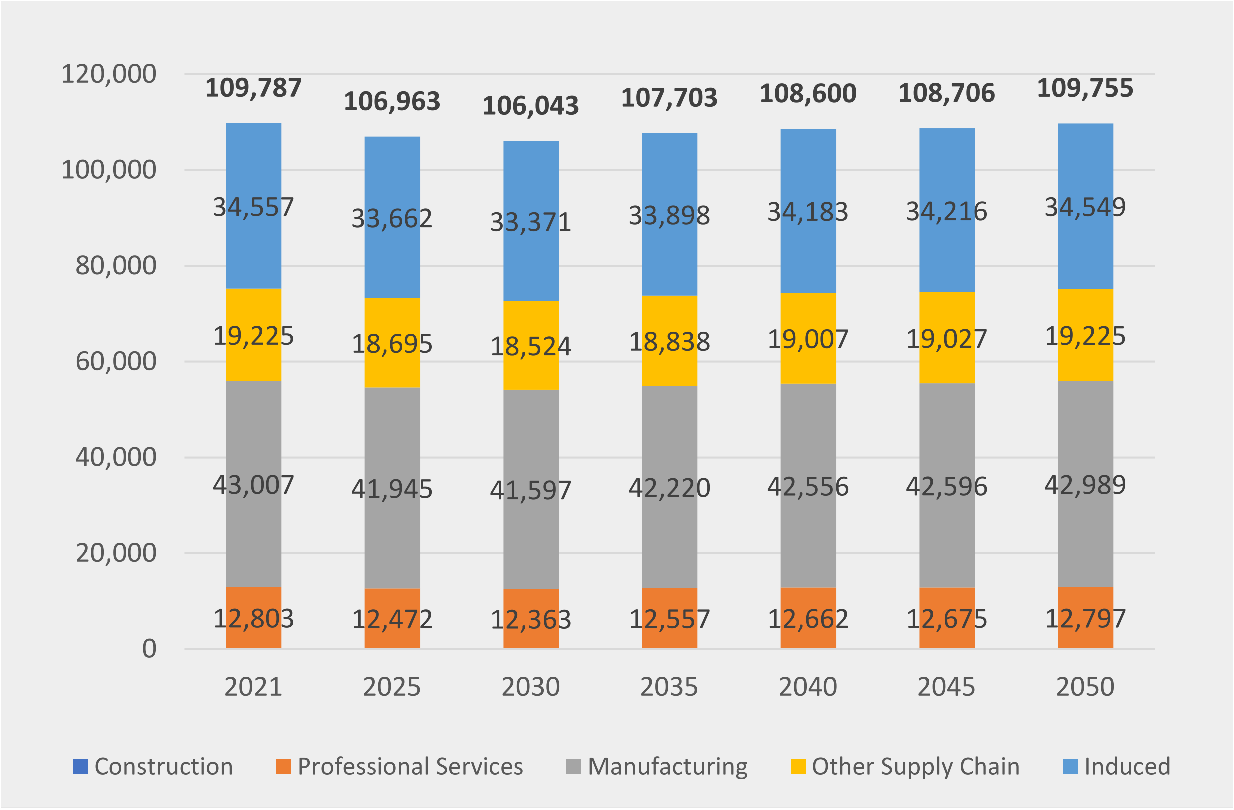
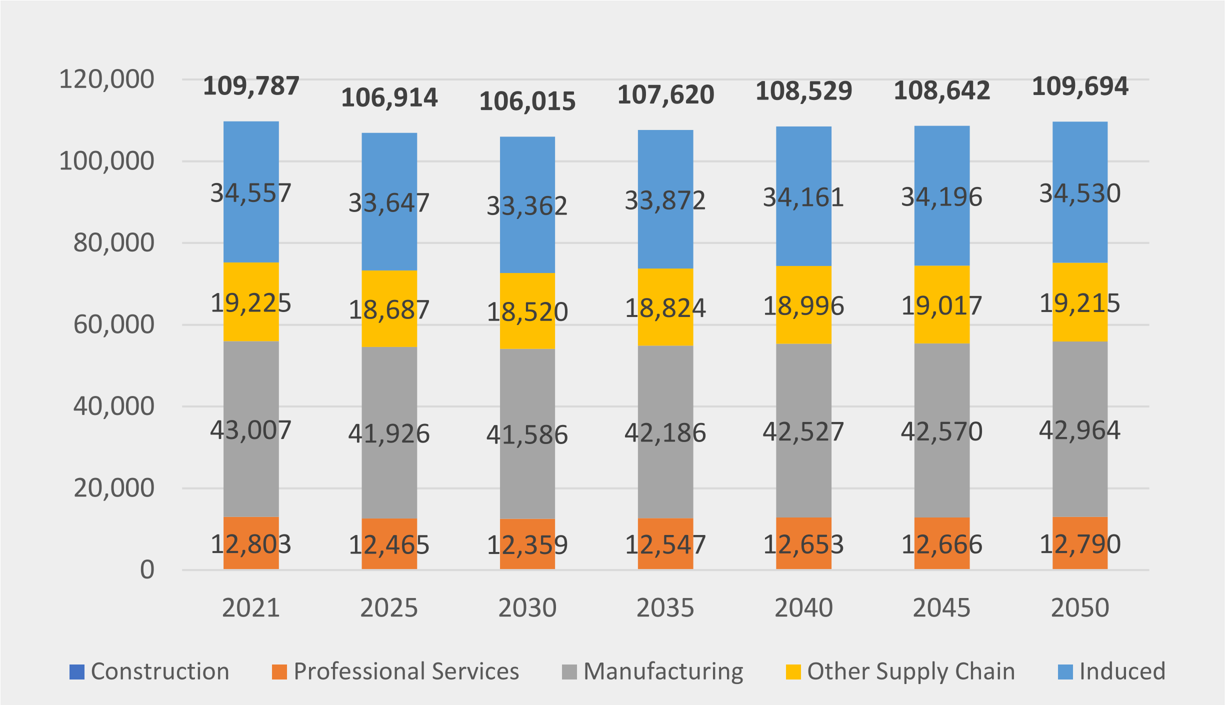


Figure 88. Vehicle Manufacturing Outputs (2021-2050) – Moderate Electrification



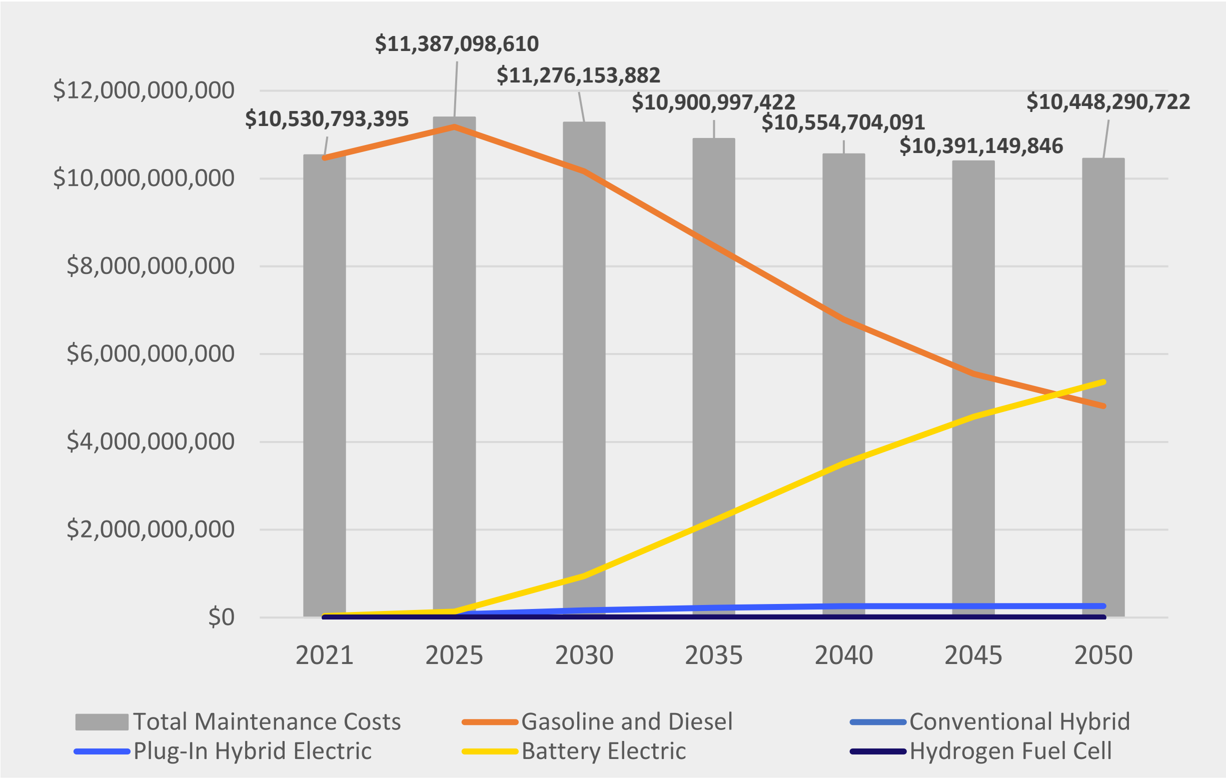
Vehicle Maintenance

Vehicle Maintenance, a displaced sub-sector, consists of internal combustion engine, braking system, transmission, and electrified component maintenance along with other miscellaneous vehicle maintenance costs.

Under both scenarios, total Vehicle Maintenance costs rise from 2021 to 2025 before slowly decreasing until 2045, though total maintenance costs are consistently higher in the Reference scenario than under the Moderate Electrification scenario (see Figure 89 and Figure 90). Under the Reference scenario, Vehicle Maintenance costs in 2050 fall only $82M below total maintenance costs in 2021. In comparison, total Vehicle Maintenance costs in 2050 under the Moderate Electrification scenario are nearly $1.6M lower than maintenance costs in 2021.

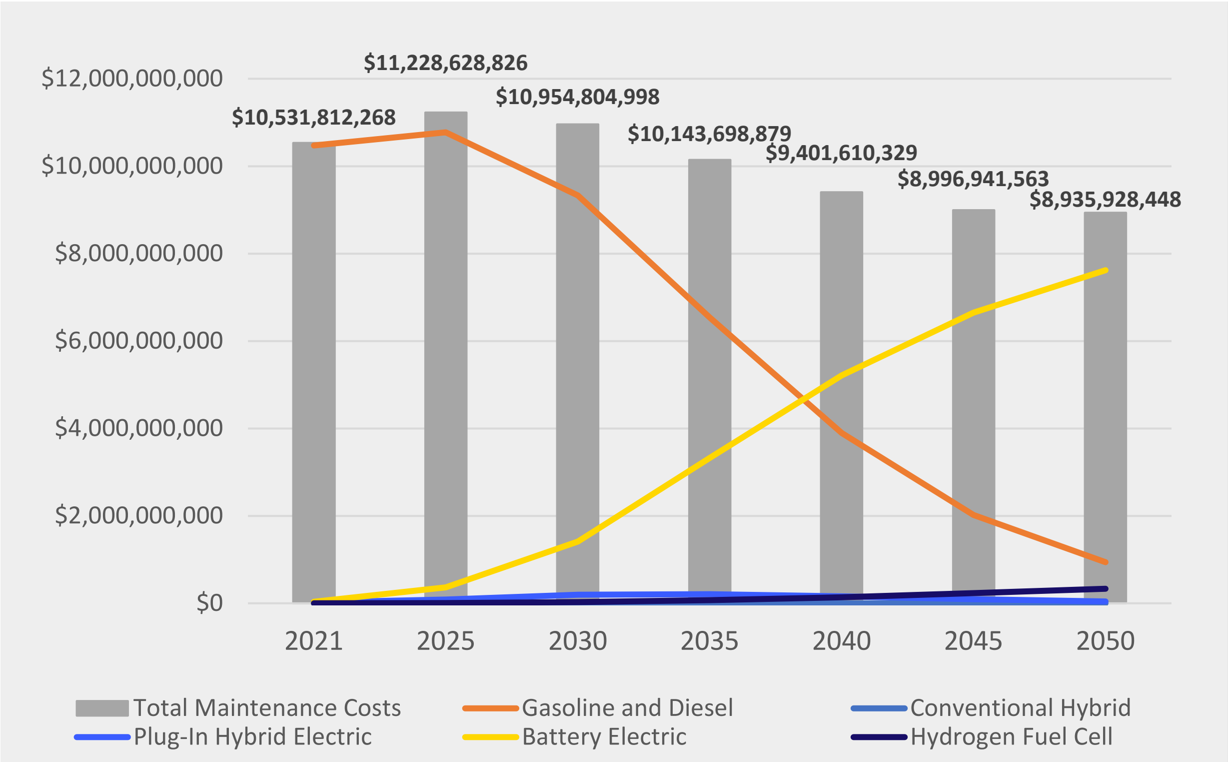
Under both scenarios, maintenance costs for gasoline- and diesel-powered vehicles peak in 2025 and then decrease until 2050. However, the decline in gasoline and diesel maintenance costs is much steeper under Moderate Electrification than under the Reference scenario; by 2050, gasoline- and diesel-powered Vehicle Maintenance costs about $4,820M under the Reference scenario but only $940M under Moderate Electrification.

Figure 89. Vehicle Maintenance Inputs (2021-2050): Total Maintenance Costs – Reference



Conversely, maintenance costs for battery electric vehicles begin to increase more quickly after 2025 under both scenarios, though the rise in battery electric maintenance costs is much steeper under Moderate Electrification than under the Reference scenario. By 2050, battery electric Vehicle Maintenance costs about $5,367M under the Reference scenario but $7,620M under the Moderate Electrification scenario.

Figure 90. Vehicle Maintenance Inputs (2021-2050): Total Maintenance Costs – Moderate Electrification



Under both scenarios, maintenance costs for hydrogen fuel cell and plug-in hybrid electric vehicles comprise a fraction of total Vehicle Maintenance costs, though plug-in hybrid maintenance costs are about 5 times greater under the Reference scenario than under Moderate Electrification and hydrogen fuel cell maintenance costs are over 150 times greater under Moderate Electrification that under the Reference scenario.

Under both scenarios, employment in the Vehicle Maintenance sub-sector peaks in 2025 and then slowly decreases until 2045, after which it slightly increases under the Reference scenario and slightly decreases under Moderate Electrification (see Figure 91 and Figure 92). Under the Reference scenario, employment in the Vehicle Maintenance sub-sector returns to 2021 level employment by 2050, whereas 8,600 jobs are displaced by 2050 under Moderate Electrification. Most of the displaced jobs under Moderate Electrification are concentrated in the Other Supply Chain category, which is slated to decrease by 6,200 jobs by 2050.

Figure 91. Vehicle Maintenance Outputs (2021-2050) – Reference

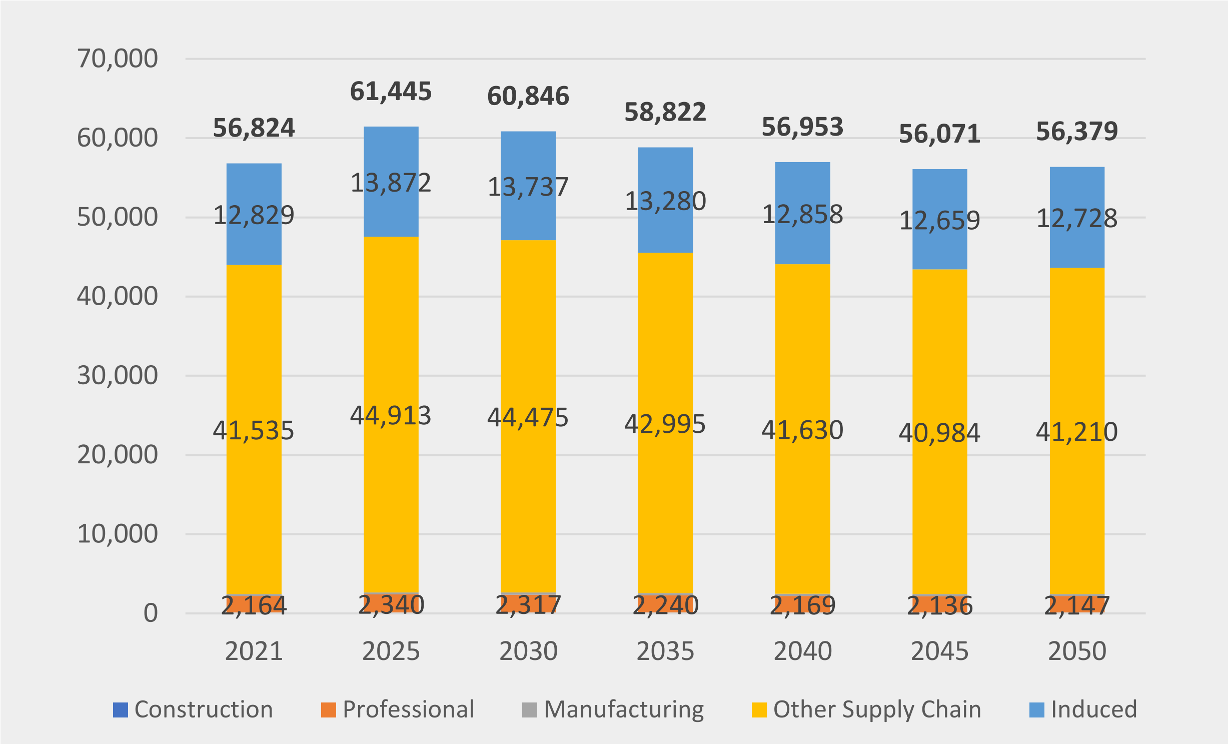
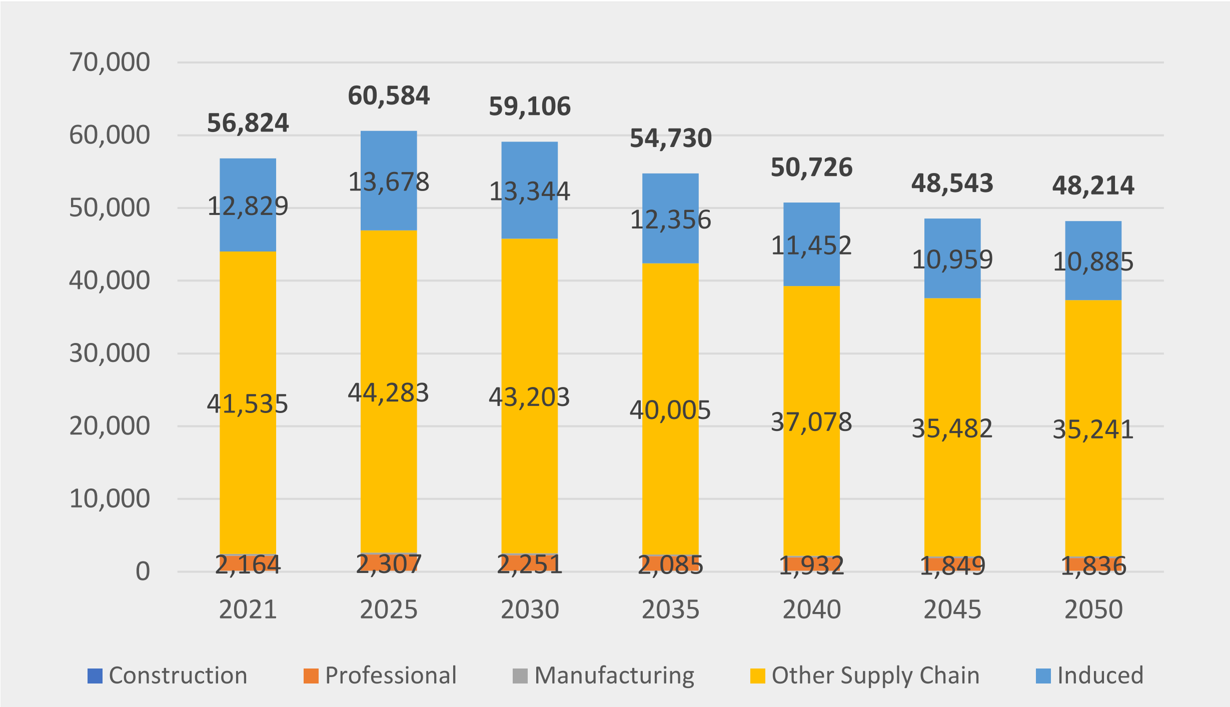


Figure 92. Vehicle Maintenance Outputs (2021-2050) – Moderate Electrification



Wholesale Trade Parts

Wholesale Trade Parts, a growth sub-sector, consists of components for light duty cars, light duty trucks, light medium duty trucks, medium duty trucks, heavy duty trucks, and buses.

Under both scenarios, vehicle stock steadily increases from 10,673,209 vehicles in 2021 to 12,818,538 vehicles in 2050 (see Figure 93 and Figure 94). Additionally, Alt vehicle stock increases while ICE vehicle stock decreases under both scenarios. By 2050, however, Alt vehicle stock is greater under Moderate Electrification than under the Reference scenario. Under the Moderate Electrification scenario, about 95 percent of vehicle stock is Alt and 5 percent is ICE by 2050 whereas about 69 percent is Alt vehicles and 31 percent is ICE vehicles in 2050 under the Reference scenario.

Figure 93. Wholesale Trade Parts Inputs (2021-2050): Vehicle Stock – Reference

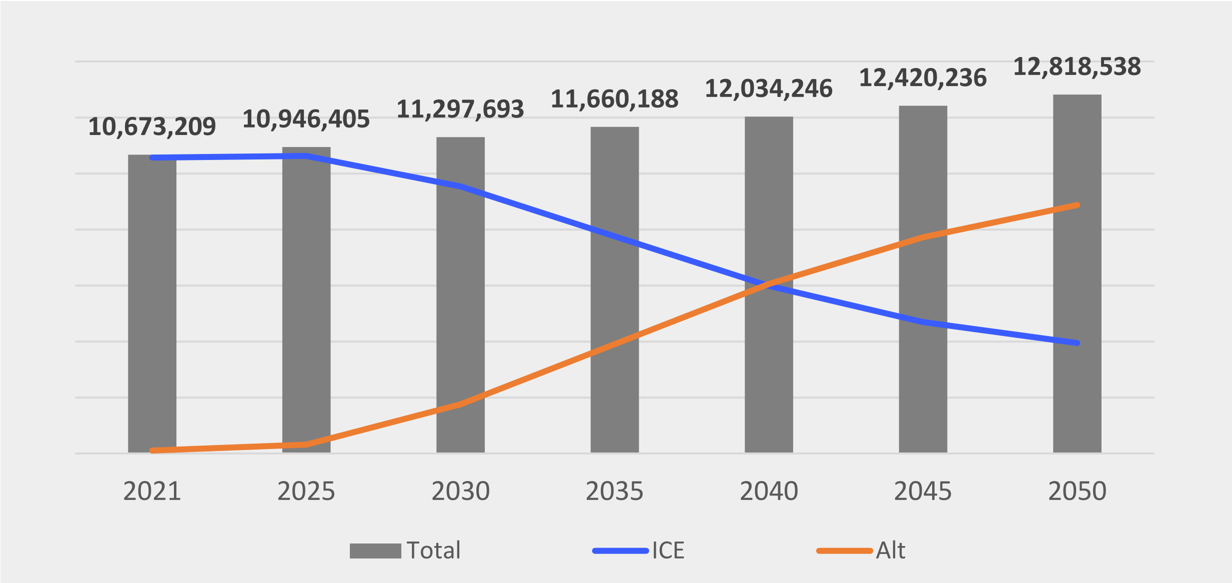
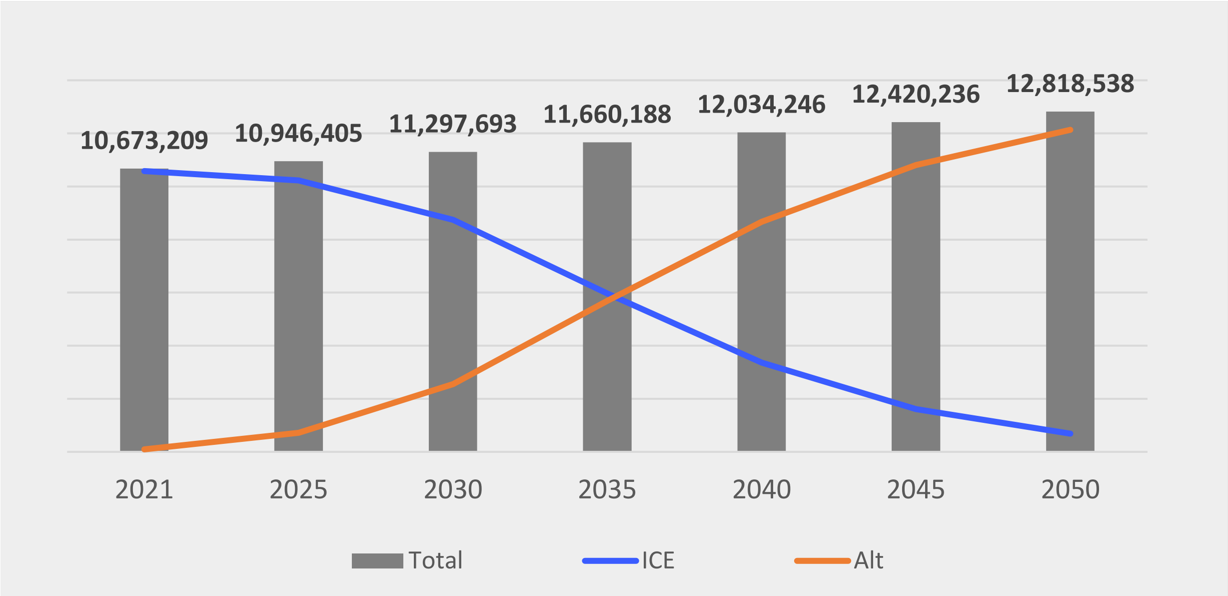


Figure 94. Wholesale Trade Parts Inputs (2021-2050): Vehicle Stock – Moderate Electrification



Under both scenarios, employment in the Wholesale Trade Parts sub-sector steadily increases by 7,800 jobs between 2021 and 2050 (see Figure 95 and Figure 96). Each industry is expected to grow at a similar rate, with no one sector comprising a majority of the job growth by 2050.

Figure 95. Wholesale Trade Parts Outputs (2021-2050) – Reference

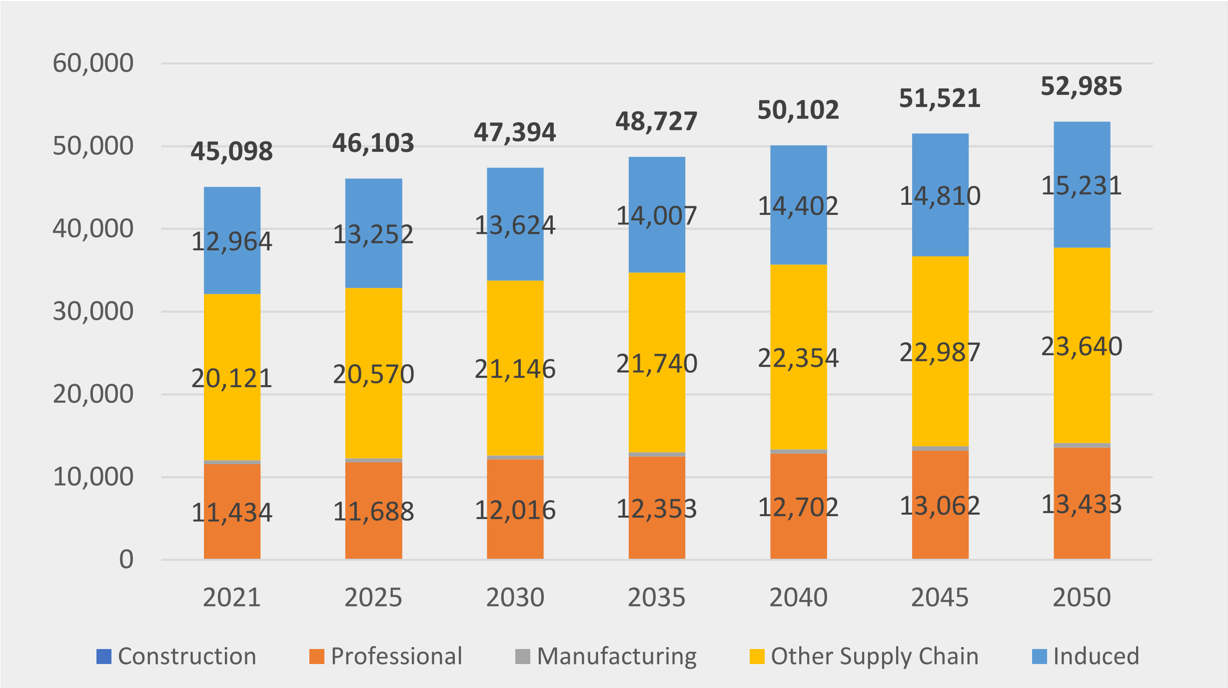
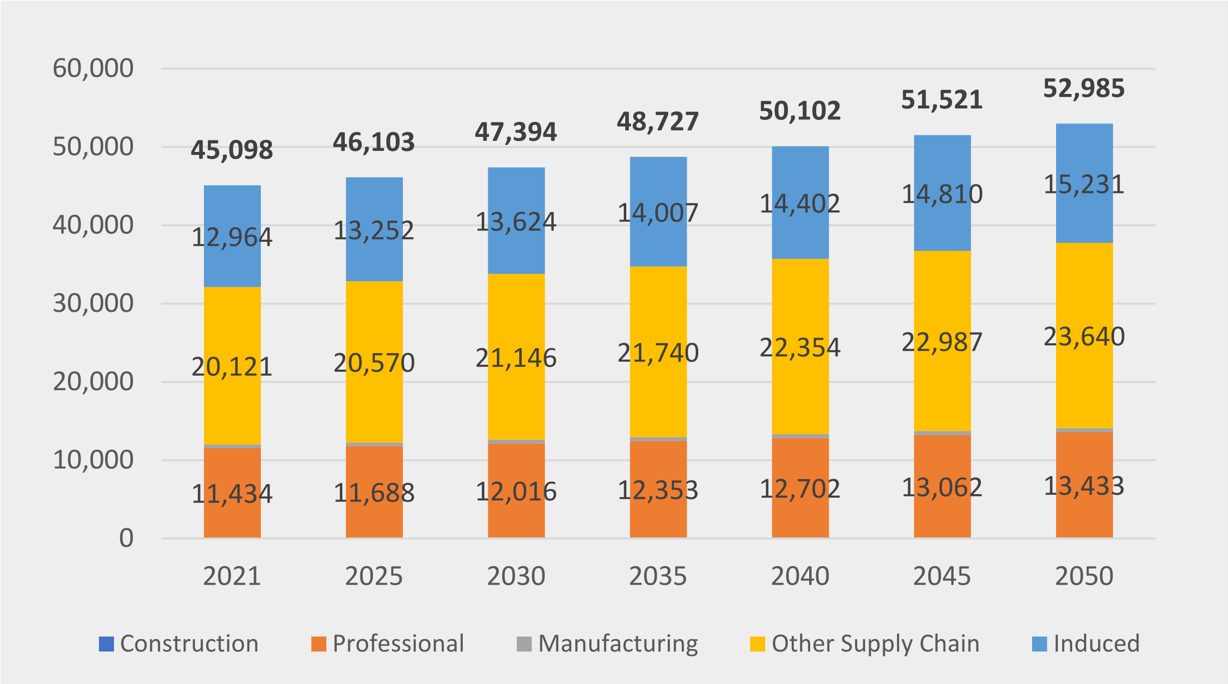


Figure 96. Wholesale Trade Parts Outputs (2021-2050) – Moderate Electrification

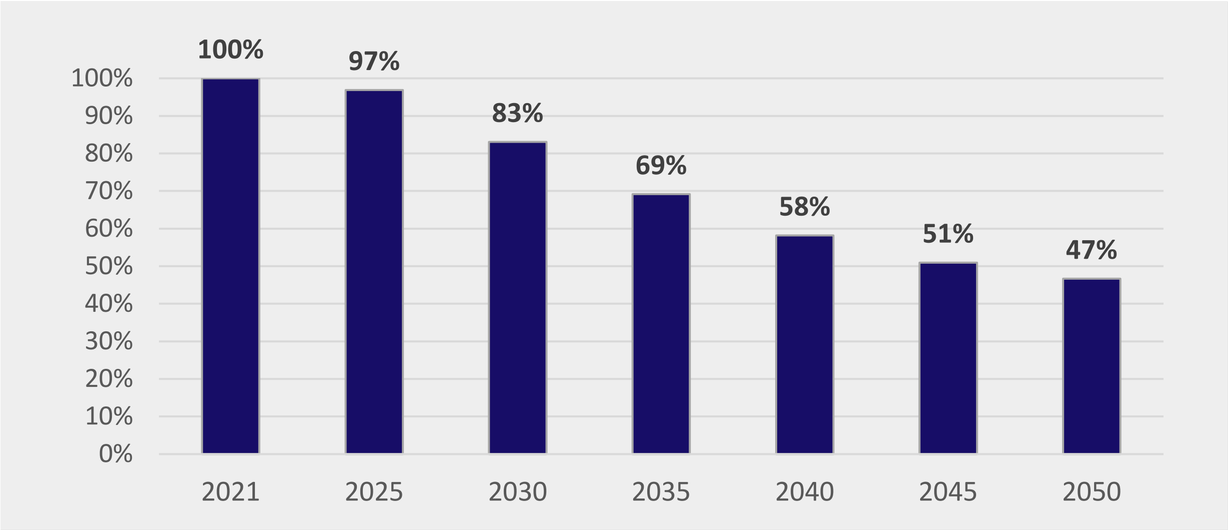


Fueling Stations

Fueling Stations, a displaced sub-sector, consists of gasoline stations and gasoline stations with convenience stores.

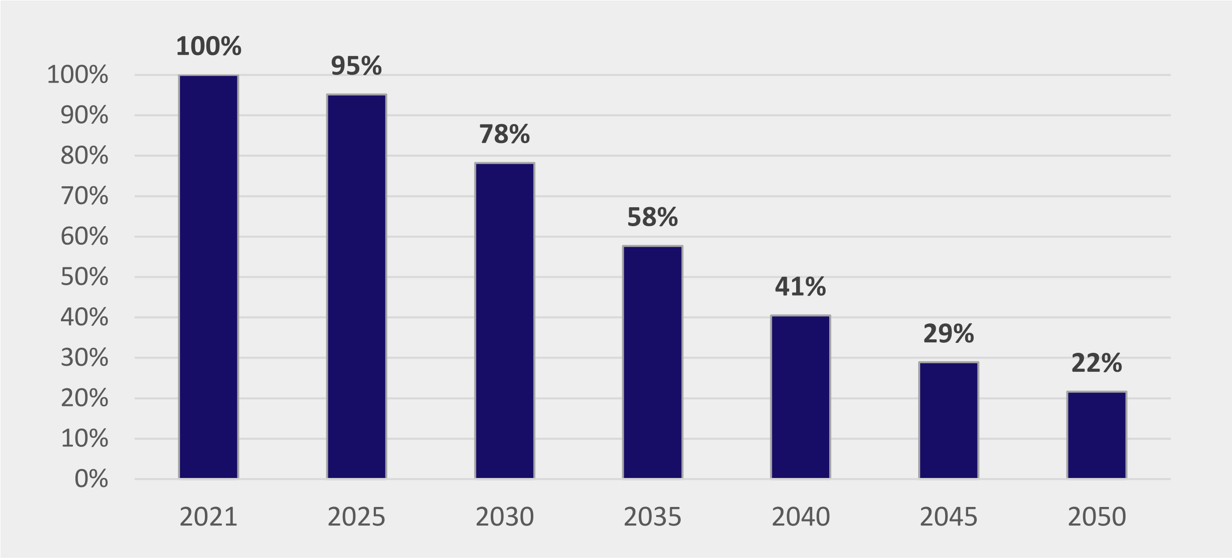
Under both scenarios, fuel demand decreases between 2021 and 2050, though fuel demand decreases more rapidly under Moderate Electrification (see Figure 97 and Figure 98). Under the Reference scenario, fuel demand decreases from 100 percent in 2021 to 83 percent in 2030 and 47 percent in 2050. Fuel demand decreases most rapidly between 2025 and 2035 under the Reference scenario, decreasing by 14 percent between 2025 and 2030 and 14 percent between 2030 and 2035.

Figure 97. Fueling Stations Inputs (2021-2050): Fuel Demand – Reference



Under Moderate Electrification, fuel demand decreases from 100 percent in 2021 to 78 percent in 2030 and 22 percent in 2050. Fuel demand decreases most rapidly between 2025 and 2030 and between 2035 and 2040 under Moderate Electrification, decreasing by 17 percent during each time frame.

Figure 98. Fueling Stations Inputs (2021-2050): Fuel Demand – Moderate Electrification



Decreased fuel demand between 2021 and 2050 results in job displacement in the Fueling Stations sub-sector across both scenarios (see Figure 99 and Figure 100). As with fuel demand, employment in the Fueling Stations sub-sector decreases between 2021 and 2050 and decreases more rapidly under Moderate Electrification than under the Reference scenario. By 2050, 17,500 Fueling Stations jobs are displaced under the Reference scenario and 25,800 jobs are displaced under the Moderate Electrification scenario. Most of the job displacement under both scenarios is concentrated in the Other Supply Chain category, which is also the largest industry segment in the Fueling Stations sub-sector.

Figure 99. Fueling Stations Outputs (2021-2050) – Reference

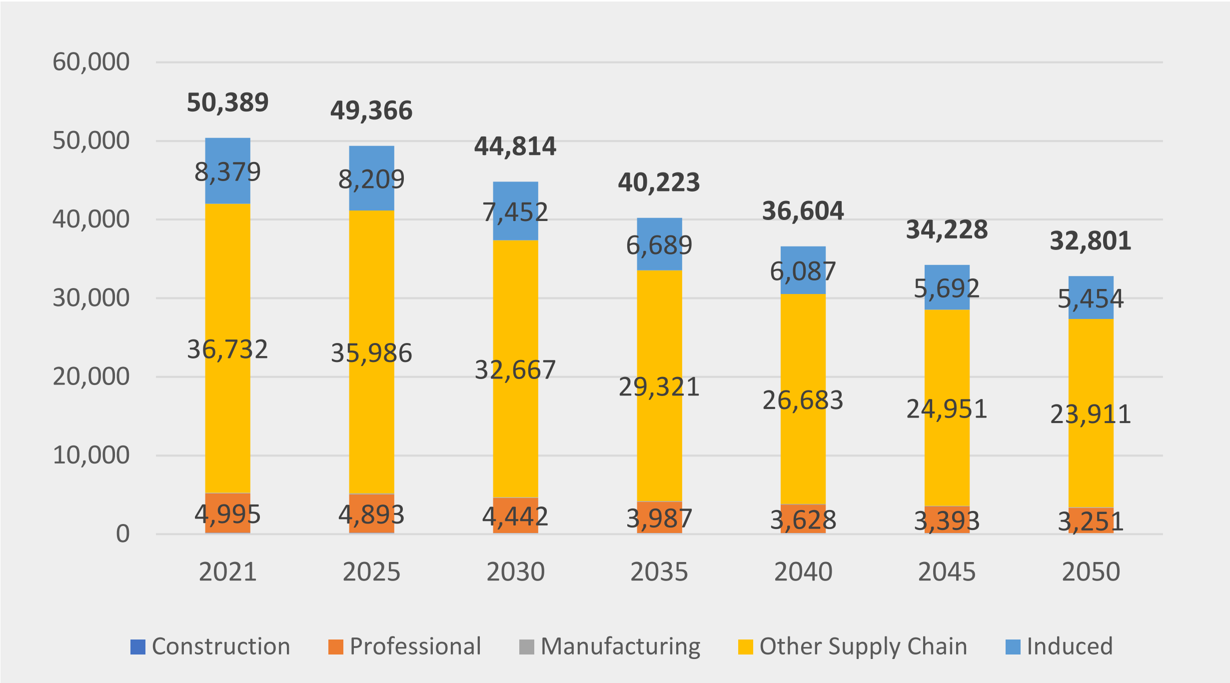
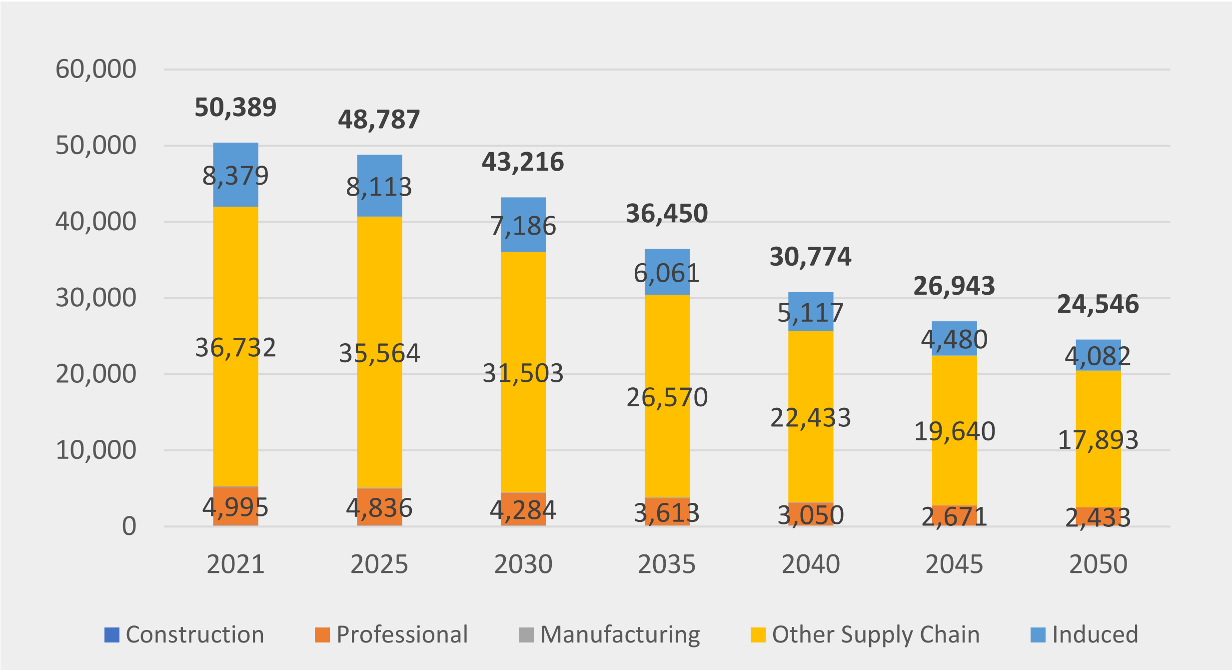


Figure 100. Fueling Stations Outputs (2021-2050) – Moderate Electrification



Charging and Hydrogen Fuel Stations

Charging & Hydrogen Fuel Stations, a growth sub-sector, is largely made up of battery electric vehicle home chargers, plug-in hybrid electric vehicle home chargers, and electric vehicle supply equipment for light duty battery electric vehicles, light duty plug-in hybrid electric vehicles, medium duty vehicles, and heavy-duty vehicles.

While investments in Charging & Hydrogen Fuel Stations peak in 2040 under the Reference scenario, investments peak in 2035 under Moderate Electrification (see Figure 101 and Figure 102). Under the Reference scenario, annual charger investment increases from $119M in 2021 to its peak at $1,830M in 2040 before slowly decreasing to $1,660M in 2050 (Figure 101). Annual charger investment is consistently higher and peaks more quickly under the Moderate Electrification scenario than under the Reference scenario. Under Moderate Electrification, annual charger investment increases steadily from $99M in 2021 to its peak at $3,032 in 2035 before slowly decreasing to $2,551 in 2050.

Figure 101. Charging & Hydrogen Fuel Stations (2021-2050): Annual Charger Investment ($M) – Reference

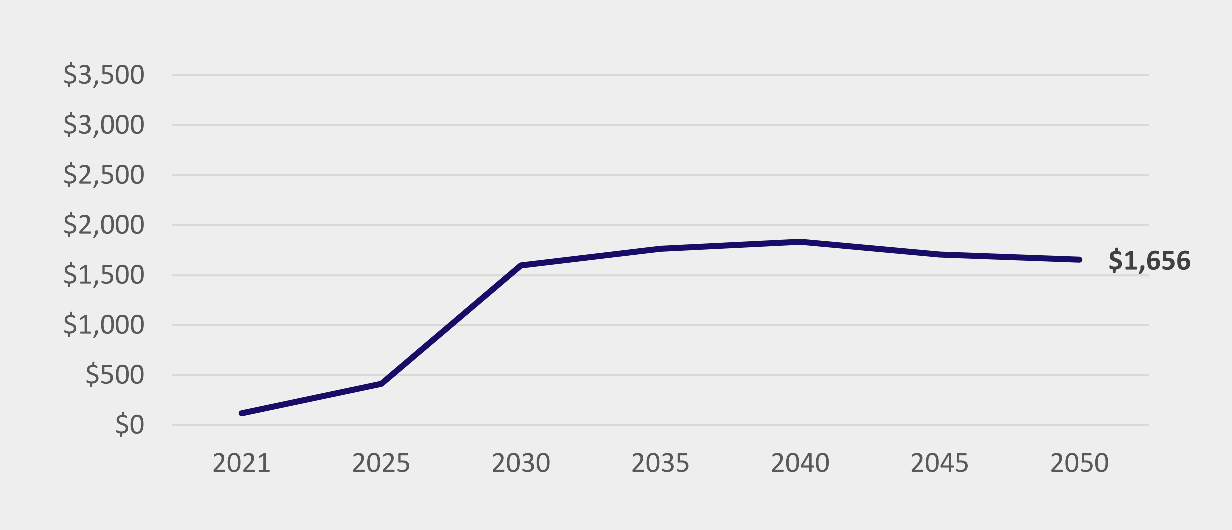
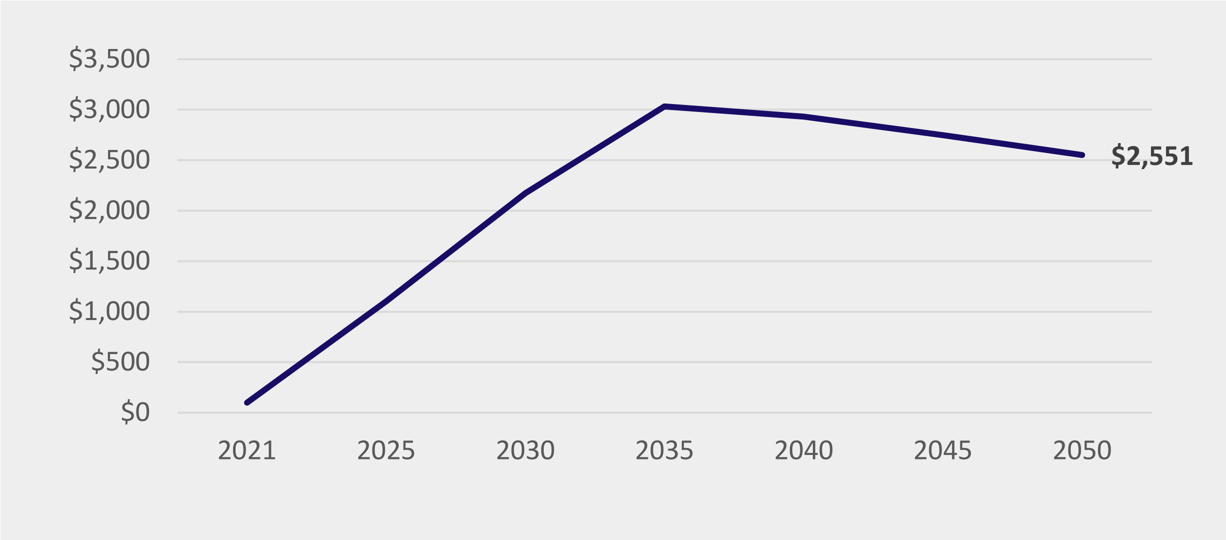
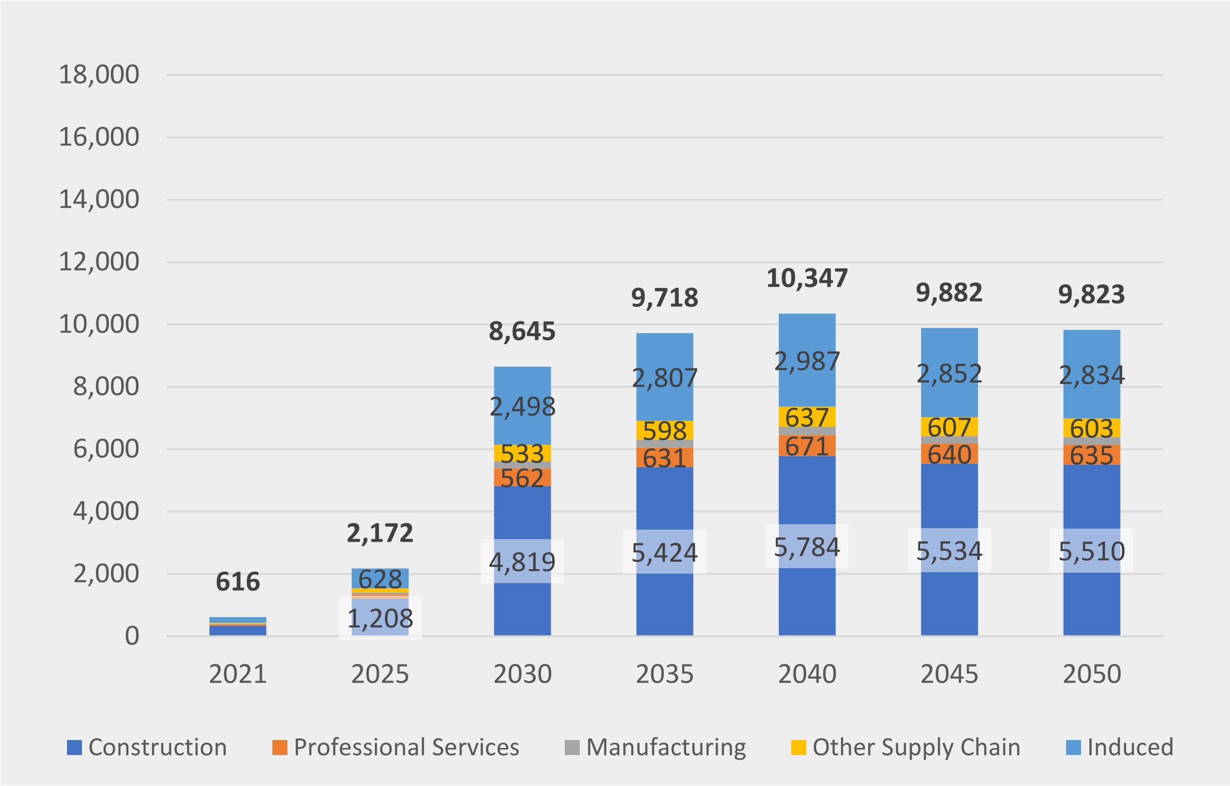


Figure 102. Charging & Hydrogen Fuel Stations (2021-2050): Annual Charger Investment ($M) – Moderate Electrification



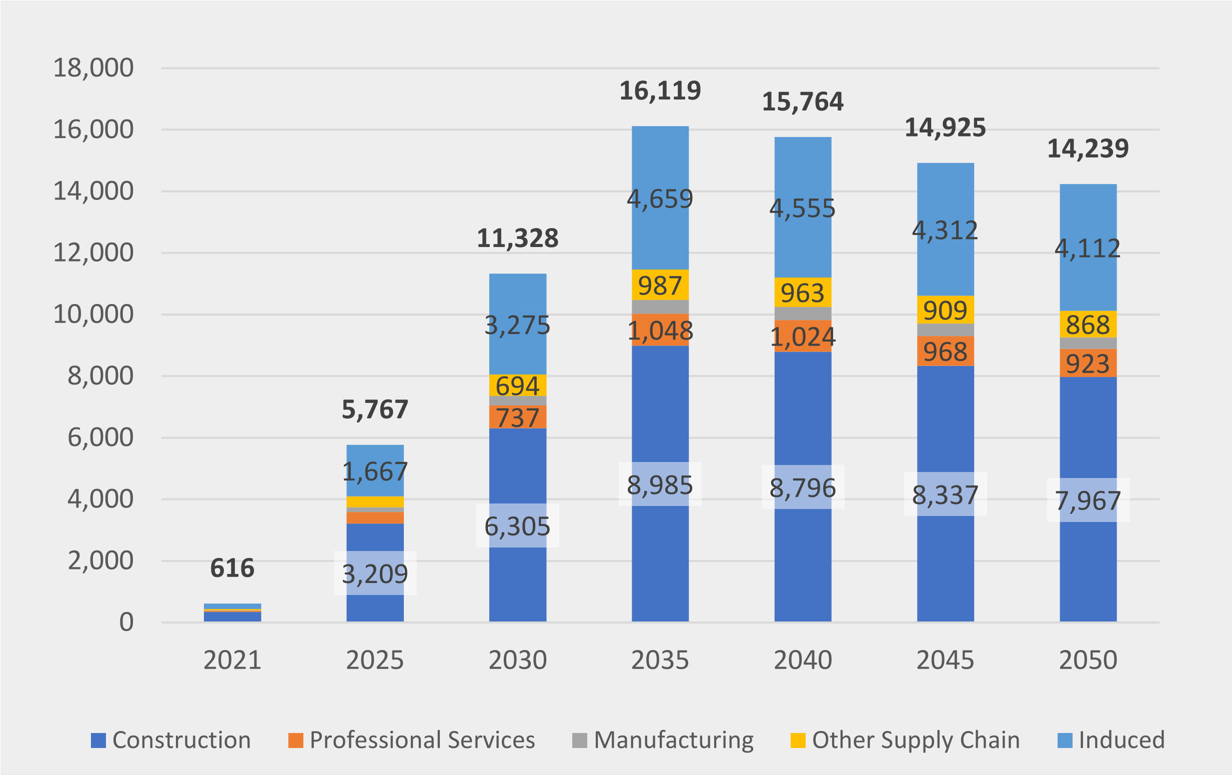
Annual charger investment patterns result in corresponding employment growth in the Charging and Hydrogen Fuel Stations sub-sector (see Figure 103 and Figure 104). Under the Reference scenario, employment spikes between 2025 and 2030 and then slowly increases to reach its peak at 10,300 jobs in 2040 before leveling out at around 9,800 jobs. The Charging and Hydrogen Fuel sub-sector sees strong employment growth between 2021 and 2035 under the Moderate Electrification scenario, then slowly decreases until 2050.

Figure 103. Charging & Hydrogen Fuel Stations Outputs (2021-2050) – Reference



By 2050, the Charging and Hydrogen Fuel Stations sub-sector gains 9,200 jobs under the Reference scenario and 13,600 jobs under Moderate Electrification. Under both scenarios, employment growth is largely driven by the Construction and Induced employment industries, which are each over 16 times greater than their 2021 employment levels by 2050 under the Reference scenario and over 23 times greater under the Moderate Electrification scenario.

Figure 104. Charging & Hydrogen Fuel Stations Outputs (2021-2050) – Moderate Electrification



Secondary Employment Outputs (2021-2030)

While the Initial Employment Outputs (IEOs) provide estimates of the changes in job quantity by 2030 and 2050 under the Reference scenario and Moderate Electrification scenarios, the Secondary Employment Outputs (SEOs) offer insights into growth and displaced sub-sectors and occupational changes that occur.

The changes in employment by industry and occupational categories are valuable in beginning to understand how the overall employment picture can often mask underlying changes to the business community and the supporting workforce. The churn that often happens with employment by industry and occupation is valuable for educators and workforce developers as they plan around the talent pipeline for the future.

This section begins with a discussion of overall SEOs— highlighting the occupational growth and displacement— followed by sector-specific outputs for both the Reference and Moderate Electrification transition scenarios.

Key Findings

- **The Electricity sector, a growing sector, will experience growth in the Solar, Land-Based Wind, Hydrogen, Distribution, Transmission, and Storage sub-sectors.** By 2030, Installation/Repair (46 percent) and Management/Professional Occupations (24 percent) make up the largest share of jobs in both scenarios.

- **The Electricity sector will experience displacement in the Other Fossil Generation and Natural Gas sub-sectors.** By 2030, Installation/Repair jobs will decline in the Reference scenario (-60 percent) and in the Moderate Electrification scenario (-50 percent). Management and Sales jobs both decline (-30 percent) in the Reference scenario, and in the Moderate Electrification scenario (-20 percent).

- **The Fuels sector gains jobs in the Moderate Electrification (4,000 jobs) scenario and loses in the Reference (-1,000 jobs) scenario.** Almost all occupational categories grow in the Moderate Electrification scenario. Installation/Repair grows (37 percent), while Administrative jobs (-12 percent) decline. Almost all occupational categories shrink in the Reference scenario, except for Installation/Repair (2 percent) jobs.

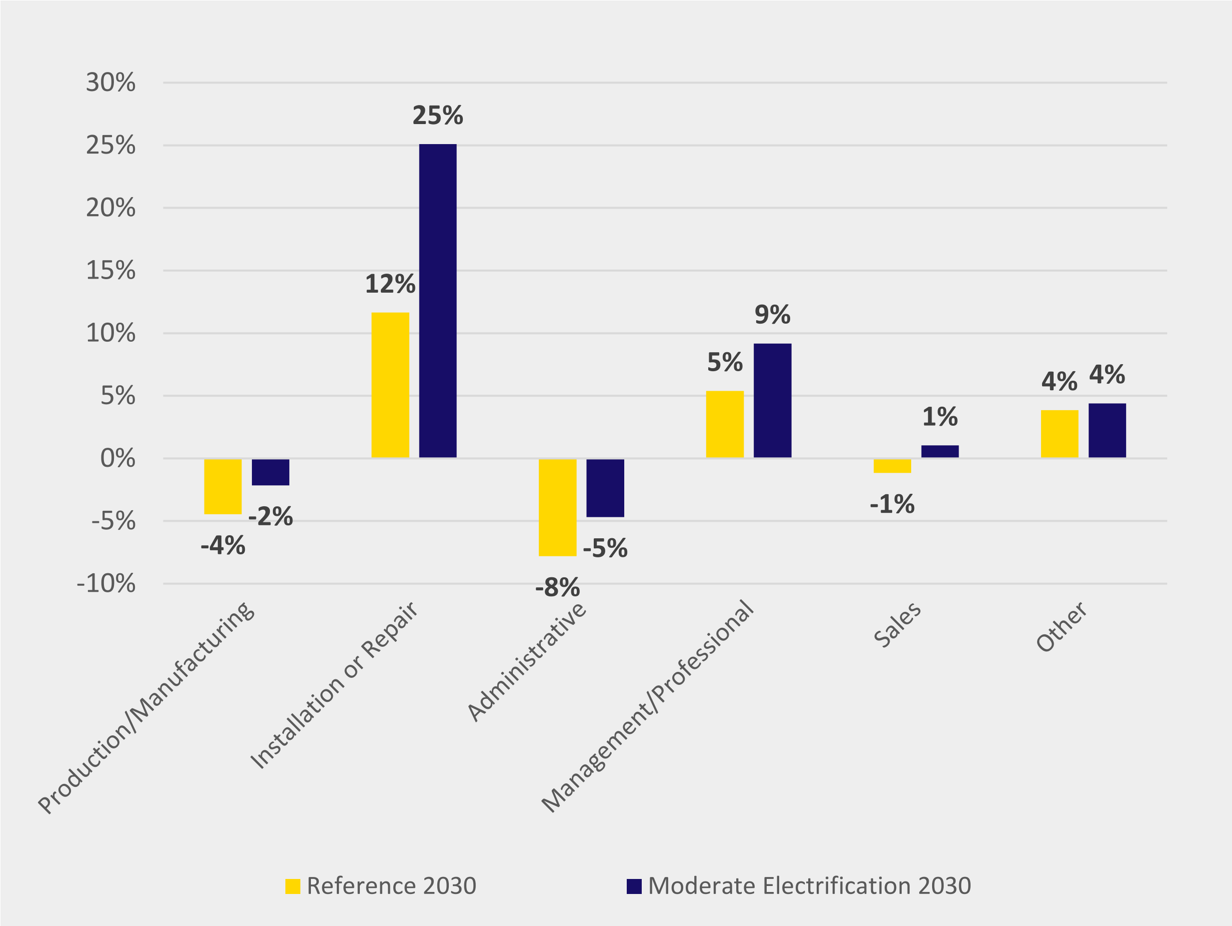
- **The Buildings sector gains jobs in both the Reference (2,089 jobs) and the Moderate Electrification (15,301 jobs) scenarios by 2030.** All occupational categories experience growth in the Moderate Electrification scenario with Installation/Repair (30 percent) and Sales (17 percent) employment driving the growth. Employment in Installation/Repair (6 percent), Management/Professional (4 percent), Sales (3 percent), and Other (2 percent) will grow in the Reference scenario, while Administrative (-8 percent) and Production/Manufacturing (-2 percent) jobs decline.

- **The Transportation sector gains jobs in both the Reference (3,254 jobs) and Moderate Electrification (2,461 jobs) scenarios**. Installation/Repair, Management/Professional and Other grow in both scenarios, while Administrative, Production/Manufacturing, and Sales decline in both scenarios. There is a small disparity in employment between scenarios, meaning that each occupational categories experiences similar growth or displacement regardless of the transition scenario.

Overall

Overall, both the Reference and Moderate Electrification scenarios lead to increases in Other occupational categories (Figure 105).[29] The Moderate Electrification scenario leads to an 8 percent decrease in Production/Manufacturing jobs and a 5 percent decrease in Administrative roles. Installation/Repair roles increase by 12 percent under the Reference scenario and by 25 percent under Moderate Electrification. Management/Professional roles increase by 5 percent in the Reference and 9 percent in the Moderate Electrification scenarios. The Reference scenario leads to a 1 percent decrease in Sales jobs while Moderate Electrification leads to a 1 percent increase in jobs by 2030. Overall, both the Reference and Moderate Electrification scenarios lead to decreases in Production/Manufacturing and Administrative occupations. The Reference scenario leads to a 2 percent decrease in Production/Manufacturing jobs and an 8 percent decrease in Administrative roles.

Figure 105. Overall Occupational Output (2021 to 2030) – Reference vs. Moderate Electrification



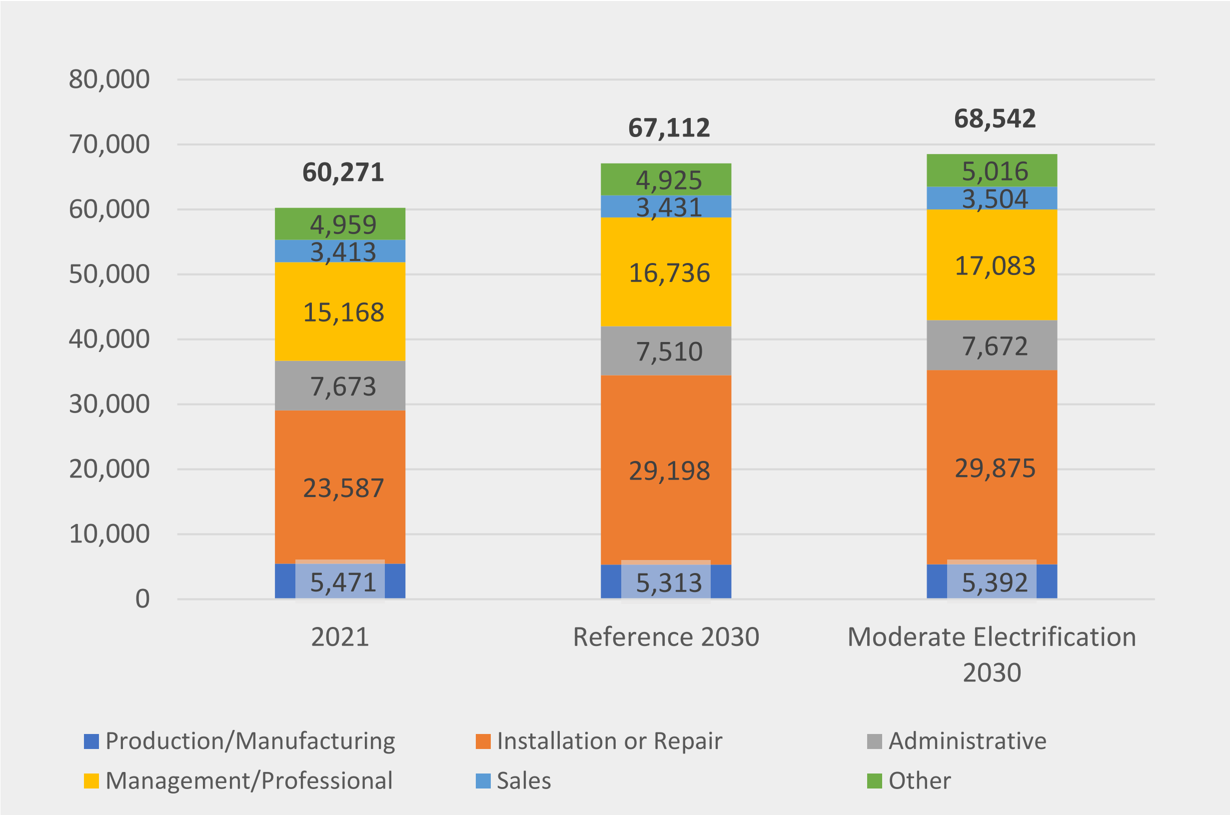
[29] The "Other" occupational category includes all other occupations not included in the Installation/Repair, Production/Manufacturing, Management/Professional, Sales, and Administrative occupational categories. While this includes SOC codes 21-0000, 25-0000, 27-0000, 29-0000, 31-0000, 33-0000, 35-0000, 39-0000, 45-0000, and 53-0000, Transportation and Material Moving Occupations (SOC 53-0000) make up most of the "Other" occupations identified in the SEO analysis.

The following is a discussion of occupational employment changes under the Reference and Moderate Electrification scenarios across all four sectors (Electricity, Fuels, Buildings, and Transportation). The data are presented for overall, growth, and displacement figures in the occupational analyses.

Electricity

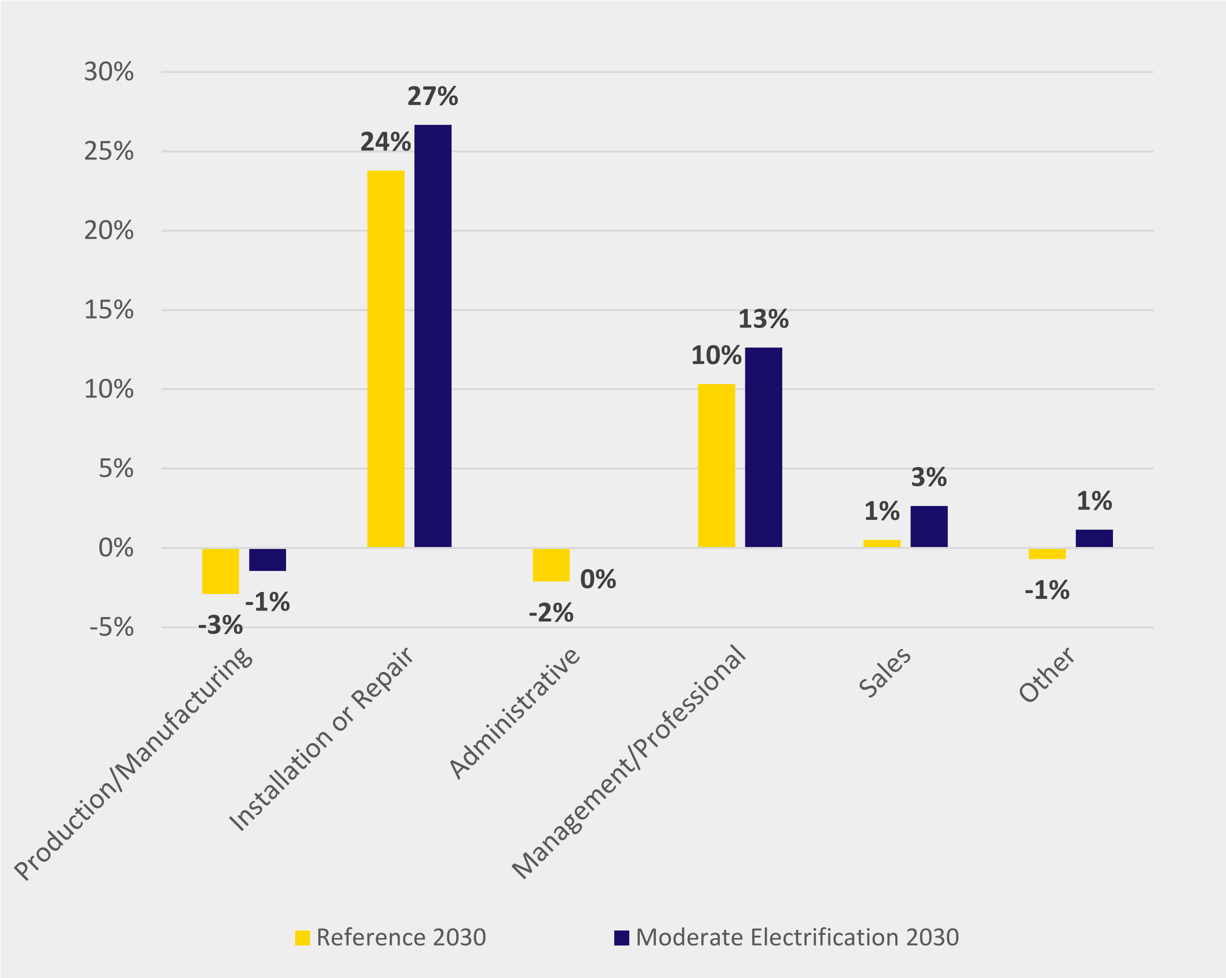
Overall, the Electricity sector will gain almost 7,000 jobs under the Reference scenario, and more than 8,000 jobs under the Moderate Electrification scenario (Figure 106). This growth will mainly be driven by Installation/Repair occupations, and Management/Professional jobs, that will add 6,000 and 2,000 jobs across both scenarios, respectively.

Figure 106. Electricity Occupational Output (2021 to 2030)



Installation/Repair grows by 24 percent under the Reference scenario, and by 27 percent in the Moderate Electrification scenario (Figure 107). Management/Professional jobs grow by 10 percent under the Reference scenario, and by 13 percent under the Moderate Electrification scenario. Sales jobs experience growth under both the Reference and Moderate Electrification scenarios, at 1 percent and 3 percent, respectively. Both Production/Manufacturing, and Administrative occupations experience a decline under both the Reference and Moderate Electrification scenarios. Other occupations experience a decline under the Reference scenario and a slight growth under the Moderate Electrification scenario.

Figure 107. Electricity Occupational Output (2021 to 2030) – Reference vs. Moderate Electrification



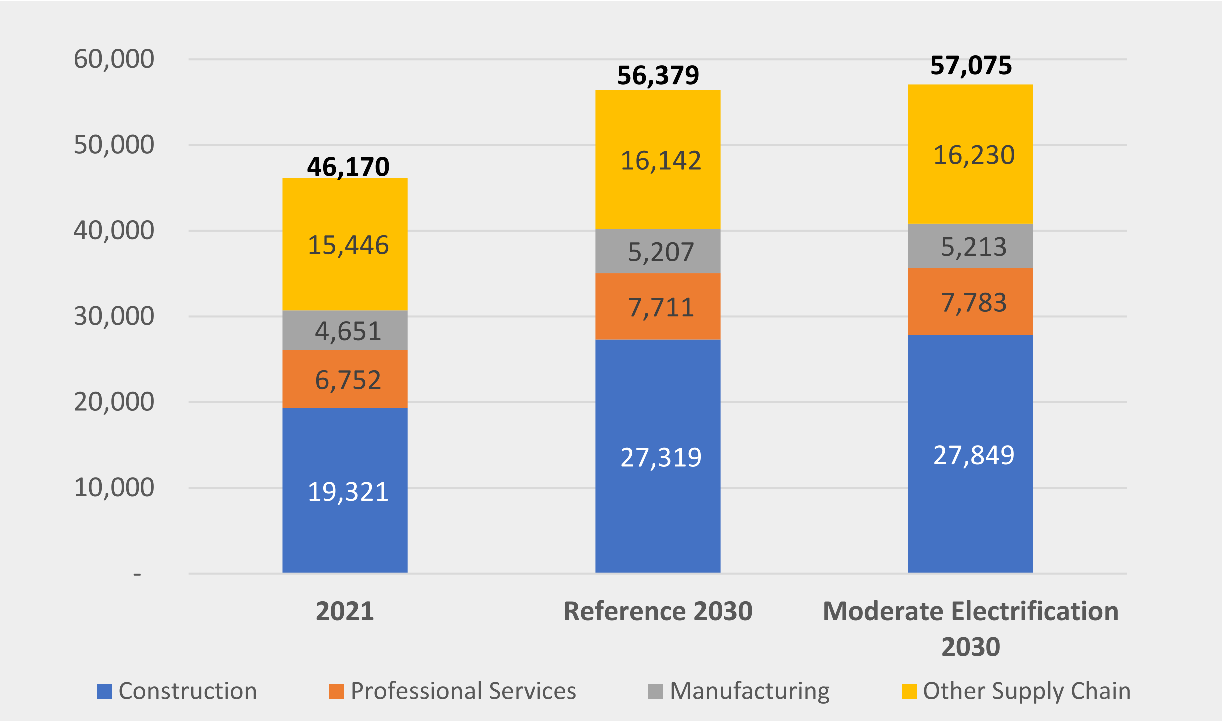
Growth Sub-Sectors

The Electricity sector will grow in the Solar, Land-Based Wind, Hydrogen, Distribution, Transmission, and Storage sub-sectors.

This growing sector will experience consistent growth in the Construction, Manufacturing, Professional Services, and Other Supply Chain[30] industries (Figure 108). By 2030, more than 10,000 jobs will be added. Construction alone will participate in that growth by adding close to 8,000 jobs in the Reference scenario and more than 8,000 jobs in the Moderate Electrification scenario. The Construction industry experiences a steady increase, going from a 42 percent share of Electricity in 2021 to a 48 percent share in 2030. Construction is closely followed by Other Supply Chain, which goes from a 33 percent share of Electricity in 2021 to a 28 percent share in 2030, followed by Professional Services and Manufacturing, holding 14 percent and 9 percent shares of Electricity by 2030.

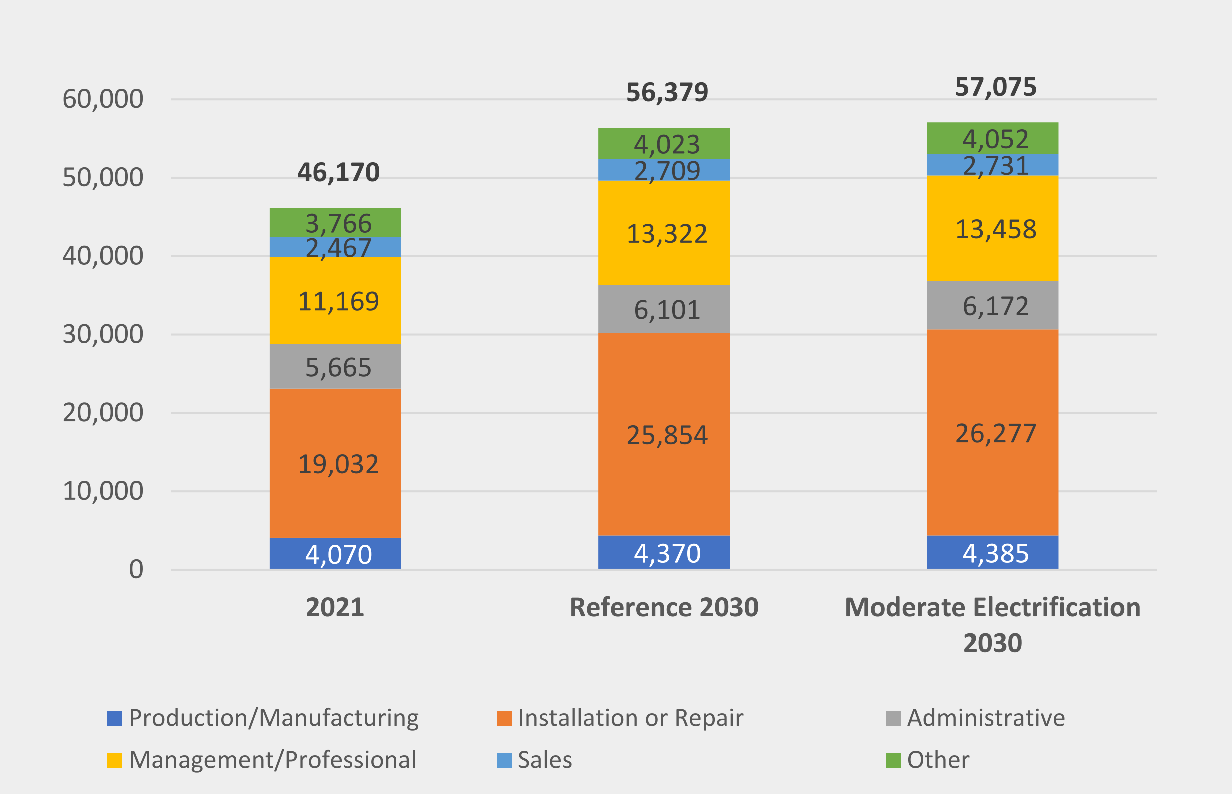
[30] Other Supply Chain industry definition includes all other industries that are not included in the Construction, Manufacturing, and Professional Services industry groups. Industries that make up most of this employment include transportation and warehousing, utilities, wholesale, and retail.

Figure 108. Electricity Growth Sub-Sectors: Industry Profile (2021-2030)



Major occupational categories in Electricity growth sub-sectors will experience consistent growth as well, with Installation/Repair driving that growth by adding more than 7,000 jobs between 2021 and 2030 (Figure 109). This accounts for 46 percent share of Electricity in both Reference and Moderate Electrification scenarios. Management/Professional Occupations experience the second largest growth, accounting for 24 percent share of Electricity in both scenarios.

Figure 109. Electricity Growth Sub-Sectors: Occupational Profile (2021-2030)

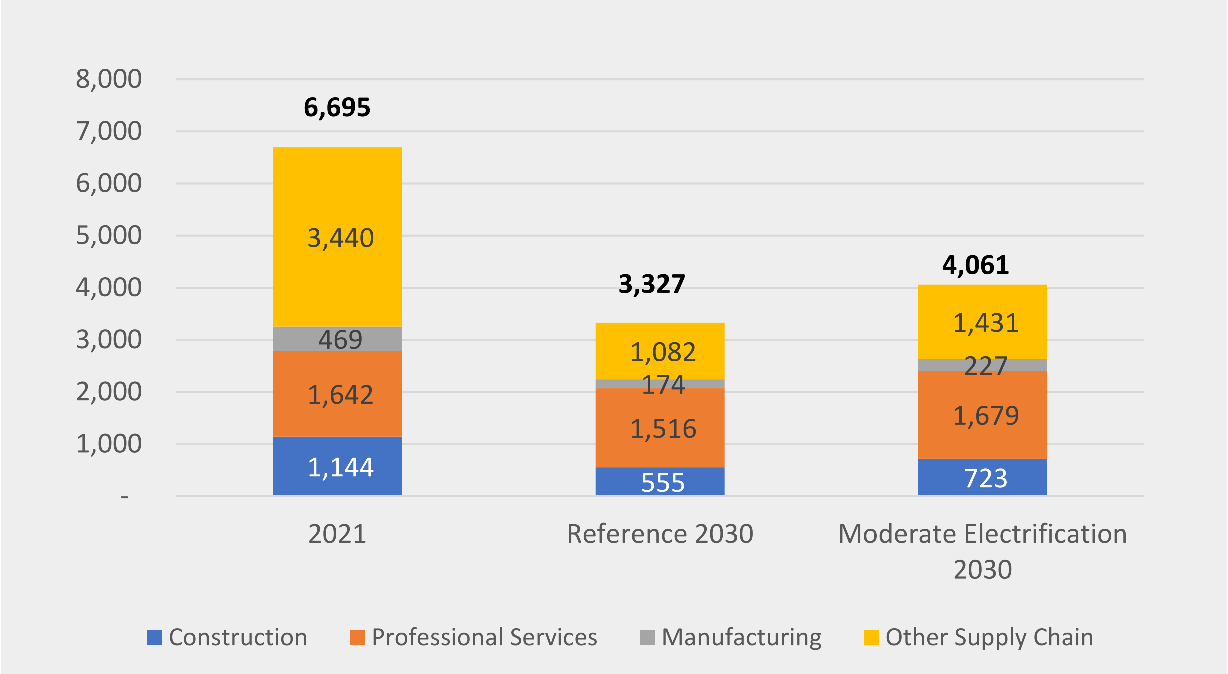


Displaced Sub-Sectors

The Electricity sector will experience displacement in the Other Fossil Fuel and Natural Gas sub-sectors.

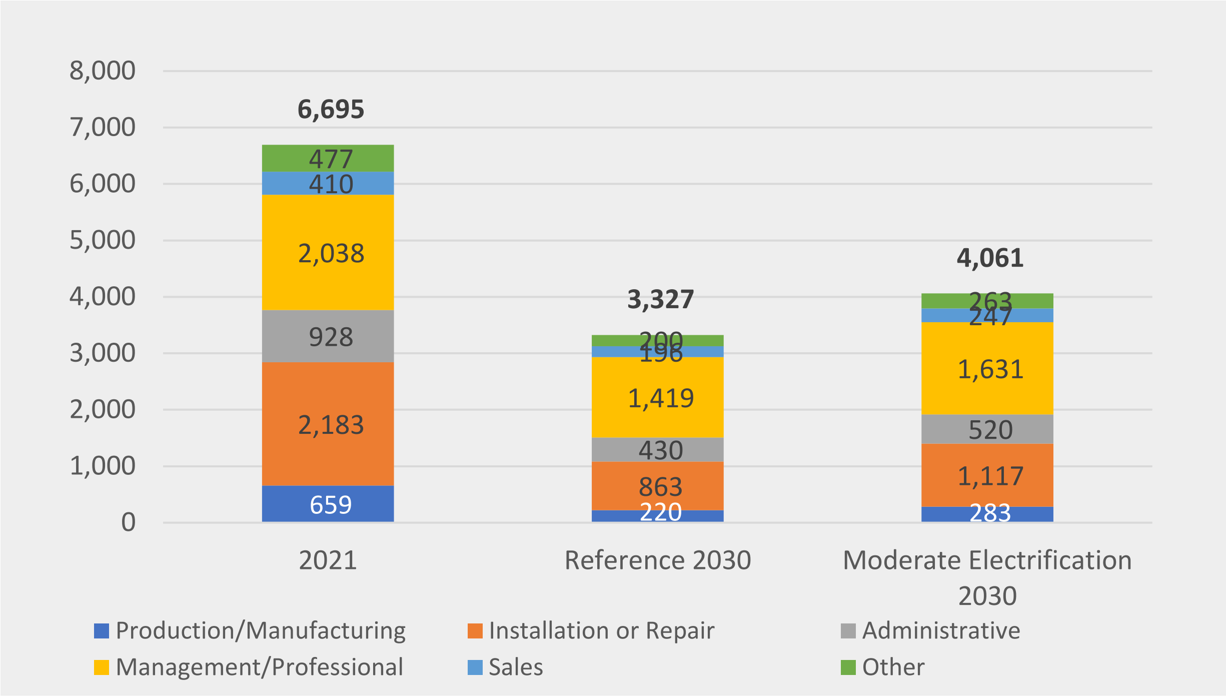
The displaced Electricity sub-sectors will experience job losses in both the Reference scenario (-3,000 jobs) and Moderate Electrification (-2,500 jobs) scenarios (Figure 110). Most displacement will be driven by Other Supply Chain jobs, which goes from occupying 51 percent of the displaced Electricity sub-sectors, to 32 percent under the Reference scenario, and 35 percent under the Moderate Electrification scenario. Construction, which occupies 17 percent of the displaced Electricity sub-sectors, will lose approximately 500 jobs under the Reference scenario, and 400 jobs under the Moderate Electrification scenario.

Figure 110. Electricity Displaced Sub-Sectors: Industry Profile (2021-2030)



Major occupational categories in the displaced Electricity sub-sectors will experience a decline between 2021 and 2030. Installation/Repair will see the sharpest decline in both the Reference (-60 percent) and Moderate Electrification (-50 percent) scenarios (Figure 111). Management and Sales follow closely, with a 30 percent loss in jobs under the Reference scenario, and a 20 percent loss under the Moderate Electrification scenario. Out of the approximately 3,500 jobs displaced in Electricity sub-sectors, more than 1,000 will come out of Installation/Repair occupations. Construction and Sales occupations will lose approximately 500 jobs and 200 jobs, respectively, by 2030 under both scenarios.

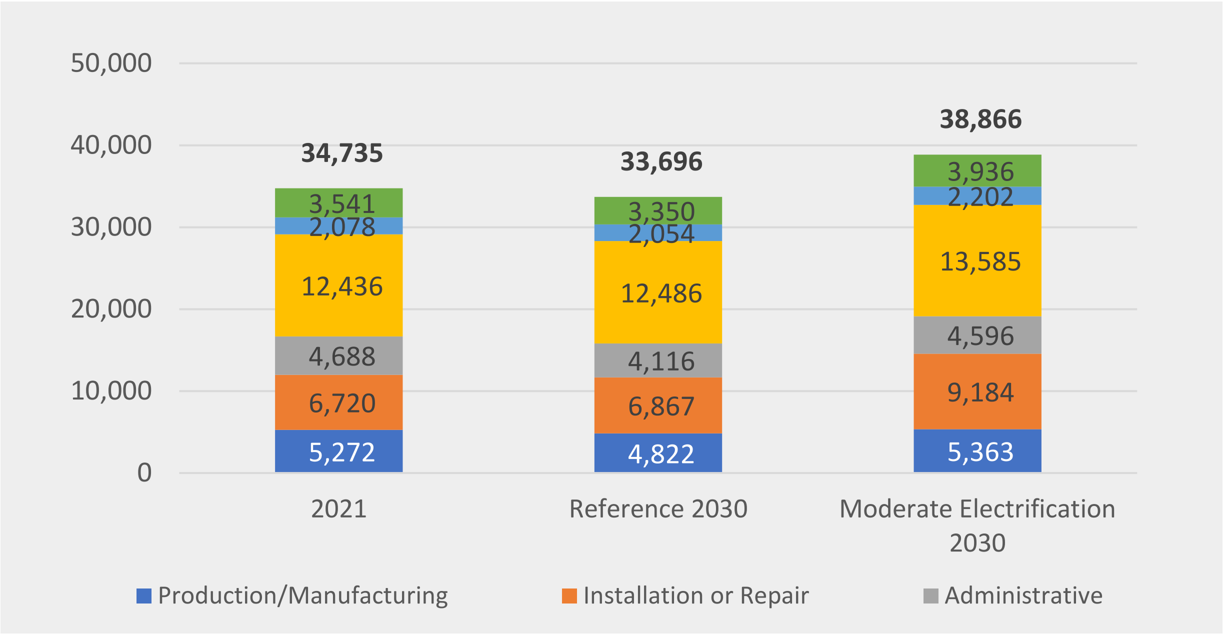
Figure 111. Electricity Displaced Sub-Sectors: Occupational Profile (2021-2030)



Fuels

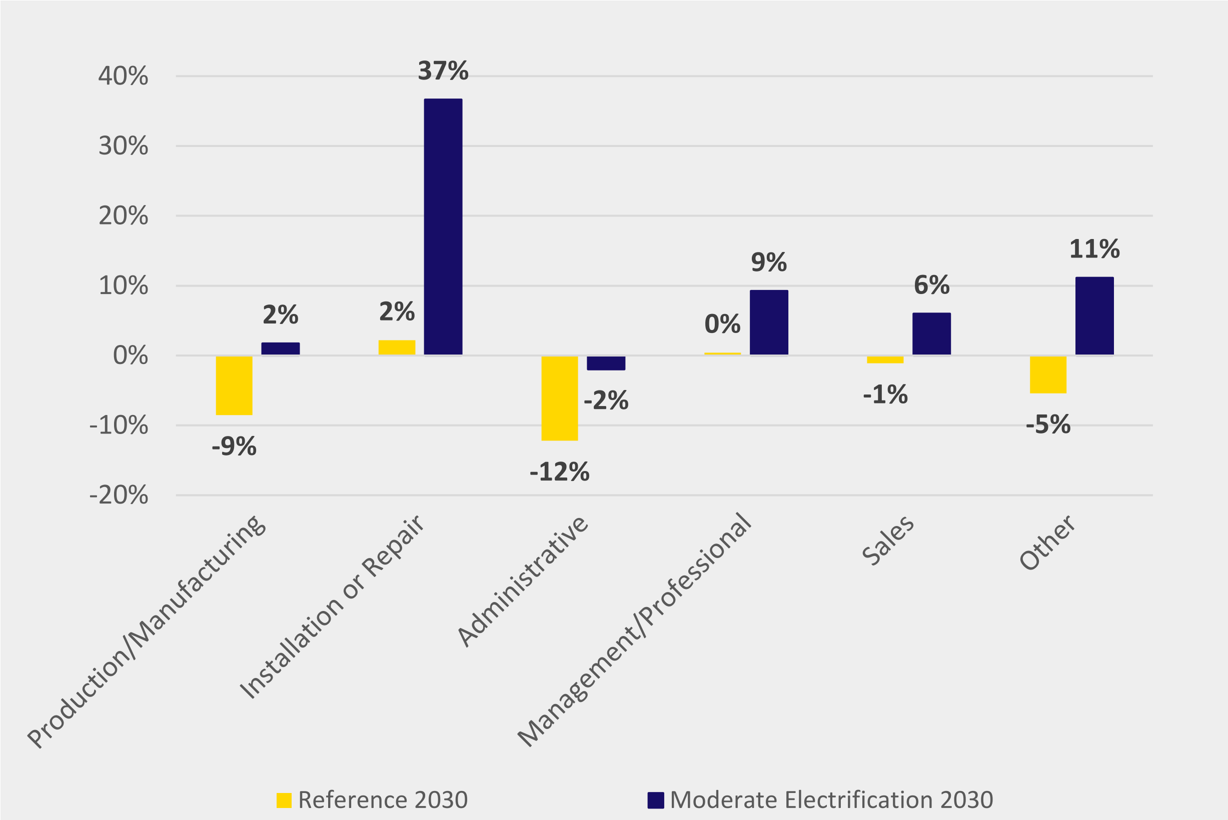
Overall, the Fuel sector loses jobs in the Reference Scenario (-1,000 jobs) and gains approximately 4,000 jobs in the Moderate Electrification scenario (Figure 112). In the Reference scenario, the loss in jobs is mainly caused by a decrease in Production/Manufacturing (-450 jobs) and Administrative (-500 jobs). In the Moderate Electrification scenario, the growth is mainly driven by Installation/Repair jobs, that creates almost 2,500 additional jobs. Management/Professional jobs, add about 1,100 jobs, followed by Production/Manufacturing, and Sales.

Figure 112. Fuels Occupational Output (2021 to 2030)



As seen in the chart below, almost all industries shrink in the Reference scenario, except for Installation/Repair jobs, which grow by 2 percent (Figure 113). In the Moderate Electrification scenario, almost all occupations experience some growth, except for Administrative jobs, which decline by 12 percent. Installation/Repair grows by 37 percent in the Moderate Electrification scenario, followed by Management/Professional occupations at 9 percent, and Sales at 6 percent.

Figure 113. Fuels Occupational Output (2021 to 2030) – Reference vs. Moderate Electrification

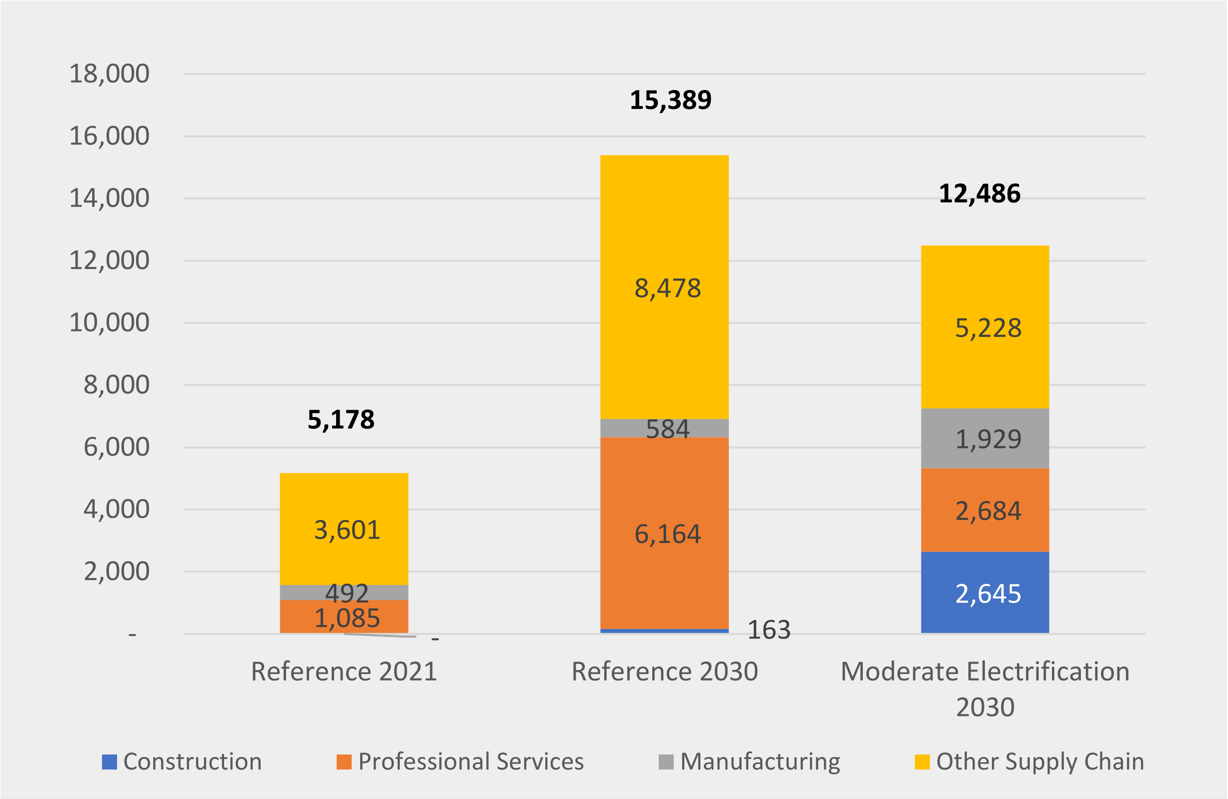


Growth Sub-Sectors

In the Reference scenario, the Fuels sector will experience growth in the Natural gas, Natural Gas Distribution, and Hydrogen sub-sectors. In the Moderate Electrification scenario, the Fuels sector will experience growth in the Bioenergy and Hydrogen sub-sectors.

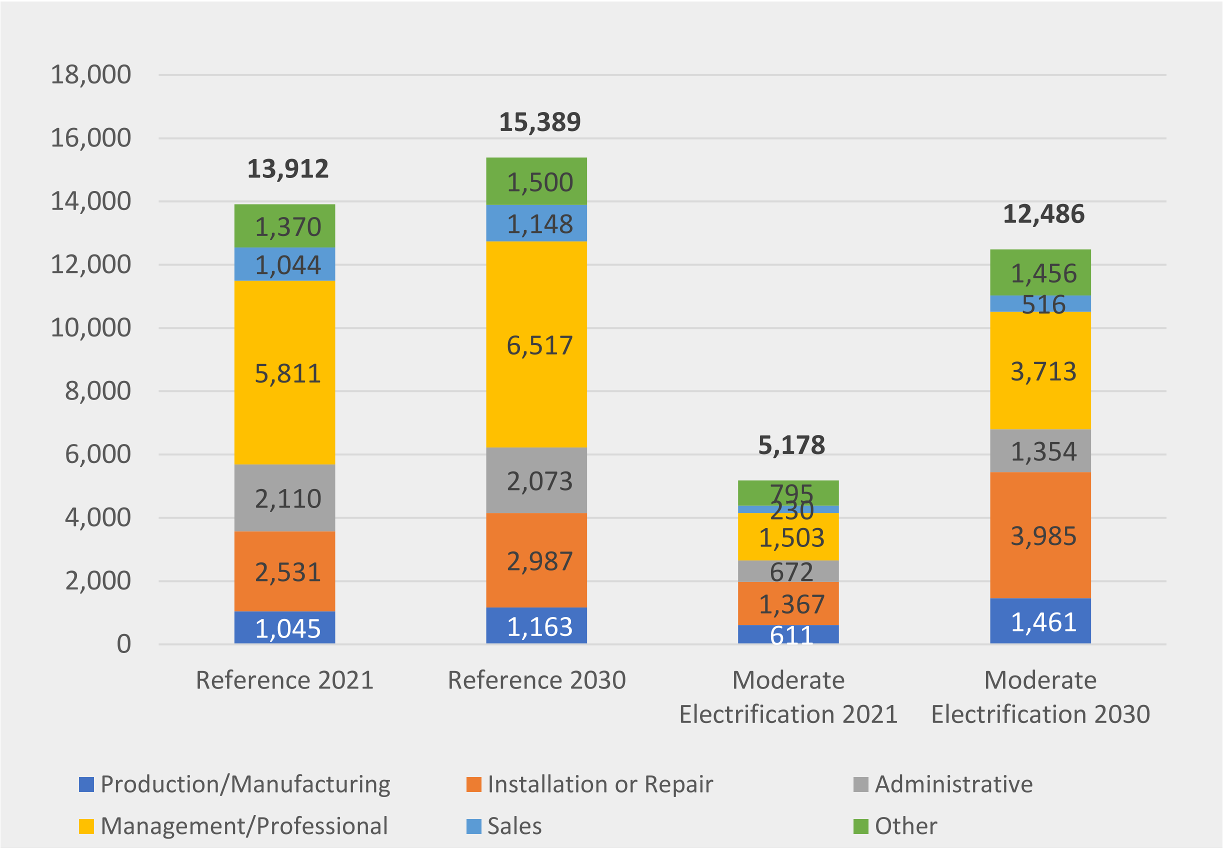
In the Reference scenario, this growth will be mainly driven by Other Supply Chain, creating almost 5,000 additional jobs by 2030 (Figure 114). Professional Services will also create close to 5,000 additional jobs by 2030. Other Supply Chain will also be driving the growth in the Moderate Electrification scenario, occupying a 41 percent share of the sector by 2030. Construction and Professional Services will participate in growth equally in this scenario, with Manufacturing creating the least number of jobs.

Figure 114. Fuels Growth Sub-Sectors: Industry Profile (2021-2030)



Fuel sub-sectors will experience growth across all major occupational categories, in both the Reference and Moderate Electrification scenarios (Figure 115). In the Reference scenario, growth will mostly be driven by Management/Professional occupations, which represent 42 percent of the growth sub-sectors and adds 700 jobs by 2030. In the Moderate Electrification, growth will mostly be driven by Installation/Repair jobs, representing more than 30 percent of the growth sub-sectors, and adding more than 2,500 jobs by 2030.

Figure 115. Fuels Growth Sub-Sectors: Occupational Profile (2021-2030)

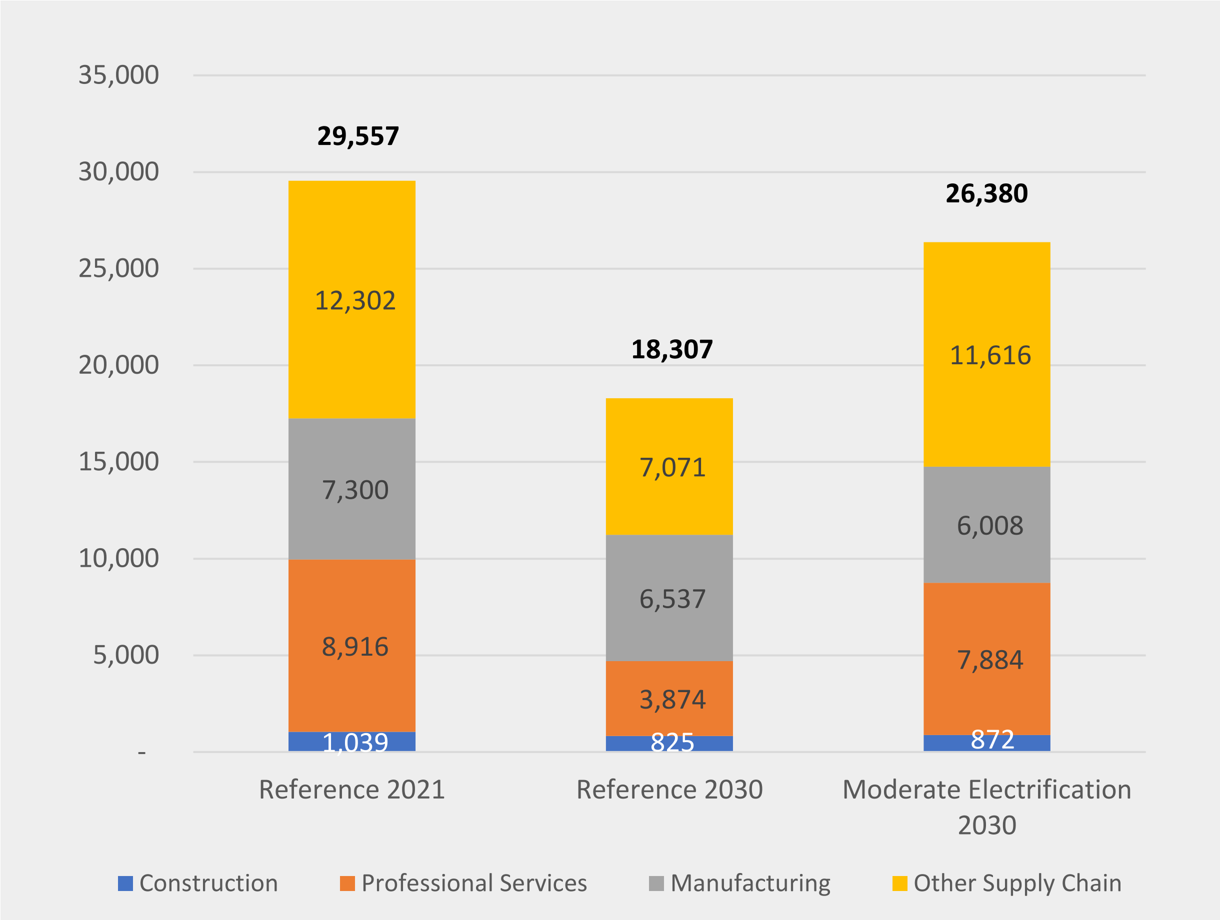


Displaced Sub-Sectors

In the Reference scenario, the Fuels sector will experience displacement in the Bioenergy and Petroleum sub-sectors. In the Moderate Electrification scenario, the Fuels sector will experience displacement in the Petroleum, Natural Gas, and Natural Gas Distribution sub-sectors.

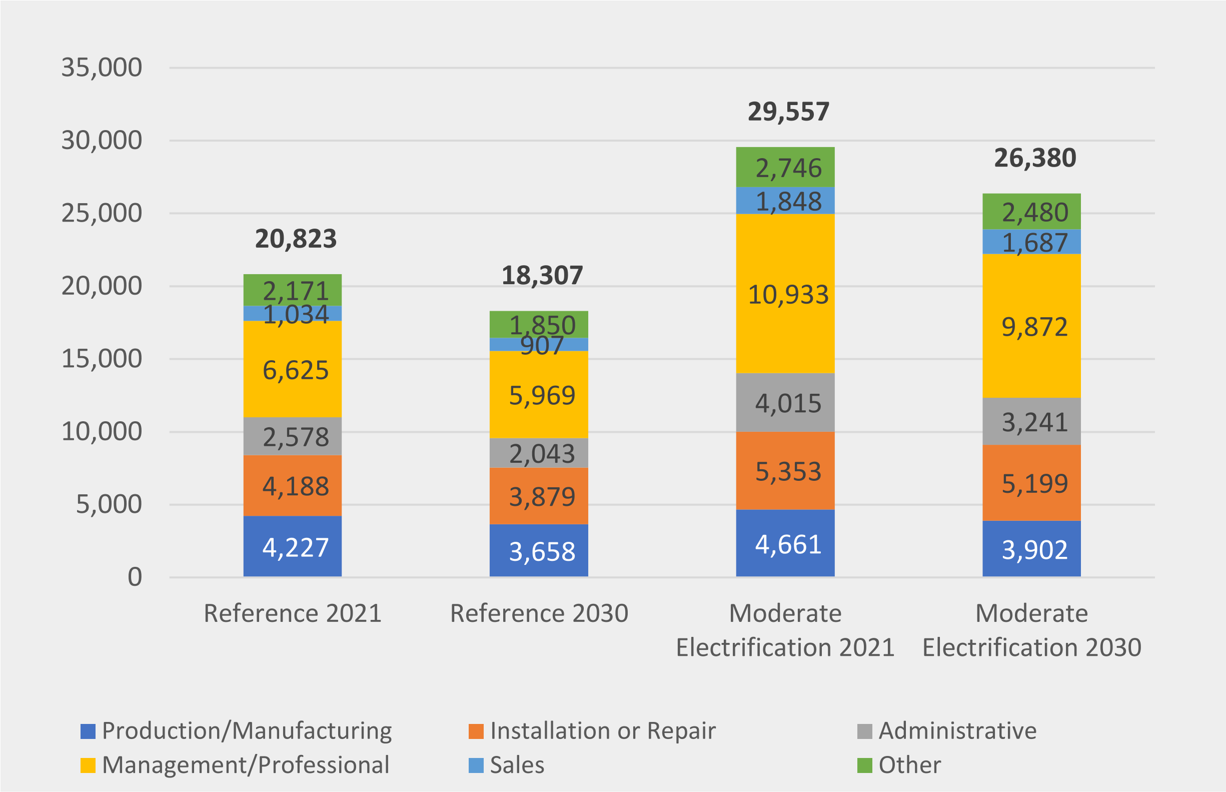
Displaced Fuel sub-sectors will experience losses in both the Reference (-11,000 jobs) and Moderate Electrification (-3,000 jobs) scenarios (Figure 116). In the Reference scenario, industries that will experience the most displacement by 2030 are Other Supply Chain (-5,000 jobs) and Professional Services (-5,000 jobs). In the Moderate Electrification scenario, Manufacturing (-1,000 jobs) experiences the most displacement followed by Other Supply Chain and Professional Services (-680 jobs).

Figure 116. Fuels Displaced Sub-Sectors: Industry Profile (2021-2030)



Fuels displaced sub-sectors show a consistent decline across all occupational categories in both scenarios (Figure 117). Management/Professional occupations, and Administrative jobs drive job losses in both scenarios. Other occupational categories have comparable displacement figures across both scenarios as well.

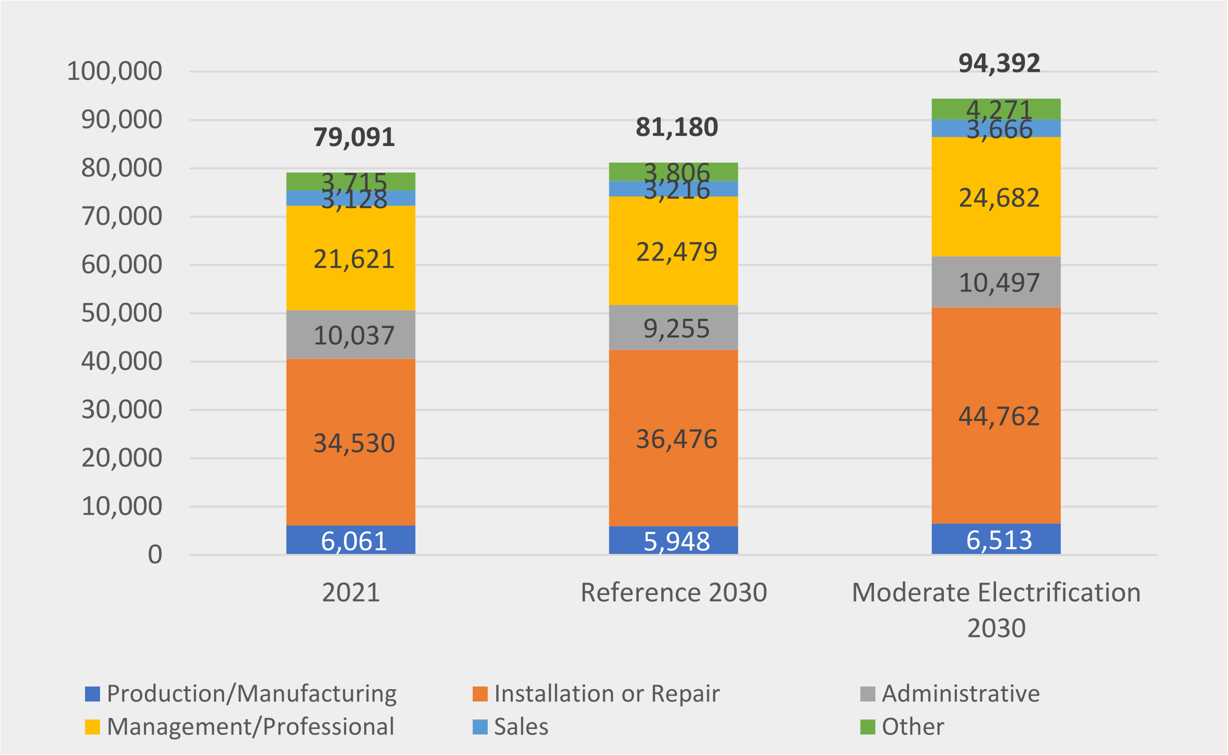
Figure 117. Fuels Displaced Sub-Sectors: Occupational Profile (2021-2030)



Buildings

Overall, employment in the Buildings sector is expected to increase in both the Reference scenario and Moderate Electrification scenarios by 2030 (Figure 118). Under the Reference scenario, the number of jobs in the Buildings sector is slated to increase from 79,091 jobs in 2021 to 81,180 in 2030, for an increase of 2,089 jobs in 9 years. Job growth is more substantial under the Moderate Electrification scenario; Buildings sector employment is expected to grow to 94,392 jobs by 2030 under the Moderate Electrification scenario for an increase of 15,301 jobs compared to 2021 employment levels.

Figure 118. Buildings Occupational Output (2021 to 2030)

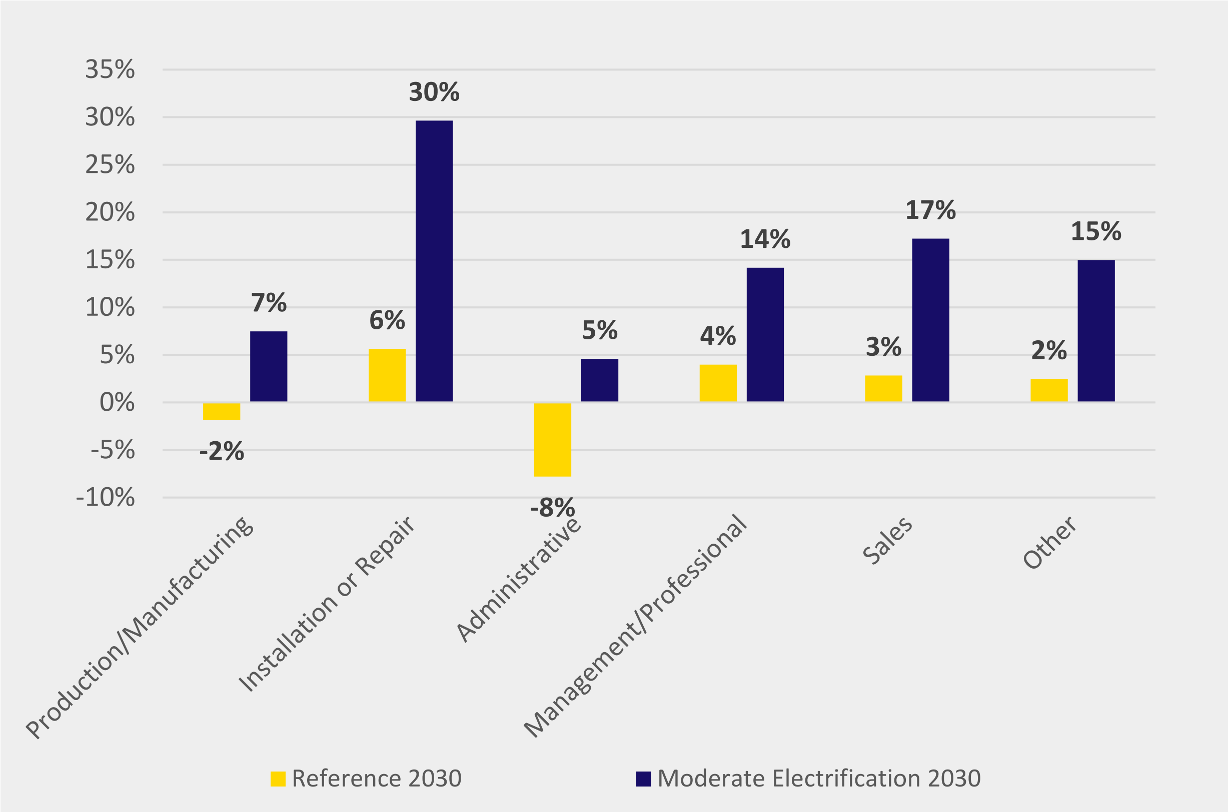


Under the Reference scenario, Installation or Repair, Management/Professional, Sales, and Other occupations are expected to grow while jobs in Production/Manufacturing and Administrative occupations are expected to be displaced. Most of the employment growth by 2030 under the Reference scenario is driven by increased employment in the Installation/Repair and Management/Professional occupational categories, which are projected to gain 1,946 and 858 jobs, respectively.

Under the Moderate Electrification scenario, all occupational categories—Production/Manufacturing, Installation or Repair, Administrative, Management/Professional, Sales, and Other—are expected to see employment growth by 2030. Most of the employment growth is expected to come from Installation/Repair occupations, which are expected to gain 10,232 jobs by 2030 under Moderate Electrification.

Installation or Repair, Sales, Other, and Management/Professional occupations are expected to grow in both scenarios, but their growth is between 10 percent and 24 percent greater under the Moderate Electrification scenario (Figure 119). Both Production/Manufacturing and Administrative occupations grow under the Moderate Electrification scenario but are displaced under the Reference scenario.

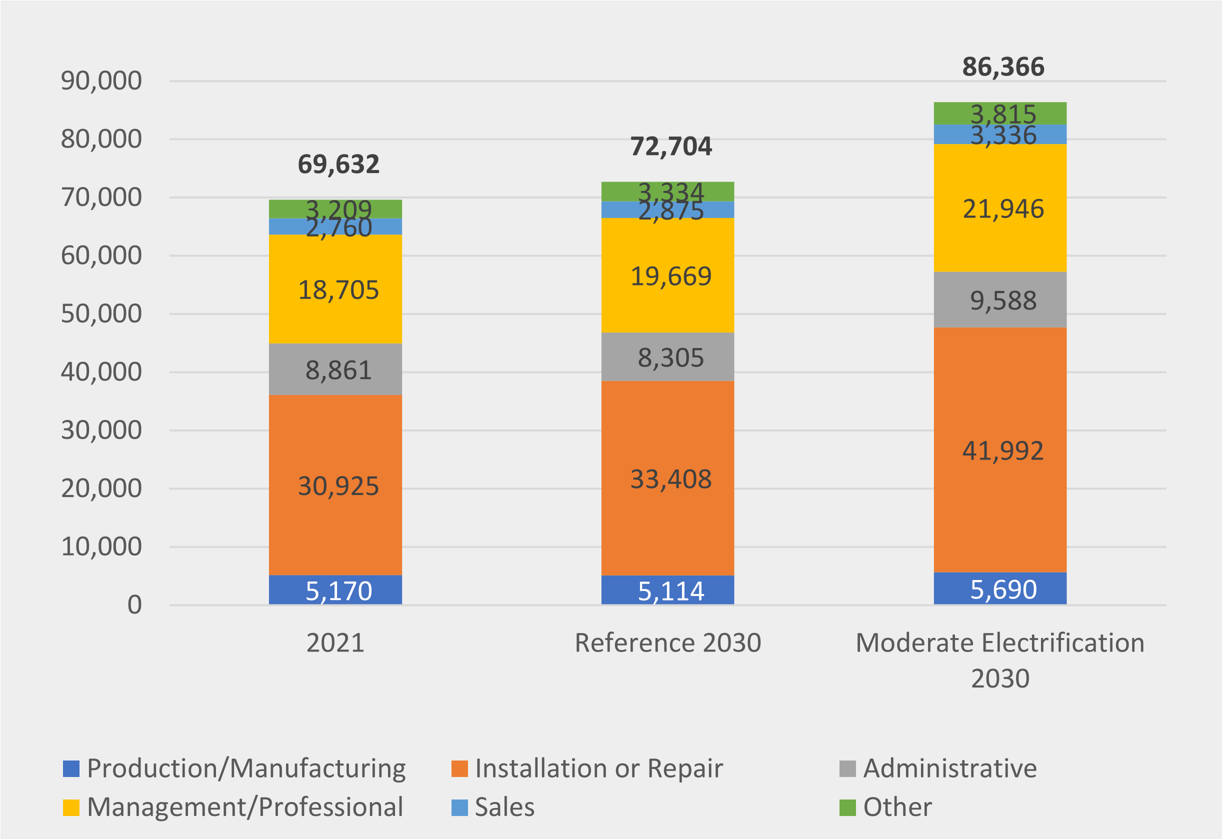
Figure 119. Buildings Occupational Output (2021 to 2030) – Reference vs. Moderate Electrification



Growth Sub-sectors

By 2030, the Residential HVAC, Residential Shell, Commercial HVAC, and Residential Other Buildings sub-sectors grow under both scenarios (Figure 120). Under the Reference scenario, these sub-sectors are slated to grow by 3,072 jobs—from 69,632 jobs in 2021 to 72,704 jobs in 2030. The Installation or Repair, Management/Professional, Sales, and Other occupational categories grow while the jobs in the Production/Manufacturing and Administrative occupational categories are displaced. The occupational category driving most of the job growth under the Reference scenario is Installation or Repair, which gains 2,483 jobs by 2030.

Figure 120. Buildings Growth Sub-Sectors: Occupational Profile (2021-2030)

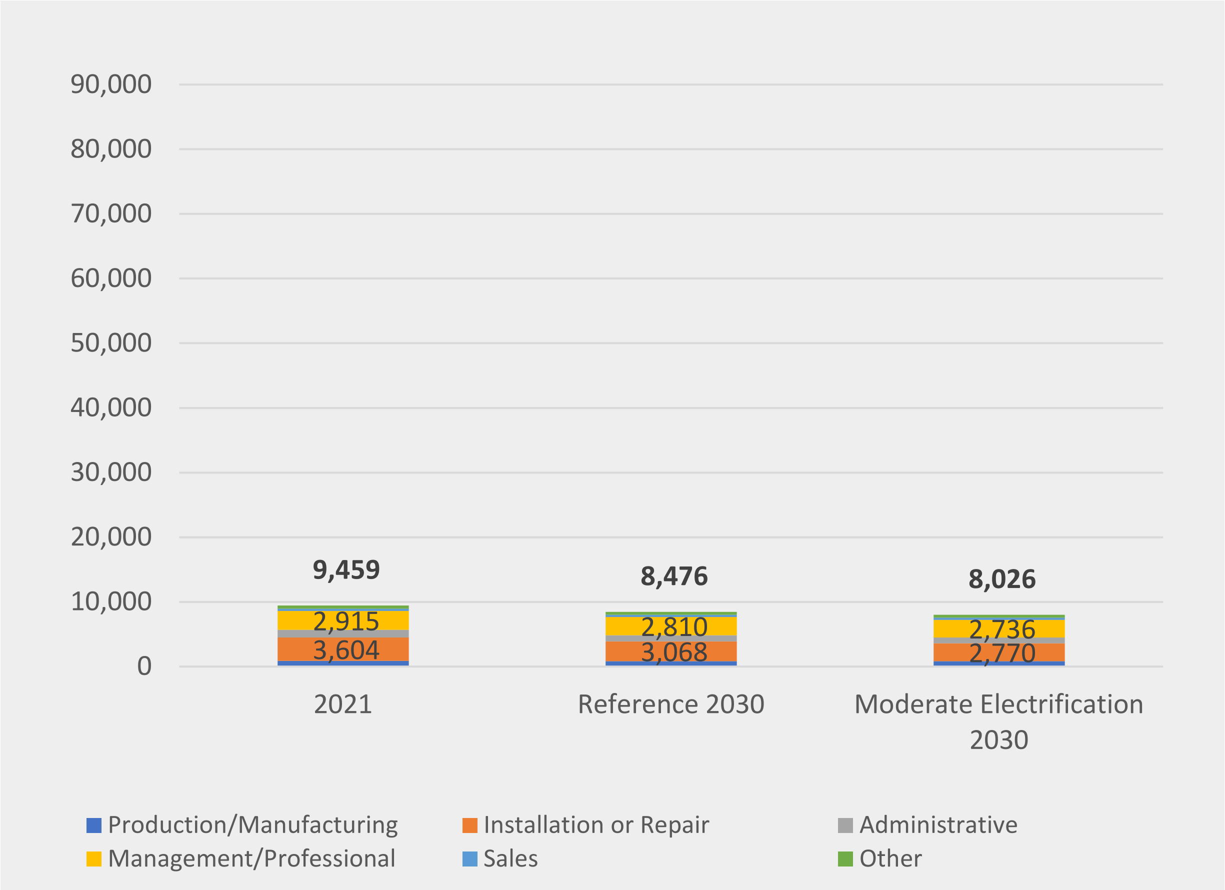


Under the Moderate Electrification scenario, the growth sub-sectors are slated to increase their employment by 16,734—from 69,632 jobs in 2021 to 86,366 jobs in 2030. All occupational categories see job growth by 2030 under this scenario, though the occupational category driving most of the overall job growth under Moderate Electrification is the Installation/Repair occupational category; Installation/Repair occupations grow by 11,067 jobs by 2030.

Displaced Sub-sectors

Under both scenarios, jobs in the Commercial Other sub-sector are displaced by 2030 (Figure 121). Under the Reference scenario, the Commercial Other sub-sector is slated to decrease by 983 jobs—from 9,459 jobs in 2021 to 8,476 jobs in 2030. Most of the job displacement is concentrated in the Installation/Repair occupational category, which decreases by 536 jobs.

Figure 121. Buildings Displaced Sub-Sectors: Occupational Profile (2021-2030)

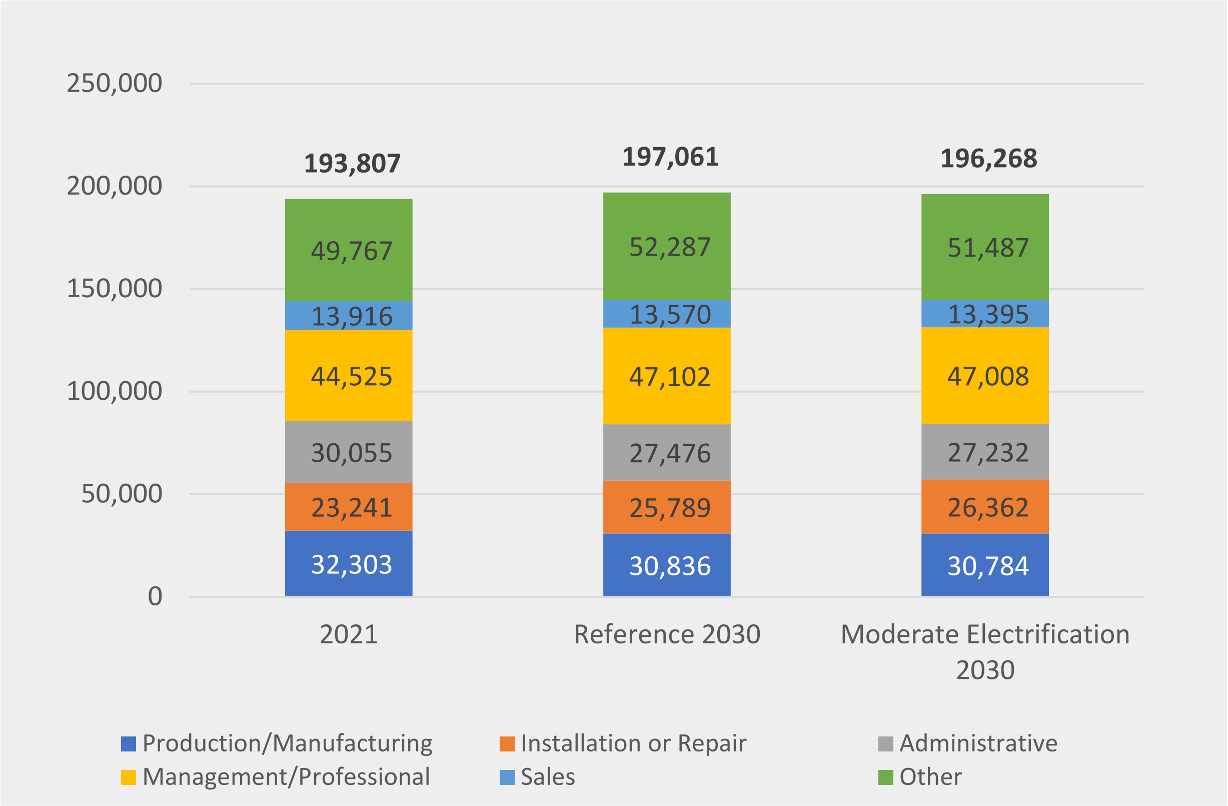


Under the Moderate Electrification scenario, the Commercial Other sub-sector is slated to decrease by 1,433 jobs—from 9,459 jobs in 2021 to 8,026 jobs in 2030. Most of the job displacement is concentrated in the Installation/Repair occupational category, which decreases by 834 jobs. All occupational categories are expected to see job displacement by 2030 under both scenarios.

Transportation

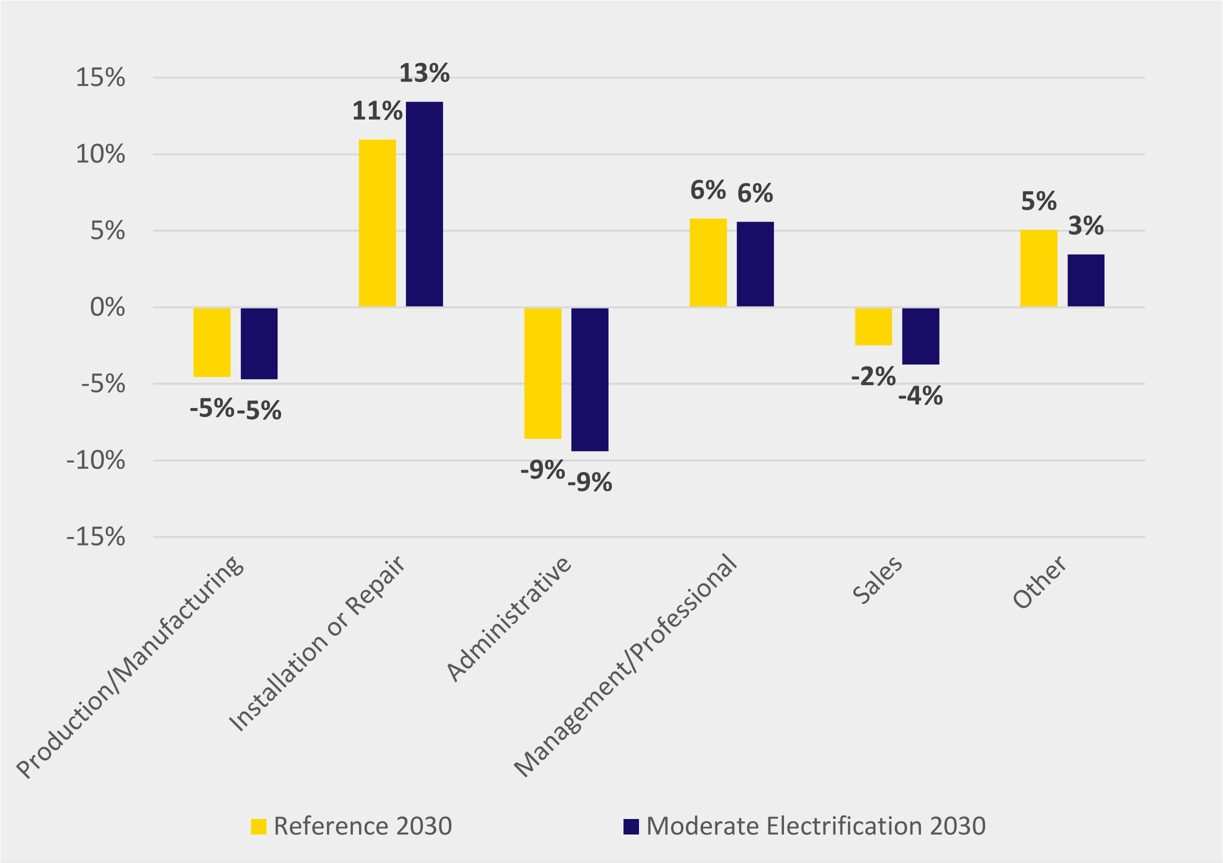
Overall, employment in the Transportation sector is expected to increase in both the Reference and Moderate Electrification scenario by 2030 (Figure 122). Under the Reference scenario, the number of jobs in the Transportation sector is slated to increase from 193,807 jobs in 2021 to 197,061 in 2030, for an increase of 3,254 jobs in 9 years. The Transportation sector is expected to see slightly less job growth under Moderate Electrification; Transportation sector employment is expected to grow to 196,392 jobs by 2030 under the Moderate Electrification scenario for an increase of 2,461 jobs compared to 2021 employment levels.

Figure 122. Transportation Occupational Output (2021 to 2030)



Installation or Repair, Management/Professional, and Other occupations are slated to grow under both scenarios while Production/Manufacturing, Administrative, and Sales occupations are displaced under both scenarios. There is also not a large disparity between employment outcomes in the Reference and Moderate Electrification scenarios, meaning that each occupational category has a similar amount of job growth or displacement regardless of scenario. Under both scenarios, Installation or Repair, Management/Professional, and Other occupations are expected to grow while jobs in Production/Manufacturing, Administrative, and Sales occupations are expected to be displaced.

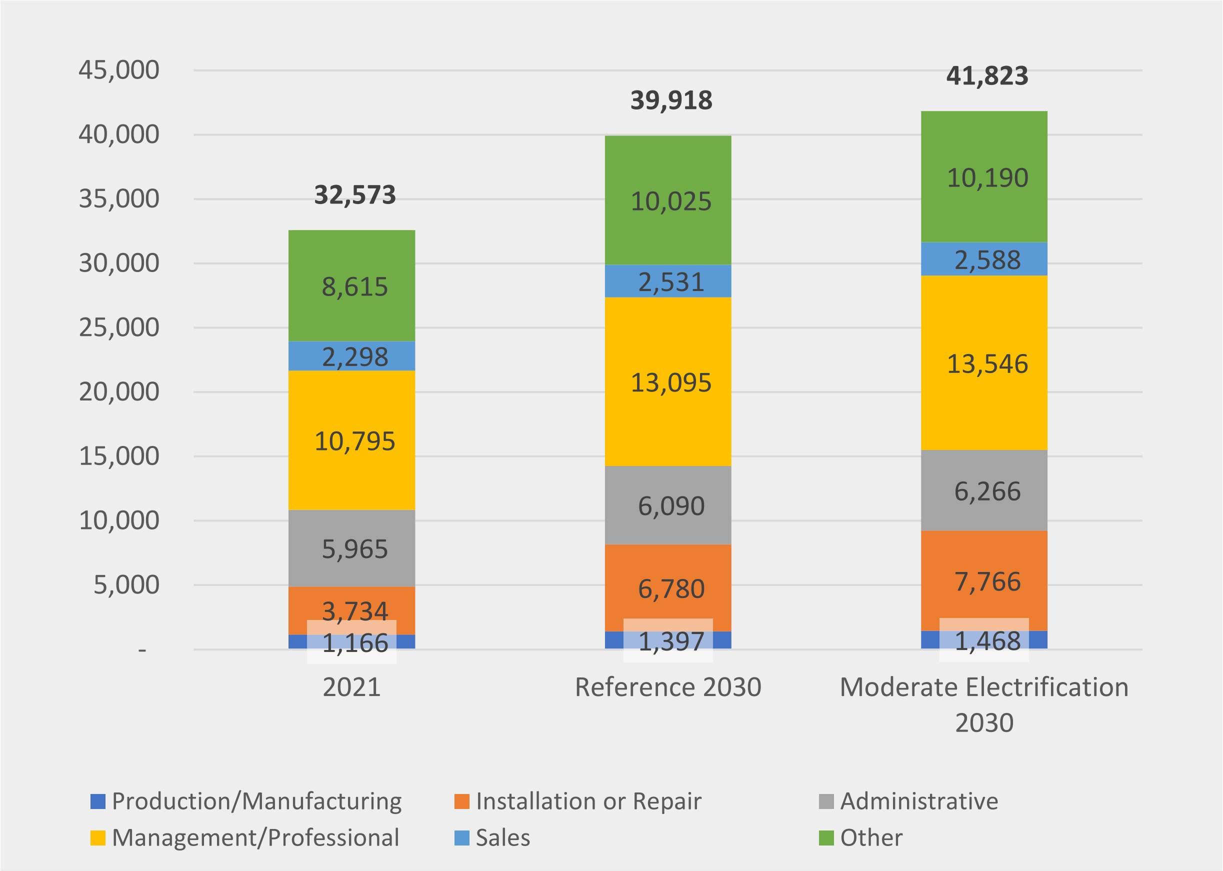
Figure 123. Buildings Occupational Output (2021 to 2030) – Reference vs. Moderate Electrification



Growth Sub-sectors

The Wholesale Trade and Charging Stations sub-sectors are expected to grow by 2030 under both scenarios (Figure 124). Under the Reference scenario, these sub-sectors are slated to grow by 7,345 jobs—from 32,573 jobs in 2021 to 39,918 jobs in 2030. All occupational categories are slated to grow by 2030, though Installation/Repair and Management/Professional are the sub-sectors driving most of the job growth, gaining 3,046 jobs and 2,301 jobs, respectively.

Figure 124. Transportation Growth Sub-Sectors: Occupational Profile (2021-2030)

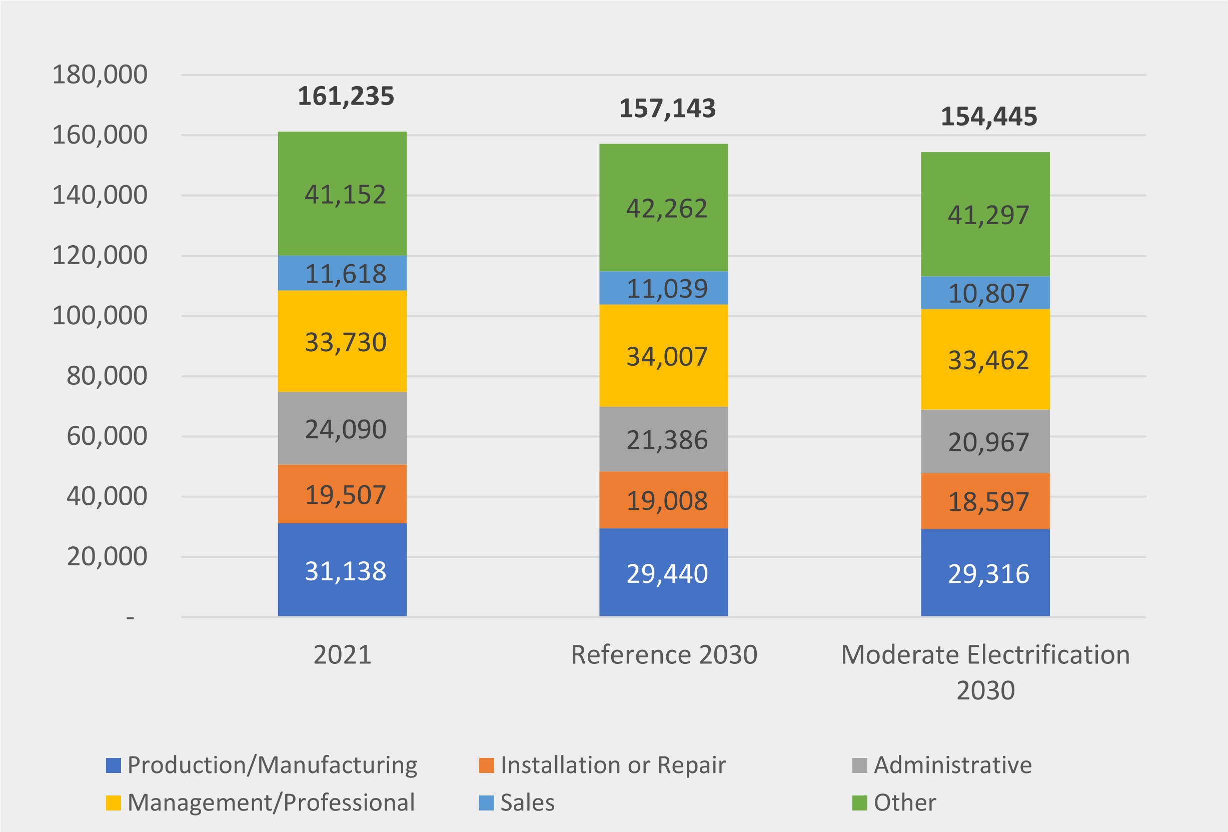


Under the Moderate Electrification, the Wholesale Trade and Charging Stations sub-sectors are expected to grow by 9,251 jobs—from 32,573 jobs in 2021 to 41,823 jobs in 2030. All occupational categories are slated to grow by 2030, though Installation/Repair and Management/Professional are the sub-sectors driving most of the job growth, gaining 4,031 and 2,751 jobs, respectively.

Displaced Sub-sectors

Under both scenarios, jobs in the Fueling Stations, Vehicle Manufacturing, and Vehicle Maintenance sub-sectors are displaced by 2030 (Figure 125). Under the Reference scenario, employment in these sub-sectors is slated to decrease by 4,092 jobs—from 161,235 jobs in 2021 to 157,143 jobs in 2030. Except for the Management/Professional and Other, all occupational categories see job displacement by 2030. Most of the job displacement is concentrated in Administrative and Production/Manufacturing occupations, which decrease by 2,704 jobs and 1,698 jobs, respectively.

Figure 125. Transportation Displaced Sub-Sectors: Occupational Profile (2021-2030)



Under the Moderate Electrification scenario, the Commercial Other sub-sector is slated to decrease (-6.790 jobs)—from 161,235 jobs in 2021 to 154,445 jobs in 2030. Except for Other, all occupational categories see job displacement by 2030. Most of the job displacement is concentrated in Administrative (-3,124 jobs) and Production/Manufacturing occupations (-1,822 jobs).

Workforce Implications

The following is a discussion of employment changes delineated by region and wage categories for both the Reference and Moderate Electrification scenarios at the sectoral level. The data are presented for overall, growth and displacement figures.

Key Findings

- **The Moderate Electrification scenario leads to more overall net changes in jobs added by 2030.** In Chicago, the Moderate Electrification scenario creates more additional jobs (4,800 jobs) than the Reference scenario (1,500 jobs). The Moderate Electrification also creates more jobs for the rest of ComEd (22,200 jobs) than the Reference case (6,800 jobs). In Illinois, the Moderate Electrification case creates 13,600 jobs, while the Reference scenario allows for 6,700 jobs by 2030.

- **The Moderate Electrification scenario also leads to the highest increases in Tier 1 jobs, i.e, the highest wage jobs**. While Tier 1 jobs— i.e., the highest paying jobs— in the Reference scenario increase by 9 percent by 2030, the same tier under the Moderate Electrification scenario will increase by 17 percent. The Reference scenario (-2 percent) leads to a decrease in Tier 3 jobs— i.e., the lowest wage jobs— whereas Tier 3 jobs in the Moderate Electrification scenario do not change.

Regional Analysis

The following section is a discussion of regional level changes in employment between 2021 and 2030 for three regions: Chicago, the rest of ComEd service areas[31] and the rest of Illinois (Table 15).[32]

Table 15. Regional Definitions

Chicago	Employment figures for Chicago are estimated based on industry-level comparisons to employment in Illinois, since the E3 RESOLVE analysis does not provide this level of geographic detail. The IMPLAN multipliers used to estimate employment effects across the Chicago economy are the ones for Cook County.
ComEd Service Areas	The ComEd Service Area was defined using data from the ComEd team, to determine the counties where the effects of the mitigation strategies take place. Employment figures for this region are estimated based on industry-level comparisons to employment in Illinois. The IMPLAN multipliers used to estimate employment effects in the ComEd Service Area, are the ones for the combined region created from the list of counties within the ComEd Service Area.
Illinois	The Illinois region follows the industry employment proportions from the 2022 USEER and uses statewide multipliers from IMPLAN. The region considers all the territory of the state of Illinois.

Overall

On net, the Moderate Electrification scenario leads to more jobs added by 2030 (Table 16). The Moderate Electrification leads to 4,800 net jobs added in Chicago compared to 1,500 net jobs added under the Reference

[31] This regional definition excludes ComEd Service Areas that are in Chicago.

[32] This regional definition excludes Chicago and the rest of ComEd Service Areas.

scenario. For the rest of ComEd, Moderate Electrification leads to 22,200 net jobs added whereas the Reference scenario leads to 6,800 net jobs added. In the rest of Illinois, Moderate Electrification leads to 13,600 net jobs added compared to 6,700 net jobs added in the Reference scenario.

Table 16. Overall Regional Output (2021– 2030) – Reference vs. Moderate Electrification

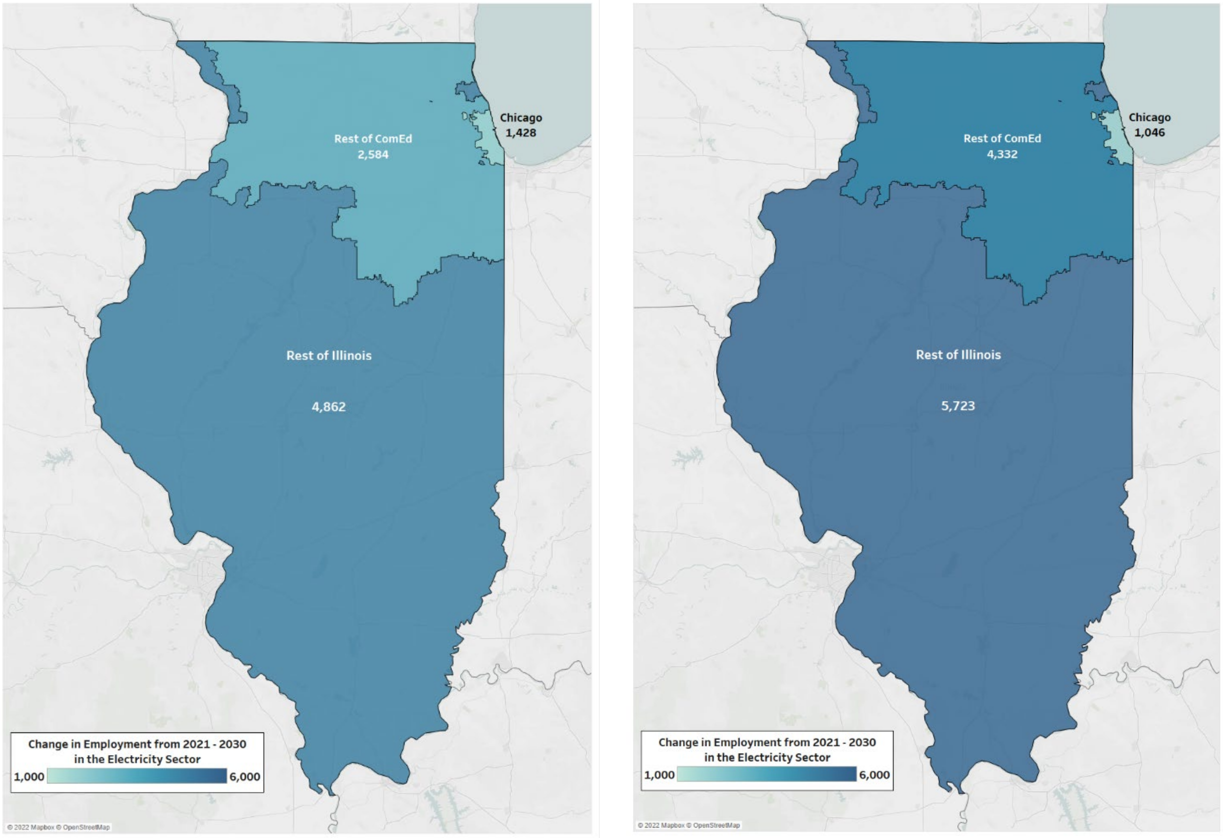
SECTOR	2021	Reference (2030)	Moderate Electrification (2030)	Net Change from 2021 - Reference	Net Change from 2021 - Moderate
Rest of Illinois					
Electricity	24,057	28,919	29,780	+4,862	+5,723
Fuels	11,963	11,712	12,776	-251	+813
Transportation	99,408	99,402	98,644	-7	-764
Buildings	20,869	23,008	28,758	+2,139	+7,889
Overall	**156,298**	**163,041**	**169,959**	**+6,743**	**+13,661**
Rest of ComEd					
Electricity	51,953	54,536	56,285	+2,584	+4,332
Fuels	30,672	29,616	34,199	-1,056	+3,527
Transportation	130,601	135,370	135,340	+4,769	+4,739
Buildings	59,649	60,171	69,334	+522	+9,685
Overall	**272,874**	**279,693**	**295,158**	**+6,819**	**+22,284**
Chicago					
Electricity	19,364	20,791	20,410	+1,428	+1,046
Fuels	12,453	12,127	12,690	-325	+238
Transportation	32,706	32,971	33,076	+265	+370
Buildings	27,424	27,565	30,596	+141	+3,172
Overall	**91,946**	**93,455**	**96,772**	**+1,509**	**+4,826**

In Chicago, net changes in the Reference scenario are largely driven by additions in Electricity (1,400 jobs) whereas net changes under Moderate Electrification are driven by Buildings (3,100 jobs) and Electricity (1,000 jobs). For the rest of ComEd, Transportation (4,700 jobs) leads to higher net changes under the Reference scenario whereas Buildings (9,600 jobs) drive the net changes under Moderate Electrification. For the rest of Illinois, Electricity (4,800 jobs) leads to the highest net change in the Reference scenario and Buildings (7,800 jobs) leads to the highest net change in the Moderate Electrification scenario.

Electricity

In Chicago, the Reference scenario and the Moderate Electrification scenarios add 1,400 and 1,000 jobs respectively (see Figure 126). For the rest of ComEd, the Moderate Electrification scenario leads to 4,300 jobs added and the Reference scenario leads to a net addition of 2,500 jobs. For the rest of Illinois, the Reference scenario leads to a net growth of 4,800 jobs and the Moderate Electrification scenario leads to 5,700 jobs added.

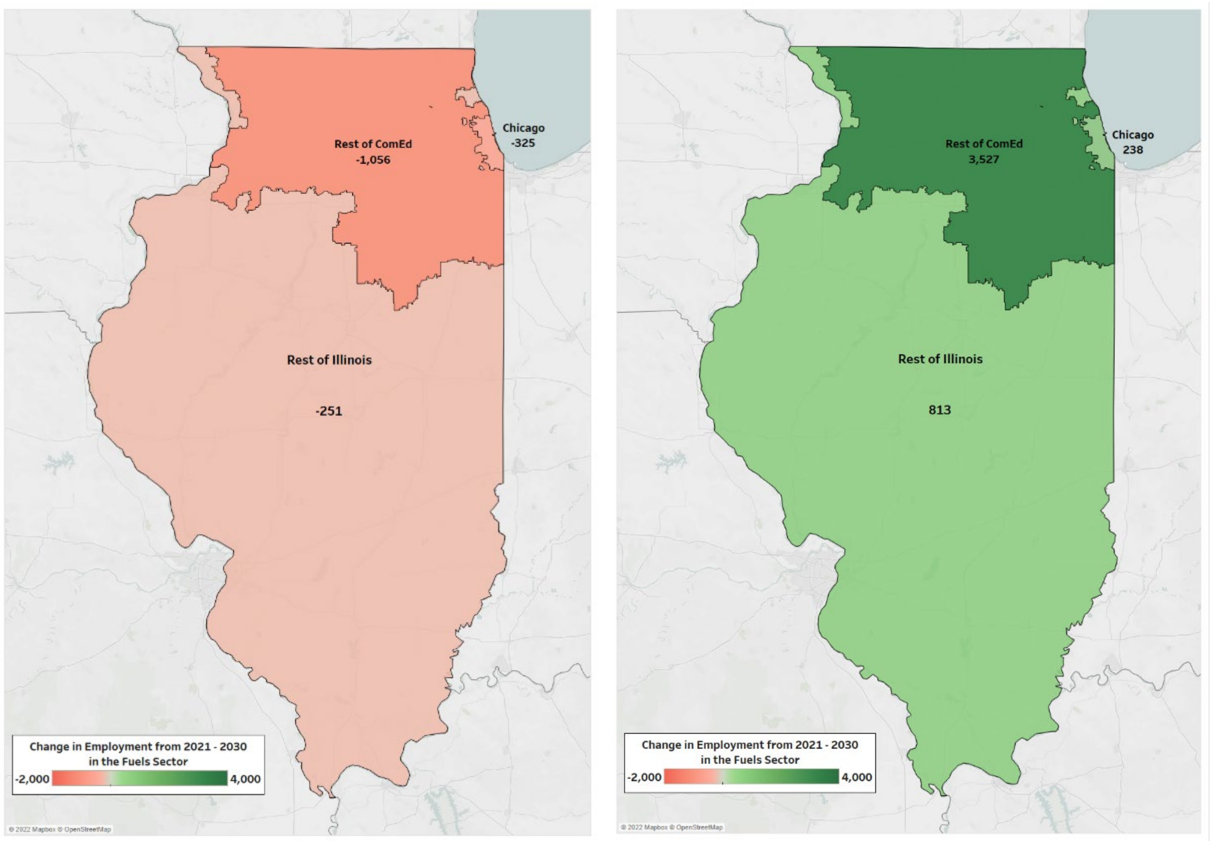
Figure 126. Electricity Regional Output (2021– 2030) – Reference vs. Moderate Electrification



Fuels

The Reference scenario (-300 jobs) leads to a loss of Fuels jobs in Chicago compared to the Moderate Electrification scenario, which leads to 200 jobs added (Figure 127). For the rest of ComEd, the Moderate Electrification scenario leads to 3,500 jobs added and the Reference scenario (-1,000 jobs) leads to net job displacement. For the rest of Illinois, the Moderate Electrification scenario leads to 800 jobs added and the Reference scenario (-200 jobs) leads to a net displacement.

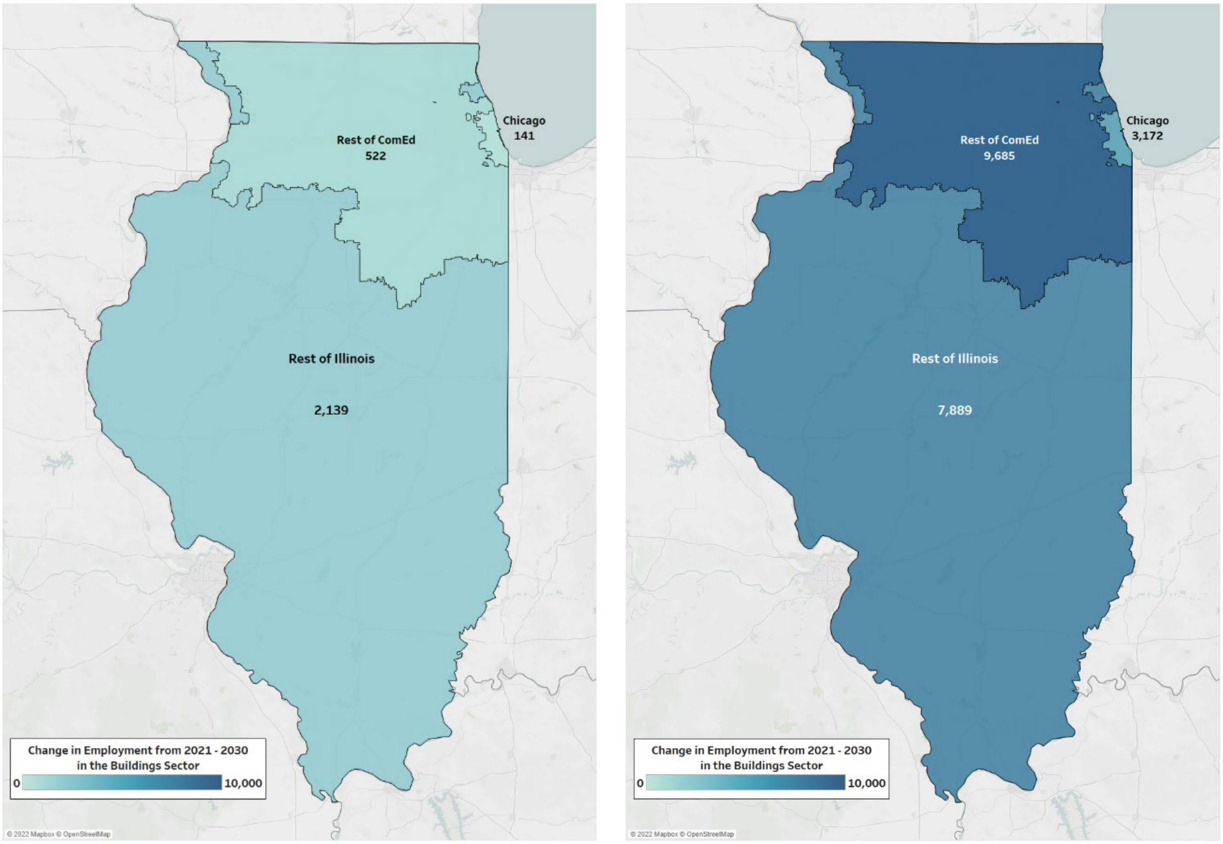
Figure 127. Fuels Regional Output (2021– 2030) – Reference vs. Moderate Electrification



Buildings

In Chicago, the Reference scenario and the Moderate Electrification scenarios lead to Buildings net growth of 100 and 3,100 jobs, respectively (see Figure 128). For the rest of ComEd, the Moderate Electrification scenario leads to 9,600 jobs added and the Reference scenario leads to a net growth of 500 jobs. For the rest of Illinois, the Reference scenario leads to a net growth of 7,800 jobs and the Moderate Electrification scenario leads to 2,100 jobs added.

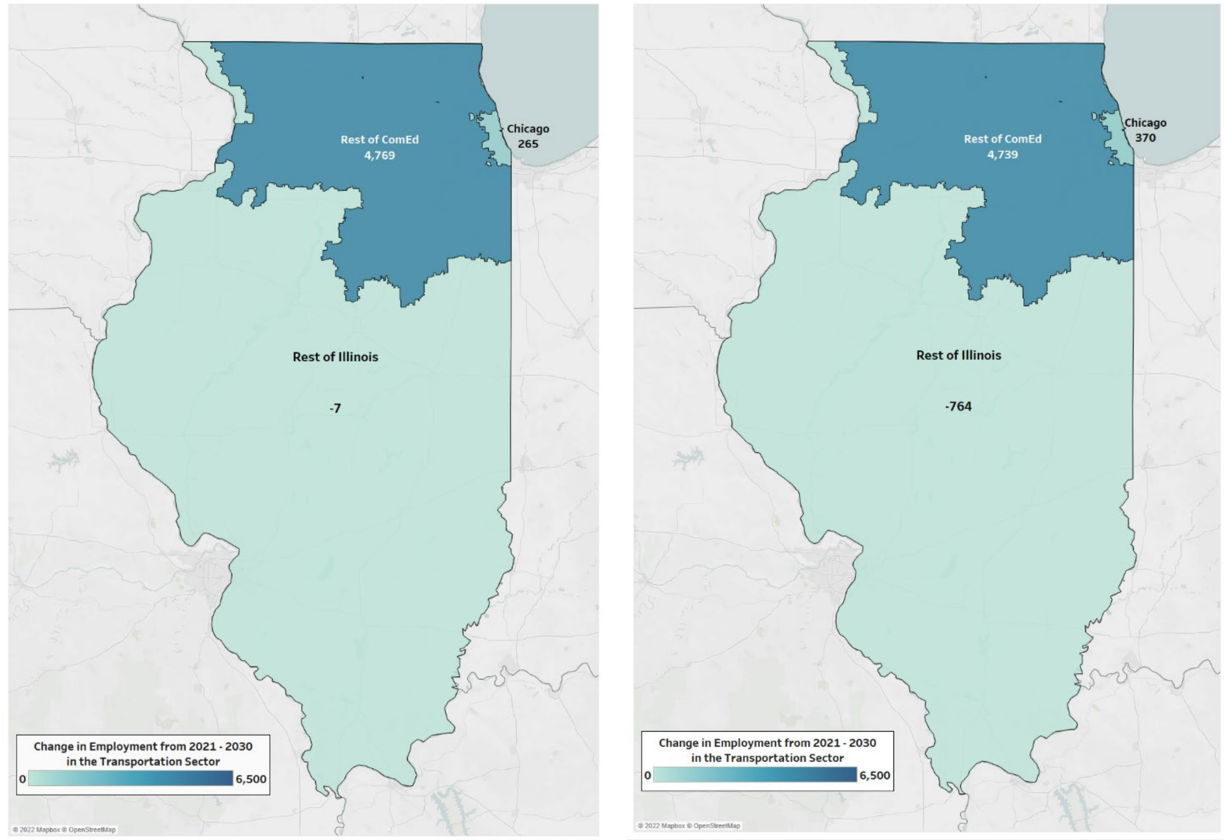
Figure 128. Buildings Regional Output (2021– 2030) – Reference vs. Moderate Electrification



Transportation

In Chicago, the Reference and the Moderate Electrification scenarios lead to Transportation net growth of 200 and 300 jobs, respectively (Figure 129). For the rest of ComEd, both scenarios respectively lead to approximately 4,700 net job growth by 2030. For the rest of Illinois, both the Reference scenario (-7 jobs) and the Moderate Electrification scenario (-700 jobs) lead to the displacement of Transportation jobs by 2030.

Figure 129. Transportation Regional Output (2021– 2030) – Reference vs. Moderate Electrification



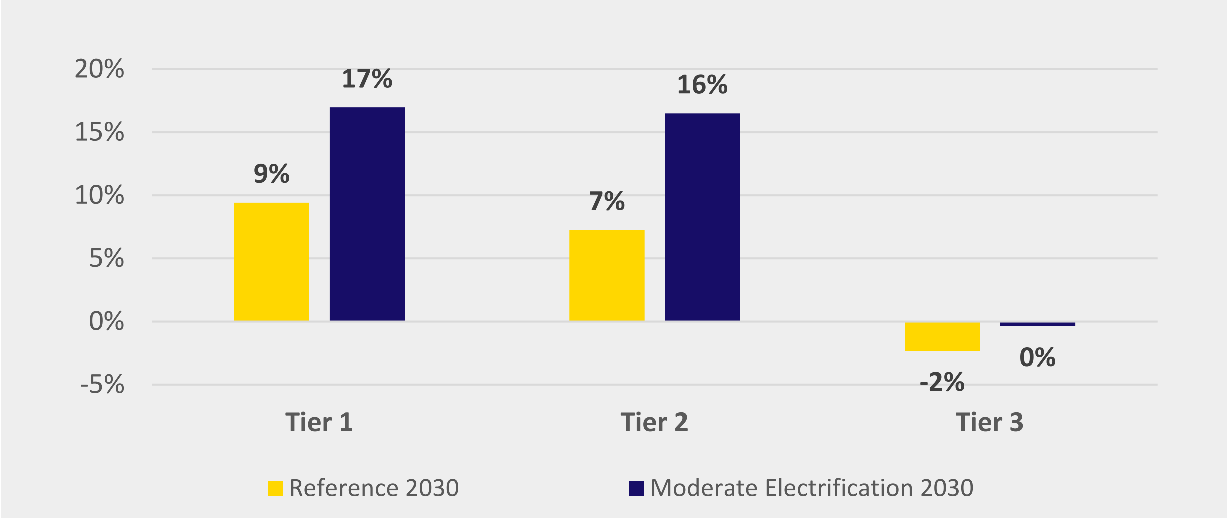
Job Quality (Sustainable Wage) Analysis

The following is a discussion of SEO sustainable wage analysis results. Changes in employment by 2030 are compared to the 2021 baseline across the three wage categories (Table 5 in the Methodology & Forecast Approach section).

Overall

By 2030, the largest increases in employment from the 2021 baseline across all wage categories will occur under the Moderate Electrification scenario **(**Figure 130**)**. While Tier 1 jobs— i.e., the highest paying jobs— in the Reference scenario increase by 9 percent by 2030, the same tier under the Moderate Electrification scenario will increase by 17 percent. Tier 2 jobs— i.e., the moderate paying wage category— increase by 7 percent in 2030, compared to 17 percent in the Moderate Electrification scenario. Under the Reference scenario. Tier 3 jobs— i.e., the lowest paying jobs— decrease by 2 percent compared to 0 percent under the Moderate Electrification scenario.

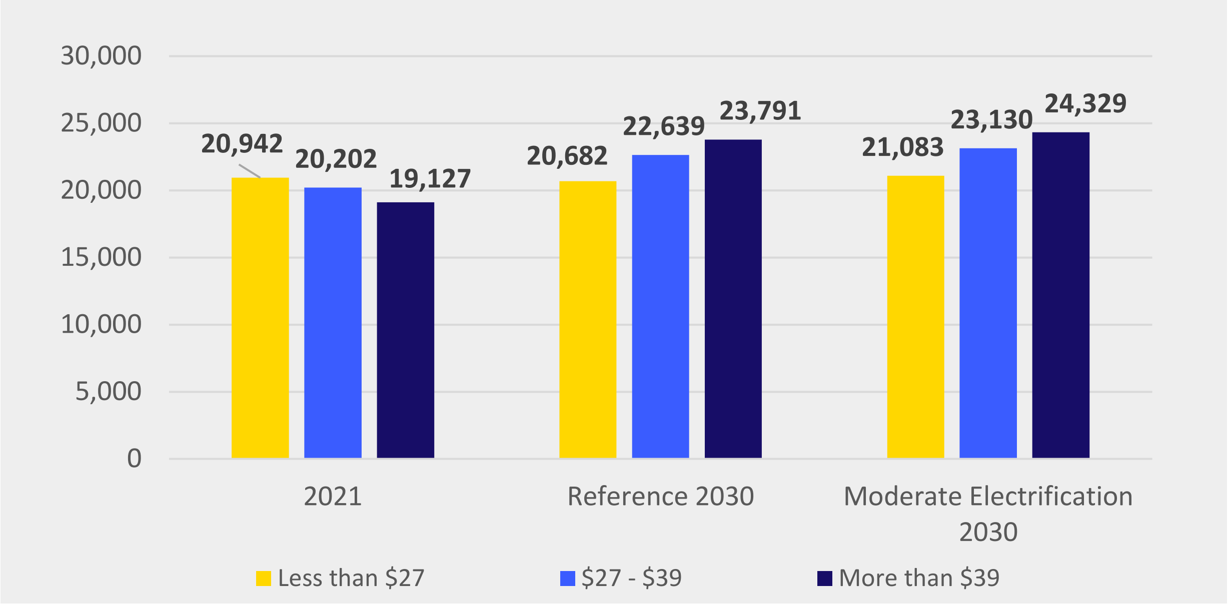
Figure 130. Overall Job Quality Analysis (2021– 2030) – Percentage Change



Electricity

Across wage tier categories, the Moderate Electrification scenario leads to more jobs added in 2030 compared to the Reference scenario (Figure 131). Tier 1 jobs will increase in both the Moderate Electrification (5,200 jobs) and Reference (4,600 jobs) by 2030. Tier 2 jobs under Moderate Electrification will increase by 2,900 jobs compared to 2,400 jobs in the Reference scenario. Tier 1 jobs will outnumber Tier 2 and Tier 3 jobs by 2030 in both the Reference and Moderate Electrification scenarios.

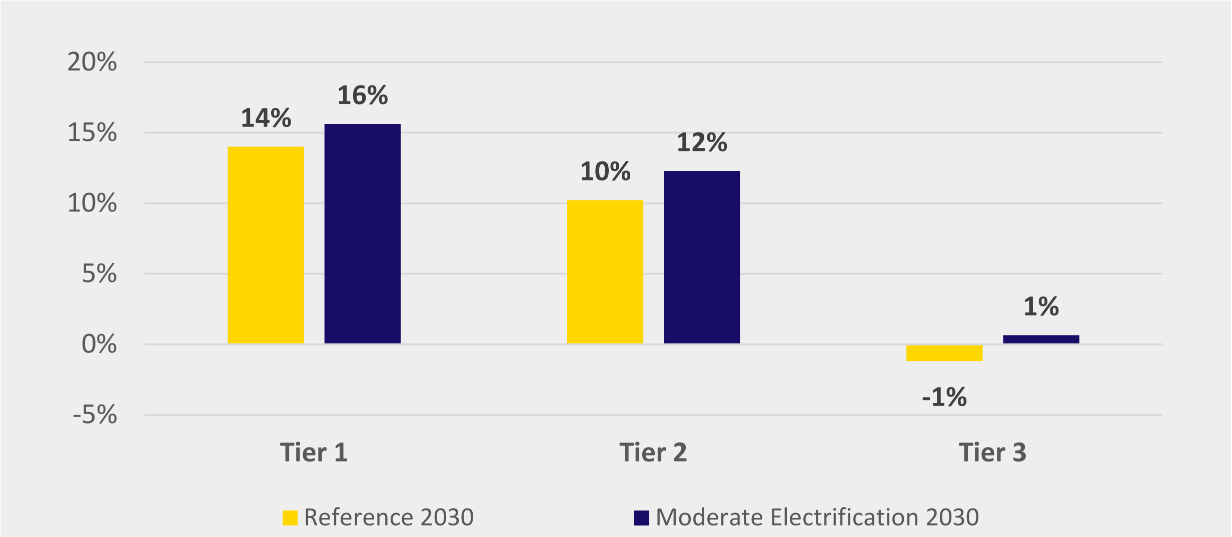
Figure 131. Electricity Job Quality Analysis (2021– 2030) – Overall Employment



The Moderate Electrification scenario adds a higher percentage of jobs from the 2021 baseline across the three wage tiers (Figure 132). However, job changes in both transition scenarios are largely comparable, with 2 percentage point differences between scenarios across all three tiers. While Tier 1 jobs in the Reference scenario increase by fourteen percent in 2030, Tier 1 jobs under Moderate Electrification will increase by 16 percent. By

2030, Tier 2 jobs increase by 10 percent in the Reference scenario and 12 percent under Moderate Electrification. Tier 3 jobs decrease by one percent in the Reference scenario compared to Moderate Electrification where the jobs will increase by 1 percent.

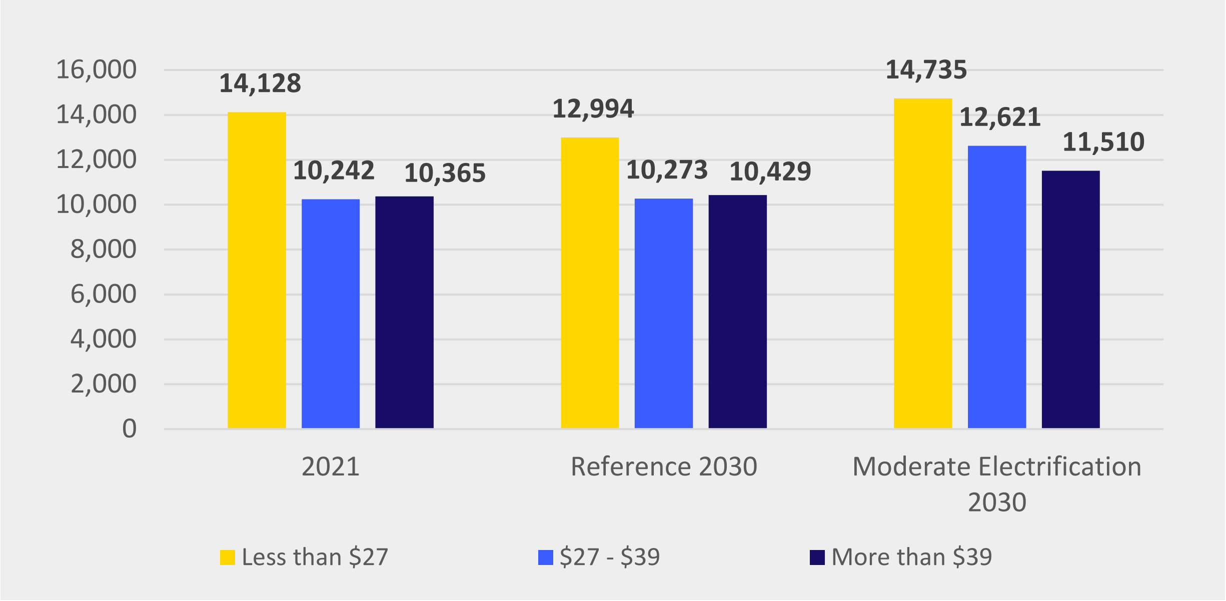
Figure 132. Electricity Job Quality Analysis (2021– 2030) – Percentage Change



Fuels

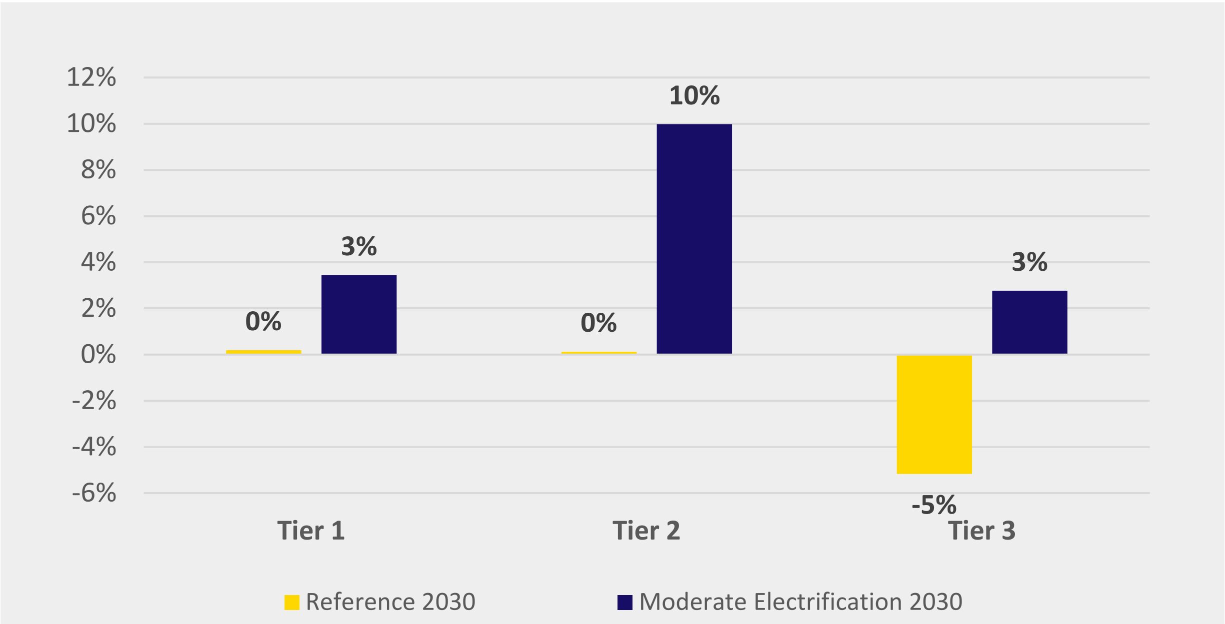
Tier 3 jobs represented approximately 40 percent of Fuels jobs in 2021 and will maintain that share by 2030 in both the Reference and Moderate Electrification scenarios (Figure 133). While the Reference scenario leads to a decrease in Tier 3 jobs by 2030, the Moderate Electrification scenario leads to more Tier 1 and Tier 2 jobs**.** While Tier 1 and Tier 2 jobs remain relatively constant in the Reference scenario by 2030, Tier 1 (1,100 jobs) and Tier 2 (2,300 jobs) jobs respectively increase under Moderate Electrification. The Reference scenario leads to a decrease under the Reference scenario (-1,100 jobs) and an increase under Moderate Electrification (600 jobs).

Figure 133. Fuels Job Quality Analysis (2021– 2030) – Overall Employment



Tier 2 jobs (10 percent) lead to the highest percentage change from the 2021 baseline under the Moderate Electrification scenario **(**Figure 134**)**. Comparatively, Tier 1 and Tier 3 jobs respectively increase by 3 percent under Moderate Electrification. Tier and Tier 2 jobs do not experience significant percentage changes in the Reference scenario whereas Tier 3 jobs decrease by 5 percent in 2030.

Figure 134. Fuels Job Quality Analysis (2021– 2030) – Percentage Change

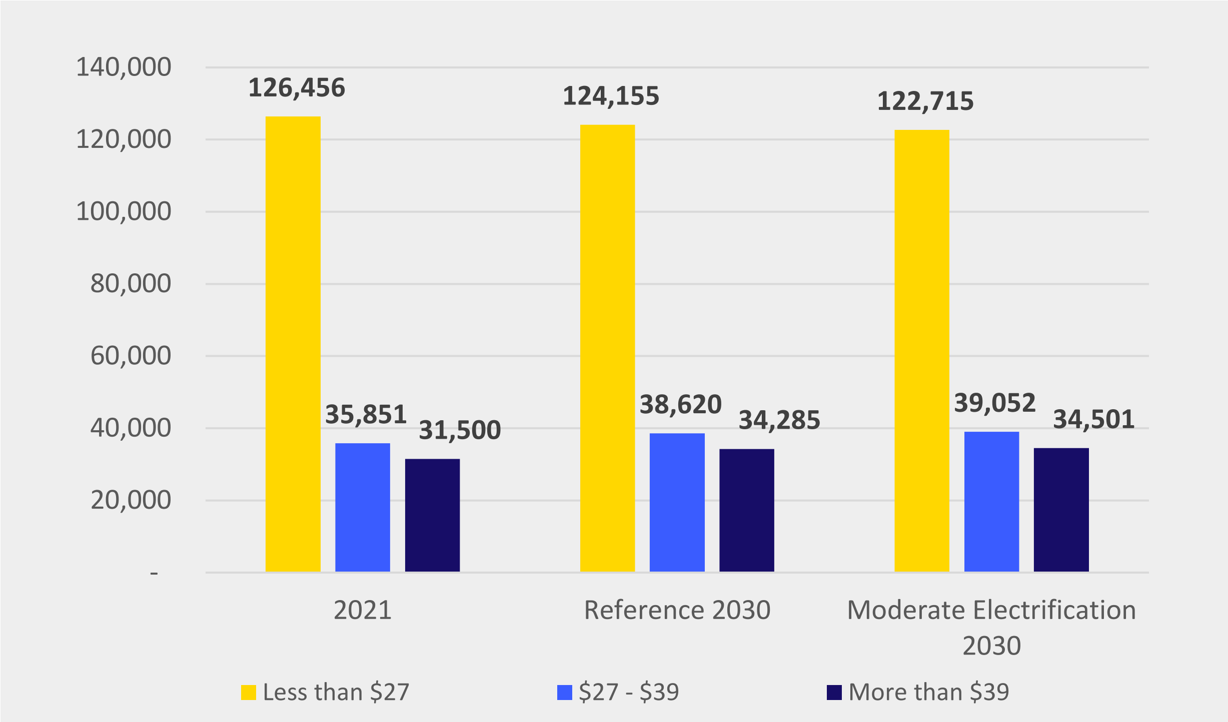


Transportation

Tier 3 jobs represented approximately two thirds of Transportation jobs in 2021; by 2030, the share of Tier 3 jobs decreases slightly in both the Reference scenario and the Moderate Electrification scenario (Figure 135). While Tier 3 jobs maintain the largest share of Transportation jobs in 2030 under both scenarios, Tier 3 jobs are also the only wage category that experiences losses.

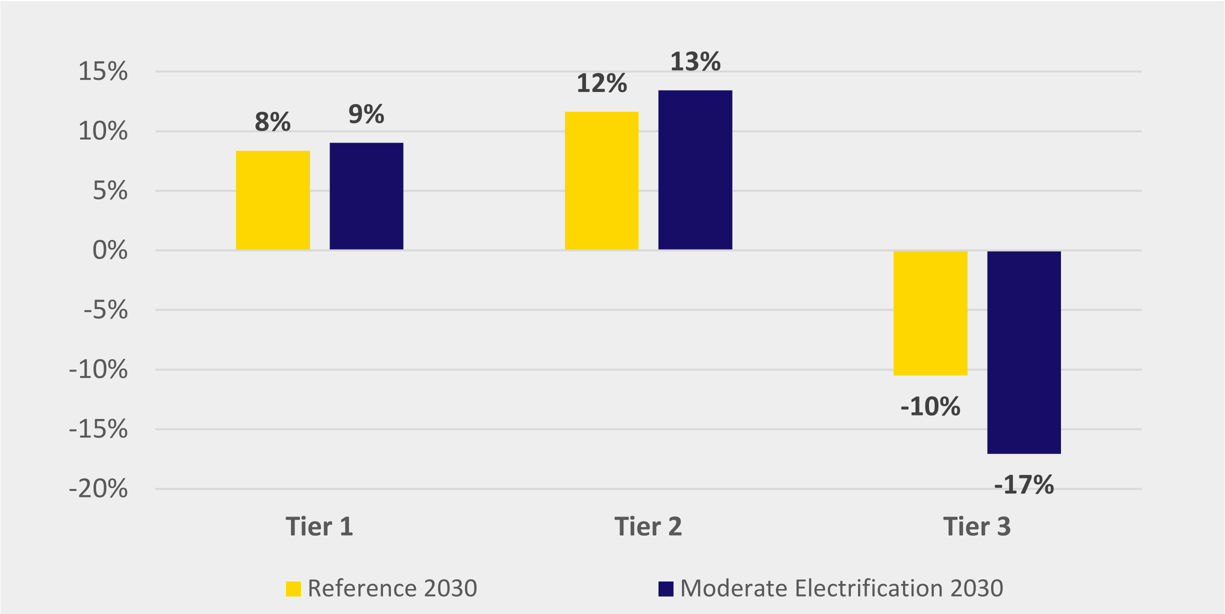
Tier 1 and Tier 2 jobs experience moderate increases while Tier 3 jobs decrease significantly in both scenarios by 2030**.** By 2030, there are 2,700 and 3,200 additional Tier 2 jobs under the respective Reference and Moderate Electrification scenarios. Tier 1 jobs under both scenarios also increase in similar magnitude by 2030. Conversely, Tier 3 jobs decrease by 2,300 and 3,700 jobs in the Reference and Moderate Electrification scenarios, respectively.

Figure 135. Transportation Job Quality Analysis (2021– 2030) – Overall Employment



The Moderate Electrification scenario leads to higher percentage increases in Tier 1 (9 percent) and Tier 2 (13 percent) jobs, and a higher percentage decrease in Tier 3 (-17 percent) jobs (Figure 136). In the Reference scenario, Tier 1 and Tier 2 jobs increase by 8 and 12 percent, respectively. Tier 3 jobs, on the other hand, decreases by 10 percent in the Reference scenario.

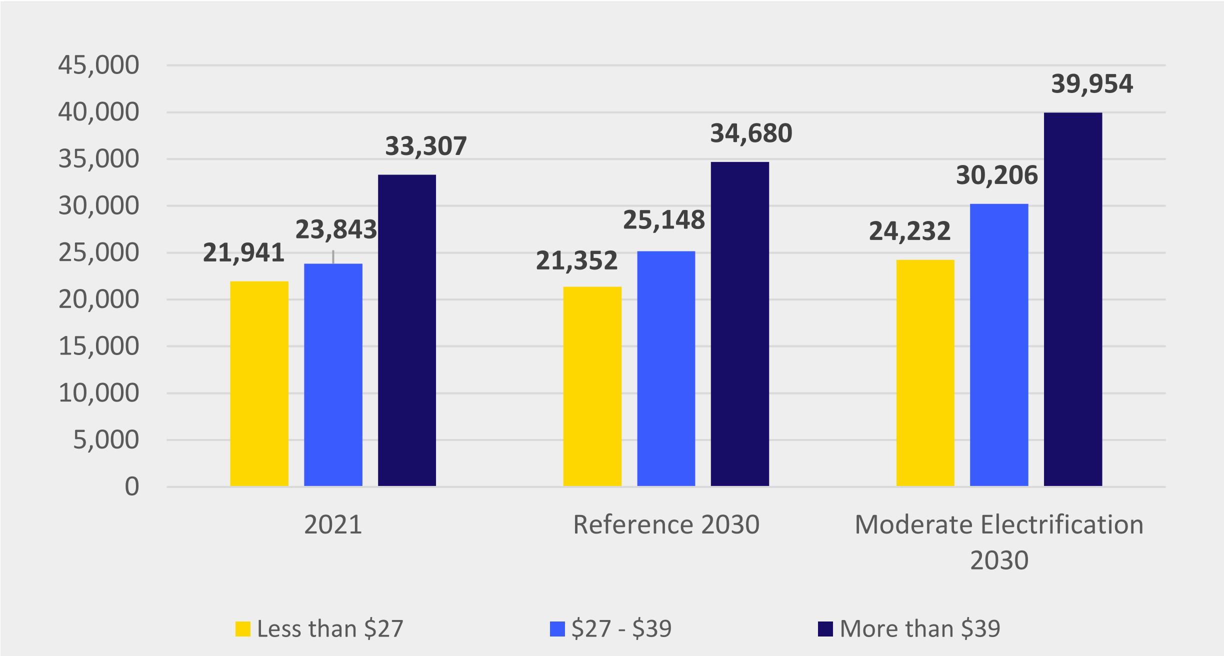
Figure 136. Transportation Job Quality Analysis (2021– 2030) – Percentage Change



Buildings

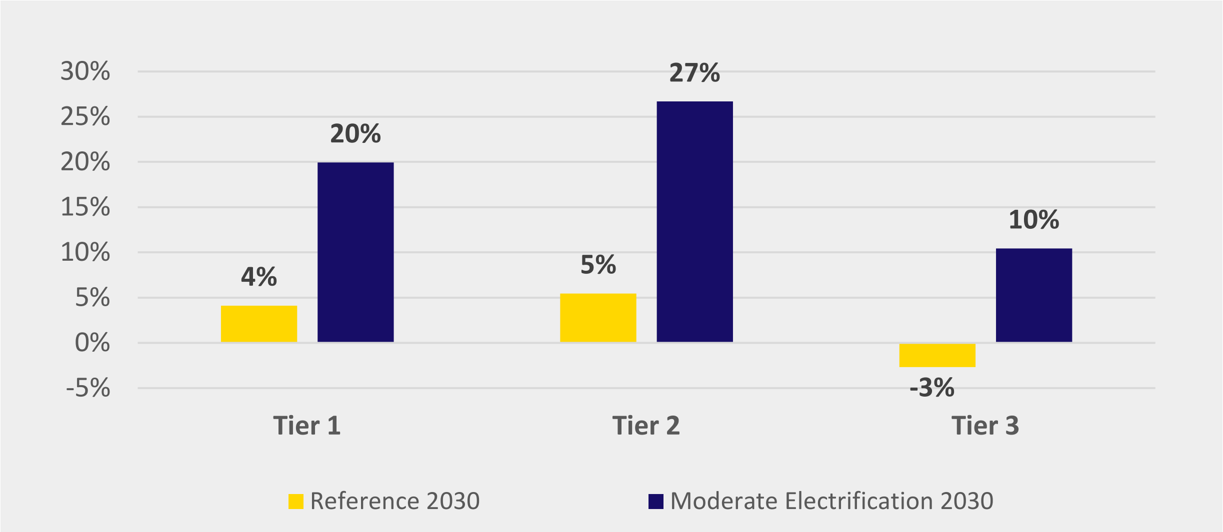
Tier 1 jobs represent 42 percent of Buildings jobs in 2021 and 2030 in both the Reference and Moderate Electrification scenarios (Figure 137). Moderate Electrification leads to job increases across all wage categories whereas the Reference scenario leads to Tier 3 job losses**.** Tier 1 jobs increase by 1,300 in the Reference scenario, and 6,600 under Moderate Electrification. Tier 2 jobs increase by 1,300 in the Reference and 6,300 under Moderate Electrification. In the Reference scenario, Tier 1 jobs decrease by 500 jobs whereas Tier 1 jobs increase by 2,200 jobs under Moderate Electrification.

Figure 137. Buildings Job Quality Analysis (2021– 2030) – Overall Employment



By 2030, Tier 2 jobs have the highest percentage change from the 2021 baseline under the Moderate Electrification scenario **(**Figure 138**)**. Tier 2 jobs increase by 27 percent under Moderate Electrification; comparatively, Tier 1 jobs increase by 20 percent and Tier 3 jobs increase by 10 percent. Percent increases in Tier 1 (4 percent) and Tier 2 (5 percent) jobs in the Reference scenario are more moderate compared to the Moderate Electrification scenario. Tier 3 jobs, however, decrease in the Reference scenario (-3 percent).

Figure 138. Buildings Job Quality Analysis (2021– 2030) – Percentage Change



Conclusion

The following conclusions are based on the key findings from this study:

1. **Total jobs are increasing in the four primary sectors**, both in the short-run (through 2030) and in the long-run (through 2050).

2. **Job composition and job quality is changing in the transition to clean energy**. The employment churn—i.e., an increase in jobs in specific categories and displacement of jobs in others— will require active support for individuals transitioning from declining industries and occupations. Workforce development investments and programs will be vital in supporting transitioning workers, and workers in search of new or better opportunities. Effective workforce development interventions will be critical if Illinois is to provide these emerging high-quality employment opportunities to all residents, particularly those from under-resourced communities. This employment churn can also be seen in the occupational categories, where Installation and Repair occupations are growing by 12 to 25 percent, depending on the scenario, and Management and Professional positions are growing by 5 to 9 percent while Administrative positions decline by 5 to 8 percent with smaller declines seen in Production and Manufacturing occupations. The opportunity arising from all this employment churn is more high-quality jobs, as Tier 1 (high-paying jobs) and Tier 2 (middle wage jobs) employment, experience strong growth and Tier 3 employment (lower-paying jobs) is flat or declining. The challenge is these growing positions in Management and Professional occupations, as well as those in Installation and Repair will likely require more training and education.[33]

3. **The scenario matters and will considerably impact Illinois's workforce and economic development plans**. The differences between the Reference case (CEJA, baseline scenario) and the Moderate Electrification scenario show considerable variation in their net employment impacts. Both the Fuels and Buildings sectors are highly sensitive to the scenario. For example, while the Fuels sector will lose 1,500 jobs by 2030 in the Reference case, it will grow by more than 4,500 jobs by 2030 under Moderate Electrification. Additionally, the Buildings sector will experience less than 3,000 added net jobs under the Reference case or more than 20,000 added net jobs under Moderate Electrification by 2030. As a result, Illinois decision-makers will need to make timely choices on the pathway to adopt in transitioning from the status quo to be more effective in workforce development planning.

[33] While the team only focused on the Reference and Moderate Electrification cases, there is an additional high electrification scenario from the E3 study which would likely result in greater changes in employment profiles across the four sectors.

Appendices

The Appendix Section is organized in the following manner:

A. Glossary
B. Model Inputs & Data Sources
C. Stakeholder Engagement
D. Review of Comparable Research: Bibliography
E. Review of Comparable Research: Detailed
F. Review of Comparable Research: Tables

A. Glossary

Abbreviation	Term	Definition
	Reference Scenario	Business-as-usual vision of the future, that includes existing Federal policies (I.e., CEJA and the Inflation Reduction Act.
	Moderate Electrification Scenario	Scenario that would achieve Illinois' target of economy-wide net zero GHG emissions by 2050, with aggressive actions in all sectors, high electrification, and a significant role for hydrogen and gas back-up for heating.
	Under resourced Communities	General term used to describe people or communities that have been under-invested or disproportionately impacted by environmental harms; for the purposes of this Jobs Study, this includes the terms defined in CEJA: equity investment eligible community (EIEC), low-income, economically disadvantaged community, and equity-focused population
	Solar	Growth sub-sector that includes technologies such as photovoltaics, solar heating, cooling, and concentrating solar power.
	Land-Based Wind	Growth sub-sector with technologies such as distributed or small-scale wind, and utility-scale wind.
	Hydropower	Hydropower uses hydroelectric power, achieved by converting gravitational potential of a water source to produce power.
	Hydrogen	Growth sub-sector comprised of technologies such as thermal processes and electrolytic processes.
	Distribution	Sub-sector made-up of technologies such as power lines and smart grid.
	Transmission	Growth sub-sector comprised of technologies such as overhead lines, HVAC cables, HDVC power transmission, and HVAC/HDVC Hybrid overhead lines.
	Biomass	Growth sub-sector that uses technologies such as phytomass to produce biofuels or used as a heat and electric-producing energy source.

	Storage	Growth sub-sector comprised of technologies such as batteries, thermal energy, flywheels, and pumped storage hydropower.
	Natural Gas Generation	Displaced sub-sector comprised of technologies such as natural gas-fueled power plants.
	Nuclear	Sub-sector comprised of technologies such as nuclear power plants.
	Other Fossil Generation	Displaced sub-sector comprised of technologies such as coil, oil, and other fossil fuel-burning power plants.
	Hydrogen Fuel	Growth sub-sector comprised of technologies such as hydrogen fuel cells
	Bioenergy	Growth sub-sector comprised of technologies such as renewable diesel, ethanol, biodiesel, renewable gasoline, renewable natural gas, renewable jet fuel, and jet kerosene.
	Natural Gas	Displaced sub-sector comprised of technologies such as natural gas fuels.
	Natural Gas Distribution	Displaced sub-sector comprised of technologies such as natural gas pipelines and liquified natural gas trucks and tankers.
	Petroleum Fuels	Displaced sub-sector comprised such as oil and gas pipelines, kerosene, and oil and fuel trucks and tankers.
	Residential HVAC	Growth sub-sector with technologies such as residential air conditioning, residential single and multi-family space heating.
	Residential Shell	Growth sub-sector with technologies such as insulation, glazing, paints, films, and windows.
	Residential Other	Growth sub-sector comprised of technologies such as refrigerators and freezers, washers and dryers, water heaters, and stoves.
	Commercial HVAC	Growth sub-sector consists of technologies such as commercial air conditioning, space heating, and ventilation.
	Commercial Other	Displaced sub-sector that consists of technologies such as water heating, general service lighting, high intensity discharge lighting, refrigeration.
	Vehicle Manufacturing	Displaced sub-sector largely made up of automobile, tire, brake system, body, steering, and suspension component manufacturing.
	Vehicle Maintenance	Displaced sub-sector that consists of internal combustion engine, braking system, transmission, and electrified component maintenance.
	Wholesale Trade Parts	Growth sub-sector consists of components for light duty cars, light duty trucks, light medium duty trucks, medium duty trucks, heavy duty trucks, and buses.
	Fueling Stations	Displaced sub-sector consists of gasoline stations and gasoline stations with convenience store.
	Charging & Hydrogen Fuel Stations	Growth sub-sector, largely made up of battery electric vehicle home chargers, plug-in electric hybrid vehicle

		home chargers, and electric vehicle supply equipment for electric vehicles.
BLS	Bureau of Labor Statistics	Provides statistical guidance to the Department of Labor and works in partnerships with agencies to support their data needs.
CAPEX	Capital Expenditure	
CEJA	Climate and Equitable Jobs Act	Provides a framework for transitioning out of carbon emissions from the energy and transportation sectors.
EIMA	Energy Infrastructure Modernization Act	Provided a framework to encourage grid infrastructure modernization and smart grid investments.
I/O Modeling	Input-Output Modeling	Quantitative economic model that represents the interdependencies between different sectors of a region's economy.
IEOs	Initial Employment Outputs	Initial Employment Outputs provide estimates of the changes in job quantity in five-year increments, for both transition scenarios.
IMPLAN		IMPLAN is used to focus on the overall employment impacts of inputs in Illinois.
JEDI	Jobs and Economic Development Impact	JEDI tools estimate the local economic impacts of the construction and operation of power generation and biofuel plants.
MW	Megawatts	
NAICS	North American Industry Classification System	Standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data.
NREL	National Renewable Energy Laboratory	
O&M	Operations & Maintenance	
OPEX	Operational Expenditure	
SEOs	Secondary Employment Outputs	Secondary Employment Outputs offer insights into the occupational changes into the occupational changes which occur in growing and displaced sub-sectors.
SOC	Standard Occupational Classification	Federal statistical standard used by federal and state agencies to classify workers into occupational categories for the purpose of collecting, calculating, or disseminating data.
USEER	United States Energy & Employment Report	A comprehensive summary of national and state-level employment, workforce, industry, occupation, unionization, demographic, and hiring information

B. Model Inputs & Data Sources

Modeling and Output Structure

The **Electricity** sector is split into 11 sub-sectors:

1. Solar
2. Land-based Wind
3. Hydropower
4. Hydrogen
5. Biomass
6. Distribution
7. Transmission
8. Storage
9. Natural Gas Generation
10. Other Fossil Generation
11. Nuclear

The **Fuels** sector is split into 5 sub-sectors:

1. Hydrogen
2. Bioenergy
3. Natural Gas
4. Natural Gas Distribution
5. Petroleum Fuels

The **Buildings** sector is split into 5 sub-sectors:

1. Commercial HVAC
2. Commercial Other
3. Residential HVAC
4. Residential Shell
5. Residential Other

The **Transportation** sector is split into 5 sub-sectors:

1. Vehicle Manufacturing
2. Vehicle Maintenance
3. Wholesale Trade Parts
4. Conventional Fueling Stations
5. Charging & Hydrogen Fuel Stations

Ultimately, the project only modeled the four sectors outlined, but would consider modeling the secondary sectors (Table 17) as time and resources become available.

Table 17. Secondary Sectors

Category	Sector
Energy Demand	Industry
Non-Energy	Waste
	Non-Energy Emissions Activities
	Agriculture and Working Lands

Detailed Modeling Assumptions

Electricity

The Electricity growth sub-sectors, Solar, Hydrogen, Land-Based Wind, Distribution, Transmission, and Storage use investment data derived from the E3 RESOLVE analysis.

SOLAR

The distributed and utility solar models use capital cost data from NREL's *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmarks, With Minimum Sustainable Price Analysis: Q1 2022* to estimate capital expenditures based on E3 RESOLVE capacity addition outputs. The research team uses E3 RESOLVE operations and maintenance investment data.

The research team uses cost data from NREL's *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020* to split investment data into industry inputs.

- Distributed solar CAPEX investments are input into data derived from a weighted average of the 7kW mixed residential model (figure 12) and the 0.2MW commercial ground mount model (figure 22), and O&M investments are input into data derived from the weighted average of the residential and commercial ground mount models in figure 10.

- Utility solar CAPEX investments are input into data derived from the single axis tracker 100MW model (figure 30), and O&M investments are input into data derived from the tracking model in figure 10.

STORAGE

Use capital cost data from NREL's *U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020* to estimate capital expenditures based on E3 RESOLVE capacity addition outputs. The research team uses E3 RESOLVE operations and maintenance investment data. The research team uses the same NREL report to split investment data into industry inputs, using the 60MW, 4hr standalone Li-ion model.

HYDROGEN

Hydrogen investments include hydrogen fuel cell investments only.

TRANSMISSION AND DISTRIBUTION

2021 baseline Transmission and Distribution employment figures are based on 2021 IL Transmission and Distribution employment. Distribution is split from Transmission using 2019 employment in NAICS 221121 - Electric Bulk Power Transmission and Control and NAICS 221122 - Electric Power Distribution.

LAND-BASED AND OFFSHORE WIND

Land-based wind outputs are generated using NREL's JEDI Land Based Wind Model Beta rel. W10.30.20, using installed capacity from the E3 RESOLVE analysis as input. The offshore wind resource was not included in the E3 RESOLVE modeling for the transition scenarios, so it is not included in the jobs analysis.

ELECTRICITY NEUTRAL

The Electricity neutral sub-sectors, Hydropower, Biomass, and Nuclear, have unchanging inputs from the E3 RESOLVE model, so employment outputs are unchanging from the 2021 baseline.

ELECTRICITY DISPLACEMENT

The Electricity displacement sub-sectors, Natural Gas Generation and Other Fossil Generation, use scaled 2021 baseline utilities employment as input into IMPLAN multipliers. 2021 baseline utilities employment is scaled by capacity retirements as detailed in the E3 RESOLVE data. Employment associated with decommissioning Other Fossil Generation facilities are included in the employment outputs.

Fuels

HYDROGEN FUELS

The Hydrogen Fuels sub-sectors use investment data derived from the E3 PATHWAYS analysis. Hydrogen production is assumed to be 100 percent green hydrogen electrolysis, industry allocation of investments are derived from the 2020 Peterson et al report, "Hydrogen Production Cost From PEM Electrolysis – 2019" from the DOE Hydrogen and Fuel Cells Program Record.

BIOENERGY

The Bioenergy sub-sectors use investment data derived from the E3 PATHWAYS analysis. Industry allocation of investments for bioenergy fuels are derived from the NREL JEDI Biorefinery Sugars to Hydrocarbon Model rel. SH1.13.17.

NATURAL GAS DISTRIBUTION

Natural gas Distribution scale 2021 baseline IL employment databased on declining fuel demand from the E3 PATHWAYS analysis. Natural gas Distribution 2021 baseline employment is derived from NAICS 221210 – Natural Gas Distribution.

Buildings

The Buildings sub-sectors use investment data derived from the E3 PATHWAYS Analysis.

COMMERCIAL AND RESIDENTIAL HVAC

Commercial and Residential HVAC sub-sector industry spending patterns are adjusted based on PATHWAYS data, allocating supply chain expenditures to the following commodities:

- air conditioning, refrigeration, and warm air heating equipment,
- sheet metal,
- fabricated pipes and pipe fittings, and
- power boilers and heat exchangers.

RESIDENTIAL SHELL

Residential shell sub-sector industry spending patterns are adjusted based on PATHWAYS data, allocating supply chain expenditures to the following commodities:

- paints and coatings,
- mineral wool (insulation),

- metal windows and doors, and
- wood windows and doors.

Commercial shell investments are not generated by the PATHWAYS model, so employment in this area is not included in the Jobs Study.

COMMERCIAL AND RESIDENTIAL OTHER

Commercial and Residential Other sub-sector industry spending patterns are adjusted based on PATHWAYS data for, allocating supply chain expenditures to the following commodities:

- household laundry equipment,
- household refrigerators and home freezers,
- lighting fixtures,
- heating equipment (except warm air furnaces),
- other major household appliances,
- household cooking appliances, and
- air conditioning, refrigeration, and warm air heating equipment.

Transportation

VEHICLE MANUFACTURING

To estimate employment for the Vehicle Manufacturing sub-sector, the research team scales baseline 2021 employment by projected vehicle sales data provided by the PATHWAYS analysis. This approach assumes that Vehicle Manufacturing employment grows or declines proportionally with sales of the vehicle types served by each manufacturing sector. In applying this approach, the research team distinguishes between Vehicle Manufacturing related to conventional vehicles, manufacturing related to alternative vehicles, and manufacturing that serves both conventional and alternative vehicles. In addition, the research team distinguishes between employment related to vehicles sold in the Illinois market and employment related to vehicles sold outside the Illinois market. The research team assumes that the former scales with Illinois vehicles sales and that the latter remains constant over time.

VEHICLE MAINTENANCE

The research team's assessment of employment related to Vehicle Maintenance reflects differences between the maintenance requirements of alternative vehicles and the maintenance requirements for conventional vehicles. Information on maintenance costs per mile by vehicle type and component category (e.g., engine, braking system, transmission, etc.) are from a 2021 Argonne National Laboratory report titled, "Comprehensive Total Cost of Ownership Quantification for Vehicles with Different Size

Classes and Powertrains." Based on this information and projected changes in the amount and composition of the vehicle mile travelled over time as obtained from the PATHWAYS analysis, the research team adjusts 2021 baseline employment to reflect changing needs for maintenance labor over time.

WHOLESALE TRADE PARTS

The research team estimates changes in employment related wholesale trade for vehicle parts based on projected changes in the vehicle stock over time. The research team starts with 2021 baseline USEER employment data. The research team distinguishes between wholesale employment serving the Illinois market and employment serving other markets, as well as between wholesale employment related to conventional vehicles and employment related to alternative vehicles. To project changes in employment over time, the research team scales wholesale employment serving the Illinois market based on projected changes in conventional vehicle stock and alternative vehicle stock over time, obtained from the PATHWAYS analysis. The research team assumes no change in employment serving non-IL market and assumes the same employment requirements across vehicle technologies.

FUELING STATIONS

The research team estimates changes in fueling station employment based on projected changes in fossil fuel and biofuel consumption over time. As an initial step, the research team estimates 2021 baseline employment at Illinois fueling stations using U.S. Census Bureau data, which report employment separately for fueling stations with and without convenience stores. For fueling stations with convenience stores, the research team estimates that 61 percent of revenues are related to fuel sales, based on research from the National Association of Convenience Stores. For this segment of the fueling station market, the research team assumes that 61 percent of baseline employment scales proportionately with projected changes in fossil fuel and biofuel consumption over time, based on fuel consumption projections from the PATHWAYS analysis. The other 39 percent of employment for these fueling stations is assumed to remain unchanged over time. For fueling stations without gas stations, the research team scales the full 100 percent of baseline employment with projected changes in fossil fuel and biofuel consumption over time. The research team assumes no gas stations transition to charging stations, providing a high-end estimate of potential job reductions.

CHARGING STATIONS

For the Charging Stations sub-sector, the research team projects an increase in employment to meet increased demand for chargers by type. This includes manufacturing, installation labor, and materials. Total charger investments across alternative fuel types are derived from the PATHWAYS analysis and are broken out into hardware, installation materials, and installation labor investments following data collected by the International Council on Clean Transportation. Expected maintenance hours per year per charger are derived from the US DOE Alternative Fuels Data Center. The research team assumes MD/HD vehicles exclusively use DC Fast chargers, the share of LD vehicles using DC Fast chargers remains constant (50 percent DC Fast, 50 percent Level 2), and all maintenance and installation labor is in-state.

C. Stakeholder Engagement

The ComEd team conducted interviews with stakeholders as part of this study which focused on:

- Stakeholder views on the economy in Illinois today;
- Stakeholder understanding of the impacts of the pandemic on their organizations;
- Stakeholder thoughts on the future impact of CEJA on the workforce; and
- Assess what role (if any) stakeholders see ComEd having in the transition to a no-carbon economy by 2050.

Below is a breakdown of the stakeholders by their areas of focus, geographical reach, and the type of organization they represent:

Figure 139. Stakeholder Breakdown by Focus Area

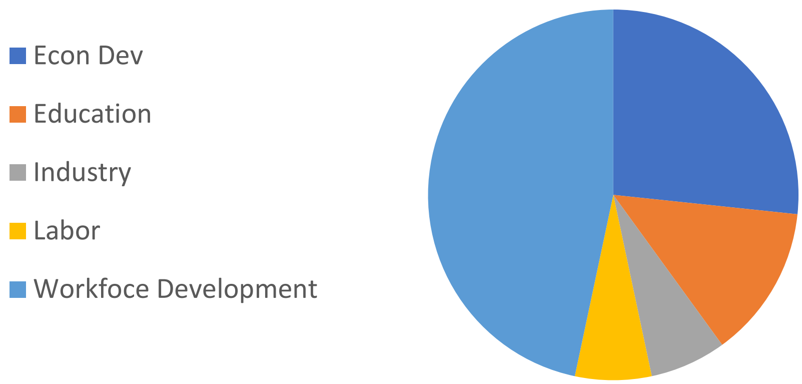
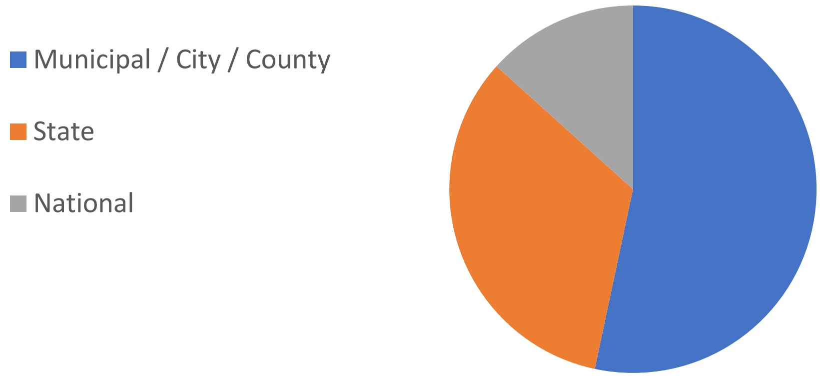


Figure 140. Stakeholder Breakdown by Geographical Reach



The following themes emerged overall:

- Stakeholders generally hold a positive outlook on the regional economy, saying the economy is improving and they have fully recovered from the effects of the pandemic.

- Finding, hiring, and developing talent remained a major concern, with the majority interviewed saying that it is somewhat difficult to find, hire, and develop qualified employees. Many expressed concerns about keeping up with salary demands as well as employee expectations for flexibility stemming from remote/hybrid work during the pandemic
- All stakeholders expressed a strong desire for ComEd to support workforce development as the state continues its clean energy transition:
    - Most stakeholders also expressed a strong desire for more aligned, coordinated training efforts across the region to ensure the best use of resources and ability to help more individuals and communities.
- The biggest concerns expressed by stakeholders surrounded ensuring that equity remains at the center of CEJA implementation – ensuring that low-income households participate in the clean energy transition. In particular, they expressed the importance of meeting the basic needs of individuals and communities (such as housing, childcare, transportation) to fulfill the promise of better jobs and careers.

D. Review of Comparable Research: Bibliography

Table 18 provides the list of workforce development sources and studies— with different geographical, industry, and policy lenses— utilized for this study.

Table 18. Overview of Reviewed Literature & Resources

Authored by:	ID	Year	Geography	Title of Report
UC Berkeley - Goldman School of Public Policy	BW01	2020	National	*2035 The Report*
Environmental Entrepreneurs (E2), E4TheFuture, BW Research	BW02	2020	National	*Build Back Better, Faster (BBBF): How Clean Energy Can Create Jobs*
The Brookings Institution	BW03	2021	National	*How renewable energy jobs can uplift fossil fuel communities and remake climate politics*
NYSERDA, BW Research	BW04	2021	New York	*Just Transition Working Group 2021 Jobs Study*
Clean Energy Trust, Environmental Entrepreneurs (E2), BW Research	BW05	2020	Midwest	*Clean Jobs Midwest*
Cornell University - The Worker Institute	BW06	2017	New York	*Reversing Inequality, Combatting Climate Change: A Climate Jobs Program for New York State*
Energy and Environmental Economics, Inc. (E3)	BW07	2020	New York	*Pathways to Deep Decarbonization in New York State*
Energy Innovation: Policy and Technology LLC - Energy Policy Solutions (EPS) Simulator	BW08		National	
The Nature Conservancy	BW09	2009	National	*Forest Carbon Strategies in Climate Change Mitigation*
Industrial Economics (IEc), university of Maryland - Inforum	BW10		National	*Employment Impacts of the Clean Power Plan*
Natural Resources Defense Council (NRDC), BW Research	BW11	2012	National	*American Wind Farms: Breaking Down the Benefits from Planning to Production*
National Renewable Energy Laboratory (NREL), BW Research	BW12	2019	National	*The Wind Energy Workforce in the United States: Training, Hiring, and Future Needs*
Princeton University - Carbon Mitigation Initiative	BW13	2020	National	*Net-Zero America: Potential Pathways, Infrastructure & Impacts*
Demos, Political Economy Research Institute (PERI) - University of Massachusetts Amherst	BW14	2019	New York	*The Climate and Community Act: A Big Win for New York State on Jobs and the Economy*
Princeton University – ZERO LAB	BW15	2021	National	*Influence of high road labor policies and practices on renewable energy costs, decarbonization pathways, and labor outcomes*
UC Berkeley, California Workforce Development Board (CWDB)	BW16	2020	California	*Putting California on the High Road: A Jobs and Climate Action Plan for 2030*

UC Berkeley	BW17	2017	San Joaquin Valley	*The Economic Impacts of California's Major Climate Programs on the San Joaquin Valley (SJV)*
UC Berkeley, University of Southern California, Occidental College	BW18	2016	California	*Advancing Equity in California Climate Policy*
UCLA- Luskin Center for Innovation (Inclusive Economics)	BW19	2019	California	*California Building Decarbonization: Workforce Needs and Recommendations*
United States Climate Alliance (USCA), BW Research	BW20	2020	UCSA member states	*US Climate Alliance: Jobs in the Clean Energy Economy*
National Association of State Energy Officials (NASEO), Energy Futures Initiative (EFI), BW Research	BW21	2022	National	*2022 U.S. Energy & Employment Report (USEER)*
Resources for the Future (RFF)	BW22	2019	Vermont	*An Analysis of Decarbonization Methods in Vermont*
The Zero Carbon Consortium, Sustainable Development Solutions Network (SDSN)	BW23	2020	National	*America's Zero Carbon Action Plan*
The Great Plains Institute	BW24	2018-2021	Midcontinent	*A Road Map to Decarbonization in the Midcontinent*
Multidisciplinary Digital Publishing Institute (MDPI)	BW25	2021	International	*A Comparative Review of National and Regional Just Transition Initiatives*
Labor Network for Sustainability	BW26	2021	National	*Workers and Communities in Transition: Report of the Just Transition Listening Project*
Advanced Energy Economy, BW Research	BW28	2021	Illinois	*Electrifying Illinois: Economic Potential of Growing Electric Transportation*
City of Chicago: Office of the Mayor	BW29	2022	Chicago, Illinois	*2022 Chicago Climate Action Plan*
Commonwealth Edison (ComEd), University of Illinois – Regional Economic Applications Laboratory (REAL)	BW30	2021	Chicago, Illinois	*Annual Jobs Creation Report*
Energy and Environmental Economics, Inc. (E3)	BW31	2022	Illinois	*Illinois Decarbonization Study: Climate and Equitable Jobs Act and Net Zero by 2050*

E. Review of Comparable Research: Detailed

This appendix contains a detailed writeup of findings from the literature review of over thirty sources with a national, regional and Chicago scope. Tables Referenced in this section can be found under Appendix Review of Comparable Research: Tables

Transition Scenarios

The following sub-sections discuss the different scenarios considered across the literature. The literature utilized a range of transition scenarios to low-carbon economies.

Net-Zero America: Potential Pathways, Infrastructure & Impacts

In Reference to a 2019 baseline, *Net-Zero America* defined and modeled five scenarios—E+ (aggressive end-use electrification, unconstrained energy-supply options), E- (less aggression end-use electrification, unconstrained energy-supply options), E-B+ (E- electrification, higher biomass), E+RE- (E+ electrification, constrained renewable energy), and E+RE+ (E+ electrification, 100 percent renewable energy by 2050). The scenarios assume different energy demand levels and distinct combinations of renewable and non-renewable energy supply sources to reach a national CO2 emissions target of -0.17GtCO2 by 2050 (Table 1). The report identified six pillars for deep decarbonization: Energy Efficiency and Electrification; Clean Electricity; Bioenergy and other zero-carbon fuels; CO2 Capture, Utilization, and Storage; Reduced Non-CO2 Emissions; and Enhanced Land Sinks.

Table 19. Overview of Net-Zero America Transition Scenarios[34]

	REF ~AEO 2019	E+ high electrification	E- less-high electrification	E- B+ high biomass	E+ RE- renewable constrained	E+ RE+ 100% renewable
CO_2 emissions target		- 0.17 $GtCO_2$ in 2050				
Electrification	Low	High	**Less high**	**Less high**	High	High
Wind/solar annual build	n/a	10%/y growth limit	10%/y growth limit	10%/y growth limit	**Recent GW/y limit**	10%/y growth limit
Existing nuclear	50% → 80-y life	50% → 80-y life	50% → 80-y life	50% → 80-y life	50% → 80-y life	**Retire @ 60 years**
New nuclear	Disallow in CA	Disallow in CA	Disallow in CA	Disallow in CA	Disallow in CA	**Disallowed**
Fossil fuel use	Allow	Allow	Allow	Allow	Allow	**None by 2050**
Maximum CO_2 storage	n/a	1.8 Gt/y in 2050	1.8 Gt/y in 2050	1.8 Gt/y in 2050	**3 Gt/y in 2050**	**Not allowed**
Biomass supply limit	n/a	13 EJ/y by 2050 (0.7 Gt/y biomass) [*No new land converted to bioenergy*]		**23 EJ/y by 2050 (1.3 Gt/y biomass)**	13 EJ/y by 2050 (0.7 Gt/y biomass) [*No new land converted to bioenergy*]	

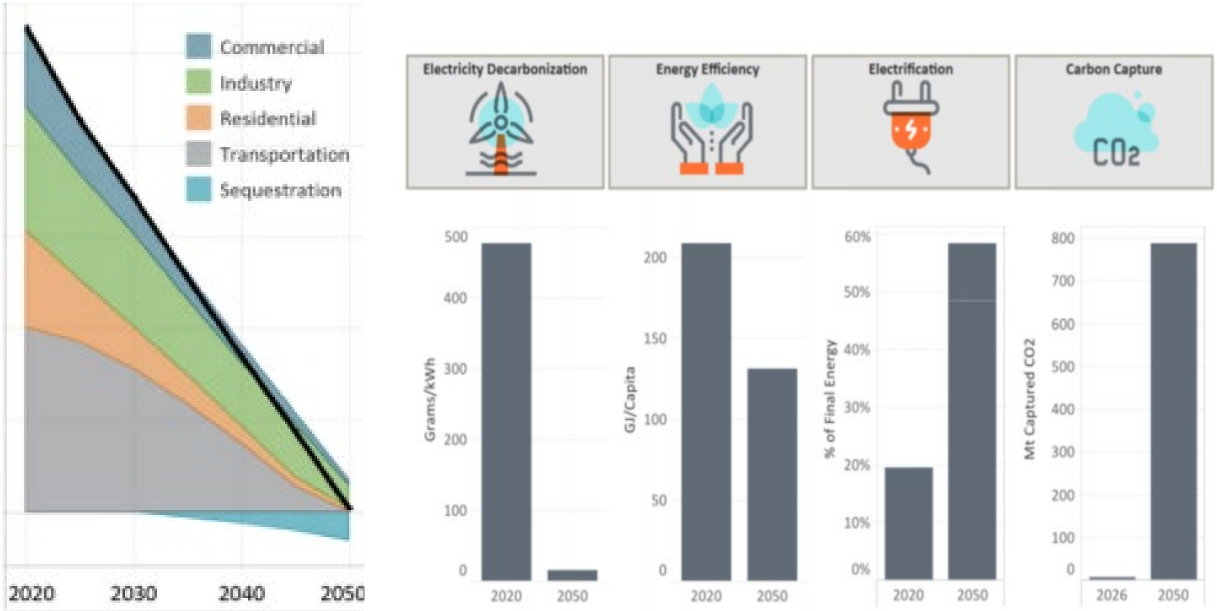
America's Zero Carbon Action Plan

America's Zero Carbon Action Plan outlines six scenarios for meeting net-zero targets while fulfilling baseline energy demands: The Central Case (least cost); Limited Land; Delayed Electrification; 100 percent Renewable Primary Energy; Low Demand; and Net Negative.

Modeling for transitioning to a low-carbon system also hinges on four pillars: energy efficiency, electricity decarbonization, electrification (switch from fossil fuel combustion), and carbon capture.

[34] Princeton University

Figure 141. America's Zero Carbon Action Plan Key Pillars for Transition to Low Carbon[35]



2035 The Report

2035 The Report provides conservative estimates of decarbonization potential by 2035 using the latest renewable energy cost data. The studies model two scenarios—no new polies and 90 percent clean electricity by 2035[36]—for national and regional electricity generation, and groups assumptions on the costs of technology investments into three buckets: base-cost, low-cost, and higher-cost.

Figure 142 below shows the Midcontinent Independent System Operator (MISO) generation mix by 2035 if no new policies are implemented and base technology costs are assumed. Under these assumptions, renewable energy sources make up a smaller percentage of electricity generation compared to carbon-intensive energy sources.

[35] Sustainable Development Solutions Network (SDSN)

[36] The studies define clean electricity as carbon-free electricity.

Figure 142. No New Policy, Base-Cost Scenario, MISO Generation Mix (2035)[37]

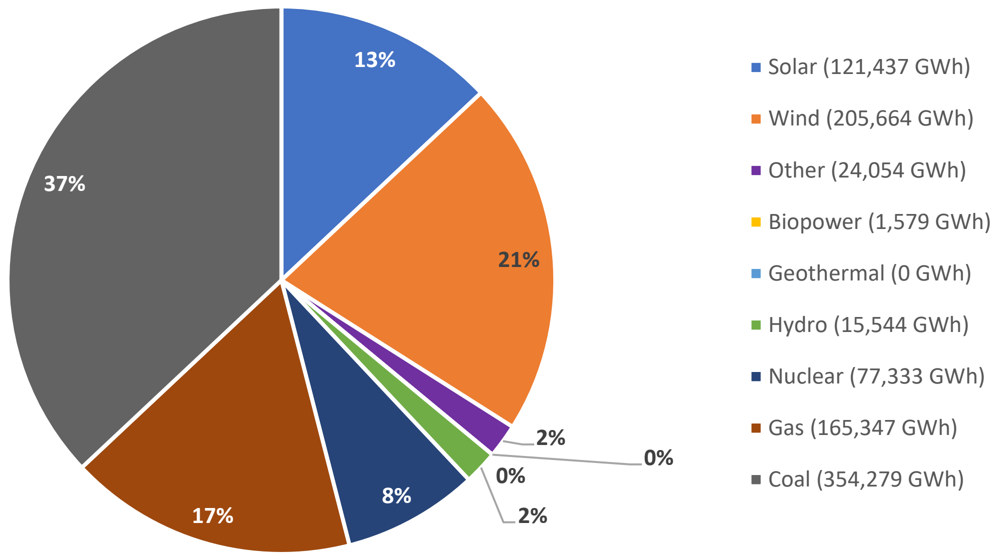
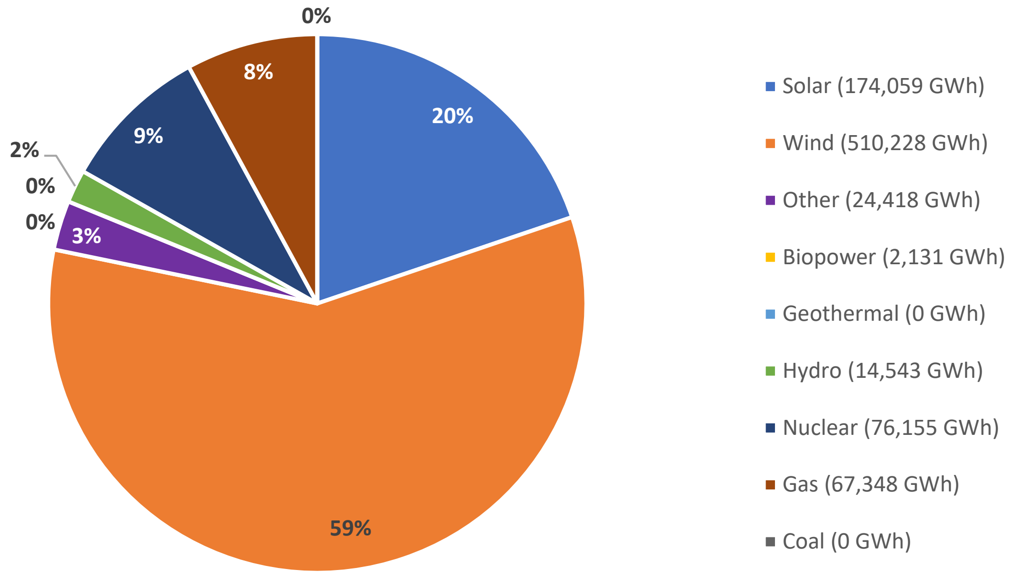


Figure 143 shows the MISO generation mix when the model assumes a new energy policy of 90 percent clean electricity by 2035 under base technology cost assumptions. Renewable energy generation, particularly wind, makes up a higher percentage of the generation mix compared to carbon-intensive generation sources.

[37] University of California Goldman School of Public Policy. 2035 The Report.

Figure 143. 90 percent Clean Energy, Base-Cost Scenario, MISO Generation Mix (2035)[38]



Job Creation

In October 2011, the Illinois General Assembly enacted the Energy Infrastructure Modernization Act (EIMA) designed to encourage grid infrastructure modernization and smart grid investment. ComEd submitted annual and quarterly EIMA job creation reports between 2012 and 2021 which identified the number of full-time equivalent jobs created in the prior year and cumulatively. In addition to the head counts of full-time employees, ComEd also provided part-time, contractor and induced employee headcounts. The EIMA Jobs Creation Reports were specific to ComEd job creation because of EIMA.

Policy Goals

The literature proposed policies to arrange a variety of concerns that can be grouped climate goals or equitable transition. The following sub-sections discuss these policies.

Climate and Equitable Jobs Act (CEJA)

The Climate and Equitable Jobs Act (CEJA), passed in late 2021, became a nation-leading document on combating climate change with a focus on creating jobs and facilitating an equitable transition to a zero-carbon economy.[39] Climate goals include one hundred percent carbon-free power by 2030 and, one hundred percent renewable energy by 2050. Substantial investments for workforce development will be made in low-income communities, environmental justice areas and Black, Indigenous and People of Color (BIPOC) communities. One of the overarching goals is the creation of thirteen Clean Jobs Workforce Hubs geared towards, and located in, fossil fuel and under resourced communities, which are also often BIPOC communities and environmental justice areas. CEJA also makes provisions for capacity building of contractors and community ownership projects. Such provisions

[38] 2035 The Report

[39] S.B. 2408, 2021-2022, 102nd General Assembly. (Illinois 2022). https://legiscan.com/IL/text/SB2408/id/2433158.

make it one of the nation's leading documents on transitioning to low-carbon economies while creating jobs and facilitating opportunities for under resourced communities.

City of Chicago – 2022 Chicago Climate Action Plan

Below is a list of goals outlined in the *2022 Chicago Climate Action Plan* and some strategies that will be undertaken to meet those goals:

1. Increase access to utility savings and renewable energy, prioritizing households
    - **Strategies**: retrofit buildings; connect communities in the city to renewable energy
2. Create jobs, develop circular economies, and improve air quality by pioneering clean last-mile logistics
    - **Strategies**: reduce waste and landfilling
3. Deliver a robust zero-emission mobility network that connects communities and improves air quality
    - **Strategies**: make transit, walking, and biking accessible for all trips; increase transit performance; transition to zero-emission transit and fleets
4. Drive equitable development of Chicago's clean-energy future
    - **Strategies**: transition away from fossil fuel use; enable and begin building/personal vehicle electrification; align building codes and standard with climate best practices (e.g., net-zero carbon construction, tree planting, green roof and walls installation); decommission fossil power; enable energy storage
5. Strengthen communities and protect health
    - **Strategies**: collect data (e.g., community energy burden, water and soil quality, air quality); enable data-driven decision-making; enable community resiliency Table 10 shows climate-goal-specific policy recommendations from the reviewed literature. Renewable energy generation and energy efficiency projects were often cited as key opportunities for workforce development and providing employment opportunities for disadvantaged communities.

F. Review of Comparable Research: Tables

Table 20. Industry/Sector Classification Across Examined Reports

	Electricity		Buildings	Transportation	Fuels			Waste	Working Lands	*Other	
	Generation	TDS			Industry & Manufacturing	Fuels	Conversion & Capture				
Build Back Better, Faster	Renewable Generation	Grid Modernization	Energy Efficiency								
Pathways to Deep Decarbonization in New York State	Clean Electricity		Buildings	Transportation	Industry	Fuels & Zero Emissions	CCSU	Non-Combustion	Natural and Working Lands		
CEIR	Renewable Generation	Grid Modernization and Energy Storage	Energy Efficiency	Alternative Vehicles		Clean Fuels					
Clean Jobs Midwest	Renewable Generation	Grid Modernization and Energy Storage	Energy Efficiency	Alternative Vehicles		Clean Fuels					
Reversing Inequality, Combatting Climate Change	Energy		Building	Transportation							
Energy Policy Solutions Simulator	Electricity Supply		Buildings and Appliances	Transportation	Industry				Agriculture, Land Use, and Forestry	District Heat & Hydrogen	Research and Development
Net-Zero America	Electricity	Transmission & Distribution Networks and Infrastructure	Buildings and Appliances	Vehicles	Industry		Fuels Conversion		Land use	Option Creation	
The Climate and Community Act	Renewable Energy		Energy Efficiency								
Putting California on the High Road	Energy			Transportation	Industrial			Waste	Natural and Working Lands	Water	
California Building Decarbonization	Renewable Energy Construction	Electricity Generation and Distribution	Building Electrification		Equipment Manufacturing	Gas Distribution					
U.S. Climate Alliance	Renewable Generation	Grid Modernization and Energy Storage	Energy Efficiency	Alternative Vehicles		Clean Fuels					

Table 21. Occupation Classification Across Examined Reports

	USEER, CEIR, U.S. Climate Alliance & Clean Jobs Midwest	Employment Impacts of the Clean Power Plan	2035 The Report	Putting California on the High Road (Defined by major SOC codes)	California Building Decarbonization
White Collar				Sales, Office and Administrative Support (41, 43)	Workers with skills that can be readily deployed in other industries
Professional Services	Engineers; Managers; Financial Analysts; Consultants; Computer Programmers			Engineering and other technical occupations that mostly require a four-year college degree (15, 17, 19, 23, 29)	
Blue Collar				Construction, production, transportation, maintenance, repair, and similar occupations (37, 45, 47, 49, 51, 53)	Workers with skills that are more specialized to the natural gas industry
Other Miscellaneous				Community and Social Service, Arts, Design, Entertainment, Sports, and Media; Healthcare Support; Protective Service; Food Preparation and Service Personal Care and Service (21, 27, 31, 33, 35, 39)	
Managerial				Business and Financial Operations, Management, Educational Instruction and Library (13, 11, 25)	
Trade	Sales Representatives; First-Line Supervisors of Sales Workers				
Utilities	Power Plant Operators; Power Distributors and Dispatchers; Electrical Power-Line Installers and Repairers				
Agriculture & Forestry	Farmworkers and Laborers; Agricultural Equipment Operators; First-Line Supervisors of Farming and Forestry Workers				
Construction	Carpenters; HVAC Mechanics or Installers; Electricians; Solar Photovoltaic Installers		Defined under "Construction and Manufacturing"		
Other Services	Automotive Service Technicians and Mechanics; Automotive Body and Related Repairers				
Manufacturing	Assemblers and Fabricators Welders; First-Line Supervisors of Production and Operating Workers; Metal and Plastic	Defined	Defined under "Construction and Manufacturing"		
Installation		Defined			

Table 22. Modeling Approaches Across Examined Reports

	General IMPLAN	Custom IMPLAN	Proprietary Model	Investment Multipliers
2035 The Report	Generation and capacity results			
Build Back Better, Faster				Emsi and internal multipliers
Reversing Inequality, Combatting Climate Change				Internal estimate[40]
Energy Policy Solutions Simulator			1. Wassily Leontief's principles I/O model 2. DEEPER I/O model	

[40] Job estimates are for number of jobs created for every billion dollars invested

Employment Impacts of the Clean Power Plan			LIFT (University of Maryland)[41]	
The Wind Energy Workforce in the United States			JEDI	
Net-Zero America			1. DEERS 2. RIO 3. EnergyPATHWAYS	
Influence of High Road Labor Policies and Practices on Renewable Energy Costs, Decarbonization Pathways, and Labor Outcomes			DEERS	
Putting CA on the High Road		IMPLAN supplemented by multipliers from previous literature or past performance		
The Economic Impacts of California's Major Climate Programs on the San Joaquin Valley	Cap-and-Trade: cost and revenue spending inputs		JEDI	Energy Efficiency[42]
Advancing Equity in California Climate Policy			JEDI	
California Building Decarbonization	All except Electricity		JEDI (Electricity)	
An Analysis of Decarbonization Methods in Vermont			1. Dynamic Regional Computable General Equilibrium[43] 2. Incidence Model[44]	
America's Zero Carbon Action Plan		Input/Output (I/O) analysis developed by PERI and building off IMPLAN		
A Road Map to Decarbonization in the Midcontinent			FACETS	

[41] LIFT is an industry I/O analysis calibrated to the EIA's Annual Energy Outlook and incorporating changes in energy prices, efficiency, electricity generation, energy efficiency costs, power sector investment, power plant heat rates, new capacity, power plant retirements, and air pollution control devices

[42] Derived from publicly available data, literature on energy efficiency job impacts, and research from the Lawrence Berkeley Laboratory

[43] Calculates changes in supply and demand of producer and consumer goods by households and firms in each region and the corresponding changes in market-clearing prices

[44] Analyzes distributional impacts across income groups and geographic locations

Table 23. Job Creation Estimates for Electricity Sector

		Putting California on the High Road	America's Zero Carbon Action Plan	Build Back Better, Faster	Reversing Inequality, Combatting Climate Change	California Building Decarbonization	The Wind Energy Workforce in the United States	The Climate and Community Act	Wind Energy Workforce	2035 The Report	Employment Impacts of the Clean Power Plan
		Direct jobs per $1M spent	Direct, indirect jobs	Jobs each year for five years (direct, indirect & induced)	Total jobs (direct, indirect, induced) per $1M	Construction jobs (annual average, 2020-2045)		Total Direct, Indirect, Induced (annually, 2021-2030)		New construction jobs (annual average, 2020-2035)	Construction jobs/GW; O&M jobs/plant
Power Generation	Natural Gas		Energy supply: 2.1M per $388.7M	Renewable Energy: 50,000 per $13.1 in forgone tax revenue and investments	5			140,872 jobs per $24.4M			1,589; 8
	Coal				7					-122,492 O&M	
	Wind				13	Onshore: 1050	1,079 jobs per 250-MW of development and construction		5-7 O&M jobs per 100 MW	Offshore: 45,808 construction Onshore: 279,013 and 53,952 O&M	1337; 3
	Solar	SF: 4.583			14	17,600				Dist: -12,085 Utility: 122,282 and 28,752 O&M	
	Biomass				16						
	Combined cycle									-92,622 O&M	n/a; 31
	Geothermal					650					
	Nuclear									-11,532 O&M	
	Battery									81,932	

Table 24. Job Creation Estimates for Buildings Sector

		Putting California on the High Road	America's Zero Carbon Action Plan	Build Back Better, Faster	Reversing Inequality, Combatting Climate Change	California Building Decarbonization	The Climate and Community Act
		Direct jobs per $1M	Direct jobs	Jobs each year for five years (direct, indirect & induced)	Direct jobs per $1M spent	Construction jobs (annual average, 2020-2045)	Total Direct, Indirect, Induced (annually, 2021-2030)
Retrofits	SF/Small MF EE and Solar Water Heating:	10.896					71,990 jobs per $7.4M
	Large MF EE and Renewables:	4.664					
	HVAC		97,117 per $32.4M	737,200 per $60.7M in stimulus	5.3		
	Other commercial and residential		47,913 per $15.3M				
	Appliances		5,722 per $3.1M			Residential: 32,650	
	Refrigeration		8,058 per $2.8M			Small and Medium Commercial: 3,100	
	Lighting		-1,874 per -$739.5M		5.1	MUSH: 20,950	
	Environmental Controls				3.8		
	Envelope Improvements				7.7		
	Office Equipment				3.8		

Table 25. Job Creation Estimates for Transportation Sector

	Putting California on the High Road	America's Zero Carbon Action Plan	Reversing Inequality, Combatting Climate Change
	Direct jobs per $1M spent	Direct jobs	Per $million (direct, indirect, induced)
Mass Transit/ Freight Rail	High Speed Rail: 4.528	Vehicles: 97,117 per $79.8M	22
	Transit and Inner-City Rail: 2.483		
Low Carbon Transit Operations	8.336		
Affordable Housing and Sustainable Communities	4.815		
Clean Vehicle Rebates:	1.707		
Hybrid and Zero-Emission Truck and Bus Vouchers:	0.346		
Enhanced Fleet Modernization:	1.628		
Car Sharing and Mobility Options:	4.2		

Public Fleet Pilot:	2.154		[redacted]
Financing Assistance Pilot	14.5		
Zero-Emission Truck and Bus Pilot	2.913		
Multi-Source Facility Demonstration	3.255		
Zero-Emission Drayage Truck Demonstration	0.634		

Table 26. Energy Industry Unionization Rates: USEER

	Sub-sectors		
	0 - 5 percent	6 - 10 percent	11 - 15 percent
Transmission, Distribution, and Storage (TDS): 17 percent	[redacted]		
Electric Power Generation (EPG): 7 percent	Solar: 4 percent	Wind: 6 percent	CHP: 9 percent
	Oil: 4 percent	Hydro: 7 percent	Natural Gas: 11 percent
	Other: 4 percent	Coal: 10 percent	Nuclear: 12 percent
		Biomass: 10 percent	[redacted]
Energy Efficiency (EE): 10 percent	Petroleum: 2 percent	Nuclear: 6 percent	
Motor Vehicles (MV): 13 percent			
Fuels: 3 percent	Coal: 1 percent	Corn Ethanol: 7 percent	
	Natural Gas: 3 percent	Biomass: 8 percent	
	Other Ethanol/Biomass: 4 percent	Other: 9 percent	

Table 27. Policy Recommendations Across Examined Reports

Employment Impacts of the Clean Power Plan	America's Zero Carbon Action Plan	Build Back Better, Faster	Reversing Inequality, Combatting Climate Change	Pathways to Deep Decarbonization in New York State
Improve individual electricity generating unit emission rates	Renewable Portfolio Standards for zero-carbon power by 2050	Renewable energy - extend Production Tax Credits and Investment Tax Credits for five years - extend the Section 1063 Grant Program two years - $1.5M investment in port infrastructure for offshore wind	Buildings - Retrofit all public schools by 2025 - Reduce energy use in all public buildings by 40 percent by 2025 - Streamline and expand access to residential retrofit programs	Additional building and transportation end-use electrification
Re-dispatch from affected steam power plants to natural gas combined cycle units	Comprehensive plan for net-zero GHG emissions by 2050 covering transport, buildings, and industry	Energy efficiency invest in an array of areas including low-income, residential, and commercial/industrial energy efficiency policies and programs	Public Transit - Reinvest in NYC transit - Develop High Speed Bus - Construct Rail	GHG reduction from non-combustion emissions sources such as landfills, agricultural sources, and refrigerants
Increase low- or zero-carbon renewable energy capacity	Align financing strategies with new federal funding programs	Grid modernization invest in utility communications and broadband, grid flexibility enhancement cybersecurity technology and workforce development, and building-to-grid integration	Renewable Energy - Install 2 GW on Solar on Schools by 2025 - Install 7.5 GW of offshore wind by 2050 - Install 2 GW of utility scale solar	Advanced bioenergy in buildings and transportation
Expand use of demand-side energy efficiency technologies	Promote densification, transit-oriented development, and complete streets			