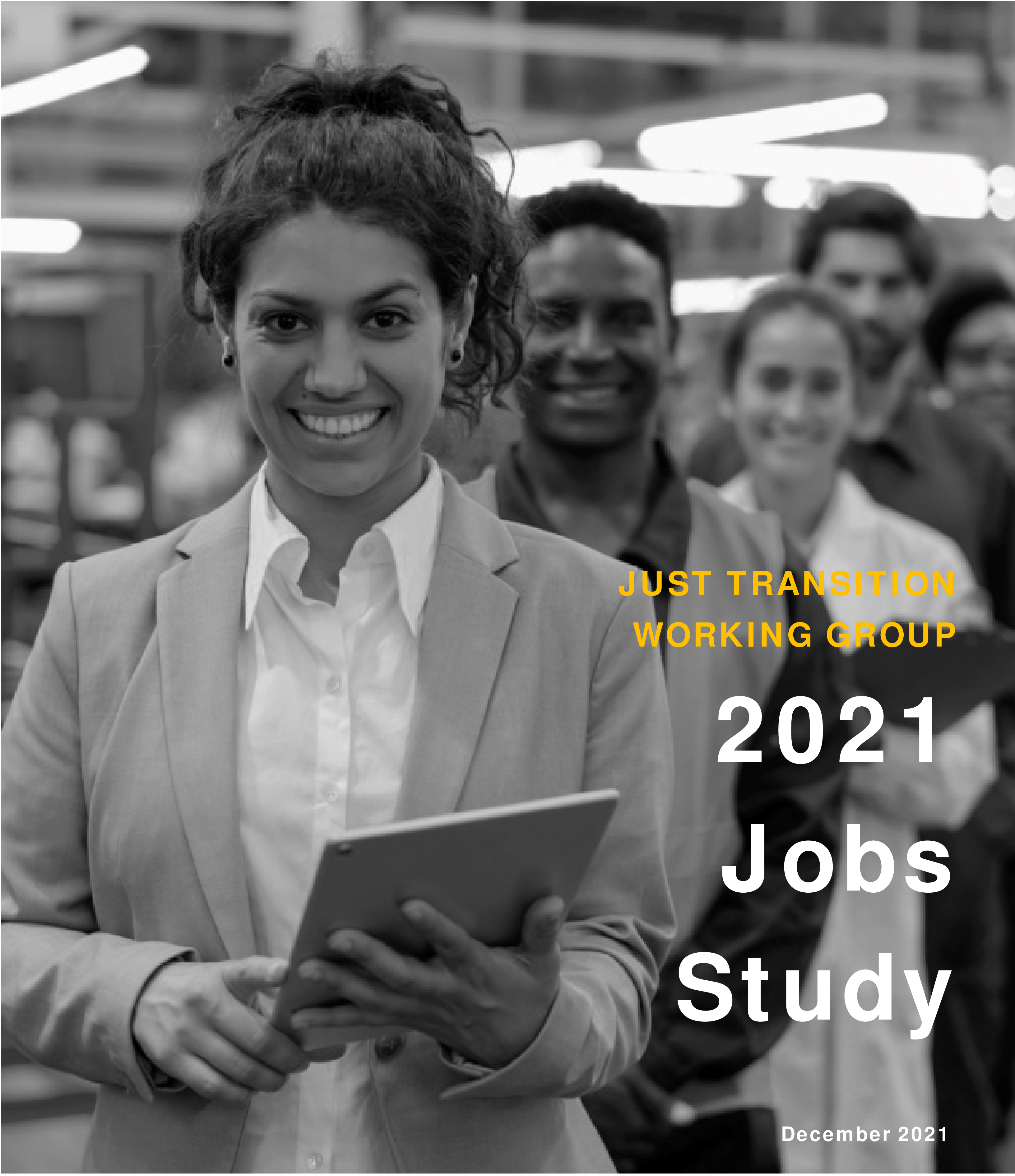

JUST TRANSITION WORKING GROUP

2021 Jobs Study

December 2021

NEW YORK
STATE OF
OPPORTUNITY.

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I. Executive Summary

Introduction

The Jobs Study and supporting research were done on behalf of the Just Transition Working Group (JTWG) as part of the New York State Climate Action Council.[1] The 2021 JTWG Jobs Study came out of New York's Climate Leadership and Community Protection Act (Climate Act), which provided some valuable insights for the direction of the study. The most relevant sections in the legislation indicated the Jobs Study would:

1. Estimate *"the number of jobs created to counter climate change, which shall include but not be limited to the energy sector, building sector, and working lands sector"*

2. Examine the *"projection of the inventory of jobs needed and skills and training required to meet the demand of jobs to counter climate change"* as well as the *"workforce disruption due to community transitions from a low carbon economy"*

3. *"Advise the council on issues and opportunities for workforce development and training related to energy efficiency measures, and renewable energy and other clean energy technologies, with specific focus on training and workforce opportunity for disadvantaged communities, and segments of the population that may be underrepresented in the clean energy workforce such as Veterans, women, and formerly incarcerated persons"*

The requirements of the Climate Act provided the foundation for the Jobs Study, supporting the development of the project's research objectives, methodology, and deliverables.

The Jobs Study project team included staff support from the New York State Energy Research and Development Authority (NYSERDA), New York State Department of Labor (NYSDOL), Department of State (NYSDOS), Department of Environmental Conservation (NYSDEC), among other state agency participation. The Jobs Study analytical framework, including the employment and workforce analyses, was led by the competitively selected BW Research contractor team, which included BW Research, Industrial Economics, and Inclusive Economics, who were responsible for building the employment impact model, generating the model outputs, and analyzing and presenting the results.

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[1] For more information on the work the state of New York is engaged in to fight climate change, please visit: https://climate.ny.gov/.

Research Objectives and Project Process

From the direction provided by the Climate Act and input from the JTWG came a project plan that provided both research objectives and three phases for moving forward. The objectives and process were categorized into three phases.

Phase 1: Develop the structure and framework of the employment impact model. The first phase began with an extensive literature review that examined more than 30 studies and employment models to better understand the best practices and concepts around modeling employment transitions from the status quo to a low- or no-carbon future. This initial phase also included synthesizing the findings of the literature review into the proposed structure and framework of the employment impact model.

Phase 2: Generate outputs from the employment impact model under different transition scenarios. The second phase focused on refining the employment impact model by running preliminary iterations of scenarios through the model. The final draft scenarios that were modeled and presented in the Jobs Study were taken from the Climate Action Council (CAC) Integration Analysis.

Phase 3: Examine the model sensitivities and workforce implications associated with the model outputs. The third phase examined the final outputs that were modeled and looked at potential sensitivities to the model and the initial workforce implications associated with the results.

RESEARCH METHODOLOGY OVERVIEW

The project methodology was developed from an extensive literature review, the experience of the contractor team, and the direction of NYSERDA staff and JTWG advisors. Ultimately, the Jobs Study was focused on measuring the change in employment in the electricity, fuels, buildings, and transportation sectors, also referred to as the primary sectors. The statutory requirement for the JTWG included a provision to also assesses the economic and jobs impact of the Climate Act on the working lands sector. It was determined that a separate and concurrent study of New York's working lands sector was being conducted by the United States Climate Alliance (USCA) and RTI International. Observations and findings from USCA and RTI's November 2021 study, "Economic Impacts of Investing in Climate Mitigation in New York Forests and Agriculture," were reported out to the JTWG and are in support of fulfilling the analysis for the working lands sector. This report does not capture USCA and RTI's analysis. Each of the primary sectors were further delineated into subsectors, for a total of 28 subsectors within the four primary sectors.

Two scenarios from the CAC Integration Analysis were used for the final modeling effort in the Jobs Study: Scenario 2, the strategic use of low-carbon fuels (S2: LCF), and Scenario 3, the accelerated transition away from combustion (S3: AT). Both modeled scenarios made considerable investments in solar and wind energy as well as transmission, distribution, and storage capacity. Both scenarios also made considerable investments in commercial and residential buildings. The S2: LCF scenario made investments in low-carbon fuels, such as liquid biofuels, while the S3: AT scenario made more sizeable early investments in grid and electrification.

The Initial Employment Outputs (IEO) estimated the quantity of job changes from 2019[2] to 2025, 2030, 2035, 2040, 2045, and 2050 under both the scenarios from the CAC Integration Analysis. The estimates for the IEO were generated from input-output models, including IMPLAN and Jobs and Economic Development Impact (JEDI), that were used to translate activities and investments for each subsector into an estimate of employment over time.

The Secondary Employment Output (SEO) estimated how jobs would change by industry, occupation, wage, and geographic distribution across New York State from 2019 to 2030 under both modeled scenarios. The estimates for the SEO were generated from the IEO direct and indirect employment estimates combined with industry staffing patterns, occupational crosswalks, and employment profiles by value chain.

The Jobs Study methodology is different from the Integration Analysis scenarios whose impacts it measures. The analysis characterizes New York's changing workforce compared to today, instead of to a Reference Case. This provides a projection of the future of work in New York State that stakeholders should prepare for and anticipate. Some of the job gains, and especially some of the displacement, are a result of transitions that can already be anticipated. For example, the 6 GW distributed solar and 9 GW offshore wind targets are already in Public Service Commission Orders and will create new job opportunities. In addition, the growing electric vehicle market share will reduce demand for workers at gas stations. Other job impacts will result from new climate actions that are articulated in the Integration Analysis; for example, expanded building electrification and industrial decarbonization will create substantial additional job opportunities.

For a more detailed description of the research methodology used for the Jobs Study, please refer to Appendix C of the report.

[2] 2019 was used as the baseline year for the Jobs Study rather than 2020, as employment had not been impacted by the pandemic in 2019.

Key Findings

INITIAL EMPLOYMENT OUTPUTS (IEO)

The IEOs provided an estimate of the total change in the number of jobs occurring in each modeled scenario (S2: LCF and S3: AT) from the four primary sectors and their 28 sub-sectors from 2019 through 2050, in five-year increments starting in 2025.

The results of the IEO show that in the 21 growing sub-sectors, total employment increased by more than over 60 percent from 2019 to 2030, adding at least 211,000 new jobs in the New York State. The seven displaced sub-sectors, that experienced a loss in employment under both scenarios, saw total jobs decline by about 14 percent from 2019 to 2030, losing approximately 22,000 jobs. Overall employment in the four primary sectors increases under either scenario by at least 189,000 jobs from 2019 to 2030, or a 38 percent increase in the workforce. From 2019 to 2050, overall employment in the four primary sectors increased by at least 268,000, or a 54 percent increase in the workforce.

Additional key findings from the IEO include:

1. **From 2019 to 2030, under both modeled scenarios, the number of jobs added from growing subsectors exceeded the number of jobs lost in displaced subsectors by a ratio of approximately ten to one**. This finding indicates that in the primary sectors, expanding the pipeline for the growing workforce will require considerably more people than simply transitioning over those that have lost employment opportunities in displaced subsectors.

2. **The buildings sector accounted for well over half of all the jobs added in growing subsectors from 2019 to 2030**, with the most sizeable increases in added jobs found in the residential HVAC and residential shell subsectors. This finding indicates the need to expand the residential building workforce considerably before 2030 to meet the expected need from either modeled scenario.

3. **Conventional fueling stations (gas stations) account for over one-third to almost one-half (depending on the scenario) of all displaced jobs in the primary sectors from 2019 to 2030**. This finding indicates that traditional fueling stations will likely need to adapt, beyond providing gasoline for cars, or face diminishing opportunities for revenue and employment.

4. **In the electricity sector, more mature subsectors like transmission, distribution, and solar will see strong growth between 2019 and 2040, while more nascent subsectors like offshore wind, storage, and hydrogen are expected to experience exponential growth**. This finding indicates that parts of the growing electricity

sector will be able to build upon their current established workforce, while other parts of this sector will almost need to start from the beginning as these subsectors have little, if any, workforce development infrastructure.

5. **In the buildings sector, employment could be significantly impacted under different scenarios where domestic manufacturing within the state of New York was increased.** If domestic manufacturing was increased to 50 percent produced within the state of New York by 2030, an additional 9,000 to 11,000 jobs would be added under the two modeled scenarios. If domestic manufacturing was increased to 100 percent produced within the state of New York by 2030, an additional 25,000 to 30,000 jobs would be added under the two modeled scenarios.

For more detailed information on the results of the IEO and model sensitivities, please go to pages 30 and 114 of the report.

SECONDARY EMPLOYMENT OUTLOOK (SEO)

The SEO's[3] provided an estimate of how jobs will change from 2019 to 2030, by industry, occupation, wages, and geography across the state of New York, under both modeled scenarios, in the four primary sectors.

The results of the SEO show that all the major industry categories for the Jobs Study, which include construction, professional services, manufacturing, and other supply chain, saw a net increase of employment in the four primary sectors from 2019 to 2030. The largest net employment increases were found in the construction and manufacturing industries. In the growth subsectors, over three-quarters of total added jobs will be found in the construction industry. In the displaced subsectors, more than four out of five industry jobs lost will be found in the other supply chain industries, which include transportation and warehousing, utilities, wholesale, and retail industries.

Additional key findings from the SEO include:

1. **Geographically, net job growth from 2019 to 2030 is evenly distributed as each of the five regions across the State sees an increase of at least 10,000 net new jobs**. This finding indicates that job growth will occur across the New York State and each of the regions should consider workforce development efforts and training to supply a well-prepared labor force for these growing positions.

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[3] The SEOs include the direct and indirect employment from the IEOs, but do not include induced employment from the IEOs.

2. **Occupationally, the largest job increases from 2019 to 2030 will be found in installation and repair positions. They are expected to account for almost two-thirds of added jobs in the growth subsectors**. This finding indicates that additional research should likely be done to understand the education and training resources that lead into these positions and the different career pathways that can be found in this category of occupations.

3. **The wage profile of jobs in the four sectors shows the largest increase from 2019 to 2030 in middle wage positions ($28 to $37 an hour[4]),** while high wage (>$37 an hour) and low wage positions (<$28 an hour) could experience declines. This finding goes against national and statewide trends that have seen middle wage positions decline over the last decade. It is also important to note that these wage projections are based on current BLS data but could change depending on the addition of transition policies that include high road labor standards and practices, such as those envisioned in the Climate Act.

For more detailed information on the results of the SEO and workforce analyses, please go to pages 102 and 121 of the report.

[4] Please note all wages in this study are developed and presented in 2019 dollars and do not include an analysis of benefits.

II. Examination of Comparable Research

Literature Review

The research team conducted an extensive review of all previously existing resources, works, and literature related to job forecasts and modeling for the clean energy economy. The studies ranged from State-specific to nationwide analyses. Three guiding questions led the review and comparison of existing literature:

1. **Structure:** How are sectors, industries, and occupational categories identified and defined?
2. **Methods:** What methods were used to estimate current or future job impacts?
3. **Scenarios and Recommendations:** What are the workforce implications of comparable studies and what were the key lessons from the literature review?

Table 1 provides a broad list of workforce development studies and sources—with differing geographical, industry, and policy lenses—that the team identified and gathered.[5]

TABLE 1. OVERVIEW OF REVIEWED LITERATURE AND RESOURCES

Author/Organization	Year	Geography	Title of Report	Abbreviated Title
UC Berkeley - Goldman School of Public Policy	2020	Countrywide	*2035 The Report*	2035 The Report
Environmental Entrepreneurs (E2), E4TheFuture, BW Research	2020	Countrywide	*Build Back Better, Faster (BBBF): How Clean Energy Can Create Jobs*	BBBF
The Brookings Institution	2021	Countrywide	*How renewable energy jobs can uplift fossil fuel communities and remake climate politics*	Brookings study
NYSERDA, BW Research	2020	New York	*New York Clean Energy Industry Report*	CEIR
Clean Energy Trust, Environmental Entrepreneurs (E2), BW Research	2020	Midwest	*Clean Jobs Midwest*	Clean Jobs Midwest
Cornell University - The Worker Institute	2017	New York	*Reversing Inequality, Combatting Climate Change: A Climate Jobs Program for New York State*	Cornell study
Energy and Environmental Economics, Inc. (E3)	2020	New York	*Pathways to Deep Decarbonization in New York State*	CAC Integration Analysis
Energy Innovation: Policy and Technology LLC - Energy		Countrywide		EPS Simulator

[5] For a full and detailed bibliography, please refer to Appendix A of this report.

Policy Solutions (EPS) Simulator				
The Nature Conservancy	2009	Countrywide	*Forest Carbon Strategies in Climate Change Mitigation*	Forest Carbon Strategies
Industrial Economics (IEc), Interindustry Forecasting Project at the University of Maryland (INFORUM)			*Economic Assessment of the Clean Power Plan*	IEc study
Natural Resources Defense Council (NRDC), BW Research	2012	Countrywide	*American Wind Farms: Breaking Down the Benefits from Planning to Production*	NRDC study
National Renewable Energy Laboratory (NREL), BW Research	2019	Countrywide	*The Wind Energy Workforce in the United States: Training, Hiring, and Future Needs*	NREL study
Princeton University - Carbon Mitigation Initiative	2020	Countrywide	*Net-Zero America (NZA): Potential Pathways, Infrastructure & Impacts*	NZA
Demos, Political Economy Research Institute (PERI) - University of Massachusetts Amherst	2019	New York	*The Climate and Community Act: A Big Win for New York State on Jobs and the Economy*	PERI study
Princeton University – ZERO LAB	2021	Countrywide	*Influence of high road labor policies and practices on renewable energy costs, decarbonization pathways, and labor outcomes*	Princeton study
UC Berkeley, California Workforce Development Board (CWDB)	2020	California	*Putting California on the High Road: A Jobs and Climate Action Plan for 2030*	Putting California on the High Road
UC Berkeley	2017	San Joaquin Valley	*The Economic Impacts of California's Major Climate Programs on the San Joaquin Valley (SJV)*	SJV study
UC Berkeley, University of Southern California, Occidental College	2016	California	*Advancing Equity in California Climate Policy*	UC Berkeley study
UCLA- Luskin Center for Innovation (Inclusive Economics)	2019	California	*California Building Decarbonization: Workforce Needs and Recommendations*	UCLA study
United States Climate Alliance (USCA), BW Research	2020	UCSA member states	*US Climate Alliance: Jobs in the Clean Energy Economy*	USCA
National Association of State Energy Officials (NASEO), Energy Futures Initiative (EFI), BW Research	2020	Countrywide	*2020 U.S. Energy & Employment Report (USEER)*	USEER
Resources for the Future (RFF)	2019	Vermont	*An Analysis of Decarbonization Methods in Vermont*	Vermont study
The Zero Carbon Consortium, Sustainable Development Solutions Network (SDSN)	2020	Countrywide	*America's Zero Carbon Action Plan (ZCAP)*	ZCAP

INDUSTRY SECTORS

This section discusses the industries, sectors, and occupational categories identified and defined in existing literature. Typical analyses of the economic impact of clean energy and transitions to a low-carbon economy are performed at the sectoral level. While the literature review revealed inconsistent naming and categorization practices, three universal sectors emerged from the research:

1. **Electricity/ Energy**, including 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.

Industry, **Water**, and **Working Lands** emerged as secondary sub-sectors that were defined with relative consistency in a selection of reports (see Table 2 for specific reports). Other sectors include **Water, Option Creation, District Heating**, and **Hydrogen.**

Table 2. Sector Classification Across Examined Reports

JTWG	USEER	CEIR, USCA, Clean Jobs Midwest	Putting CA on the High Road	NZA	ZCAP	BBBF	CAC Integration Analysis	Cornell study	EPS Simulator	UCLA study	PERI study
Electricity	Electric Power Generation	Renewable Generation	Energy	Electricity	Power	Renewable Generation	Clean Electricity	Energy	Electricity Supply	Renewable Energy Construction	Renewable Energy
	Transmission, Distribution & Storage	Grid Modernization and Energy Storage		Networks (transmission, distribution, infrastructure)		Grid Modernization				Electricity Generation and Distribution	
Buildings	Energy Efficiency	Energy Efficiency		Buildings and Appliances	Buildings and Appliances	Energy Efficiency	Buildings	Building	Buildings and Appliances	Building Electrification	Energy Efficiency
Transportation	MV	Alternative Vehicles	Transportation	Vehicles	Transport		Transportation	Transportation	Transportation		
*Waste			Waste		Materials		Non-Combustion				
Fuels			Industrial	Industry & Fuels Conversion	Industry		Industry		Industry	Equipment Manufacturing	
	Fuels	Clean Fuels					Zero Emissions Fuels			Gas Distribution	
							CCSU				
*Working Lands			Natural and Working Lands	Land use	Land use (agriculture, forests, other non-urban)		Natural and Working Lands		Agriculture, Land Use, and Forestry		
*Other			Water								
									District Heat & Hydrogen		
				Option Creation					Research and Development		

OCCUPATIONAL CATEGORIES

Most studies do not group employment impacts by occupation. Some reports delineate employment impacts by value chain but rarely provide definitions.

Studies either categorized occupations using value chain—namely Construction, Installation, Utilities, Agriculture and Forestry, Manufacturing, Trade, Professional Services and Operations and Maintenance—or work settings—Blue Collar, White Collar, Professional and Managerial (Table 3).

In this report, we delineated occupations by value chain into the value six categories:

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

Table 3. Occupation Classification Across Examined Reports

	USEER, CEIR, USCA study, and Clean Jobs Midwest	IEc study	2035: The Report	Putting CA on the High Road (Defined by major SOC codes)	UCLA study
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 under "Construction and Manufacturing"		
Installation					
Operations & Maintenance (O&M)					

Methods for Generating Employment Impacts

This section discusses the modelling approaches in reviewed studies and provides an overview of the specific approaches used.

Previous research (Table 4) 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.

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.

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 clean 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.

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.

TABLE 4. MODELING APPROACH ACROSS EXAMINED REPORTS

General IMPLAN	• **SJV study (Cap-and-Trade)** inputted compliance costs and revenue spending into IMPLAN • **UCLA study (except electricity sector)** • **2035 The Report**: ran generation and capacity modeling results through IMPLAN
Custom IMPLAN	• **Putting CA on the High Road**: sometimes use IMPLAN, sometimes uses multipliers based on previous literature or past performance • **ZCAP:** Input/Output (I/O) analysis developed by PERI that builds off IMPLAN

Proprietary Model	• **IEc study**: LIFT (University of Maryland), an industry I/O analysis calibrated to the U.S. Energy Information Administration's (EIA) 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
	• **NREL study**: JEDI
	• **Vermont study**: two RFF-developed models:
	    o dynamic regional computable general equilibrium: 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
	    o incidence model: analyzes distributional impacts across income groups and geographic locations
	• **EPS:** I/O model based upon Wassily Leontief's principles and the DEEPER I/O model
	• **SJV study**: JEDI
	• **UC Berkeley study**: JEDI
	• **UCLA study (electricity sector)**: JEDI
	• **NZA**: DEERS
	• **Princeton study**: DEERS

Investment Multipliers	• **SJV study (energy efficiency)**: derived from publicly available data, literature on energy efficiency job impacts, and research from the Lawrence Berkeley Laboratory • **BBBF**: combination of internally developed multipliers and Emsi multipliers • **Cornell study:** developed estimate for the number of jobs created for every million dollars invested

Transitioning Scenarios and Policies

This section examines emissions reduction scenarios—some of which are specific to New York State—and the resultant policy recommendations.

SCENARIOS

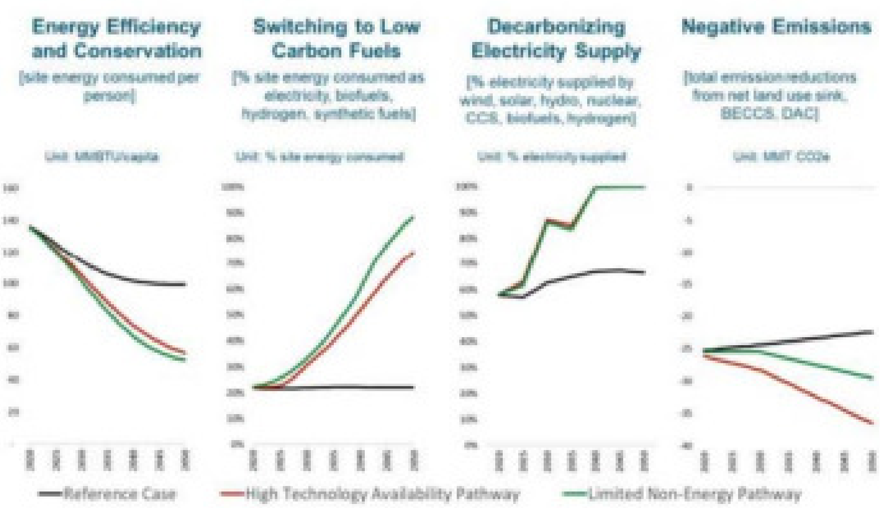
The literature utilized a range of transition scenarios to low-carbon economies, which considered emissions targets outlined in the Climate Act or other instruments.

Pathways to Deep Decarbonization in New York State

To examine the ability to meet the annual greenhouse gas (GHG) targets outlined in the Climate Act with goals to reach 40 percent GHG reductions below 1990 levels by 2030 and at least 85 percent reductions with carbon sequestration by 2050—the Pathways study established three scenarios: Baseline/Reference Case, High Technology Availability, and Limited Non-Energy. The High Technology Availability and Limited Non-Energy scenarios meet or exceed GHG emissions limits and achieve carbon neutrality by 2050 while the Reference Case only considers currently implemented policies.[6]

The Pathways study evaluated the behavior of the three scenarios against four key pillars for deep decarbonization by 2050: Energy Efficiency and Conservation, Switching to Low-Carbon Fuels, Decarbonizing Electricity Supply, and Negative Emissions (Figure 1).

FIGURE 1. PATHWAYS STUDY: KEY PILLARS FOR DEEP DECARBONIZATION



6 For more details on sector specific emissions targets, please refer to Appendix B of this report.

Net-Zero America (NZA)

In reference to a 2019 baseline, NZA 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).[7] The scenarios assume different energy demand levels and distinct combinations of renewable and non-renewable energy supply sources to reach a national CO_2 emissions target of -0.17GtCO_2 by 2050 (Table 6). The report identified six pillars for deep decarbonization: Energy Efficiency and Electrification; Clean Electricity; Bioenergy and other zero-carbon fuels; CO_2 Capture, Utilization, and Storage; Reduced Non-CO_2 Emissions; and Enhanced Land Sinks.

TABLE 5. OVERVIEW OF FIVE NZA EMISSIONS SCENARIOS

	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*]	

For 2025 and 2030, NZA identifies New York as a "green state"—i.e., a state that has announced targets for electric vehicle (EV) registrations in 2025 and/or 2030 that approach **E+** levels and generally exceed **E-** levels, which will reach 1.09 million battery-EVs in light-duty vehicles by 2025 and 2.02 million by 2030.[8] NZA also included the following high electrification approximations for New York-specific targets:

- Two-thirds of available OSW project areas in western New York State will be operational by 2050
- More than 40 GW of new solar capacity by 2050
- 40 GW of total wind capacity by 2050
- 50,000 GWh of hydrogen fuel use by 2050

[7] Princeton University, Carbon Mitigation Initiative, 2020.
[8] *Id.*

PERI Study

The PERI study examined the economic impacts of two basic pathways determined by the Climate Act.[9] In one pathway, the Climate Act allocates 40 percent of public investment toward environmentally vulnerable low-income communities in addition to enforcing high-road employment and contacting standards. If a market-based mechanism is adopted by the State in the other pathway, the Climate Act allocates 40 percent of the revenue generated toward clean energy investments in low-income communities.

The PERI study determined that such a path would require $7.4 billion in annual energy efficiency investments and $24 billion in annual renewable energy investments through 2030.

ZCAP

ZCAP 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.[10]

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 (see Figure 2 for model outcomes of the Central Case as an example).[11]

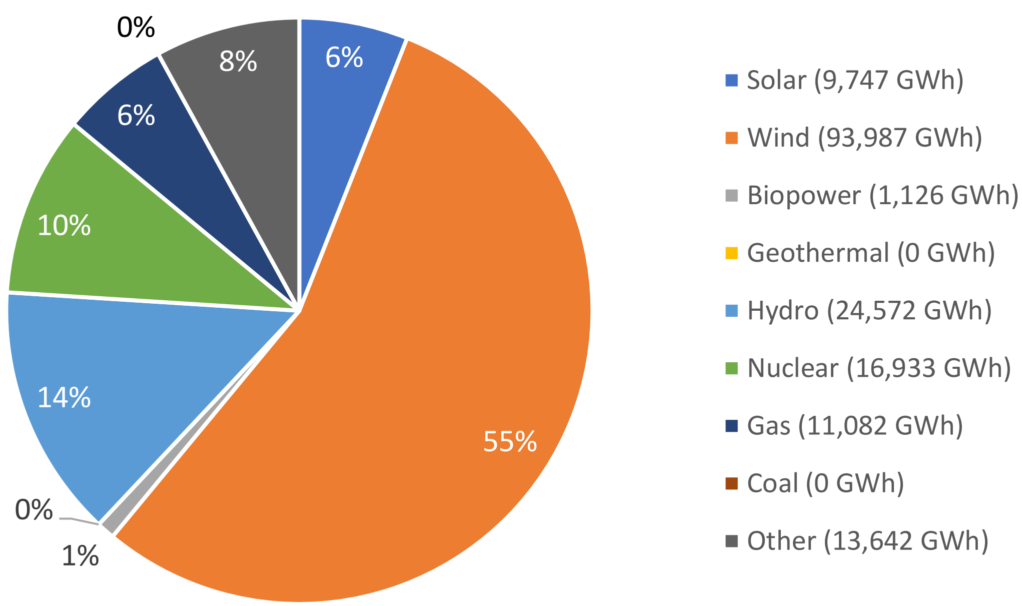
FIGURE 2. ZCAP: KEY PILLARS FOR TRANSITION TO LOW-CARBON ENERGY SYSTEMS

[9] University of Massachusetts Amherst, Demos, Political Economy Research Institute (PERI), 2019.
[10] Sustainable Development Solutions Network (SDSN), The Zero Carbon Consortium, 2020.
[11] For more details on sectoral carbon neutrality targets or central scenario outcomes by 2050, please refer to Appendix B of this report.

2035 Report

2035 The Report assumes a new energy policy of 90 percent clean energy electrical generation by 2035 and models three main scenarios: Base-cost, Low-cost, and Higher-cost.[12] Figure 3 shows the resultant New York Independent System Operator (NYISO) generation mix by 2035 for the base-cost scenario.

FIGURE 3. 2035 THE REPORT: BASE-COST SCENARIO, NYISO GENERATION MIX (2035)



POLICY RECOMMENDATIONS

The proposed policies addressed a wide range of concerns; however, climate goals and just transition emerged as the top focus of the reviewed literature.

Climate Goals

Table 7 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.

[12] UC Berkeley, Goldman School of Public Policy, 2020.

TABLE 6. POLICY RECOMMENDATIONS: CLIMATE GOALS

IEc	ZCAP	BBBF	Cornell study	CAC Integration Analysis
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 - $1.5 billion investment in port infrastructure for offshore wind	Buildings - Retrofit all public schools by 2025 - Reduce energy use in all public buildings by 40 % 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			

Just Transition

Putting California on the High Road offers a high road framework to help California's decision-makers prioritize job quality, job access, and job growth while transitioning to a carbon-neutral economy.[13] The study argues that demand-side labor market strategies and just transition programs should be included in climate policies and programs. In addition, supply-side labor market strategies must be used in conjunction with demand-side strategies and just transition levers.

The UC Berkeley study 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.[14] The study advocates for incorporating strategies such as pre-apprenticeship job training, weatherization assistance programs, and solar energy deployment in climate policy to close the climate gap and promote career-track employment.

Forest Carbon Strategies highlights case studies that demonstrate the feasibility of community forest carbon projects and the achievability of credible carbon benefits.[15] In addition, the report provides win-win scenarios in climate change mitigation, community development, and biodiversity conservation that can be scaled nationally.
ZCAP recommends that fossil-fuel dependent communities receive considerable federal- and state-level support to reclaim and repurpose land and generate new investment projects in clean energy.[16] Additionally, ZCAP recommends providing pension guarantees, employment guarantees, wage insurance, retraining support, and relocation support for displaced workers.[17]

The Cornell study recommends New York State pay special attention to workers and communities experiencing negative impacts because of the transition away from high-carbon industries and sectors.[18] The study recommends establishing a Just Transition Task Force to steer efforts such as wage and health benefit replacements, retraining and education support, increasing local stakeholder participation in economic development projects, and increasing access to skill-building opportunities.

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[13] UC Berkeley, California Workforce Development Board (CWDB), 2020.
[14] UC Berkley, University of Southern California, Occidental College, 2016.
[15] The Nature Conservancy, 2009.
[16] Sustainable Development Solutions Network (SDSN), The Zero Carbon Consortium, 2020.
[17] For more details on estimations of the cost of such adoptions, please refer to Appendix B of this report.
[18] Cornell University, The Worker Institute, 2017.

The UCLA study[19] provides 10 recommendations across three broad categories:

- *Engage with Affected Unions to Grow Good Jobs and Minimize Job Loss*
    1. Create conditions that attract skilled workers
    2. Plan an orderly transition
    3. Develop a fund for gas worker retention and transition assistance

- *Prioritize Demand-side Strategies Demand-side interventions*
    1. Pre-qualify contractors
    2. Condition incentives on skill standards or offer incentives (i.e., accelerated permitting, financial remuneration, etc.) for projects that meet certain workforce criteria
    3. Lead with the large commercial and 'Municipalities, Universities, Schools and Hospitals' (MUSH) sector
    4. Pursue aggregated community-scale decarbonization.
    5. Invest in decarbonized district energy.

- *Target Investments in Supply-side (Training) Strategies*
    1. Support the up skilling of workers through stackable credentials
    2. Structure the work to create opportunities for disadvantaged workers

The SJV study identifies increasing and broadening access to career-track jobs for workers from disadvantaged communities as a critical policy concern.[20] They identify project labor agreements with local communities, or targeted hire provisions (community workforce agreements), as the most commonly successful initiatives to support this goal.

For workforce development during net-zero transitions, NZA[21] recommends:

- Diverse workforce programs, e.g., occupational skills training, college training, and internships
- Large-scale and sustained workforce programs and corresponding federal support
- Substantial coordination between unions, public agencies, firms, and workers
- Workforce programs that include recruitment and job placement assistance
- Modifiable factors be leveraged to reduce transition risks and to facilitate legislative bargaining
- Designing policies that anticipate and leverage the skill, temporal, and locational complementarities between workforces of declining and emerging energy sectors

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[19] UCLA, Luskin Center for Innovation (Inclusive Economics), 2019.
[20] UC Berkley, 2017
[21] Princeton University, Carbon Mitigation Initiative, 2020.

Workforce Implications

This section explores the landscape of current jobs in the clean energy economy, the effect of different transitioning scenarios on job creation, and the impact job creation could have on job quality, labor standards, and unionization under different transitions.

Existing literature that examined the potential employment impacts of clean energy transitions largely focused on overall employment. While most reports did not explore the changes in job type or job quality that might occur, some comparable studies explored current and future job changes by occupation and reported on labor standards and unionization.

EXISTING JOBS

USEER estimates the 2019 total of energy industry jobs to be 345,066 and CEIR attributes 163,754 of those workers to clean energy sectors (Table 8).

TABLE 7. USEER: EXISTING ENERGY JOB ESTIMATES

	Electric Power Generation	Fuels	Transmission, Distribution & Storage*	Motor Vehicles*	Energy Efficiency
Total (USEER)[22]	47,772	16,788	71,879	81,818	126,739
Clean Energy (CEIR)[23]	23,491	2,472	2,289	8,579	126,739

* Grid Modernization in CEIR

* Clean and Alternative Vehicles in CEIR

JOB CREATION

While the highlighted studies estimate employment, the Vermont study reports labor demand outputs instead, stating that "changes in employment levels ignore changes in hours per worker. If hours per worker change in response to a carbon policy, then the reported changes in labor demand from a full employment model cannot be interpreted as changes in the level of jobs in the State."[24] The study finds that carbon pricing policies that decrease output relative to business as

[22] National Association of State Energy Officials (NASEO), Energy Futures Initiative (EFI), BW Research, 2020.

[23] NYSERDA, BW Research, 2020.

[24] Resources for the Future (RFF), 2019.

usual 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.[25]

JOB QUALITY, LABOR STANDARDS, AND UNIONIZATION

In general, reviewed studies suggest that overall wages and benefits will rise at a fast pace in a clean energy economy, despite the current high wages and unionization rates of certain fossil fuel activities.[26, 27] CEIR finds that a sample of clean energy regional workers—when compared with workers outside the industry—generally receive higher median wages and better health care and retirement benefits.[28] In general, more than 80 percent of clean energy workers in each key occupation received some health insurance; this is seven percent higher than the 73 percent of insured workers in the greater economy. Unionized workers fare better, with 87 percent of them receiving some health benefits. The EPS Simulator projects an average rise of $515 in annual wages over business as usual.[29]

The Cornell study indicates that most of California utility-scale solar construction organized under collectively bargained contracts or project labor agreements resulted in jobs with family-sustaining wages and better benefits; for example, $78,000 and $69,000 annually in Construction and Operations and Maintenance occupations.[30] NZA finds that overall wages rise much quicker in their high-electrification scenarios compared to the reference scenario with New York energy-related wages,[31] as a share of total wages by 2050, growing from one to two percent.[32] PERI reports that the main clean energy sectors—"Renewables" and "Energy Efficiency"—pay high wages, averaging roughly $70,000 for workers without a four-year college degree and $89,500 overall.[33] They delineate average total compensation in direct and indirect jobs across a few of the State's clean energy industries as shown in Table 9.

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[25] For more details on the breakdown of job creation estimates across Electricity, Buildings, Transportation, and Other Sectors, please refer to Appendix B of this report.
[26] UC Berkley, 2017
[27] Cornell University, The Worker Institute, 2017.
[28] For more detail on specific breakdowns, please refer to Appendix B of this report.
[29] NYSERDA, BW Research, 2020.
[30] Cornell University, The Worker Institute, 2017.
[31] For more detail on wage increases by sector, please refer to Appendix B of this report.
[32] Princeton University, Carbon Mitigation Initiative, 2020.
[33] University of Massachusetts Amherst, Demos, Political Economy Research Institute (PERI), 2019.

TABLE 8. PERI: AVERAGE TOTAL COMPENSATION IN CLEAN ENERGY INDUSTRY

	Building Retrofits	Wind	Solar
Workers with a high school degree or less	$60,000	$70,900	$68,200
Workers with some college or associate degree, but not a BA	$69,000	$80,200	$84,000

Most studies indicate that increased unionization within clean energy industries will support a rise in job quality. The clean energy industry already has higher unionization rates than other industries; except Fuels, all sectors have unionization rates that are higher than the national average of six percent (Table 10). The Energy Policy Solution projects that the increase in total jobs needed to achieve net-zero emissions by 2050 will largely be comprised of unionized workers.[34] The Cornell study indicates that jobs created through transportation investments are approximately 40 percent more likely to be unionized than in other industries.[35] As a result, the average hourly wage for transit and intercity bus drivers was $24.97 in 2015, well above minimum wage. The Cornell study also found that unionization of Citi Bike employees in New York City led to a 20 percent wage increase as well as predictable schedules and better benefits.

TABLE 9. USEER: INDUSTRY UNIONIZATION RATES

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

[34] Energy Innovation: Policy and Technology LLC, 2021.
[35] Cornell University, The Worker Institute, 2017.

III. The JTWG Jobs Forecast Approach

Project Framework and Workplan

This section provides an overview of the modelling framework utilized for this study.

1. The team began by selecting a sector from those identified on both the Energy Demand and Energy Supply sides (see Table 11).
2. The next step was to identify and quantify available capital and planning/operational investments as well as unit inputs into a sub-sector, sub-technology, or sub-activity over time.[36]
3. This was followed by splitting investments into industry category by technical costs data, which involves using secondary data sources to segment overall investments from the CAC Integration Analysis into industries based on activity.[37]
4. Next was to apply multipliers and reduce volatility in inputs. This reduces the volatility of investment inputs of processed investments in IMPLAN industry multipliers based on the cost allocation previously discussed.
5. Finally, the research team ran IMPLAN/JEDI Analysis by Parts to generate IEOs followed by geographic, occupation, and wage analyses to generate SEOs.

IMPLAN and JEDI are input-output (I/O) models that illustrate the interdependent relationships between different sectors of national and/or regional economies. IMPLAN focuses on the overall employment impacts that would be felt across a given economic region, in this case, New York State. JEDI models are NREL tools to estimate the local economic impacts of the construction and operation of power generation and biofuel plants. NREL provides JEDI models for various energy subsectors, including onshore wind, offshore wind, solar, and biofuels. JEDI estimates job creation by running user input of project location, facility size, and construction year, in combination with the built-in model defaults and economic multipliers.[38]

Investments or activities in a particular sector are used as inputs into the model to estimate the ripple or multiplier effect on business, household, and government expenditures, and industry employment. Estimates include direct, indirect, and induced employment:

- **Direct** = employment associated with the initial economic activity of a given investment or activity (e.g., changes in wages, production, or jobs).

[36] CAC Integration Analysis (i.e., device stocks and sales, MW electric capacity, fuel demand, etc.). Where provided, additional investments may be assumed from secondary sources.

[37] For example, installation of efficiency measures, manufacturing of EV batteries, etc.

[38] For example, data for the Buildings sector was calibrated by analyzing data on New York State's building electrification activities.

- **Indirect** = employment associated with the supply chain connected to the initial economic activity of the original investment or activity (e.g., purchases of goods and services or business tax impacts).
- **Induced** = employment based on the additional household spending resulting from the additional direct and indirect employment that is generated from the initial economic activity of the original investment or activity (e.g., wages paid, household purchases, or household tax impacts).

Table 11 provides a breakdown of the sectors defined and modeled in this study.

TABLE 10. PRIMARY SECTORS

Energy Supply		Energy Demand	
Electricity	**Fuels**	**Buildings**	**Transportation**
Solar	Natural Gas	Commercial HVAC	Vehicle Manufacturing
Offshore Wind	Natural Gas Distribution	Commercial Shell	Vehicle Maintenance
Onshore Wind	Petroleum Fuels	Commercial Other	Wholesale Trade Parts
Hydropower			
Hydrogen	Hydrogen	Residential HVAC	Conventional Fueling Stations
Biomass			
Distribution	Bioenergy	Residential Shell	Charging and Hydrogen Fuel Stations
Transmission		Residential Other	
Storage			
Natural Gas Generation			
Other Fossil Generation			
Nuclear			

For more information on the IEO and SEO methodology and assumptions, please refer to Appendix C of this report.

IV. Model Employment Outputs and Outlook

Overview

The CAC Integration Analysis combines a detailed accounting model of energy supplies and demands across the entire economy with an optimized capacity expansion model in the electric sector, incorporating insights and recommendations from Advisory Panels, Working Groups, and complementary studies. This ongoing analytic work, initiated prior to the passage of the Climate Act, modeled existing policies and explored additional actions needed to reach the State's 2030 and 2050 targets. The analysis evaluates the societal costs and benefits of various GHG mitigation scenarios, using a pathways framework to produce economy-wide resource costs for the various mitigation scenarios relative to a reference scenario. The CAC Integration Analysis is pivotal to this Jobs Study as it informs the research team's analyses of employment benefits of GHG mitigation in different sectors, namely energy, building, transportation, and working lands.

Choosing the transition scenarios modeled in this report hinged on one overarching criterion: scenarios had to meet or exceed GHG emission limits and achieve carbon neutrality by mid-century. Additionally, the foundational themes across both mitigation scenarios were based on findings from advisory panels and supporting analysis. These themes included the following:

- Zero emission in power sector by 2040
- Enhancement and expansion of transit and a reduction in vehicle miles traveled
- More rapid and widespread end-use electrification and efficiency
- Higher methane mitigation in agriculture and waste
- End-use electric load flexibility reflective of high customer engagement and advanced technologies

Transition Scenario 1, named "Strategic Use of Low-Carbon Fuels" (LCF), includes the use of bioenergy derived from biogenic waste, agriculture and forest residues, limited purpose grown biomass, and green hydrogen for difficult-to-electrify applications. Transition Scenario 2, named "Accelerated Transition Away from Combustion" (AT), includes low-to-no bioenergy and hydrogen combustion as well as accelerated electrification of buildings and transportation. The LCF factors in considerable investments made in low-carbon fuels, including liquid biofuels, while the AT factors in greater early investments made in grid and electrification. Both scenarios share a few characteristics:

- Considerable investments in Solar and Wind energy
- Continued investments in transmission, distribution, and storage capacity
- Investments in charging and hydrogen fueling stations
- Considerable investments in commercial and residential buildings

It is important to note that these investments are not *incremental* to a Reference Case but overwhelmingly represent a reprioritization of spending away from fossil fuel energy sectors towards sustainable energy sectors.

Initial Employment Outputs

The Initial Employment Outputs (IEOs) provide snapshot figures of employment between 2019 and 2050.[39] For 2019, 2025, 2030, 2035, 2040, 2045, and 2050, input data (e.g., investment streams) from the CAC Integration Analysis was broken down to different activities (e.g., generation capacity) in each subsector to give outputs (overall annual employment).

ELECTRICITY SECTOR

The electricity sector is comprised of 12 subsectors: solar, offshore wind, onshore wind, hydropower, hydrogen, biomass, distribution, transmission, storage, natural gas generation, other fossil generation, and nuclear. In 2017, Electricity was responsible for 14 percent of total GHG emissions in New York State.[40]

On net, overall employment in the electricity sector under the LCF scenario will grow to at least 212,000 by 2040, a total of 81,000 jobs added to 2019 baseline figures (Table 12). Between 2040 and 2050, total jobs decline, likely the result of this sector's comparatively earlier targets. However, these declines are largely concentrated in hydrogen and offshore wind, while the other subsectors either plateau or continue growing.

The solar, offshore wind, onshore wind, hydropower, hydrogen, biomass, distribution, transmission, and storage subsectors will grow to at least 206,000 jobs by 2040, adding approximately 94,000 jobs. Conversely, employment in the natural gas generation, other fossil generation, and nuclear subsectors will fall to just over 5,000 by 2040, a loss of more than 12,000 jobs compared to the 2019 workforce. Jobs will continue to decline in these subsectors through 2050, reaching approximately 3,500 total jobs in the final year of the analysis.

Overall employment in the electricity sector under the AT scenario will grow to at least 226,000 by 2040, a total of 95,000 jobs added to 2019 baseline figures (Table 13). The solar, offshore wind, onshore wind, hydropower, hydrogen, biomass, distribution, transmission, and storage subsectors will grow to at least 220,000 jobs by 2040, adding more than 107,000 jobs. Conversely, employment in the natural gas generation, other fossil generation, and nuclear subsectors will fall to approximately 5,500 by 2040, a loss of more than 12,000 jobs compared to the 2019 workforce.

[39] 2019 used as the baseline year due to the disrupting effects of the COVID-19 pandemic on employment figures across industries and sectors.
[40] New York State Energy Research and Development Authority (NYSERDA), 2021.

Jobs will continue to decline in these subsectors through 2050, reaching approximately 3,700 total jobs in the final year of the analysis.

TABLE 11. ELECTRICITY: OVERALL EMPLOYMENT OUTPUTS (S2: LCF)

SUB-SECTOR	YEAR						
	2019	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Solar	15,779	22,732	31,442	36,478	40,525	39,722	43,830
Offshore Wind	507	5,593	14,379	16,559	18,761	14,517	8,340
Onshore Wind	4,795	4,753	5,367	6,591	6,329	6,579	6,756
Hydropower	7,930	8,076	8,291	8,265	8,154	7,956	7,853
Hydrogen	0	0	3,374	6,947	12,712	6,667	4,323
Biomass	1,120	1,120	1,120	1,120	1,120	1,099	1,060
Distribution (Electricity)	70,510	76,007	79,709	87,113	87,226	85,544	82,067
Transmission	10,097	13,739	16,729	18,151	18,281	17,083	14,626
Storage	2,442	4,945	7,546	10,398	13,669	17,160	20,201
Displacement Sub-Sectors							
Natural Gas Generation	9,440	9,185	7,872	5,029	300	300	300
Other Fossil Generation	1,415	1,332	837	378	219	209	66
Nuclear	6,920	5,004	5,016	4,844	4,844	4,844	3,105
ELECTRICITY OVERALL	**130,955**	**152,486**	**181,682**	**201,874**	**212,140**	**201,681**	**192,527**
Net Change from 2019		**+ 21,531**	**+ 50,727**	**+ 70,919**	**+ 81,185**	**+ 70,726**	**+ 61,572**

TABLE 12. ELECTRICITY: OVERALL EMPLOYMENT OUTPUTS (S3: AT)

SUB-SECTOR	YEAR						
	2019	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Solar	15,779	22,100	29,528	34,483	37,779	36,110	41,394
Offshore Wind	507	5,593	14,705	18,929	23,840	17,261	9,850
Onshore Wind	4,795	4,753	5,970	6,456	6,292	6,769	6,944
Hydropower	7,930	8,076	8,291	8,265	8,152	7,953	7,853
Hydrogen	0	0	0	13,971	22,937	15,901	7,480
Biomass	1,120	1,120	1,120	1,120	1,120	1,099	1,060
Distribution (Electricity)	70,510	77,437	82,056	91,294	91,296	88,989	84,373
Transmission	10,097	13,689	16,660	18,067	18,265	17,129	14,784
Storage	2,442	4,659	6,677	8,992	10,889	12,442	13,446
Displacement Sub-Sectors							
Natural Gas Generation	9,440	9,259	7,962	5,621	300	300	300
Other Fossil Generation	1,415	1,359	1,341	884	300	300	300
Nuclear	6,920	5,004	5,016	4,844	4,844	4,844	3,105
ELECTRICITY OVERALL	**130,955**	**153,049**	**179,327**	**212,926**	**226,014**	**209,098**	**190,891**
Net Change from 2019		**+ 22,094**	**+ 48,372**	**+ 81,971**	**+ 95,059**	**+ 78,143**	**+ 59,936**

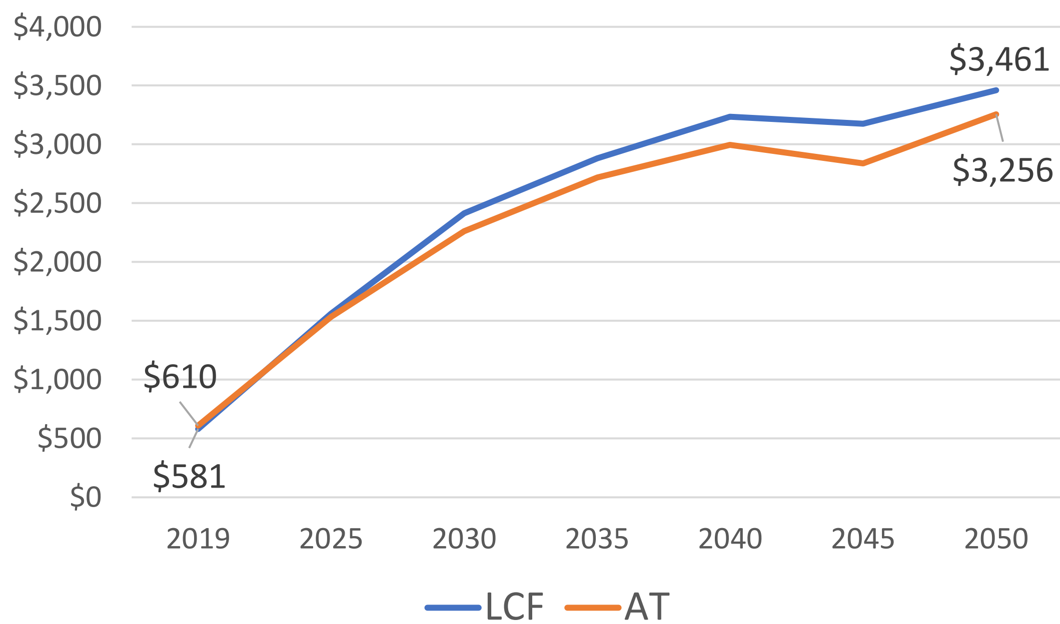
Solar

A quickly growing subsector, solar includes technologies like rooftop solar, primary photovoltaic, and concentrating solar power.

In general, overall processed investment streams trend in tandem for both the AT and LCF scenarios between 2019 and 2050 (Figure 4). Both scenarios experience considerable growth in overall processed investment streams; the LCF and AT scenarios go from processing $581M and $610M in 2019 to $3,461M and $3,256M in 2050, respectively.

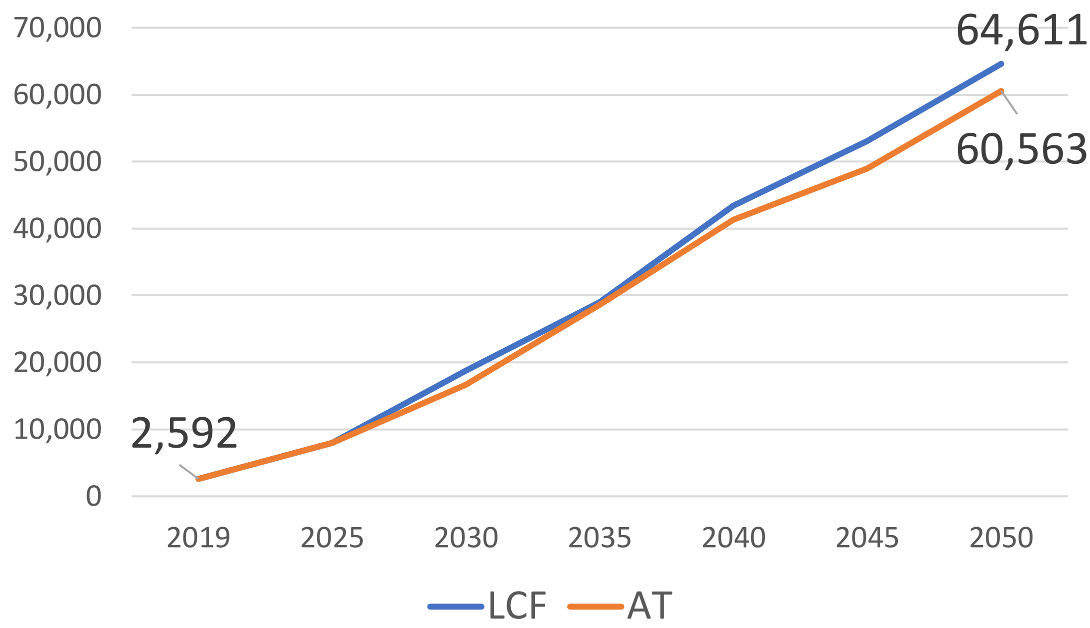
While the AT scenario processed $29M more than the LCF scenario in 2019, the AT scenario is expected to process $205M less than the LCF scenario in 2050; growth in processed investments in the LCF scenario overtakes the AT scenario in 2025 and continues to diverge from that point.

FIGURE 4. SOLAR: OVERALL PROCESSED INVESTMENT STREAM ($M)



In 2019, New York State had approximately 2,592 MW of solar generation capacity. Both the LCF and AT scenarios exhibit parallel growth trends with the AT scenario generally trending slightly lower than the LCF scenario (Figure 5). In the final year of analysis, 2050, capacity installed is estimated at 60,563 MW whereas the LCF scenario estimates 64,611 MW generation capacity, a 4,048 MW difference between the scenarios.

FIGURE 5. SOLAR: CAPACITY INSTALLED (MW)



For the LCF scenario, the $2,880M change in investment between 2019 and 2050 (see Figure 4) leads to a change of just over 28,000 jobs (Figure 6). By 2050, the construction and induced industries will add the greatest number of jobs to the 2019 baseline figures—a total of 14,817 and 6,947 jobs respectively. In the same period, professional services, manufacturing, and other supply chain will add 1,862, 482, and 3,943 jobs, respectively.

Other supply chain—which includes wholesale trade, utilities, and repair and maintenance—experiences the greatest growth rate, growing four-fold from the 2019 base figures. However, the share of both professional services and manufacturing occupations declines between 2019 and 2050, whereas the share of other supply chain occupations increases in the same period. Construction consistently holds the largest, albeit decreasing, share of the solar subsector between 2019 and 2050. The share of other supply chain and induced jobs increases, whereas the share of professional services and manufacturing jobs decreases by 2050.

The $2,646M change in investment for the AT scenario (see Figure 4) leads to similar changes in employment, adding more than 25,000 jobs by 2050 (Figure 7).

FIGURE 6. SOLAR: EMPLOYMENT OUTPUTS (S2: LCF)

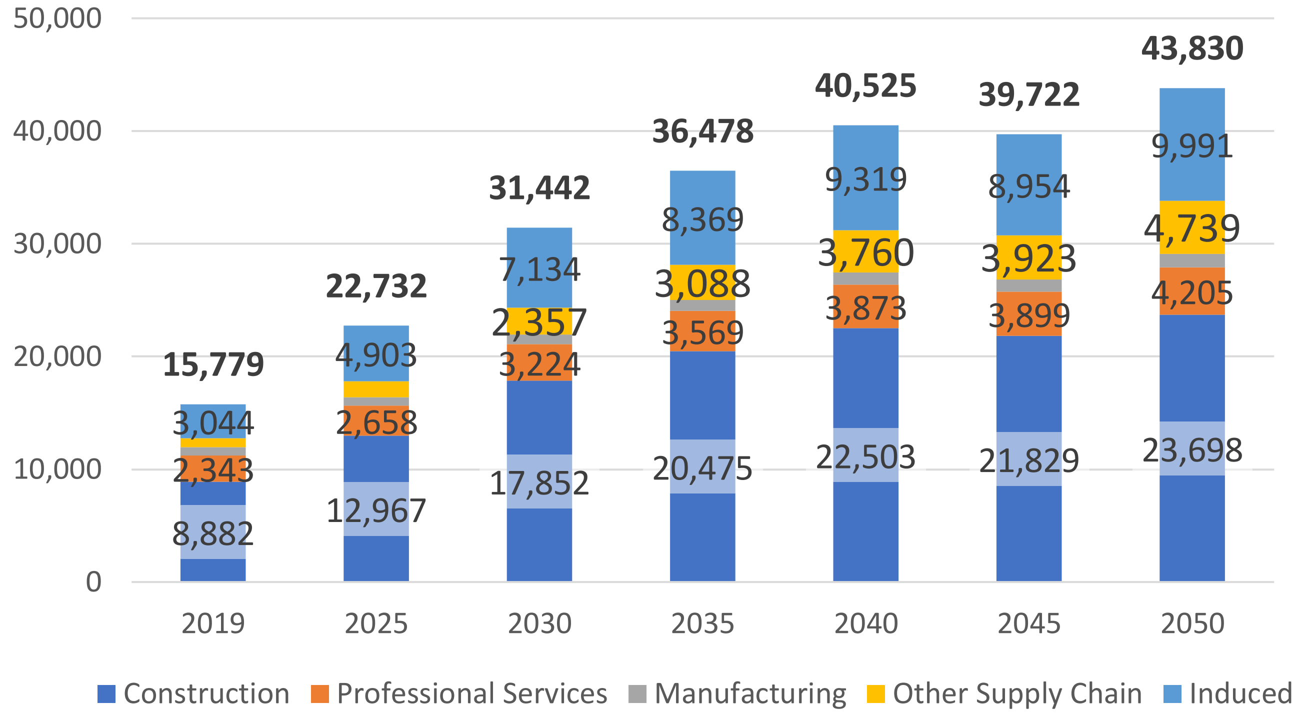
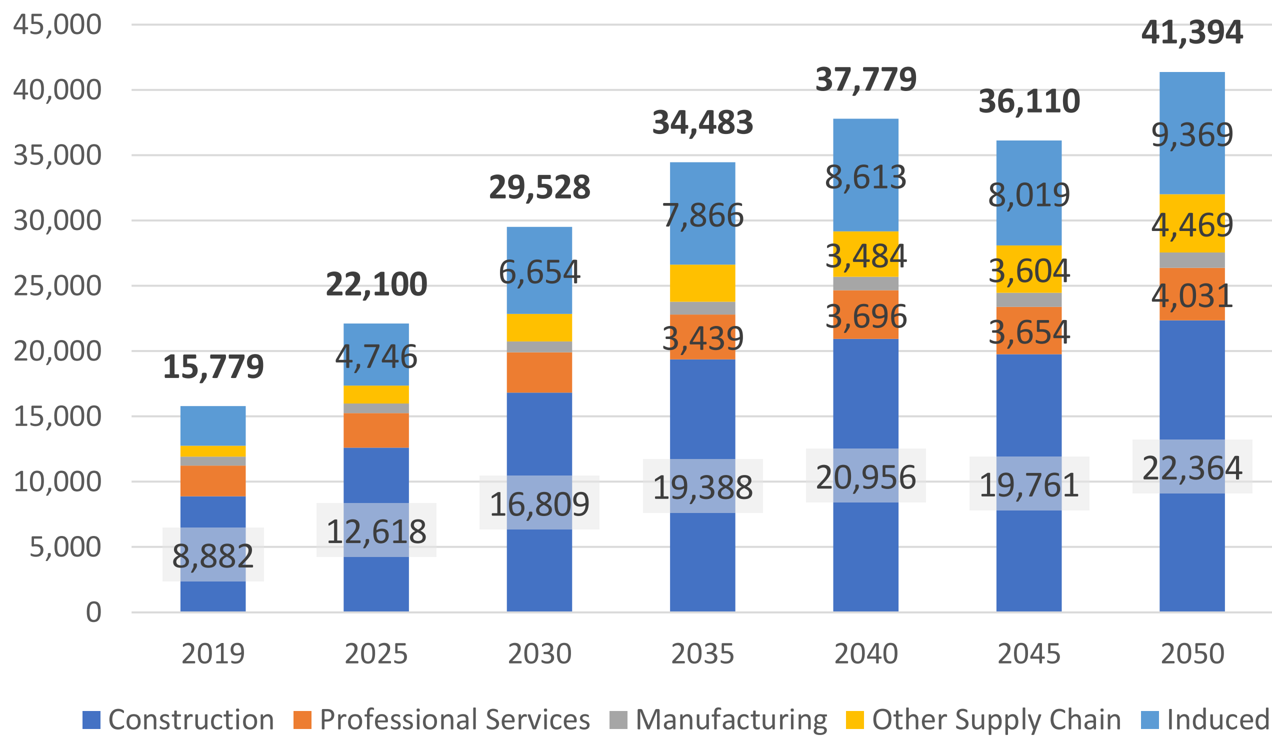


FIGURE 7. SOLAR: EMPLOYMENT OUTPUTS (S3: AT)

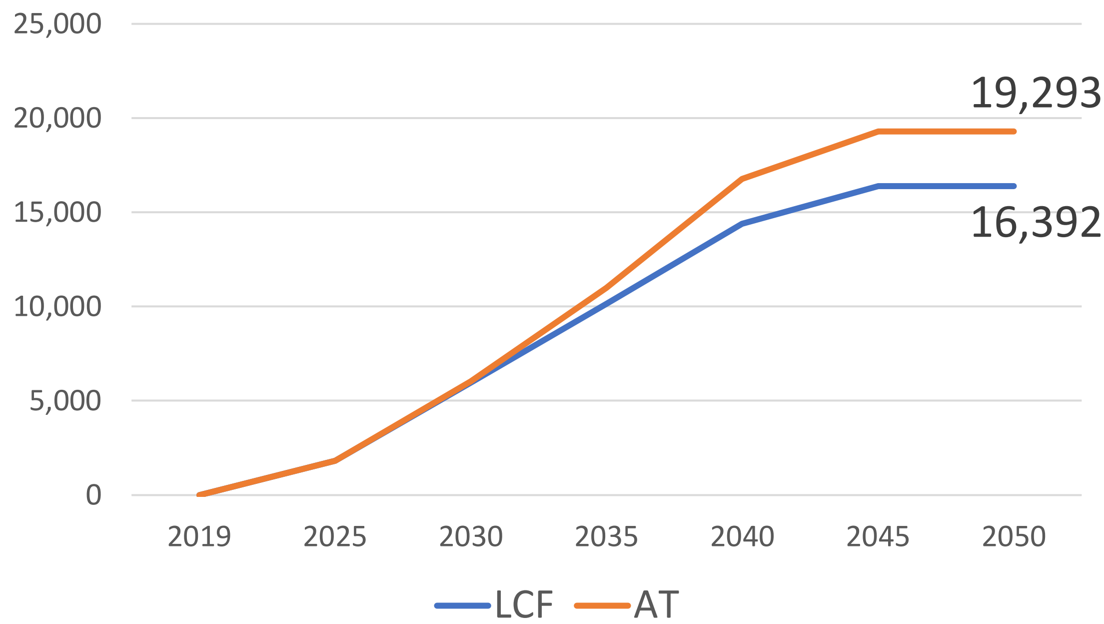


Offshore Wind

The offshore wind sub-sector consists of technologies like deep water offshore wind.[41]

Overall, New York State's offshore wind capacity will increase between 2019 and 2050, growing at similar levels for both scenarios between 2019 and 2030, before the AT scenario capacity increases more that LCF scenario capacity (Figure 8). Both the LCF and AT scenarios exhibit parallel growth trends, growing from 0 MW in 2019 to 16,392 MW and 19,293 MW by 2050, respectively.

FIGURE 8. OFFSHORE WIND: CAPACITY INSTALLED (MW)



All industries experience peak job additions in 2040 as construction growth accelerates to achieve the Climate Act's 100 percent clean electricity requirement; though construction slows after this point, 2050 figures are still above the baseline for both scenarios. For the LCF scenario, the 16,392 MW change in capacity installed between 2019 and 2050 (see Figure 8) leads to an addition of more than 18,000 jobs (Figure 9). The AT scenario shows similar changes, adding more than 23,000 jobs for 19,293 MW capacity installed (Figure 10).

In the AT scenario, the manufacturing industry adds more than 8,000 jobs to the 2019 baseline by 2040 (Figure 10). Both the construction and induced industries will add more than 5,000 jobs to 2019 baseline figures. Between 2019 and 2040, professional services and other supply chain industries will add 2,858 and 1,100 jobs, respectively. Manufacturing holds a 35 percent share of

[41] Processed investment streams are not featured for Offshore Wind because these models were run through JEDI and relied only on capacity installed.

the sub-sector in 2040, while both construction and induced industries hold more than 20 percent each in the same year. The LCF scenario shows the same trend with slightly lower estimations.

FIGURE 9. OFFSHORE WIND: EMPLOYMENT OUTPUTS (S2: LCF)

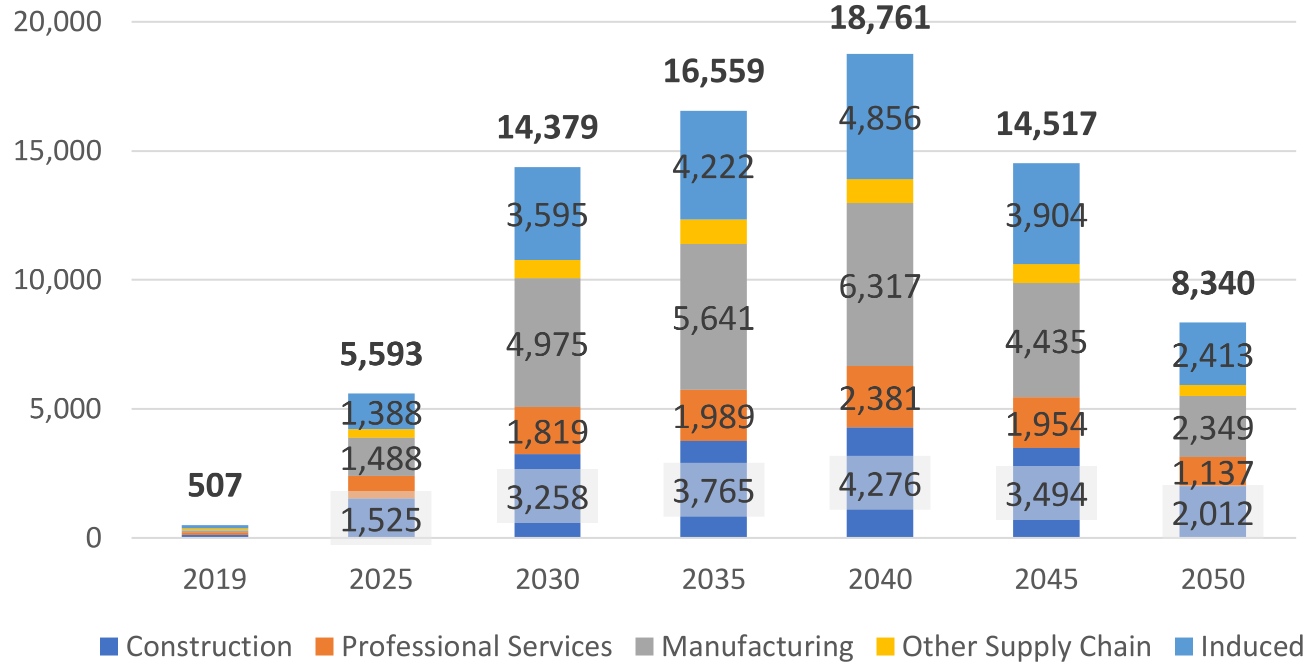
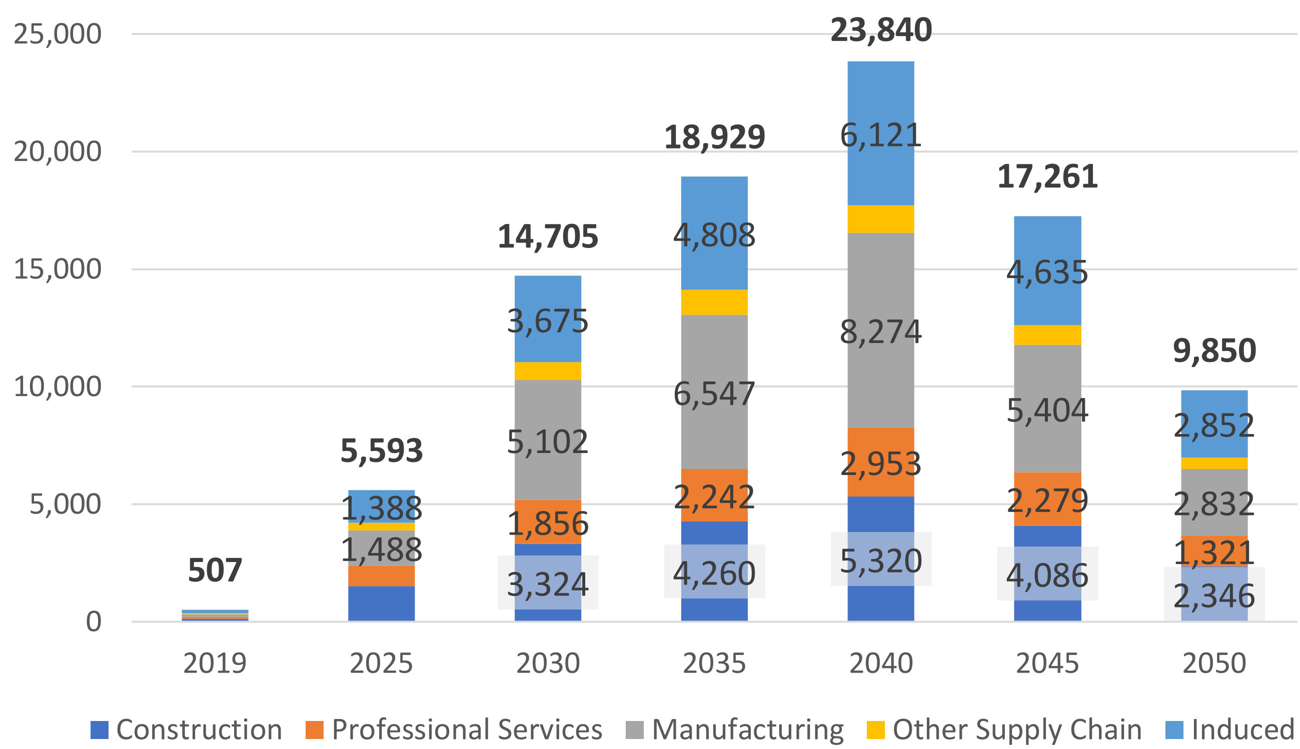


FIGURE 10. OFFSHORE WIND: EMPLOYMENT OUTPUTS (S3: AT)

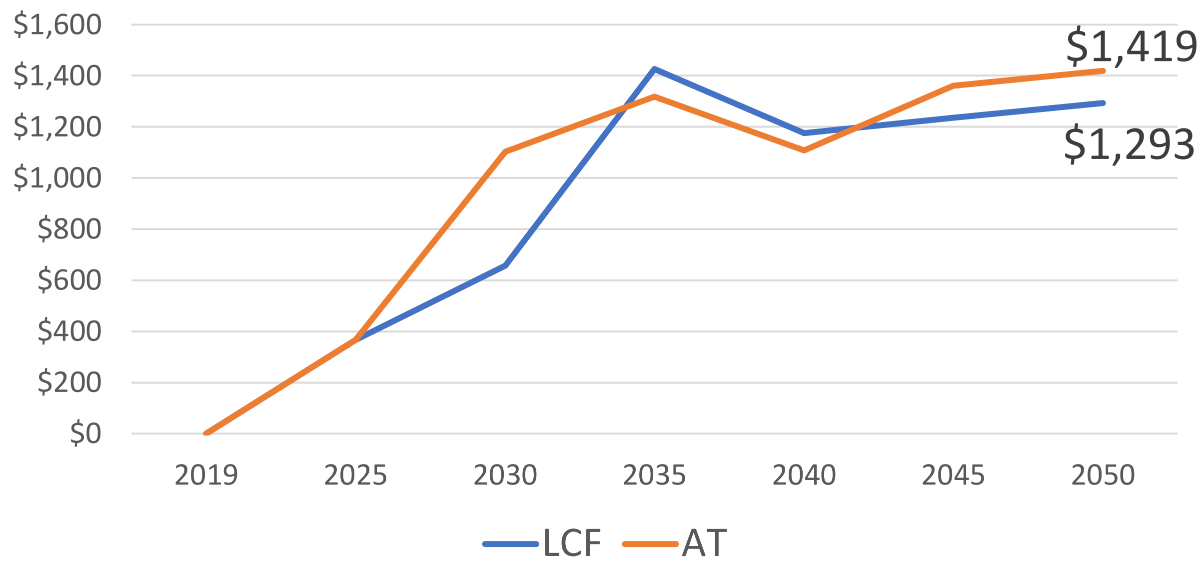


Onshore Wind

The onshore wind subsector consists of technologies like utility scale and distributed "small" onshore wind.

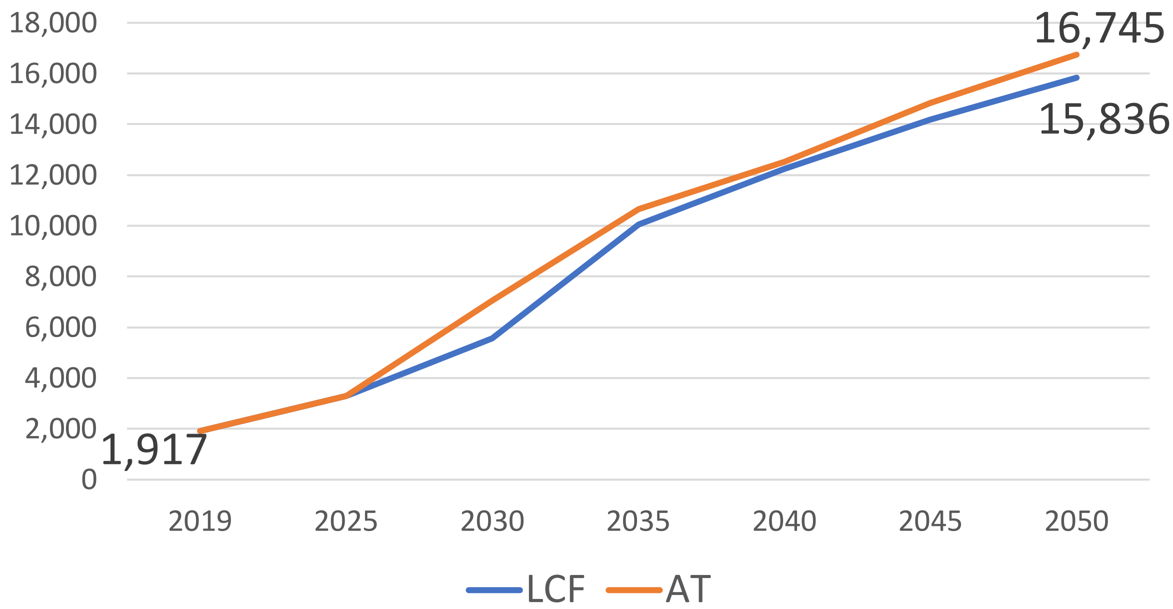
Overall processed investment streams will grow from $0M in 2019 to $366M in 2025 for both LCF and AT scenarios, after which they diverge (Figure 11). LCF scenario investments will be lower than AT scenarios in 2030, 2045, and 2050, peaking in 2035 at $1,427M overall. AT scenario investments will peak in the final year of analysis at $1,419M, a difference of $126M from 2050 LCF scenario investments.

FIGURE 11. ONSHORE WIND: PROCESSED INVESTMENT STREAM ($M)



In 2019, Onshore Wind capacity for both AT and LCF scenarios is 1,917 MW; both scenarios grow to 3,292 MW in 2025 (Figure 12). Due to higher levels of investment in the AT scenario, onshore wind capacity is slightly higher in this scenario after 2025, peaking at 16,745 MW in 2050. The LCF scenario closes the gap significantly in 2035, although onshore wind capacity remains lower until 2050.

Figure 12. Onshore Wind: Capacity Installed (MW)



Between 2019 and 2050 for the AT scenario, the induced, construction, and manufacturing industries will add the most jobs at 847, 518, and 526 jobs, respectively (Figure 14). Induced jobs consistently hold the biggest share of employment, followed by construction industry jobs. The share of professional services industry jobs falls to 13 percent by 2050, while the share of manufacturing industry jobs will rise to 19 percent.

The LCF scenario shows the same trends, albeit with fewer total jobs added across industries by 2050 (Figure 13).

FIGURE 13. ONSHORE WIND: EMPLOYMENT OUTPUTS (S2: LCF)

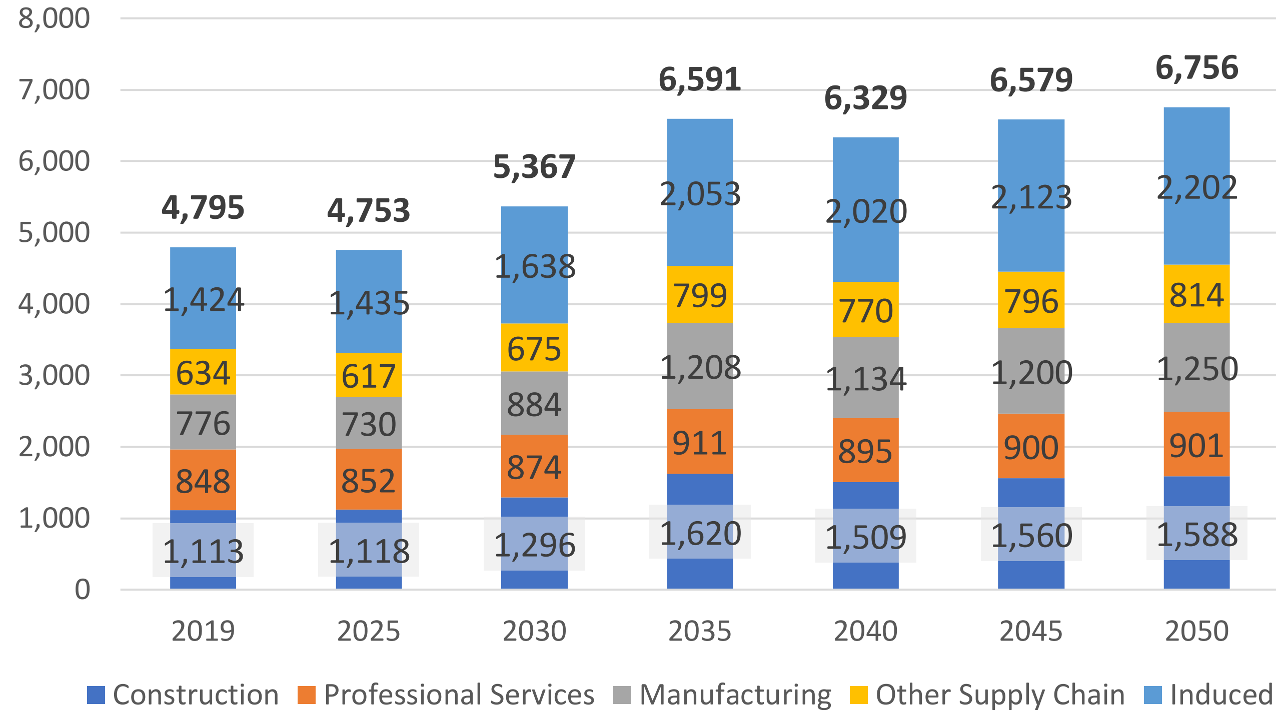
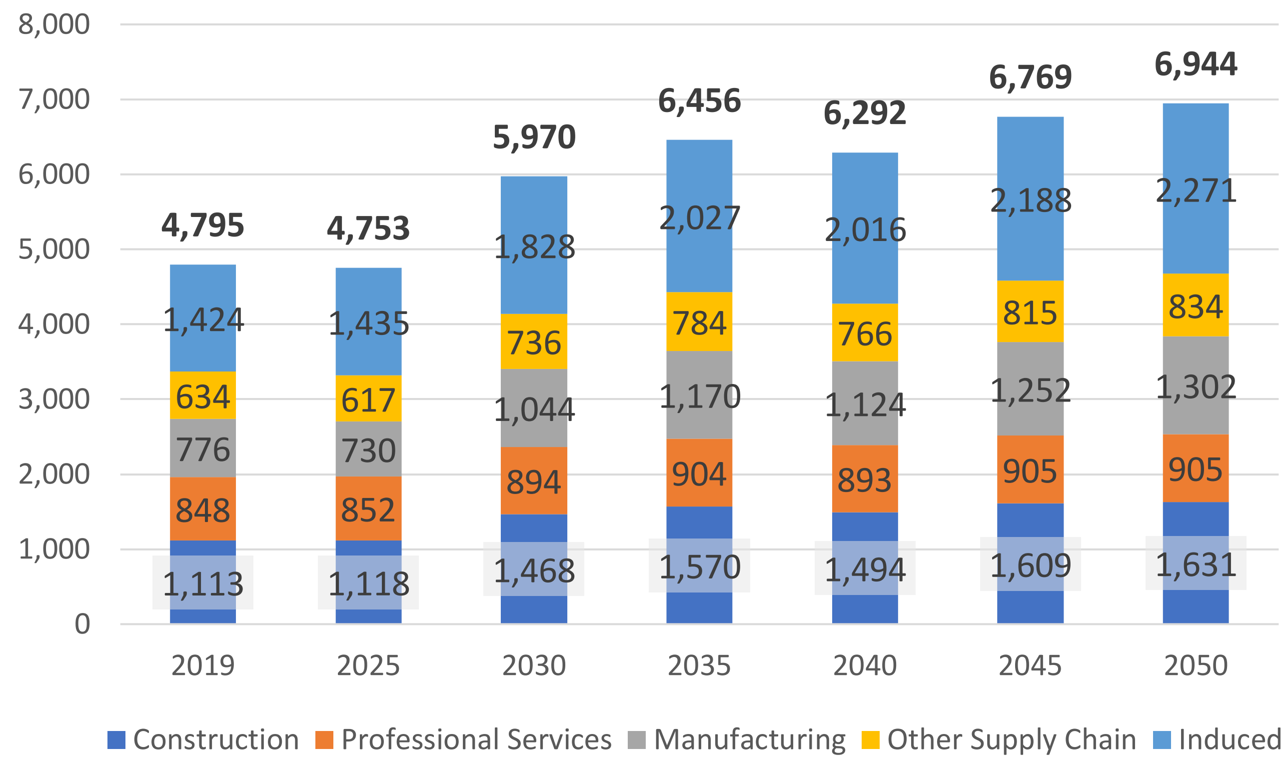


FIGURE 14. ONSHORE WIND: EMPLOYMENT OUTPUTS (S3: AT)

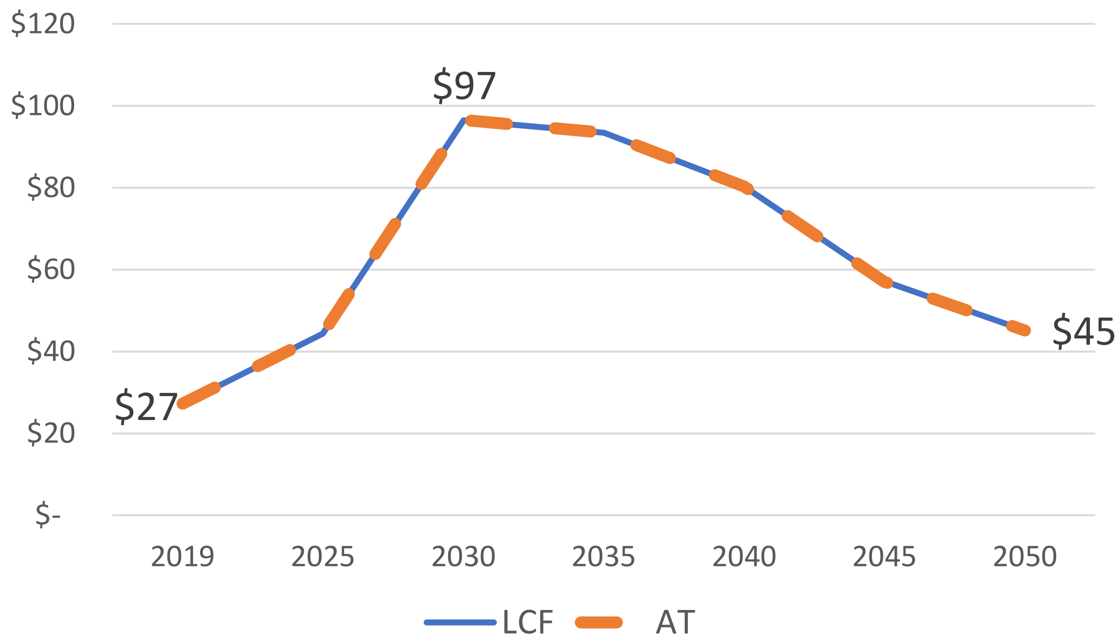


Hydropower

The hydropower sub-sector consists of hydroelectric power generation technologies.

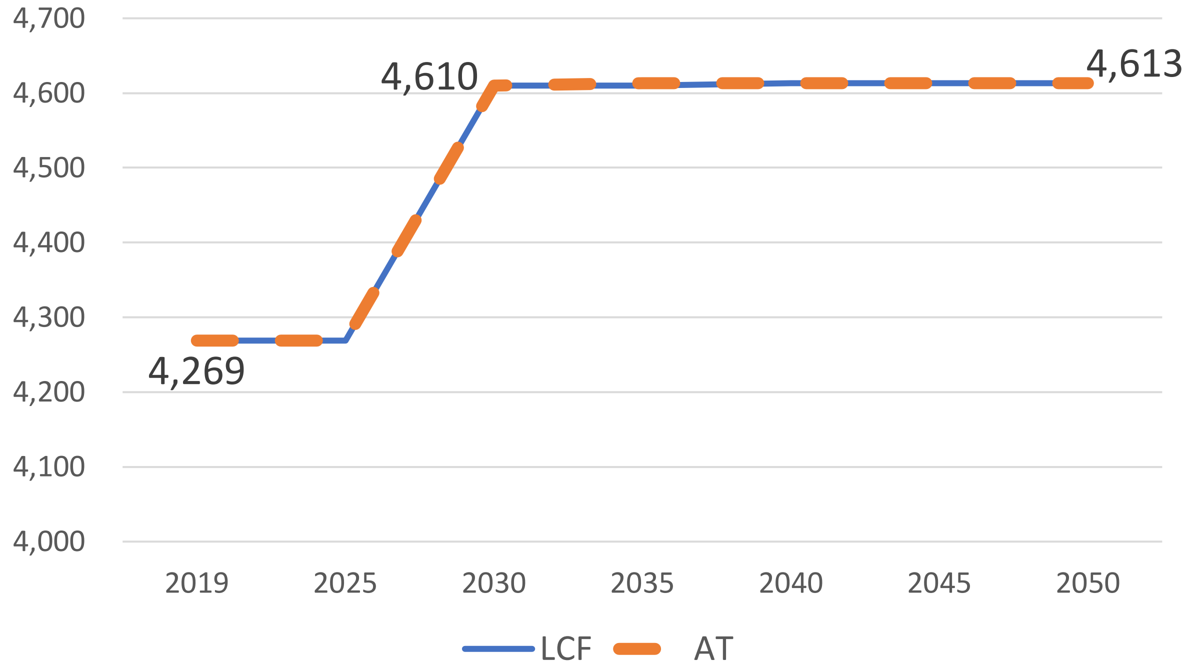
Overall investment between 2019 and 2050 is the same for both LCF and AT scenarios (Figure 15). Overall processed investment streams grow from $27M in 2019, peaking at $97M in 2030 before gradually decreasing to $45M in 2050, a net change of $18M in investments between 2019 and 2050.

FIGURE 15. HYDROPOWER: OVERALL PROCESSED INVESTMENT STREAM ($M)



For both AT and LCF scenarios, Hydropower capacity experiences a net change of 344 MW between 2019 and 2050 (Figure 16). In both 2019 and 2025, Hydropower generates 4,269 MW of electricity. A sharp 341 MW increase in capacity occurs between 2025 and 2030. Capacity installed increases an additional 3 MW in 2035 and stagnates at 4,613 MW until the final year of analysis.

FIGURE 16. HYDROPOWER: CAPACITY INSTALLED (MW)



For both LCF and AT scenarios, Hydropower will lose fewer than 100 jobs by the final year of analysis (Figures 17 and 18). Construction will drive the job losses, shedding 136 jobs by 2050. Other Supply Chain, which has a share of approximately 27 percent of the subsector, will add more than 60 jobs. Employment in the Induced industries, which occupy about 28 percent of the sector, will peak in 2035 before declining to baseline levels by 2050, leading to a net change of zero.

FIGURE 17. HYDROPOWER: EMPLOYMENT OUTPUTS (S2: LCF)

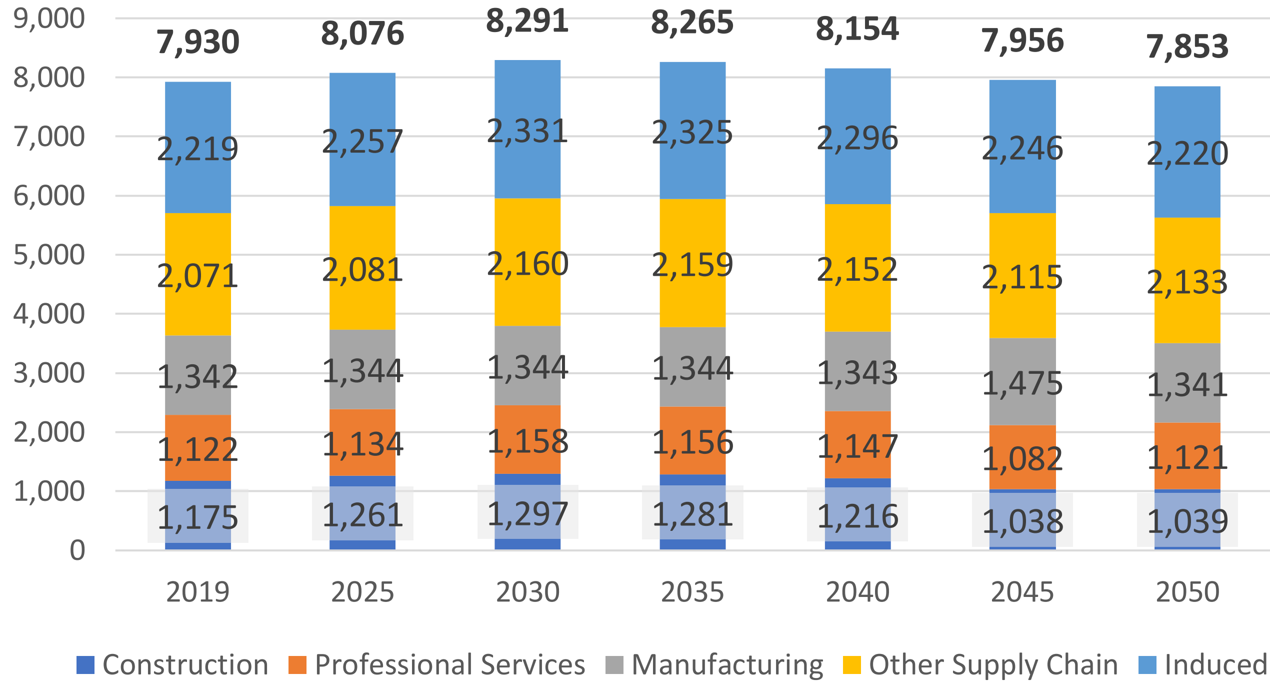
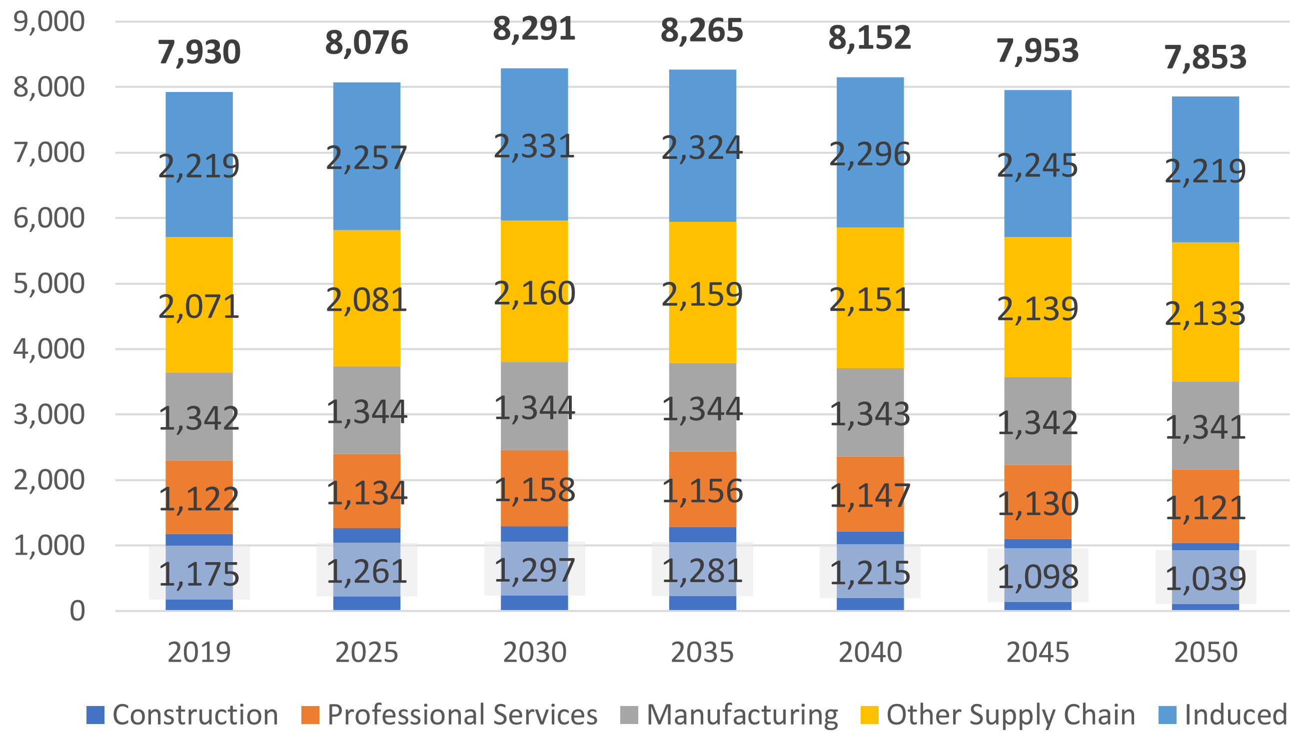


FIGURE 18. HYDROPOWER: EMPLOYMENT OUTPUTS (S3: AT)

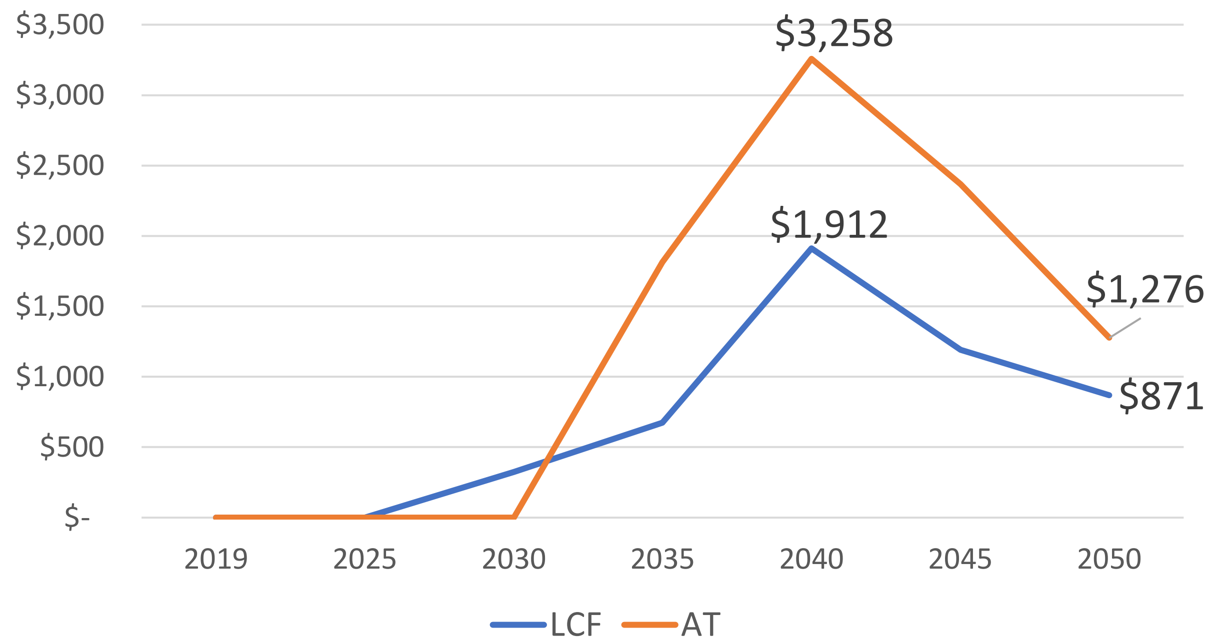


Hydrogen

The Hydrogen sub-sector consists of technologies like generators that combust synthetic fuels or bioenergy for reliability and hydrogen fuel cells that generate electricity.

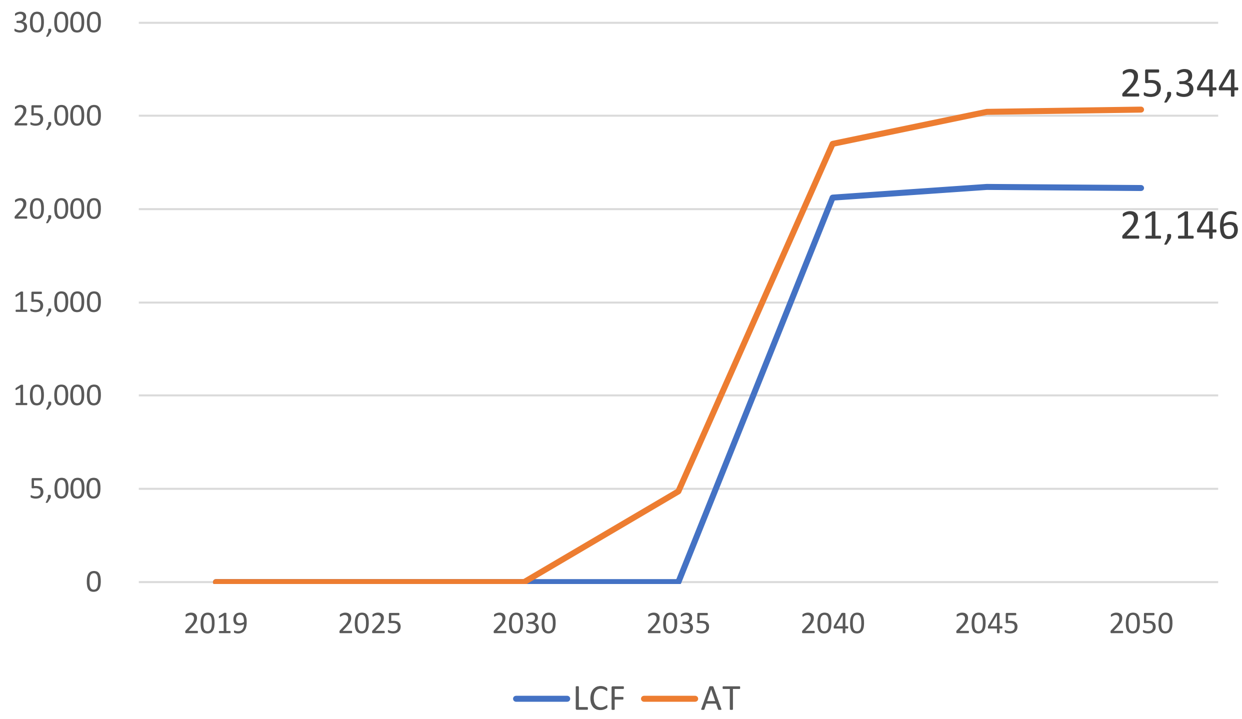
Both scenarios start off with $0M in processed investments in the baseline year, 2019 (Figure 19). Investments in the LCF scenario pick up after 2025, reaching $324M in 2030 and peaking in 2040 at $1,912M, before dipping down to $871M in the final year of analysis. For the AT scenario, overall processed investments jump from $0M in 2030 to $1,814M in 2035. Investments peak in 2040 at $3,258M before decreasing to $1,276M by 2050.

FIGURE 19. HYDROGEN: OVERALL PROCESSED INVESTMENT STREAM ($M)



In 2019, the baseline year, both scenarios have no hydrogen generation capacity (Figure 20). Despite the LCF scenario processing investments earlier than the AT scenario, hydrogen capacity starts growing between 2035 and 2040. Compared to the AT scenario, which begins installations between 2030 and 2035, the LCF scenario experiences a lag in converting investments into hydrogen generation. However, each scenario has more than 20,000 MW of capacity by 2040, with the AT scenario producing more than the LCF scenario due to higher overall investments. In 2050, capacity installed for the LCF and AT scenarios is 21,146 MW and 25,344 MW, respectively—a 4,198 MW difference.

FIGURE 20. HYDROGEN: CAPACITY INSTALLED (MW)



All industries have no jobs until 2030 for the LCF scenario and 2035 for the AT scenario (Figures 21 and 22), corresponding to the difference in processed investments previously discussed (Figure 19). In the first year of growth, 2030, the LCF scenario will add a total of 3,374 jobs across all industries, whereas the AT scenario will add 13,971 jobs in 2035. Jobs added for both scenarios peak in 2040, totaling 12,712 for the LCF scenario and 22,937 for the AT scenario. Employment declines after this point in both scenarios until 2050; however, final year figures are still above baseline figures across all industries.

In both scenarios, construction jobs hold the largest share of the subsector, accounting for 60 percent in 2030 for the LCF scenario and 62 percent in 2035 for the AT scenario. While construction jobs consistently dominate the share until 2050 in the AT scenario, construction jobs in the LCF scenario drop to 0.5 percent by 2050. The other supply chain and induced industries each hold 43 percent of the share of jobs by 2050 in the LCF scenario, a significant change from 2030 figures. Industry shares remain consistent from 2035 to 2050 in the AT scenario, with other supply chain increasing its share the most while construction jobs begin to lose their share.

FIGURE 21. HYDROGEN: EMPLOYMENT OUTPUTS (S2: LCF)

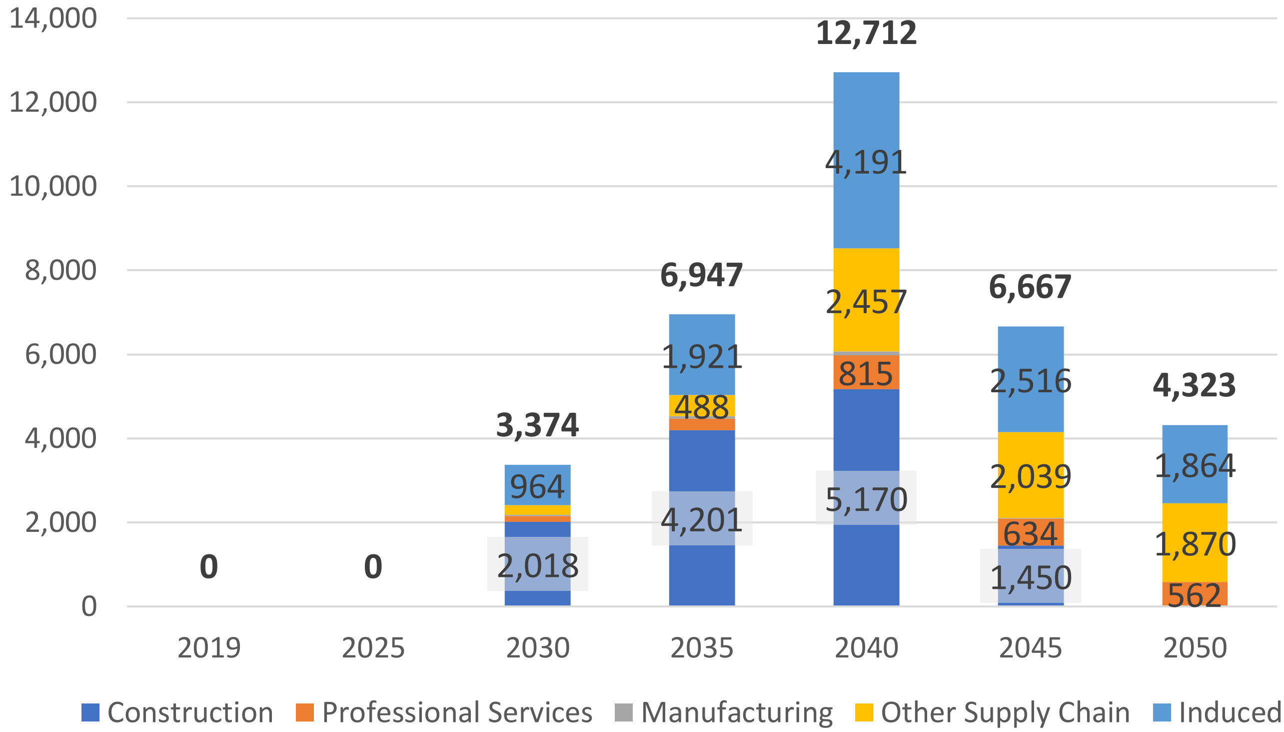
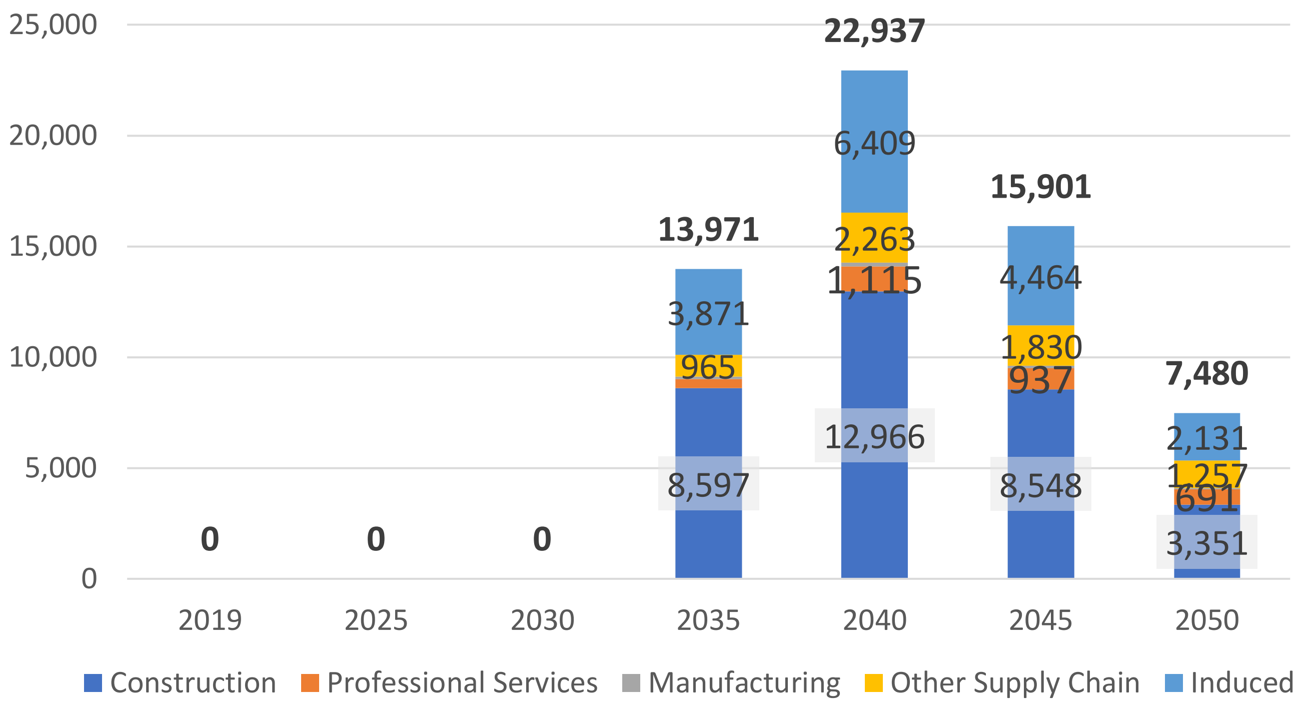


FIGURE 22. HYDROGEN: EMPLOYMENT OUTPUTS (S3: AT)

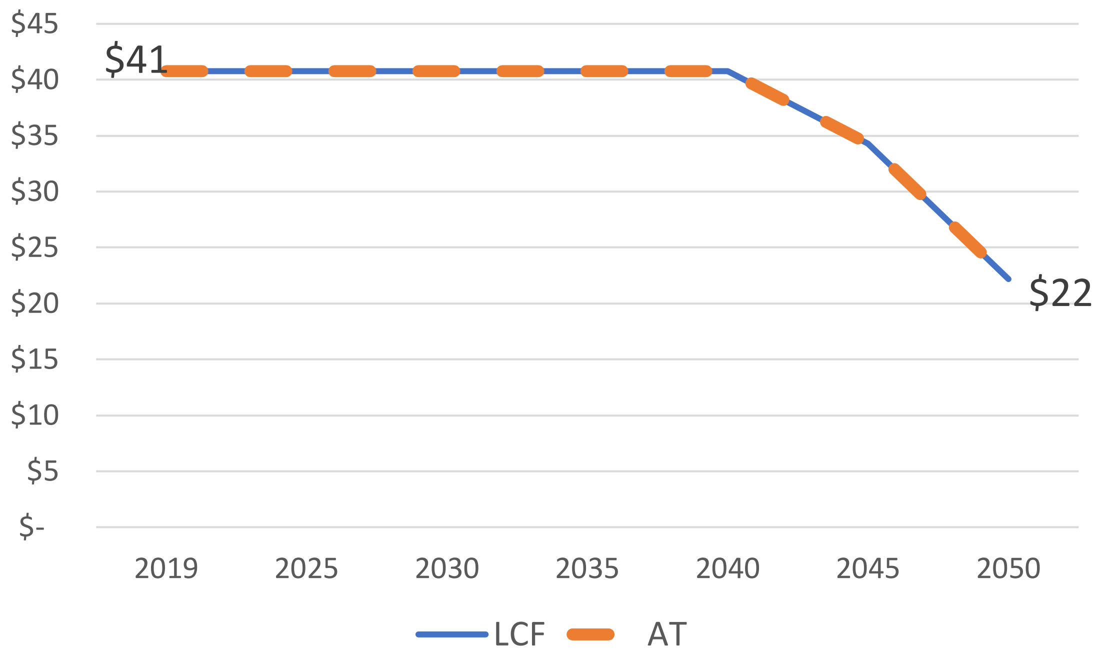


Biomass

The biomass subsector consists of biomass electric power generation technologies.

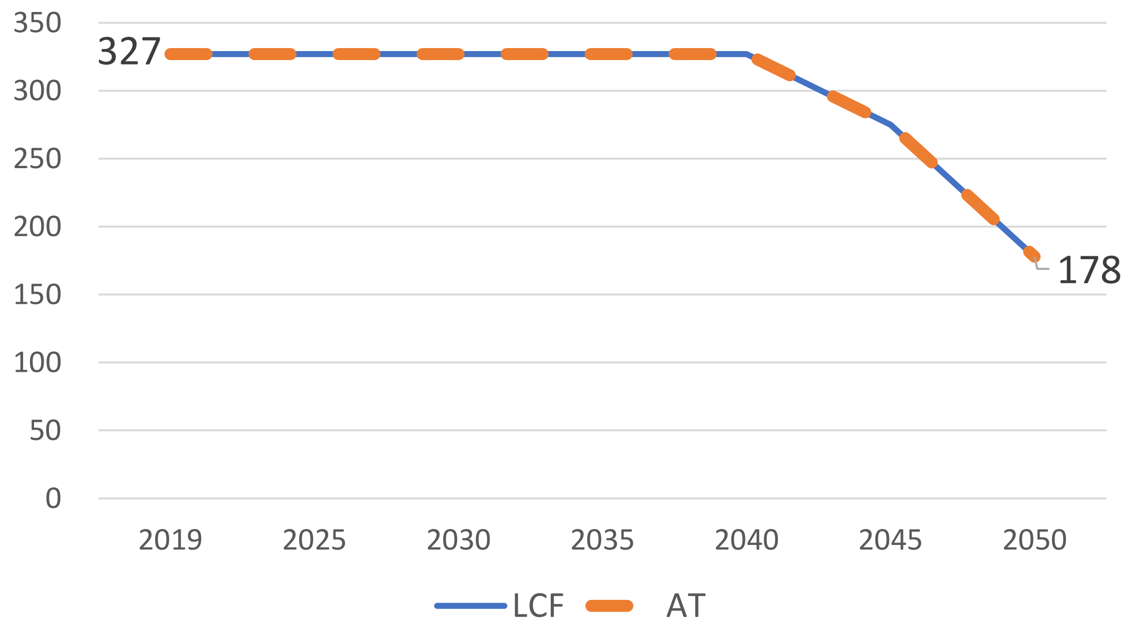
Both LCF and AT scenarios trend on the same line for overall investments between 2019 and 2050 (Figure 23). Overall processed investments maintain the baseline value of $41M until 2040; investments drop to $34M in 2045 and reach the lowest value in 2050, standing at $22M in the final year of investment.

Figure 23. Biomass: Overall Processed Investment Stream ($M)



Similar to investment, the LCF and AT scenarios show the same biomass generation capacity trends from 2019 to 2050 (Figure 24). Both scenarios maintain the 2019 baseline capacity of 327 MW until 2040, after which capacity drops to 275 MW in 2045 and 178 MW in the final year of analysis.

FIGURE 24. BIOMASS: CAPACITY INSTALLED (MW)



Biomass will lose a total of 60 jobs between 2019 and 2050, experiencing the most job losses between 2045 and 2050 when investments decrease. In both scenarios, construction and manufacturing maintain the same levels of employment whereas professional services, other supply chain, and induced employment will drop by 11, 28, and 21 jobs, respectively. Despite the jobs losses, the other supply chain and induced industries maintain the largest shares of the subsector, holding 35 and 22 percent, respectively, in 2050 (Figures 25 and 26).

Figure 25. Biomass: Employment Outputs (S2: LCF)

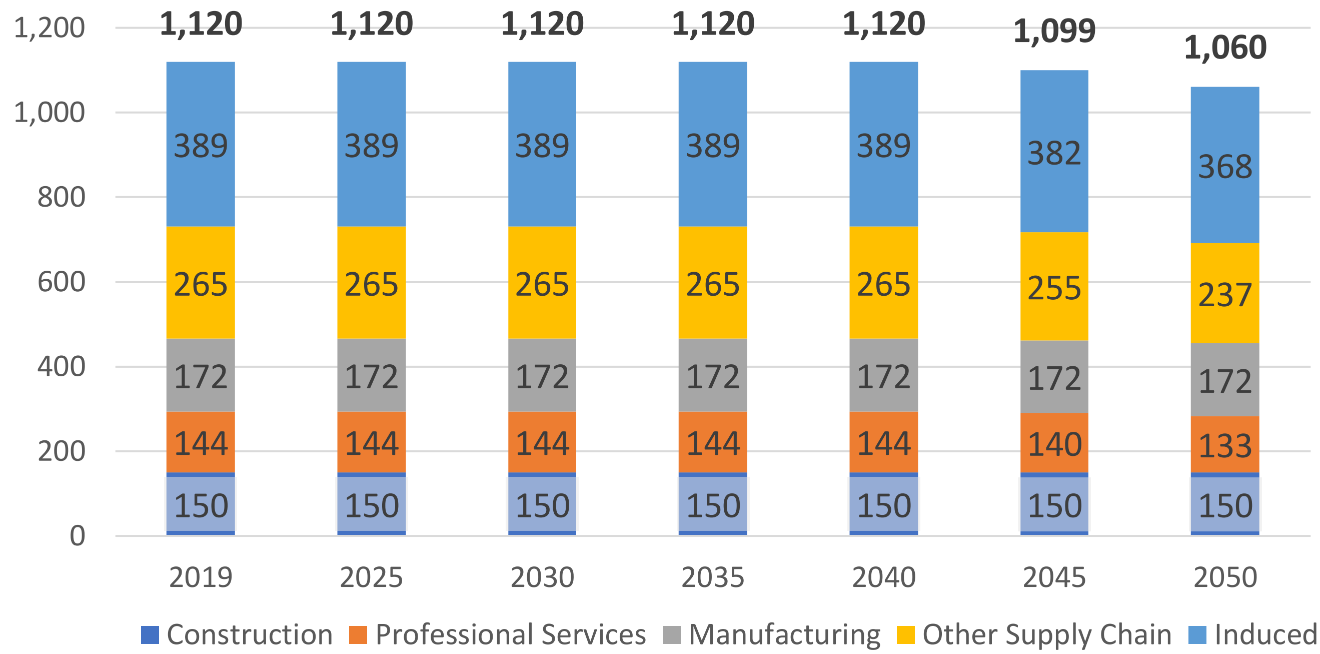
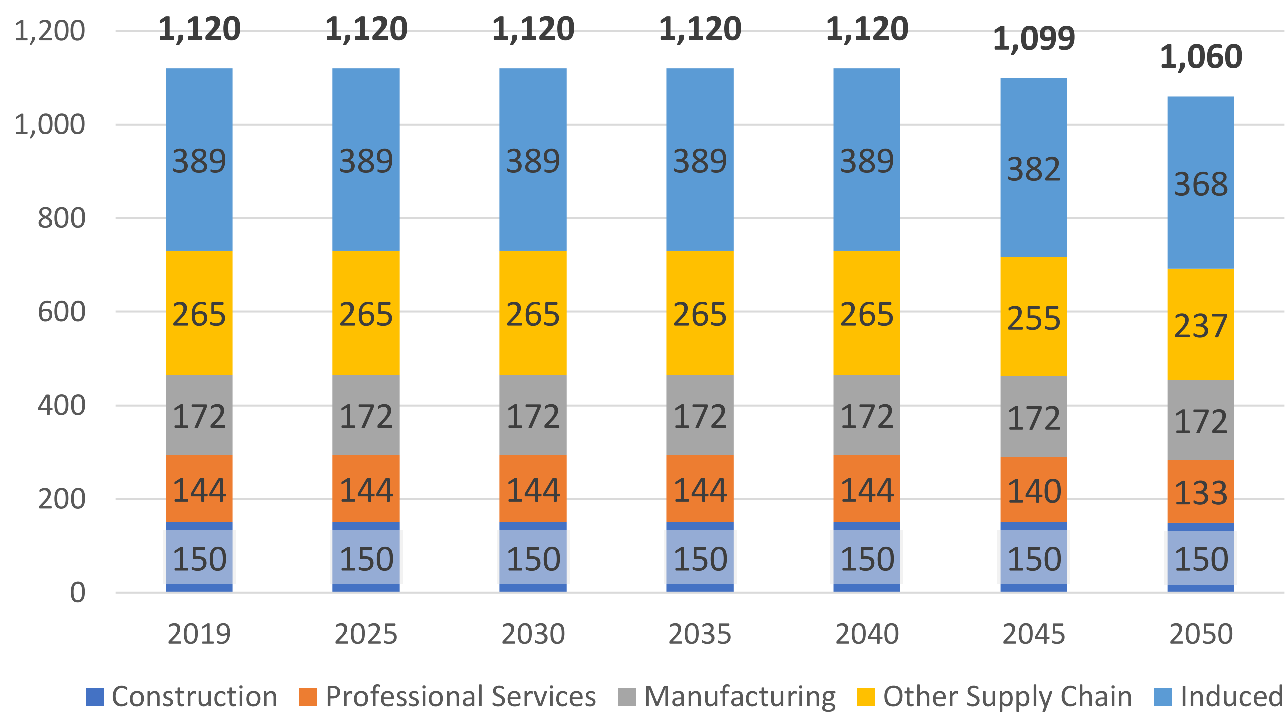


Figure 26. Biomass: Employment Outputs (S3: AT)

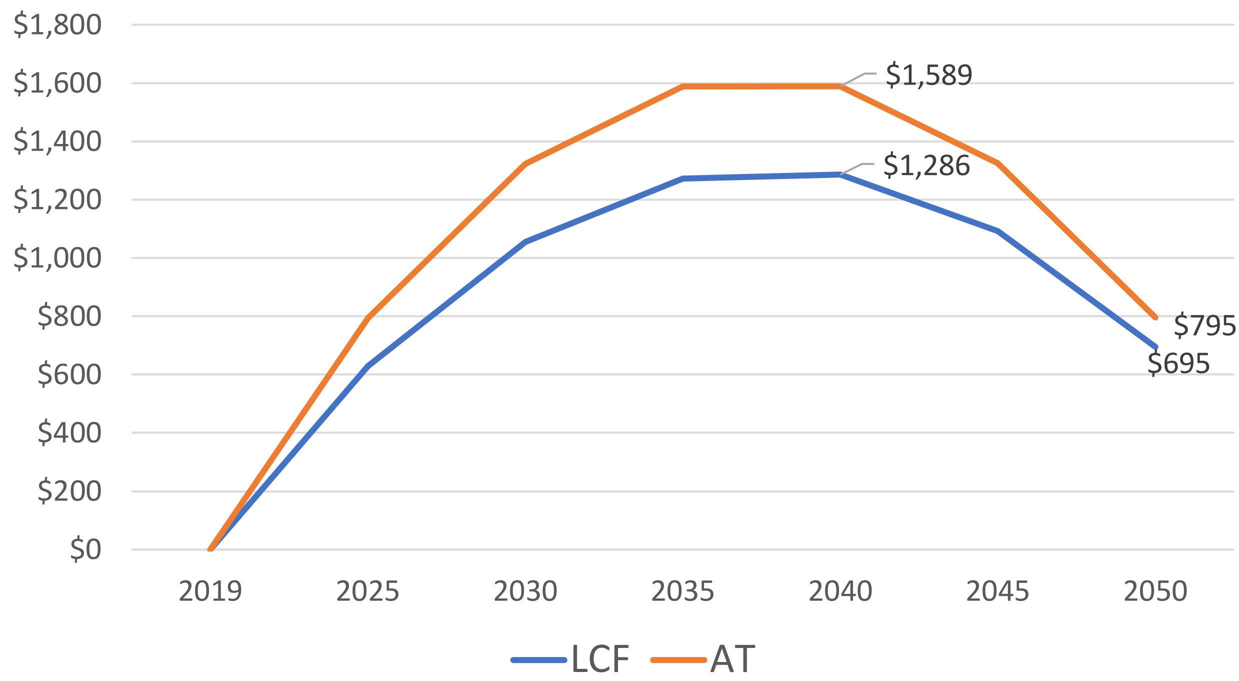


Distribution

The distribution subsector consists of technologies like power lines and local smart grid.

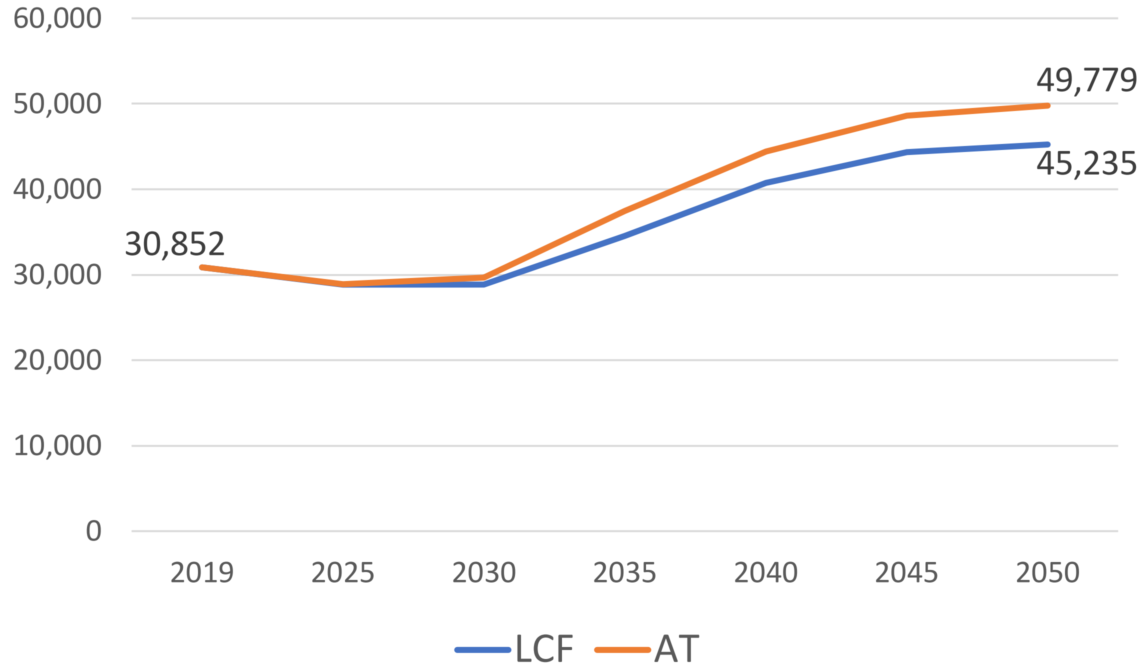
The LCF and AT scenarios exhibit the same overall investment trends, with the LCF scenario trending lower than the AT Scenario from 2019 to 2050 (Figure 27). Baseline investments begin at $0M for both scenarios, growing until they peak in 2040 at $1,589M for the AT scenario and $1,286M for the LCF scenario, a $303M difference. In the final year of analysis, overall processed investments streams drop to $795M and $695M for the AT and LCF scenarios, respectively—a $100M difference in investment.

FIGURE 27. DISTRIBUTION: OVERALL PROCESSED INVESTMENT STREAM ($M)



Both scenarios have a baseline capacity of 30,852 MW in 2019; by 2050, the AT and LCF scenarios have distribution capacities of 49,779 MW and 45,235 MW respectively (Figure 28). Although investments peak in 2040 and decrease until the final year of analysis, distribution capacity exhibits steady growth until 2050.

FIGURE 28. DISTRIBUTION: CAPACITY INSTALLED (MW)



Between 2019 and 2050, the LCF and AT scenarios will add a total of 11,557 and 13,863 jobs, respectively, with both scenarios adding the greatest number of jobs in the construction industry followed by Induced employment (Figures 29 and 30). Jobs added peak in 2035 and 2040 across all industries, corresponding to the highest levels of overall processed investments; jobs added decline as investments decrease after 2040. Although other supply chain jobs consistently occupy the largest share of distribution in both scenarios, the construction industry grows its share of the subsector as other supply chain decreases—professional services, manufacturing, and induced jobs maintain a consistent share between 2019 and 2050.

FIGURE 29. DISTRIBUTION: EMPLOYMENT OUTPUTS (S2: LCF)

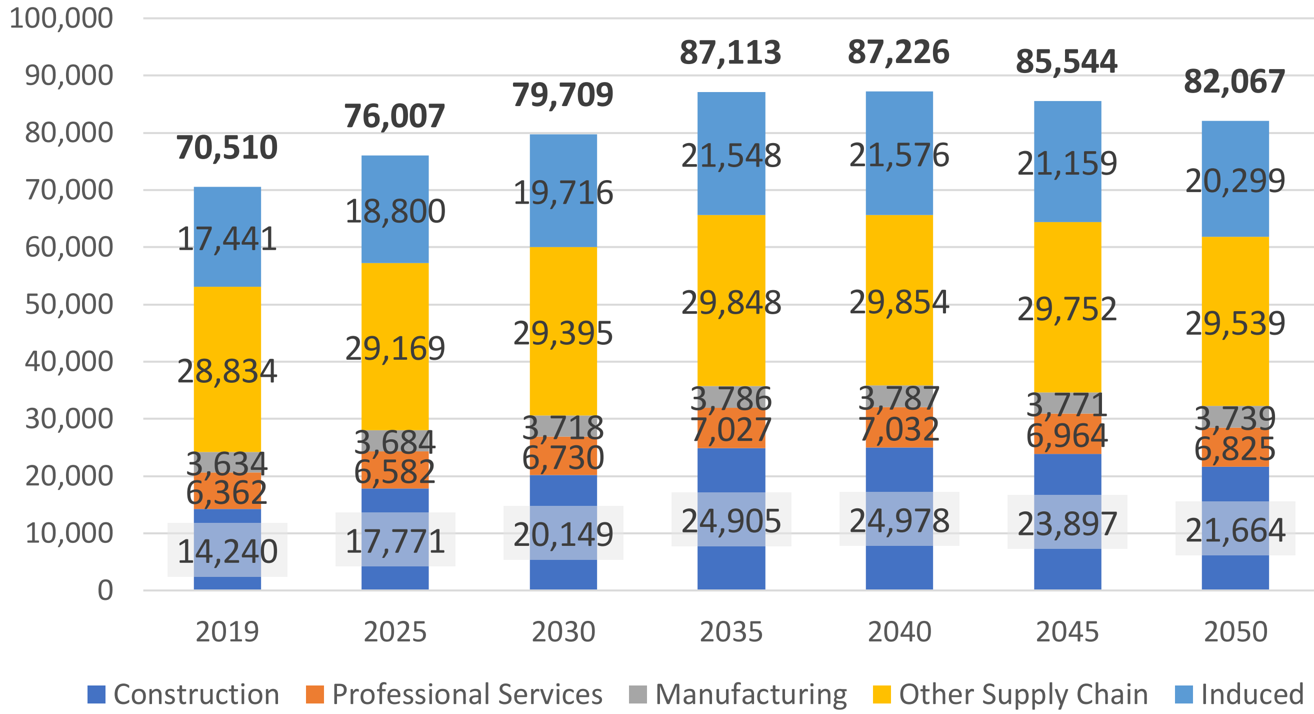
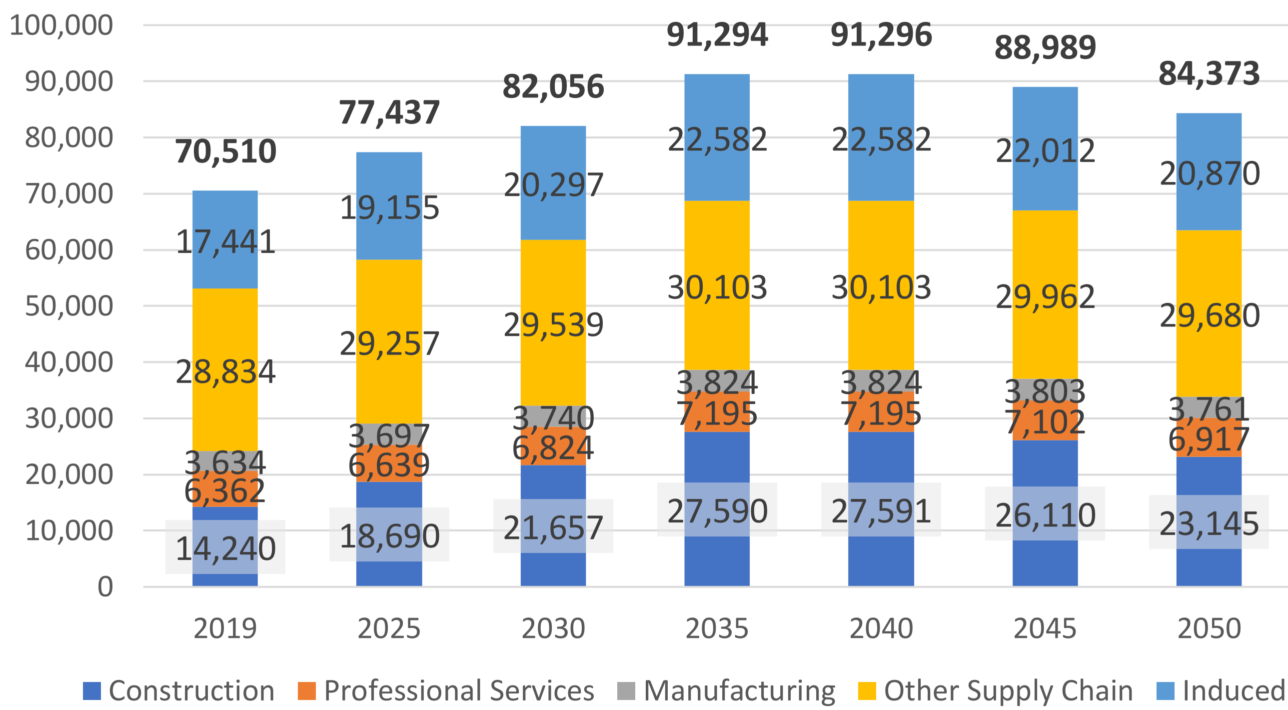


FIGURE 30. DISTRIBUTION: EMPLOYMENT OUTPUTS (S3: AT)

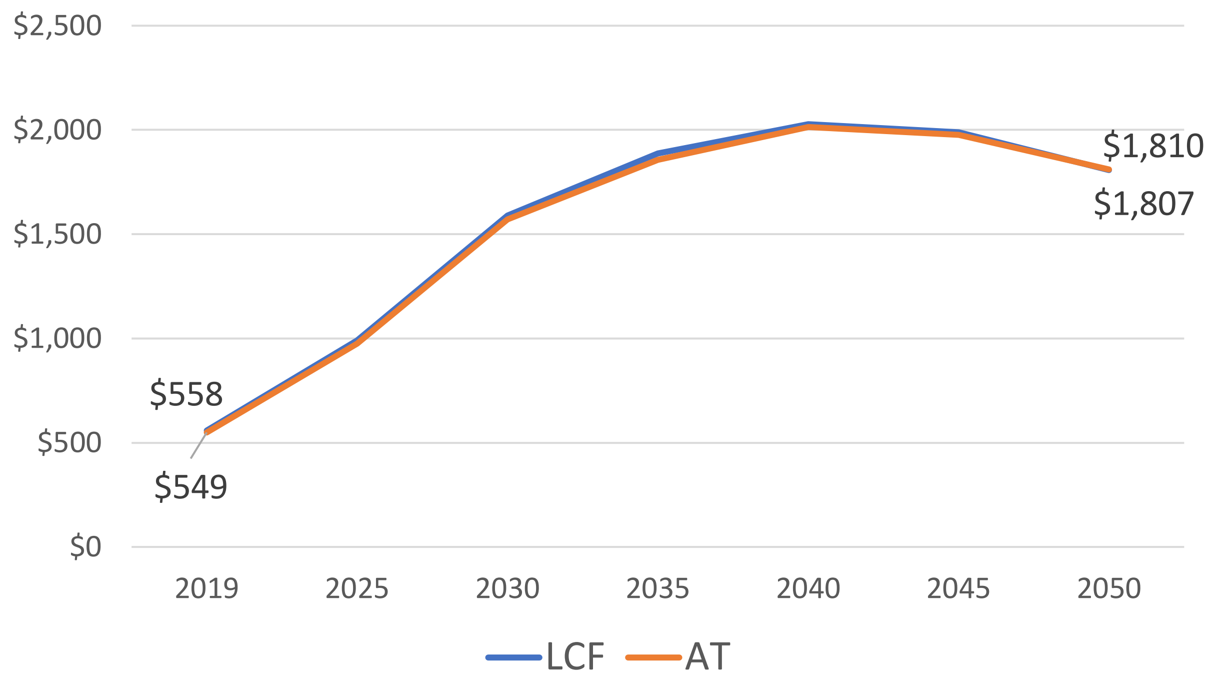


Transmission

The transmission sub-sector consists of technologies like transmission hub.

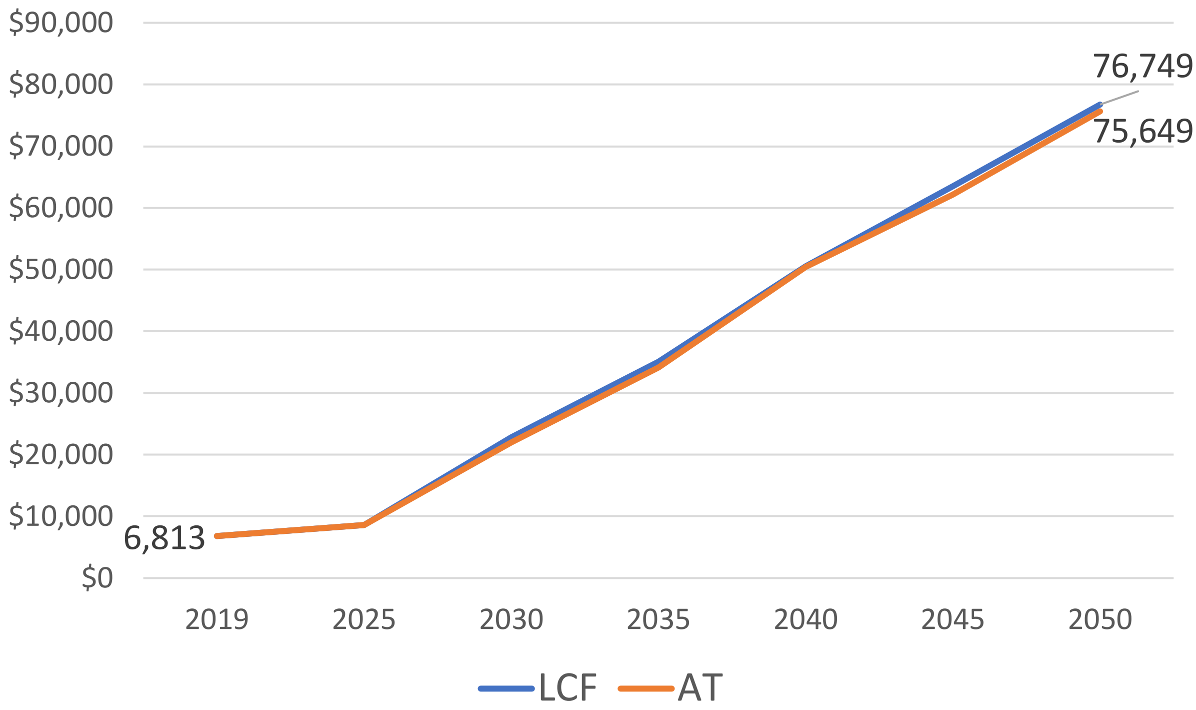
Overall processed investments between 2019 and 2050 increase steadily for both LCF and AT scenarios, with the LCF scenario generally processing slightly higher investments than the AT scenario (Figure 31).

FIGURE 31. TRANSMISSION: OVERALL PROCESSED INVESTMENT STREAM ($M)



Similarly, the LCF and AT scenarios trend closely for transmission capacity installed between 2019 and 2050 (Figure 32). Capacity will increase from 6,813 MW for both scenarios in 2019 to 76,749 MW and 75,649 MW for the LCF and AT scenarios, respectively, in the final year of analysis.

FIGURE 32. TRANSMISSION: CAPACITY INSTALLED (MW)



Between 2019 and 2050, the LCF and AT scenarios will add a total of 4,529 and 4,687 jobs, respectively, with both scenarios adding the greatest number of jobs in the construction industry followed by Induced employment (Figures 33 and 34).

In both LCF and AT scenarios, professional services, manufacturing, and induced employment maintain consistent shares of Transmission, with jobs in professional services and manufacturing occupying the lowest share. In 2019, the 4,062 other supply chain jobs will represent 40 percent of the industry; comparatively, the approximately 5,000 total jobs in 2050 occupy 35 percent of the subsector. The share of construction jobs remains above 30 percent between 2025 and 2045, overtaking and remaining above other supply chain share before dropping to 26 percent in 2050.

FIGURE 33. TRANSMISSION: EMPLOYMENT OUTPUTS (S2: LCF)

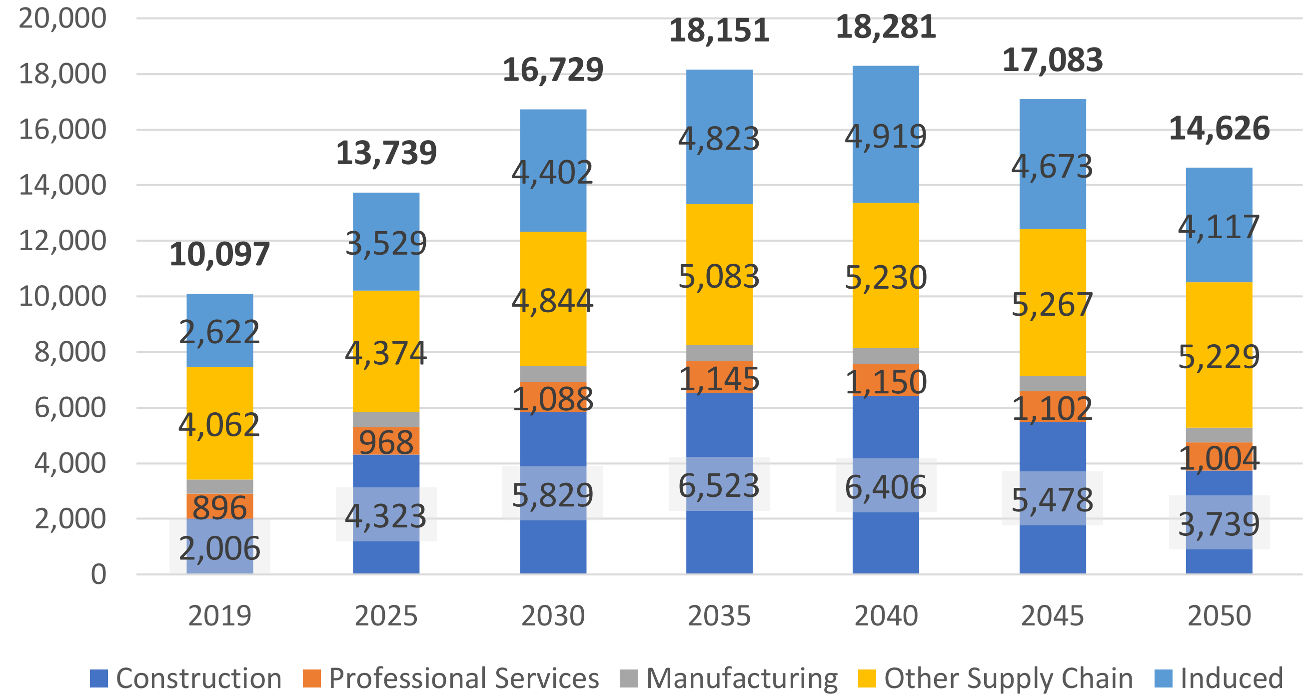
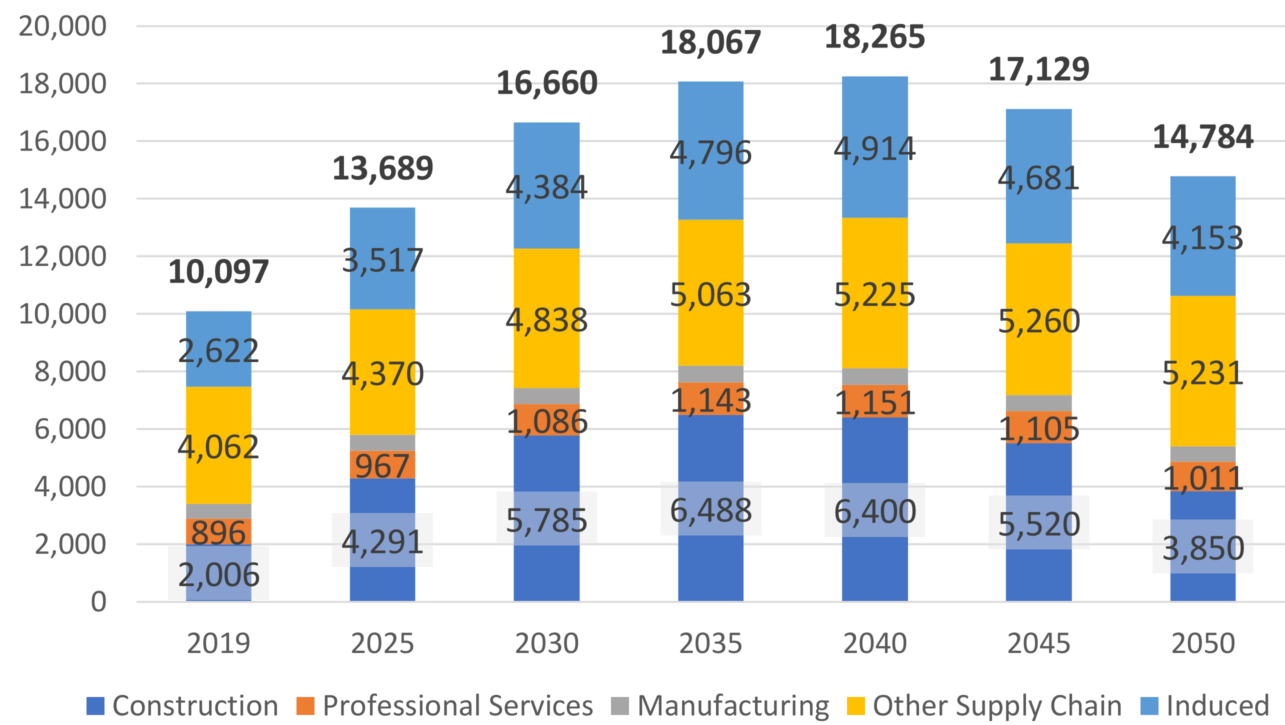


FIGURE 34. TRANSMISSION: EMPLOYMENT OUTPUTS (S3: AT)

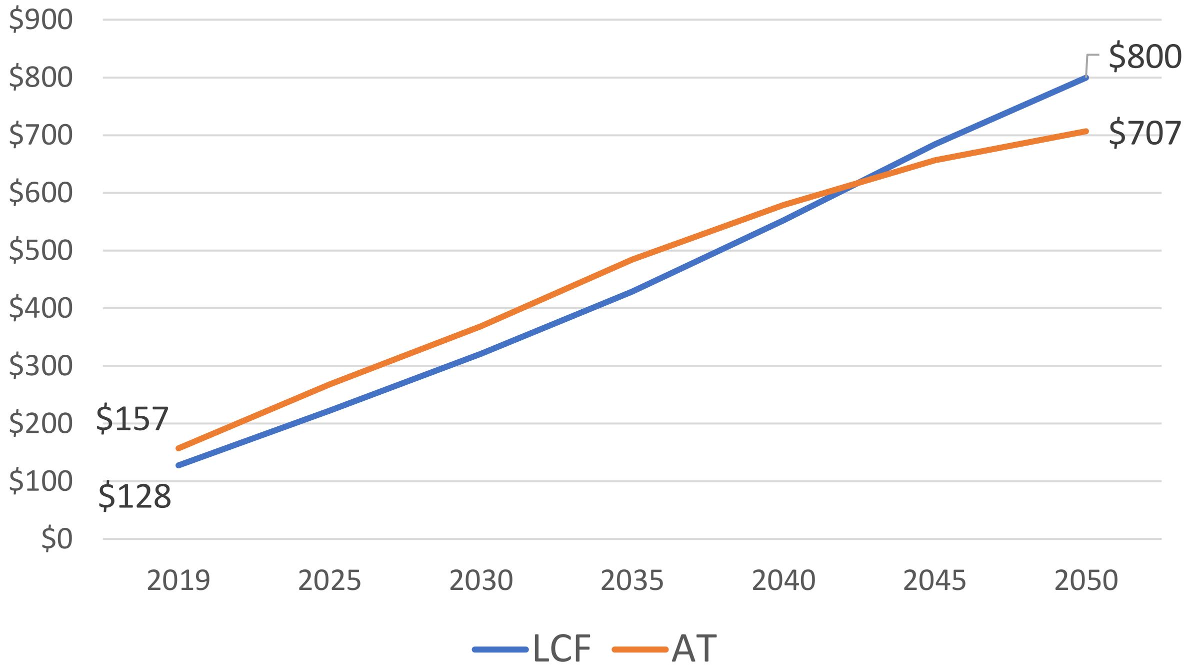


Storage

The storage subsector consists of technologies like batteries, flywheels, thermal energy, and pumped hydro.

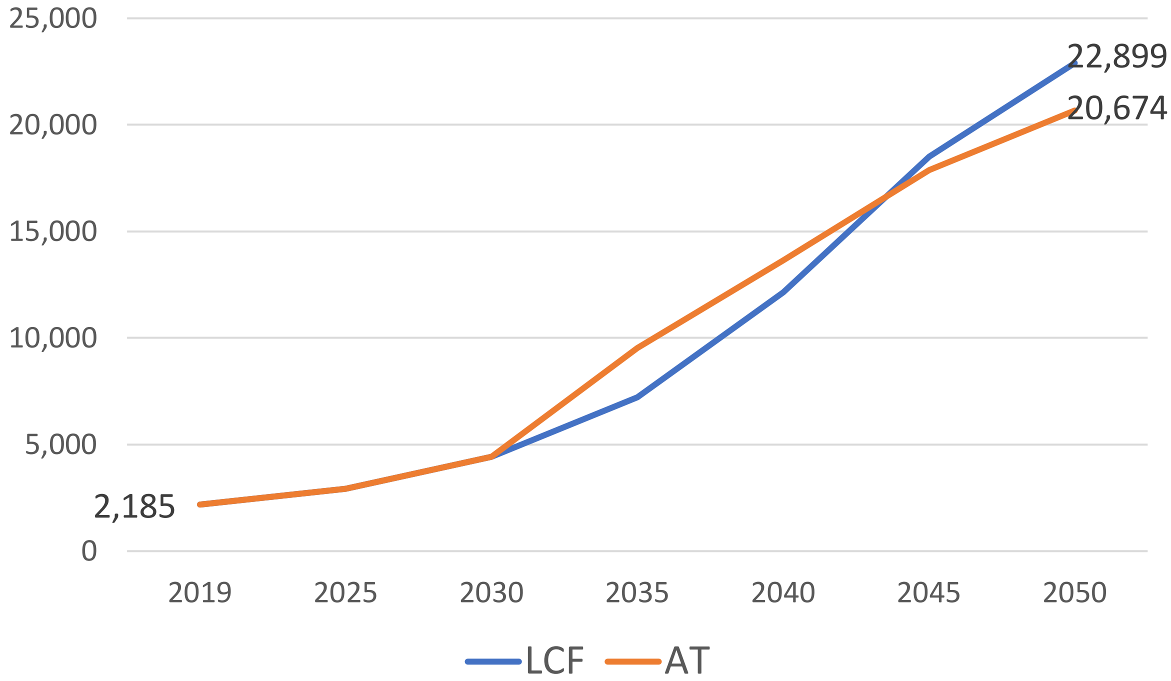
In the baseline year, the $128M of processed investments from the LCF are $29M lower than the $157M of investment from the AT scenario (Figure 35). Overall processed investment streams from the AT scenario remain higher than LCF scenario streams until LCF scenario investments overtake the AT scenario between 2040 and 2045. By the final year of analysis, overall investments processed in the LCF scenario are $93M higher than the AT scenario.

FIGURE 35. STORAGE: OVERALL PROCESSED INVESTMENT STREAM ($M)



Capacity installed in both scenarios is the same in between 2019 and 2030, with a baseline level of 2,183 MW (Figure 36). In 2035, the AT scenario has higher storage capacity compared to the LCF scenario; this remains true until LCF capacity overtakes AT capacity between 2040 and 2045, corresponding to the changes in investment observed in Figure 35. By 2050, the LCF scenario has storage capacity of 22,899 MW, 2,225 MW higher than the 20,674 MW capacity of the AT scenario.

FIGURE 36. STORAGE: CAPACITY INSTALLED (MW)



The LCF and AT scenarios will add 17,759 and 11,004 jobs, respectively, to the storage subsector between 2019 and 2050, this is largely driven by the construction and induced industries (Figures 37 and 38). All industries maintain their shares of the subsector as they grow, with construction and induced industries representing the most jobs from 2019 to 2050.

FIGURE 37. STORAGE: EMPLOYMENT OUTPUTS (S2: LCF)

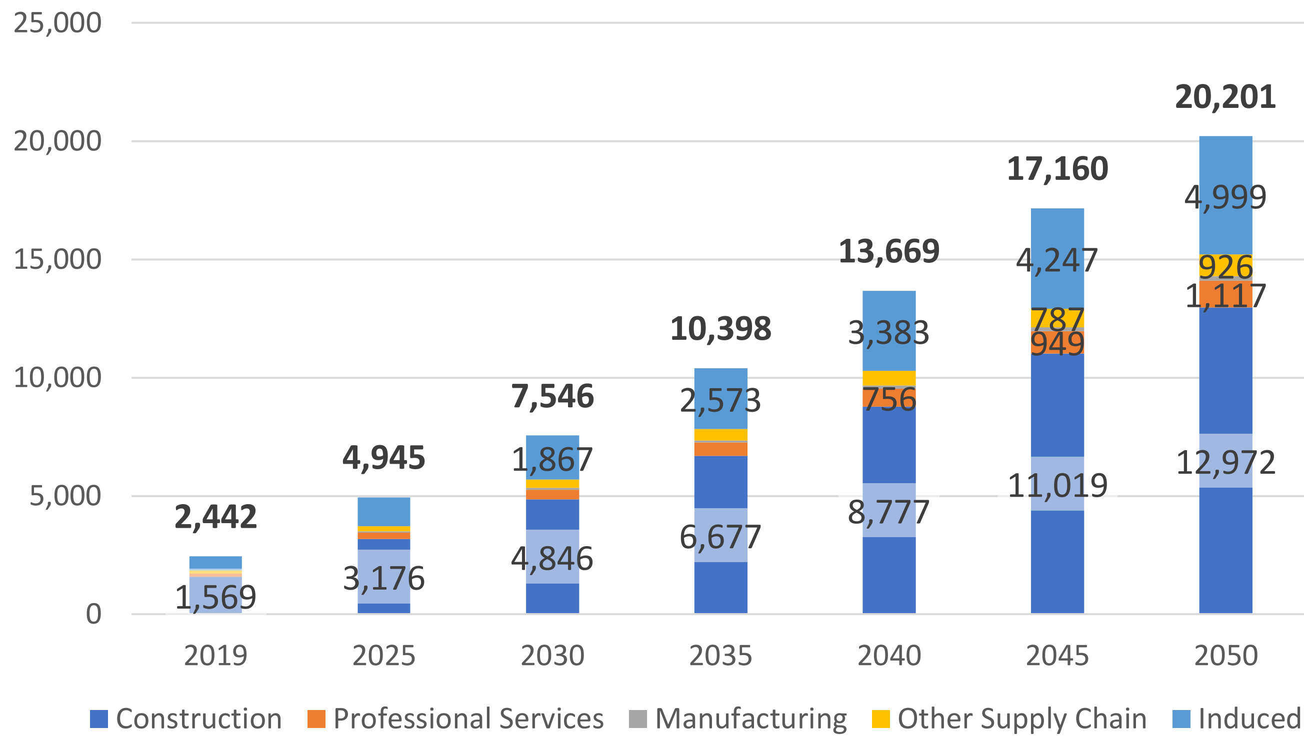
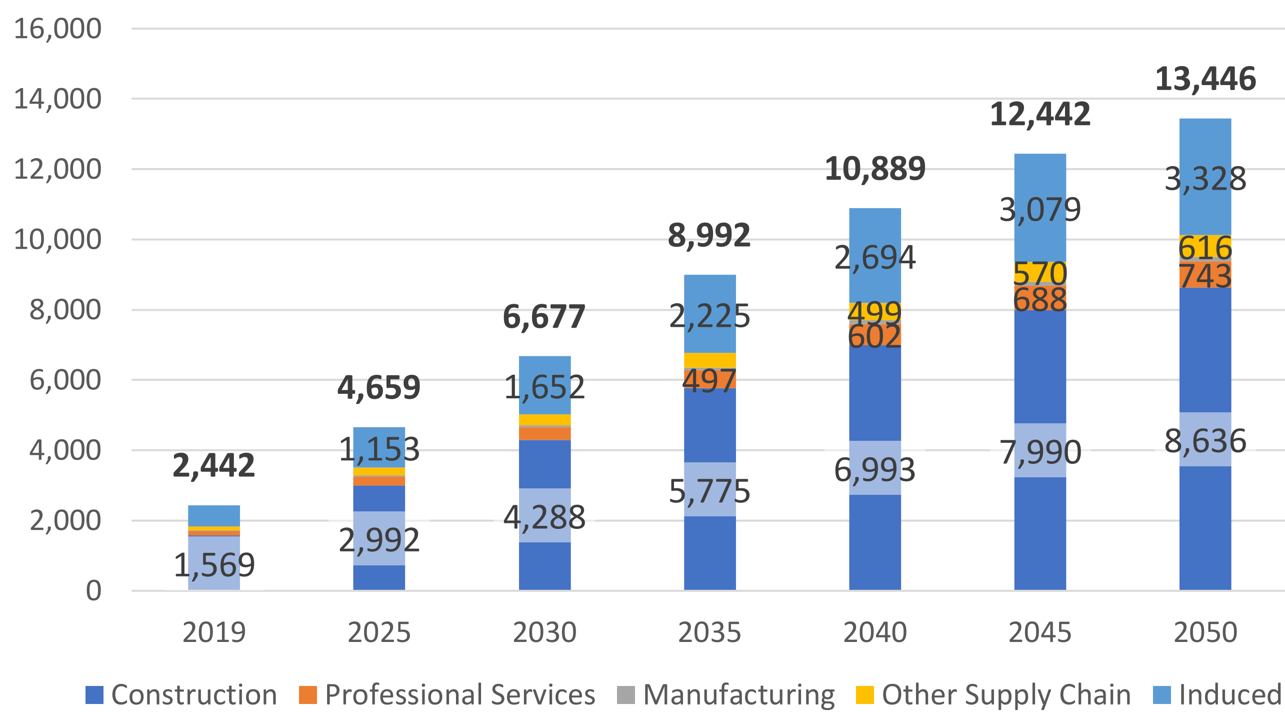


FIGURE 38. STORAGE: EMPLOYMENT OUTPUTS (S3: AT)

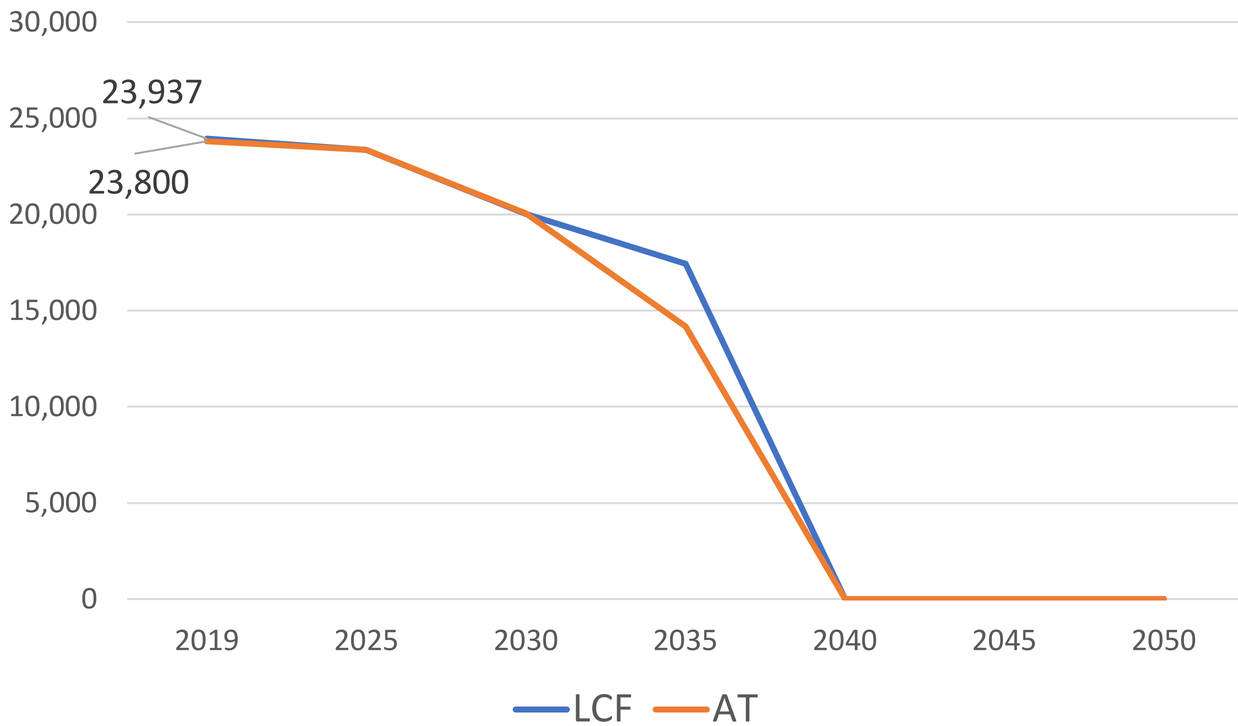


Natural Gas Generation

The natural gas generation, a displaced sub-sector, consists of technologies like natural gas fired power plants.[42]

Natural gas generation for the LCF scenario has a higher baseline (23,937 MW) than the AT scenario (23,800 MW). Between 2019 and 2035, capacity drops gradually for both scenarios before experiencing a sharp drop to 0MW capacity in 2040. Capacity installed for both scenarios will remain at 0 MW through the final year of analysis.

FIGURE 39. NATURAL GAS GENERATION: CAPACITY INSTALLED (MW)



For both scenarios, the natural gas generation subsector will lose 9,140 jobs by 2050 (Figures 40 and 41). These changes are mostly driven by losses in the other supply chain and induced industries, each of which consistently occupy more than 40 percent of the subsector between 2019 and 2050. Total job losses in other supply chain and induced equal 3,953 and 3,940, respectively, for both AT and LCF scenarios.

[42] Processed investment streams are not featured for Natural Gas Generation because these models relied on capacity installed.

FIGURE 40. NATURAL GAS GENERATION: EMPLOYMENT OUTPUTS (S2: LCF)

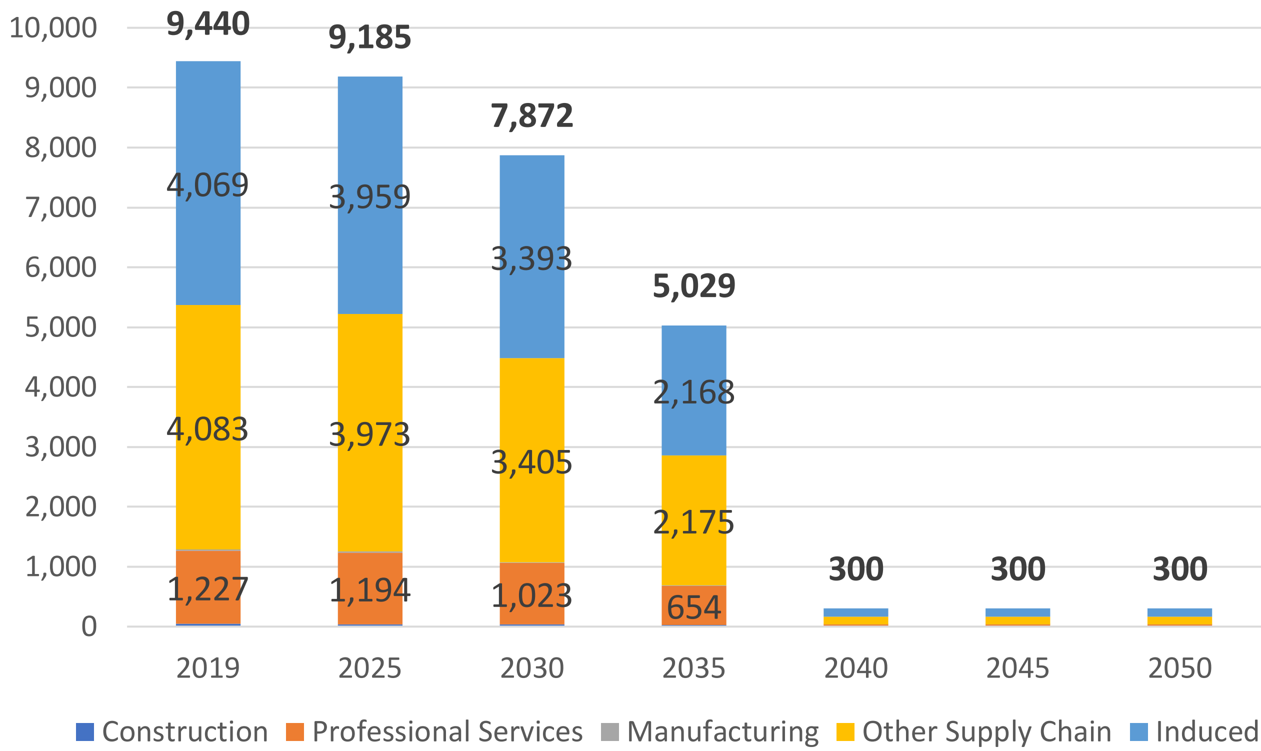
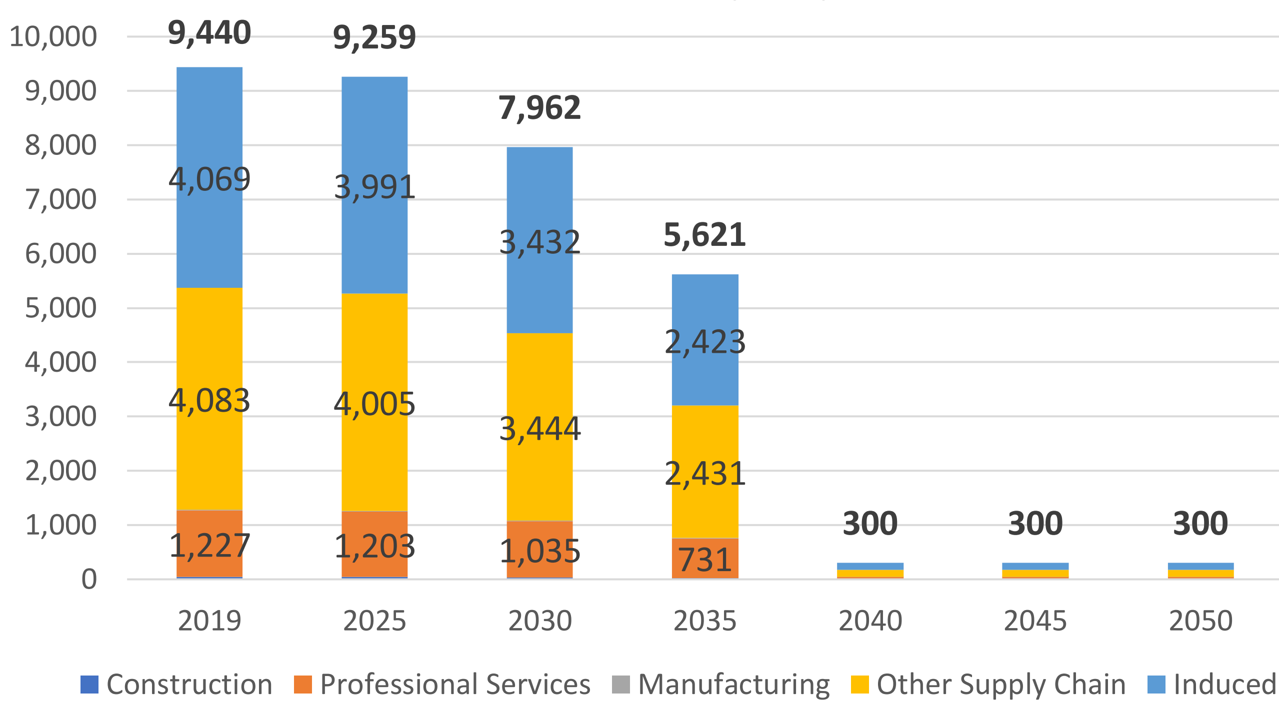


FIGURE 41. NATURAL GAS GENERATION: EMPLOYMENT OUTPUTS (S3: AT)

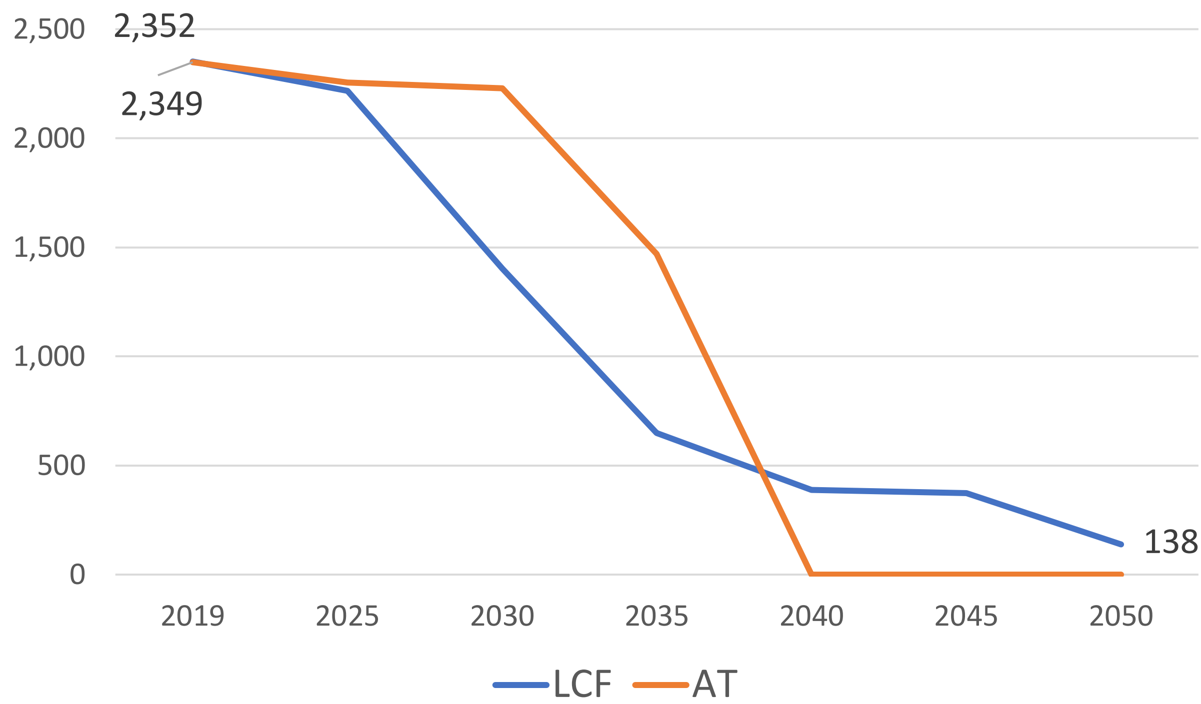


Other Fossil Generation

The other fossil generation subsector, a displaced sub-sector, consists of technologies like coal, oil, and other fossil fuel burning power plants.[43]

Both the LCF and AT scenarios have comparable baseline capacity for other fossil generation, with 2019 figures at 2,349 MW and 2,352 MW, respectively (Figure 42). The LCF scenarios experiences the sharpest drop between 2025 and 2035, after which the decline to 138 MW of capacity in 2050 is gradual. On the other hand, the AT scenario experiences the sharpest drop between 2035 and 2040, falling to 0 MW capacity through the final year of analysis.

FIGURE 42. OTHER FOSSIL GENERATION: CAPACITY INSTALLED (MW)



Other fossil generation will experience total displacement of 1,349 and 1,115 jobs for the LCF and AT scenarios, respectively, between 2019 and 2050 (Figures 43 and 44). Other supply chain and induced jobs will drive these losses as they each occupy more than 40 percent of the subsector.

[43] Processed investment streams are not featured for Other Fossil Generation because these models relied on capacity installed.

FIGURE 43. OTHER FOSSIL GENERATION: EMPLOYMENT OUTPUTS (S2: LCF)

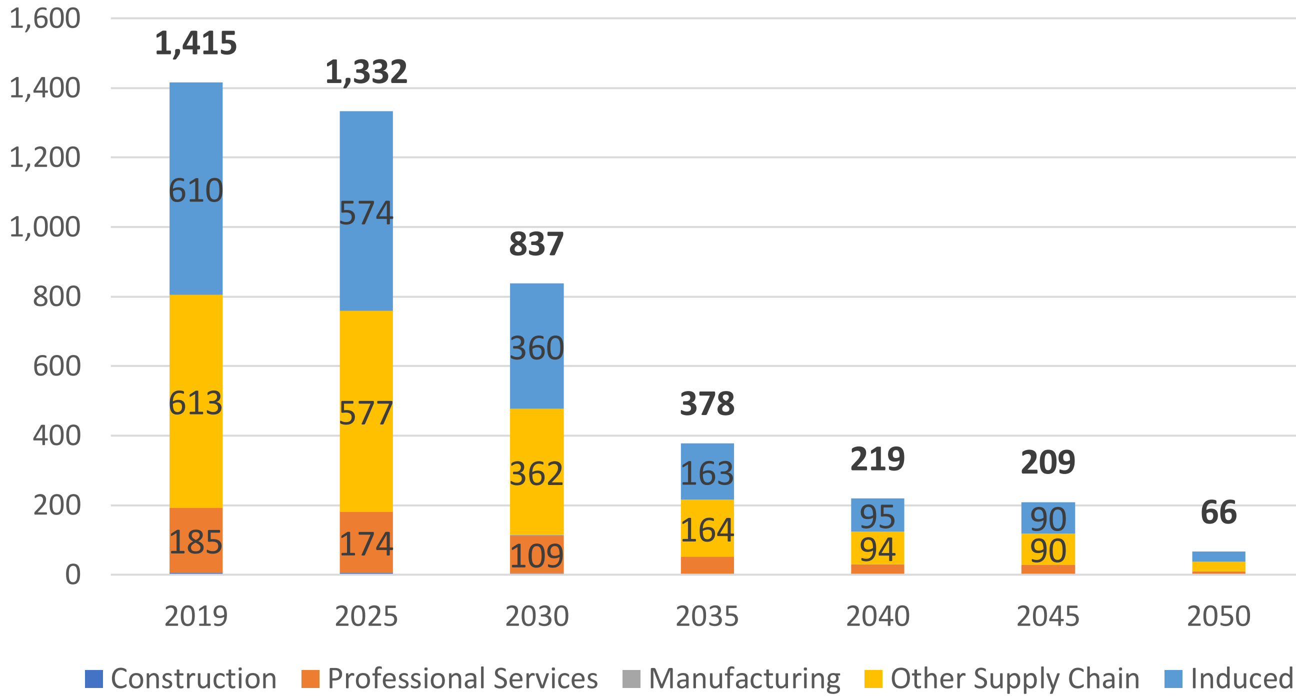
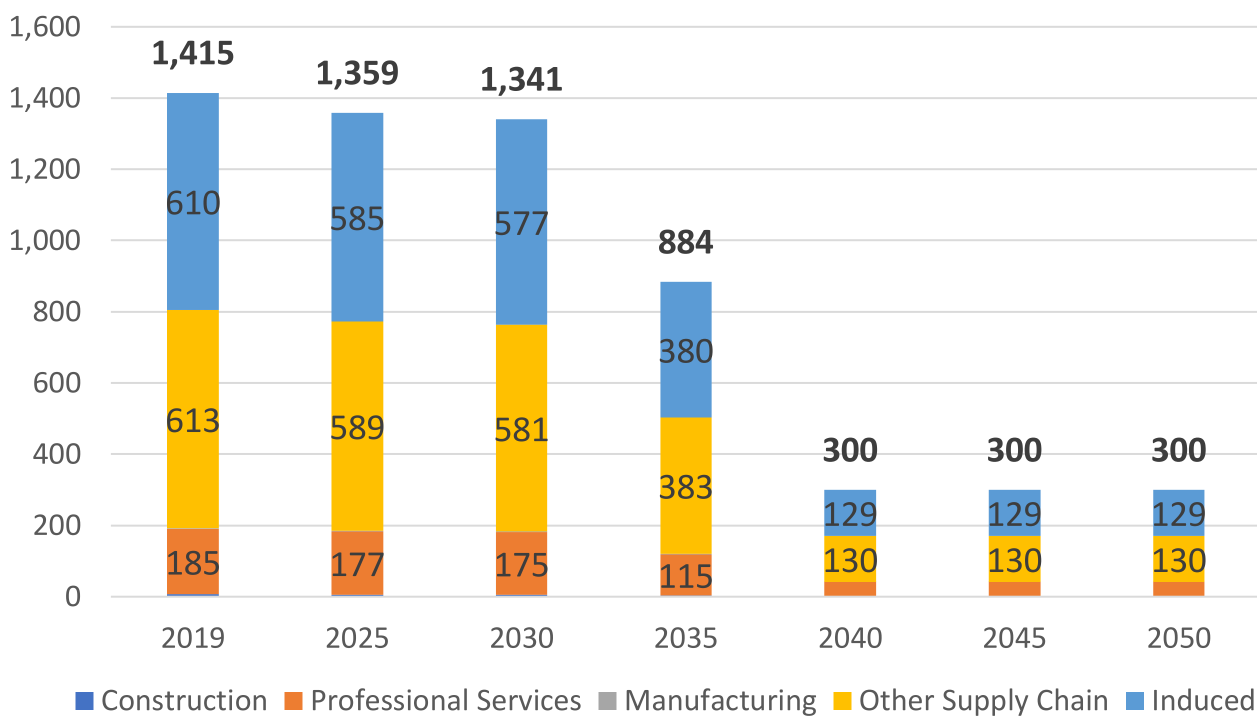


FIGURE 44. OTHER FOSSIL GENERATION: EMPLOYMENT OUTPUTS (S3: AT)



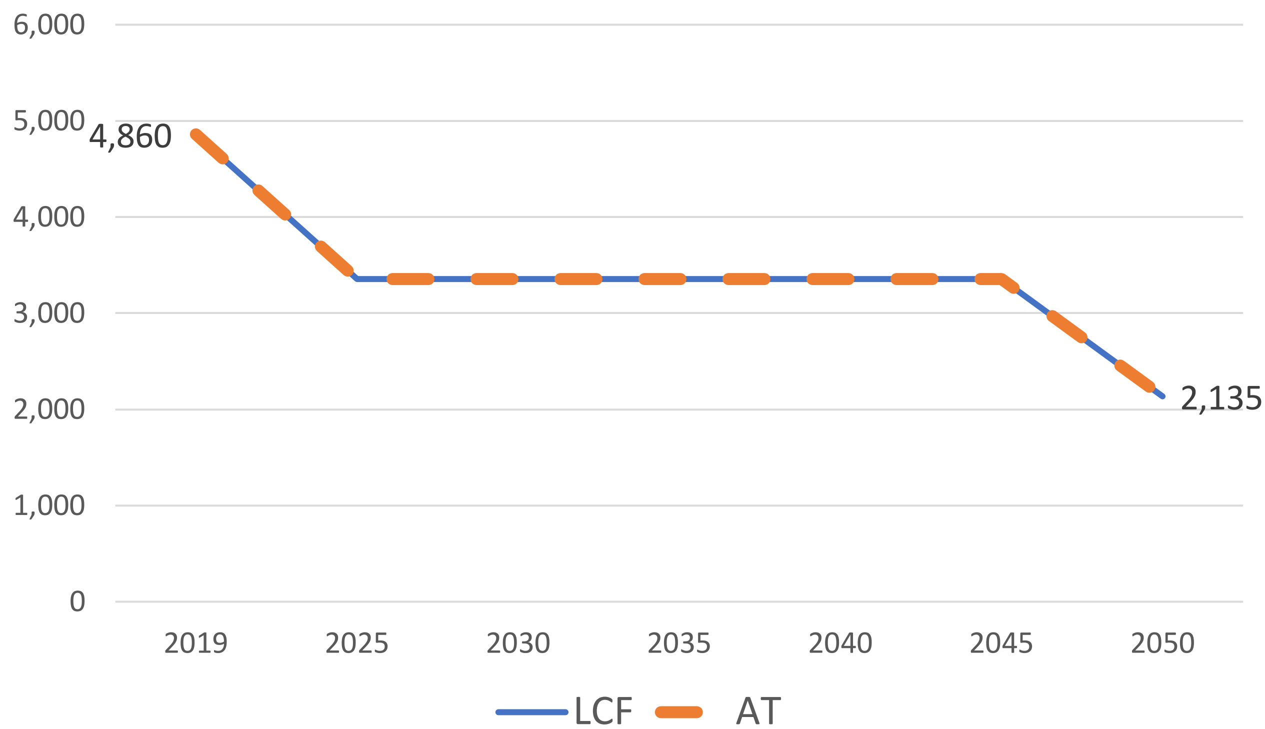
Nuclear

Nuclear, a displaced sub-sector, consists of technologies like nuclear power plants.[44]

For both scenarios—which trend along the same line—capacity installed for the nuclear sub-sector falls from a baseline of 4,860 MW in 2019 to 3,355 MW in 2025 (Figure 45). Nuclear capacity remains at the 2025 level until 2045, followed by a fall to 2,135 MW in the final year of analysis.

Specifically, the model factored in employment losses from the decommissioning of Indian Point Energy Center.

FIGURE 45. NUCLEAR: CAPACITY INSTALLED (MW)



Nuclear will lose 3,815 jobs between 2019 and 2050 for both LCF and AT scenarios (Figures 46 and 47). This displacement is largely driven by losses in the other supply chain and induced industries, each respectively losing a total of 1,660 and 1,687 jobs from 2019 to 2050.

[44] Processed investment streams are not featured for Nuclear because these models relied on capacity installed.

FIGURE 46. NUCLEAR: EMPLOYMENT OUTPUTS (S2: LCF)

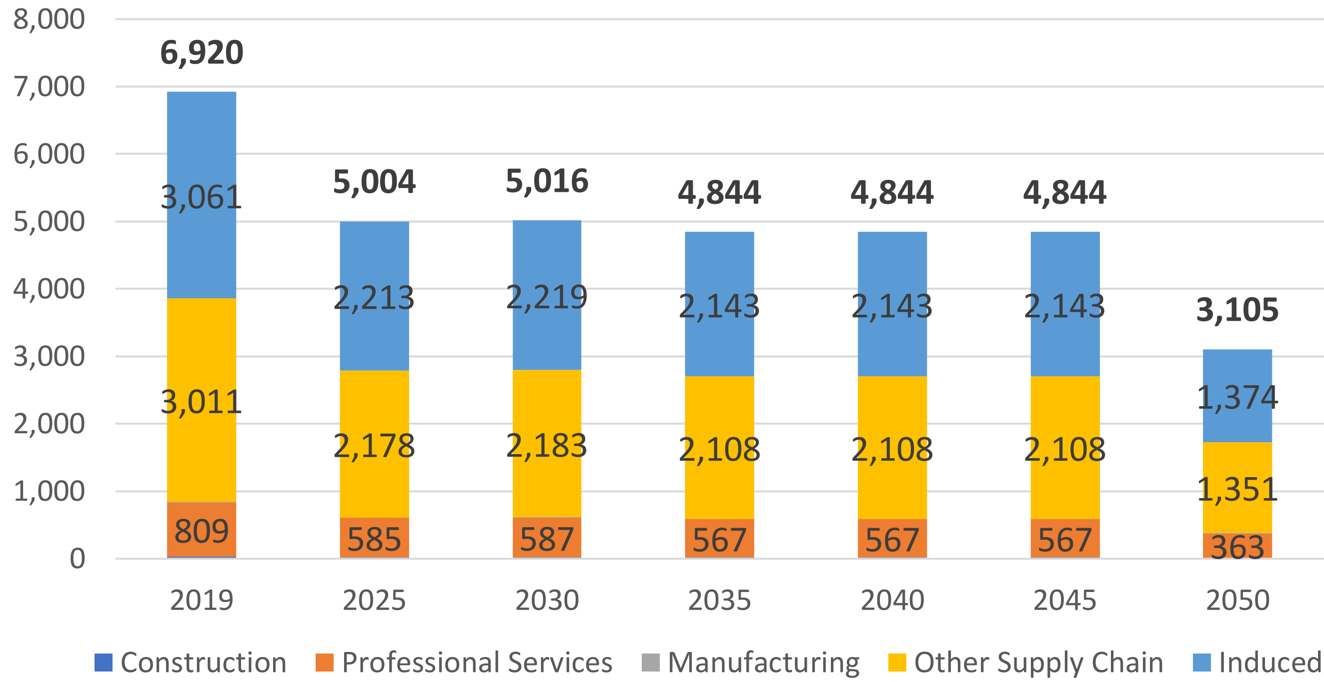
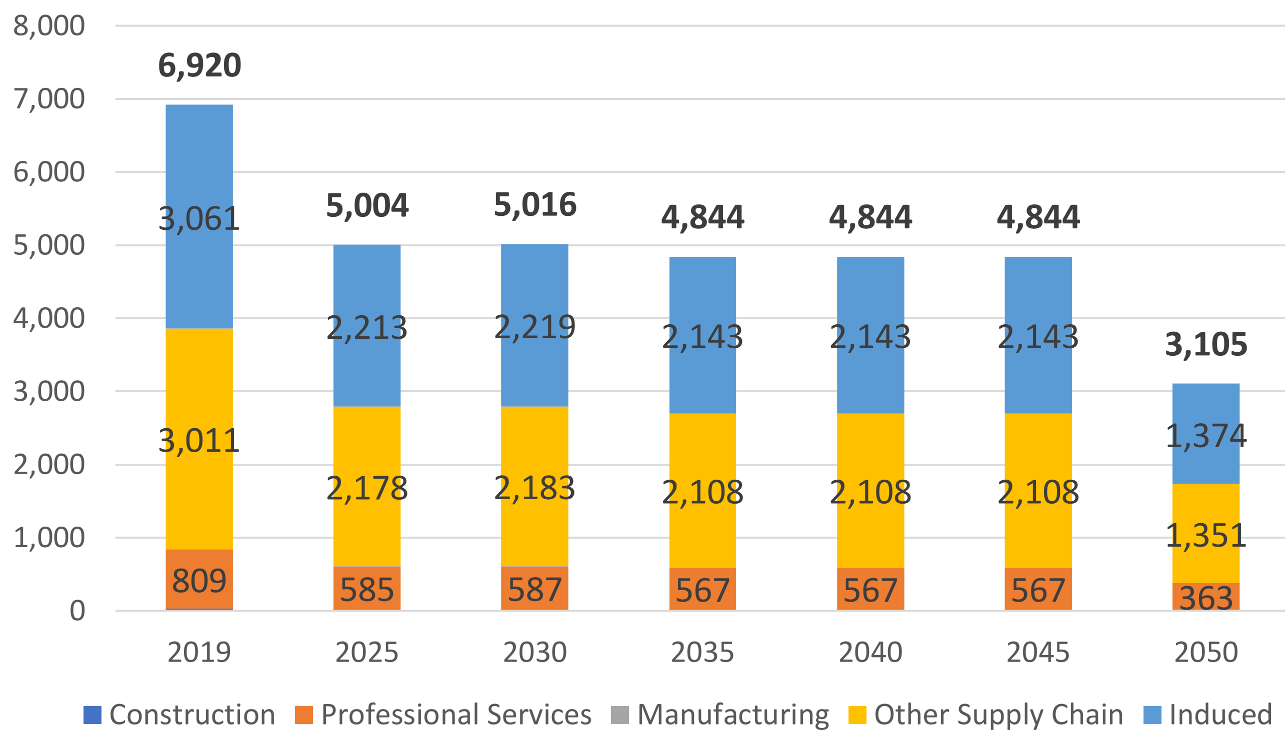


FIGURE 47. NUCLEAR: EMPLOYMENT OUTPUTS (S3: AT)



FUELS SECTOR

The fuels sector is made up of the natural gas, natural gas distribution, petroleum fuels, hydrogen fuels, and bioenergy subsectors.

On net, overall employment in the Fuels sector under the LCF scenario will decline to approximately 26,000 by 2030, a loss of more than 1,100 jobs from the 2019 baseline (Table 14). Total jobs in the fuels sector will continue to decline through 2050, reaching more than 13,000 workers.

These declines are driven by losses in the natural gas, natural gas distribution, and petroleum subsectors, in which employment falls to 14,300 by 2030, a loss of more than 4,500 compared to the 2019 workforce. Jobs continue to decline in these subsectors through 2050, reaching about 1,000 in the final year of the analysis. Although net employment will decline in the fuels sector, the hydrogen fuels and bioenergy subsectors will experience considerable growth by 2030 and 2040. In 2030, hydrogen fuels and bioenergy will experience employment increases to approximately 8,200 jobs; this is more than double the 2019 workforce and represents 5,000 jobs added to employment figures. By 2040, these two subsectors will see quadruple the employment figures in 2019, growing to as much as 11,000 and adding at least 8,000 jobs to fuels.

TABLE 13. FUELS: OVERALL EMPLOYMENT OUTPUTS (S2: LCF)

SUB-SECTOR	YEAR						
	2019	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Hydrogen Fuels	0	914	1,616	2,500	3,566	4,814	6,244
Bioenergy	2,882	5,074	6,576	7,388	7,509	6,940	5,681
Displacement Sub-Sectors							
Natural Gas	5,281	4,329	3,391	2,469	1,561	668	0
Natural Gas Distribution	7,878	8,214	7,488	5,719	3,987	2,432	1,316
Petroleum Fuels	11,077	8,921	6,874	4,937	3,109	1,390	0
FUELS OVERALL	**27,118**	**27,452**	**25,946**	**23,013**	**19,732**	**16,244**	**13,241**
Net Change from 2019		**+ 334**	**- 1,172**	**- 4,105**	**- 7,386**	**- 10,874**	**- 13,877**

On net, overall employment in the fuels sector under the AT scenario will decline to as low as 23,500 by 2030, a total of 3,500 jobs lost (Table 15). Total jobs in the fuels sector will continue to decline through 2050, reaching more than 7,000 workers.

These declines are driven by losses in the natural gas, natural gas distribution, and petroleum subsectors, in which employment falls to 19,400 by 2030, a loss of more than 4,800 jobs. Jobs continue to decline in these subsectors through 2050, reaching about 2,200 in the final year of the analysis.

Although net employment will decline in the fuels sector, the hydrogen fuels and bioenergy subsectors will experience considerable growth by 2030 and 2040. Though bioenergy jobs are projected to decline after 2035, hydrogen fuels will continue to grow through 2050.

TABLE 14. FUELS: OVERALL EMPLOYMENT OUTPUTS (S3: AT)

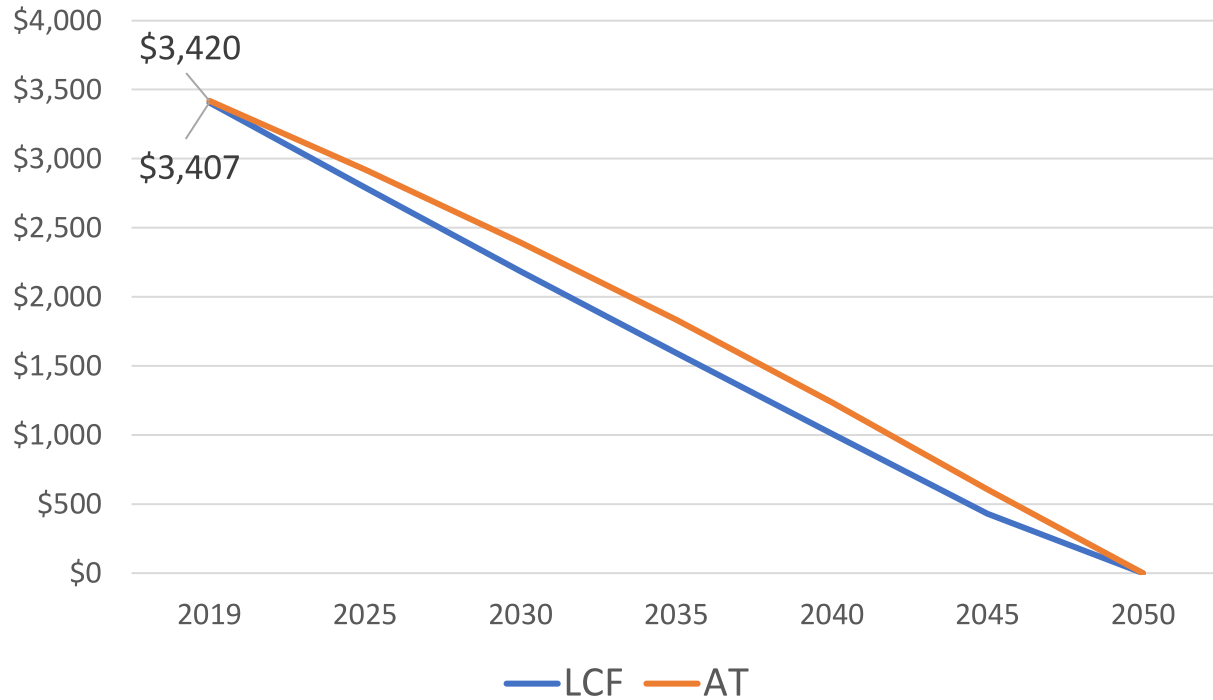
SUB-SECTOR	YEAR						
	2019	2025	2030	2035	2040	2045	2050
Growing Sub-Sectors							
Hydrogen Fuels	0	136	415	835	1,396	2,098	2,941
Bioenergy	2,882	3,473	3,733	3,661	3,259	2,524	1,960
Displacement Sub-Sectors							
Natural Gas	5,281	4,516	3,699	2,830	1,910	937	0
Natural Gas Distribution	7,878	8,381	7,451	5,839	3,925	2,158	879
Petroleum Fuels	11,077	9,736	8,283	6,719	5,042	3,253	1,353
FUELS OVERALL	**27,118**	**26,242**	**23,581**	**19,884**	**15,532**	**10,971**	**7,133**
Net Change from 2019		**- 876**	**- 3,537**	**- 7,233**	**- 11,586**	**- 16,147**	**- 19,985**

Natural Gas

The natural gas sub-sector, a displaced subsector, consists of technologies like natural gas fuels.

Overall processed investment streams for the LCF and AT scenarios have baseline values of $3,407M and $3,420M, respectively (Figure 48). Investments for both scenarios decrease down to $0M by 2050.

FIGURE 48. NATURAL GAS: OVERALL PROCESSED INVESTMENT ($M)



Overall, Natural Gas industries will lose 5,281 jobs between 2019 and 2050 in both scenarios, with employment figures going down to zero in the final year of analysis (Figures 49 and 50). The displacement is largely driven by the induced and other supply chain industries, which lose 3,040 and 1,396 jobs, respectively.

FIGURE 49. NATURAL GAS: EMPLOYMENT OUTPUTS (S2: LCF)

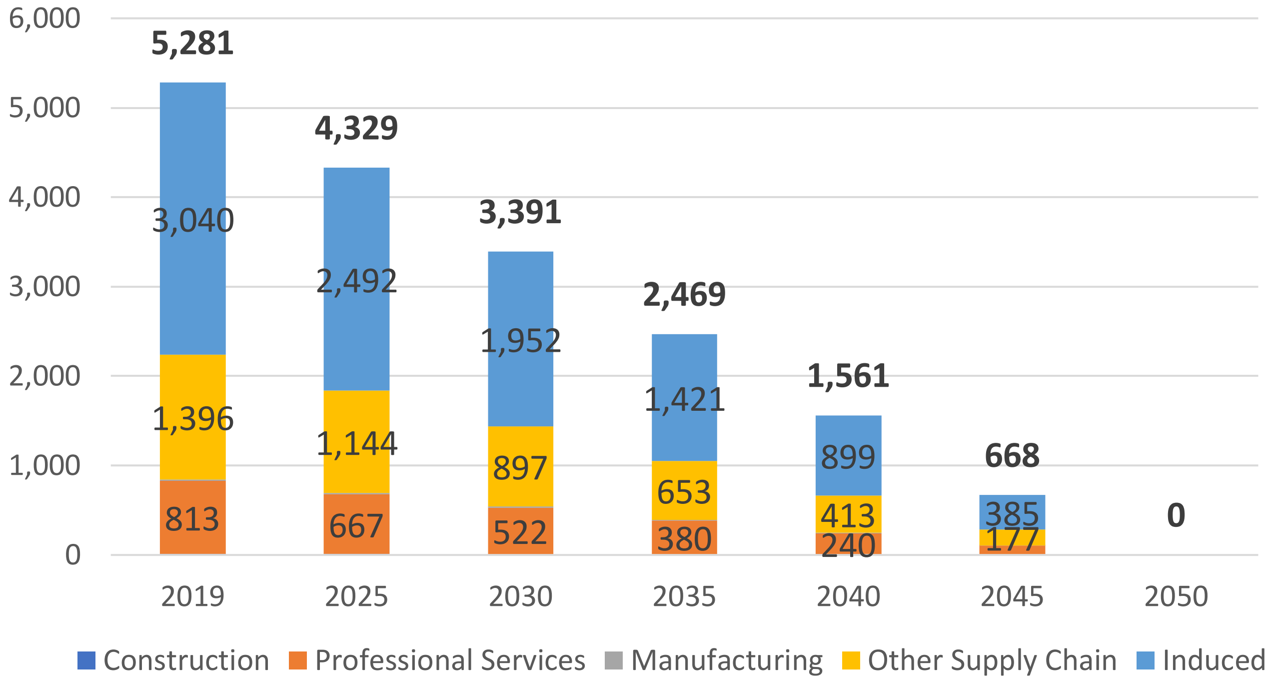
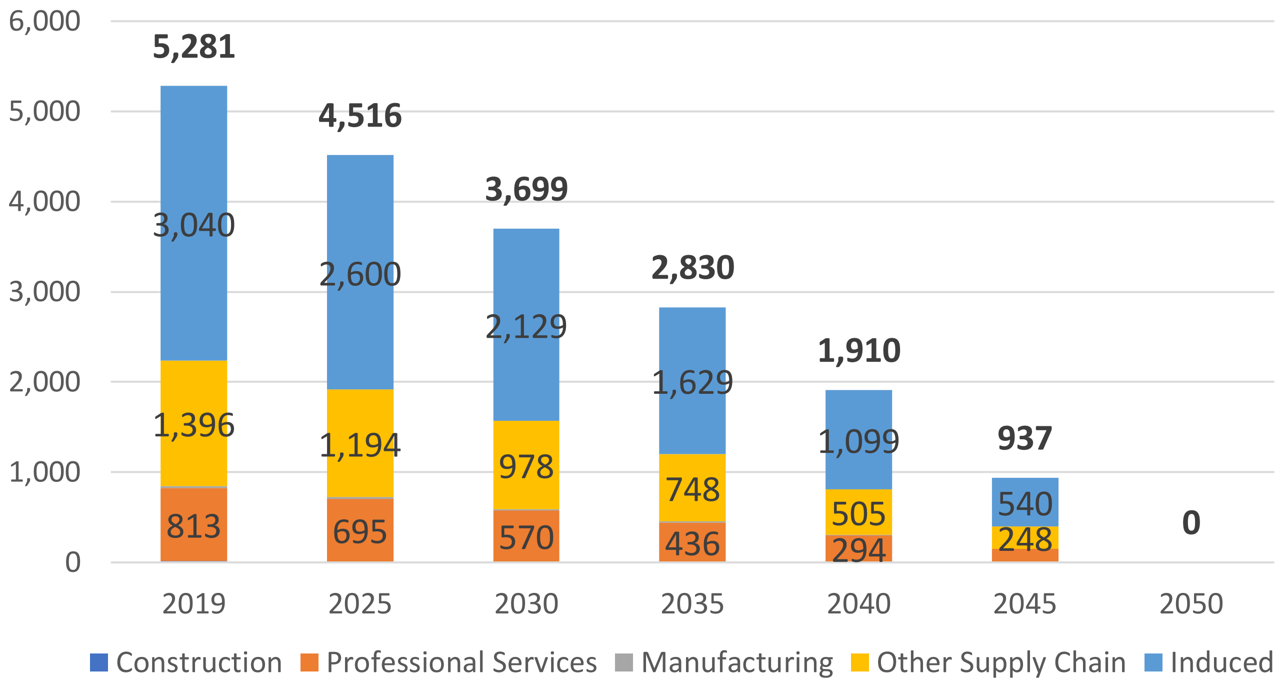


FIGURE 50. NATURAL GAS: EMPLOYMENT OUTPUTS (S3: AT)

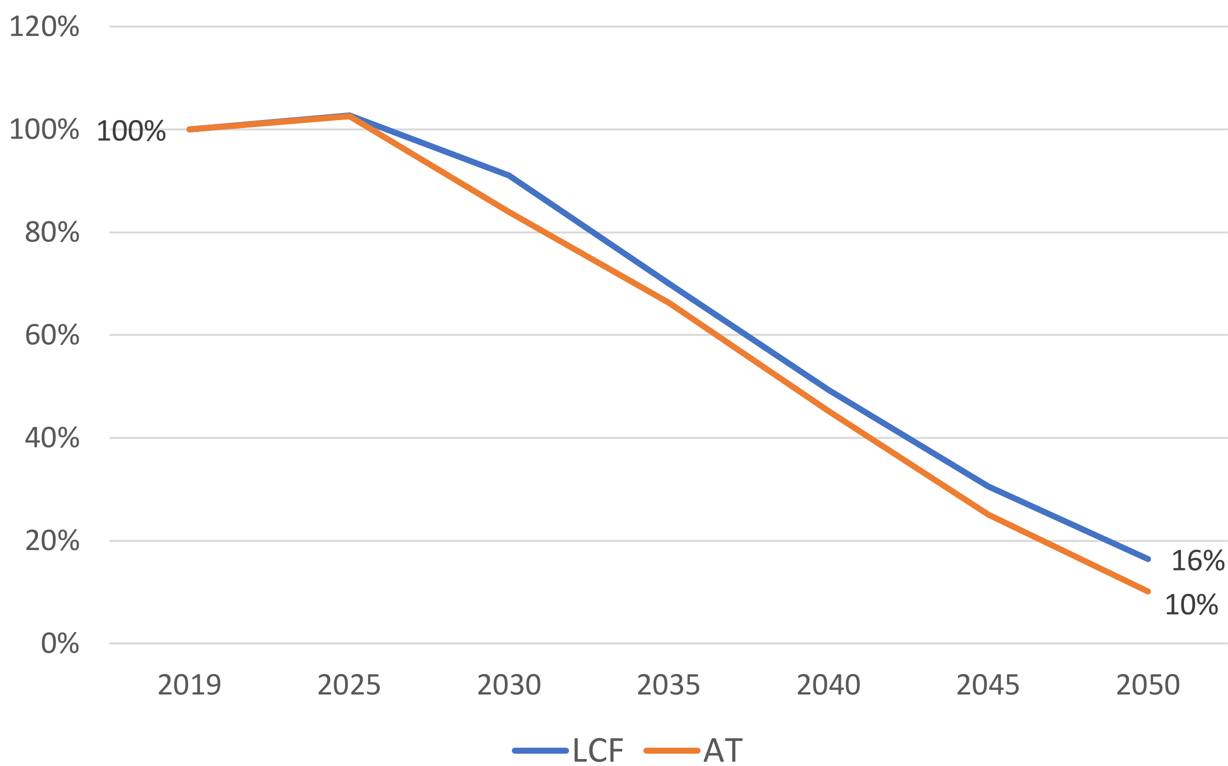


Natural Gas Distribution

The natural gas distribution, a displaced sub-sector, consists of technologies like natural gas pipelines and LNG trucks and tankers.

In the baseline year, the gas connections index for both scenarios are 100 percent and peaks at 103 percent in 2025, before gradually declining until 2050 (Figure 51). The AT scenario index trends lower than the LCF scenario index until 2050, when the AT and LCF scenarios conclude the analysis at 10 percent and 16 percent, respectively.

FIGURE 51. NATURAL GAS DISTRIBUTION: GAS CONNECTIONS INDEX



Overall, Other Supply Chain and Induced industries, which when combined consistently occupy over 80 percent of sub-sector share, will drive most of the displacement of approximately 7,000 jobs in Natural Gas Distribution for both scenarios (Figures 52 and 53). Construction and manufacturing will experience the least displacement whereas professional services will lose more than 1,000 jobs between 2019 and 2050. Peak employment across all industries occurs in 2025, corresponding to peak values of the gas connections index in both scenarios.

FIGURE 52. NATURAL GAS DISTRIBUTION: EMPLOYMENT OUTPUTS (S2: LCF)

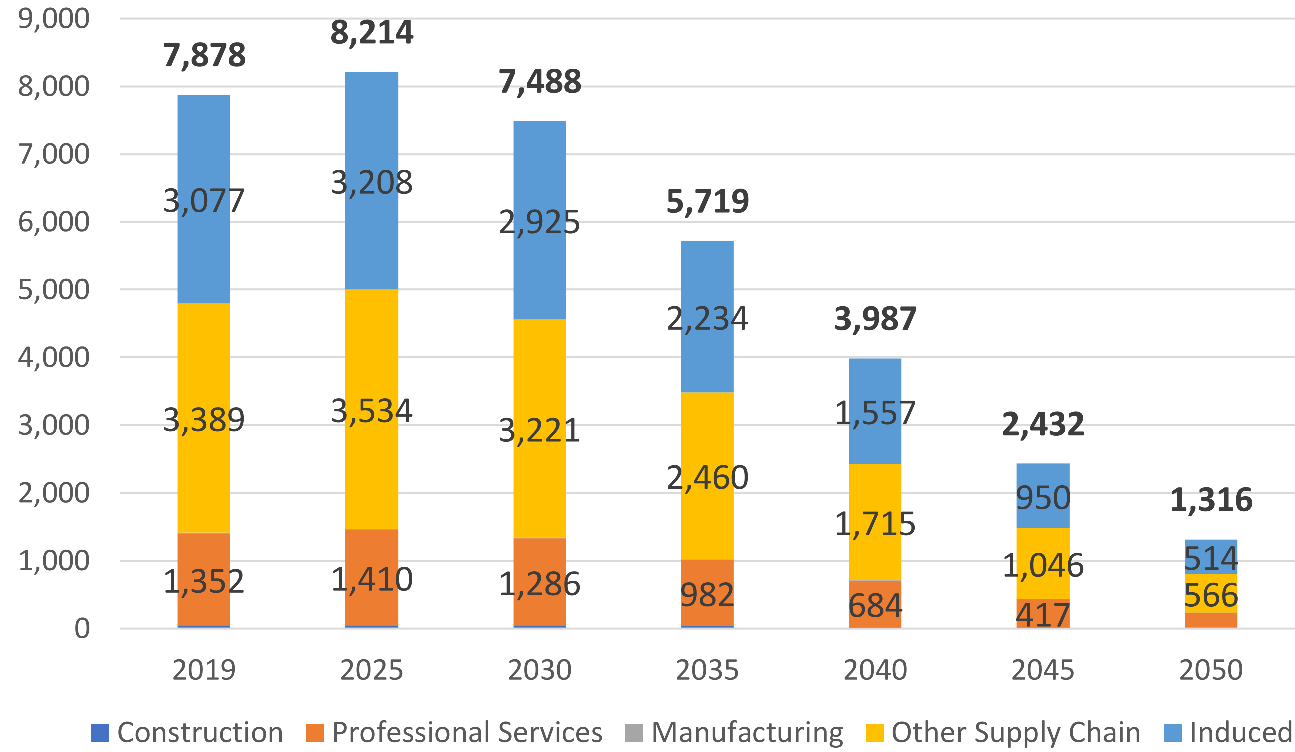
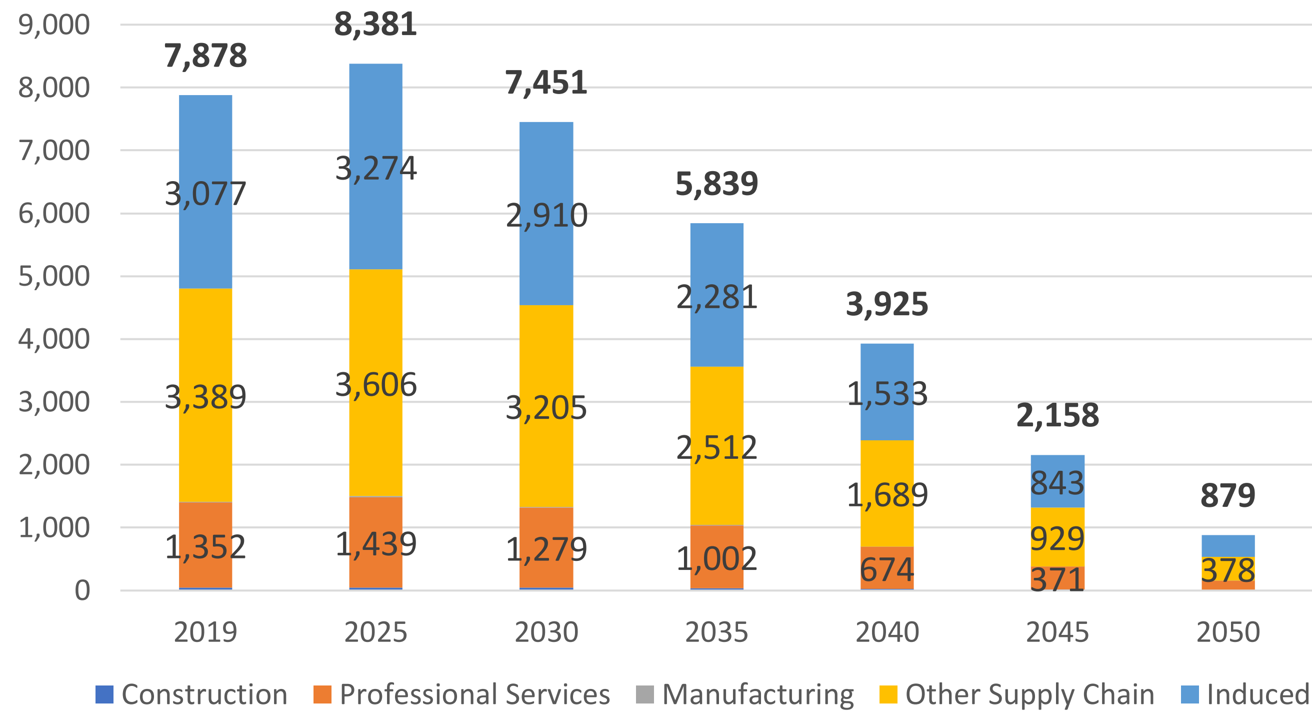


FIGURE 53. NATURAL GAS DISTRIBUTION: EMPLOYMENT OUTPUTS (S3: AT)

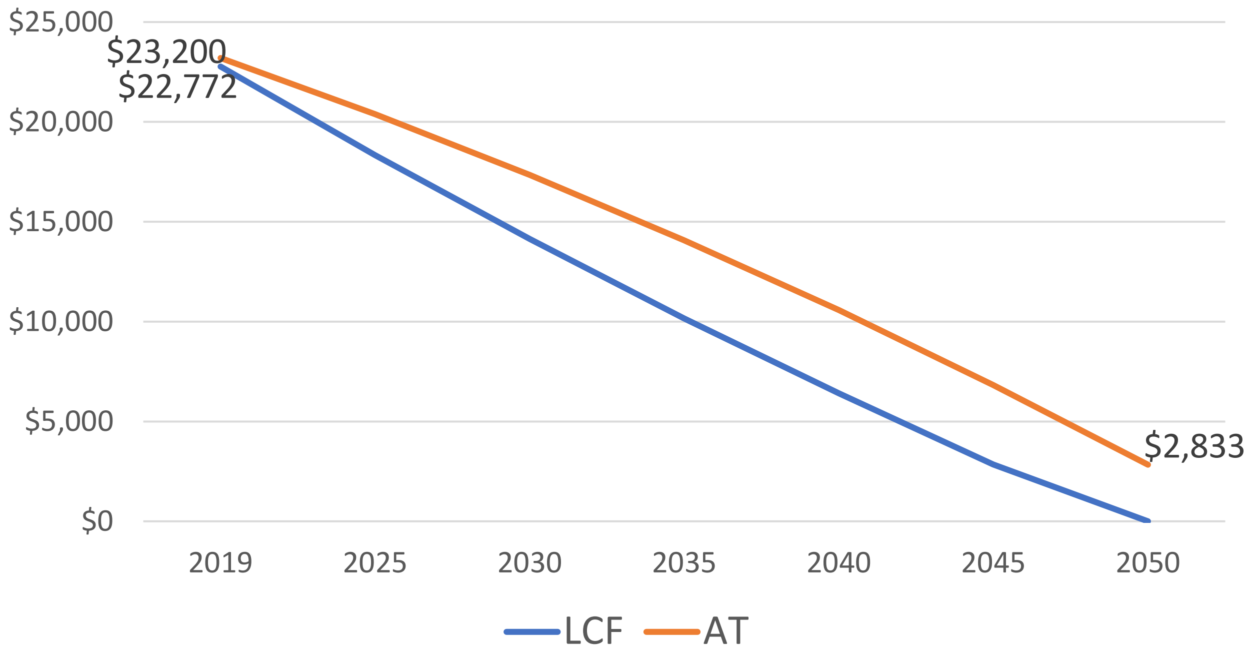


Petroleum Fuels

Petroleum fuels, a displaced subsector, consists of technologies like oil and gas pipelines, oil and gas tanker trucks, naphtha, and kerosene.

Between 2019 and 2050, overall processed investments in petroleum fuels gradually declines in both scenarios, with the LCF scenario trending lower than the AT scenario. In 2019, the LCF and AT scenarios have a difference of $428M in baseline processed investments; this difference is exacerbated to $2,833 by the final year of analysis (Figure 54).

FIGURE 54. PETROLEUM FUELS: OVERALL PROCESSED INVESTMENT STREAM ($M)



Due to decreasing investments in the LCF scenario, all industries will be displaced by the final year of analysis, which corresponds to a loss of more than 11,000 jobs in petroleum fuels between 2019 and 2050 (Figure 55). In the same period, the AT scenario will lead to a loss of 10,000 jobs across all industries, leaving more than 1,300 total jobs in 2050 (Figure 56). In both scenarios, induced and other supply chain, which represent approximately 80 percent of petroleum fuels, will drive the displacement.

FIGURE 55. PETROLEUM FUELS: EMPLOYMENT OUTPUTS (S2: LCF)

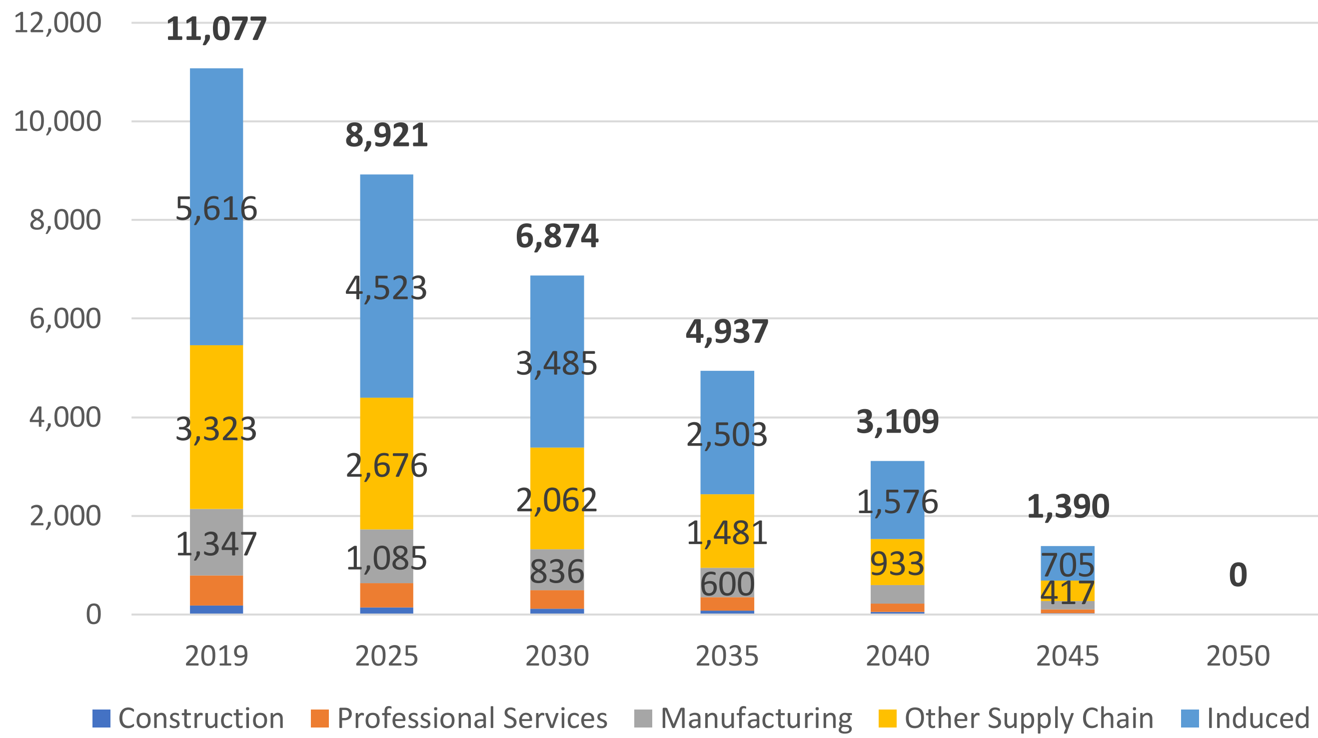
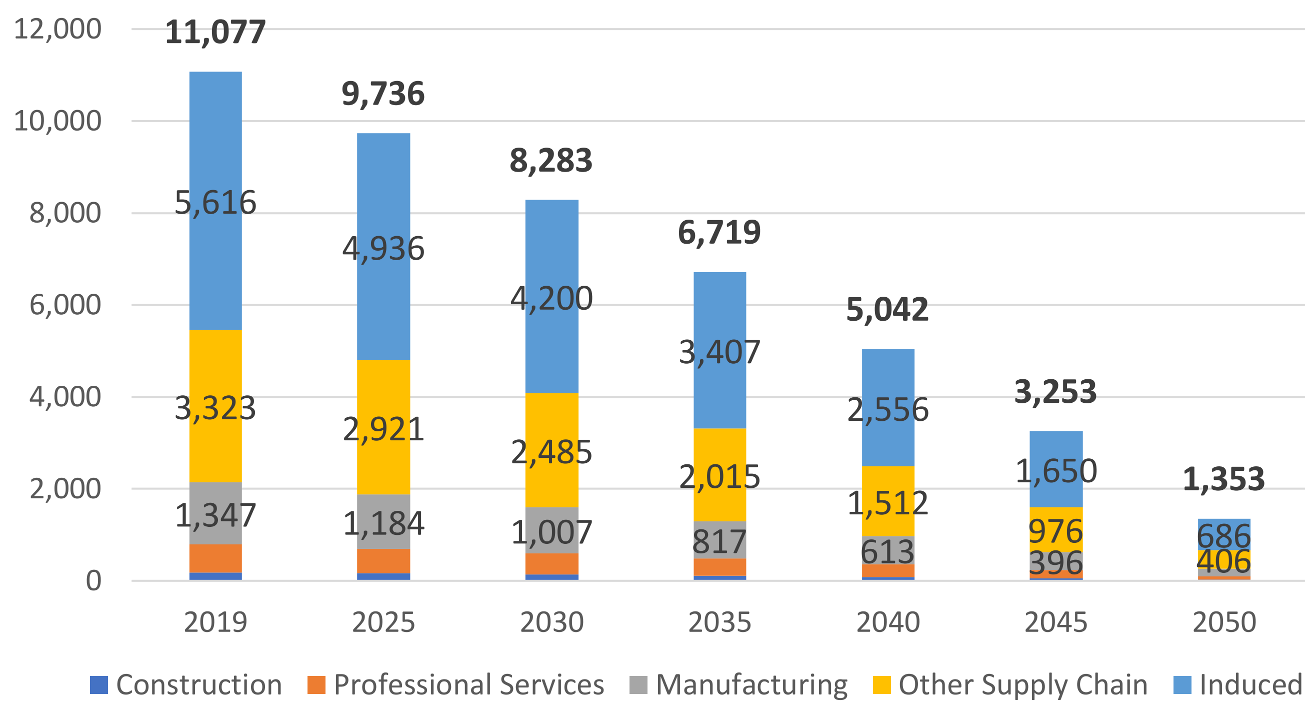


FIGURE 56. PETROLEUM FUELS: EMPLOYMENT OUTPUTS (S3: AT)

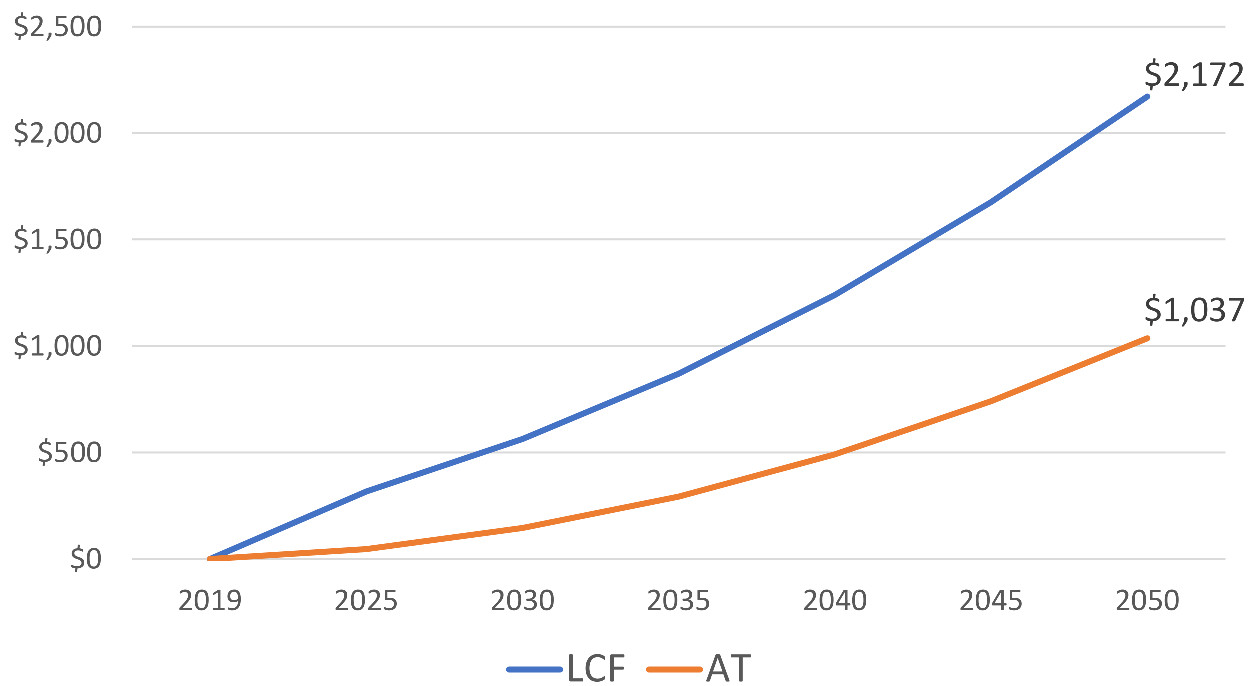


Hydrogen Fuels

The hydrogen fuels subsector consists of technologies like hydrogen as a fuel.

Both LCF and AT scenarios see increased investments, growing from $0M in 2019 to $2,172M and $1,037M in 2050, respectively (Figure 57). The LCF scenario consistently processes higher investments in all years; however, both scenarios exhibit similar upward trends.

FIGURE 57. HYDROGEN FUELS: OVERALL PROCESSED INVESTMENT STREAM ($M)



The $1,135M difference in 2050 overall investments leads to different employment outcomes for the LCF and AT scenarios (Figures 58 and 59). Hydrogen fuels employment in the LCF scenario will grow from zero jobs in 2019 to 6,244 jobs in 2050, compared to 2,941 for the AT scenario. In both scenarios, induced employment—which accounts for more than 50 percent of the hydrogen fuels subsector from 2019 to 2050—will experience the most growth, followed by other supply chain, which represents approximately 26 percent of the subsector.

FIGURE 58. HYDROGEN FUELS: EMPLOYMENT OUTPUTS (S2: LCF)

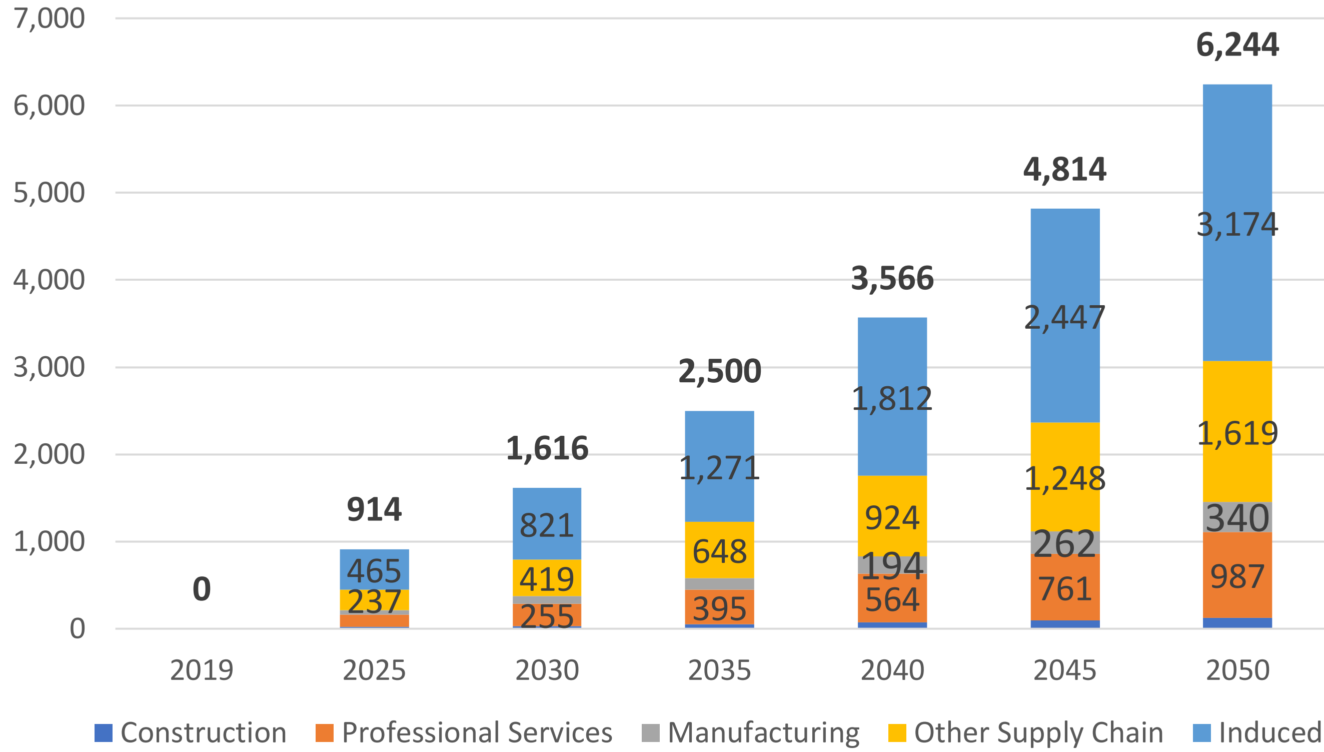
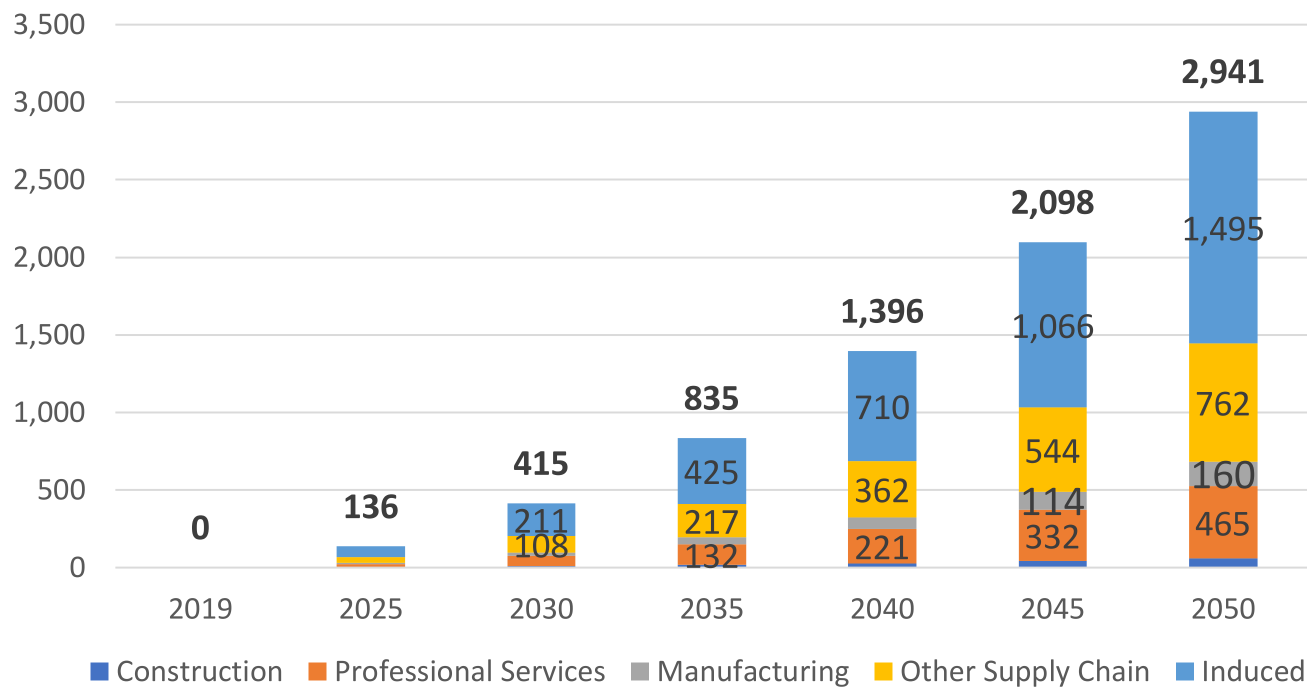


FIGURE 59. HYDROGEN FUELS: EMPLOYMENT OUTPUTS (S3: AT)

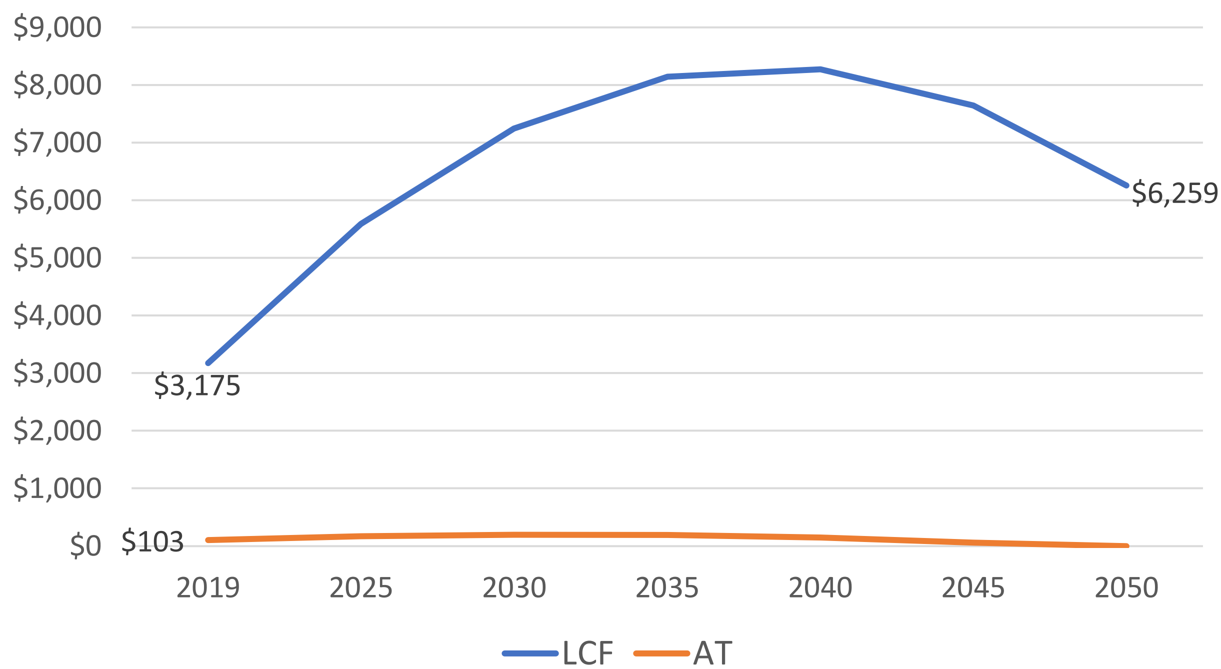


Bioenergy

The bioenergy subsector consists of technologies like ethanol, biodiesel, renewable diesel, renewable gasoline, renewable jet fuel, renewable natural gas, and jet kerosene.

The LCF and AT scenarios follow differing trends with respect to overall processed investment streams between 2019 and 2050, with the LCF scenario processing more investments than the AT scenario (Figure 60). LCF investments, which start off at a baseline of $3,175M in 2019, increase steadily to a peak of $8,273M in 2040, before gradually decreasing to $6,259M in 2050. From a baseline of $103M in 2019, AT investments peak at $198M in 2030, before steadily decreasing to $0M by 2050.

FIGURE 60. BIOENERGY: OVERALL PROCESSED INVESTMENT STREAM ($M)



Despite the same baseline employment figures across industries in 2019, employment outcome differs due to the differing levels of investment resulting in the LCF scenario leading to growth and the AT scenario leading to displacement by the final year of analysis (Figures 61 and 62).

In the LCF scenario, bioenergy will grow by a total of 2,799 jobs between 2019 and 2050, experiencing peak growth in 2040 before gradually declining. The growth is driven by close to 1,500 jobs gained in construction, followed by over 700 jobs in Induced employment, which represent more than 75 percent of bioenergy jobs when combined.

FIGURE 61. BIOENERGY: EMPLOYMENT OUTPUTS (S2: LCF)

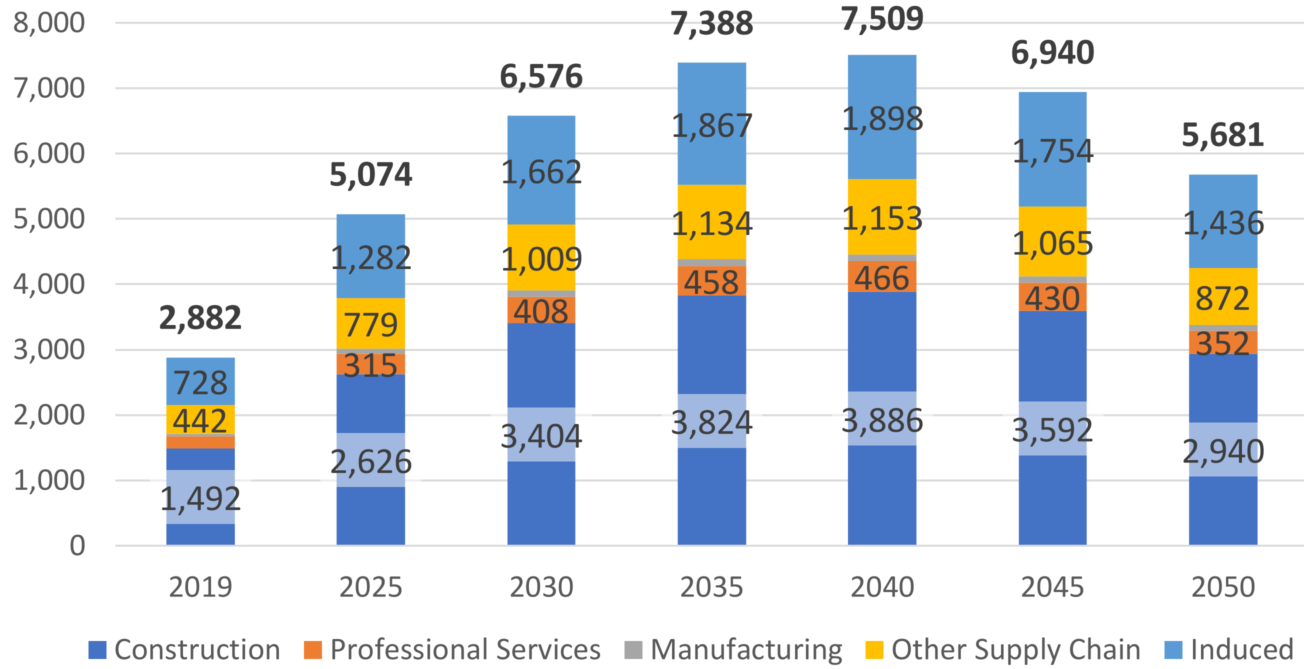
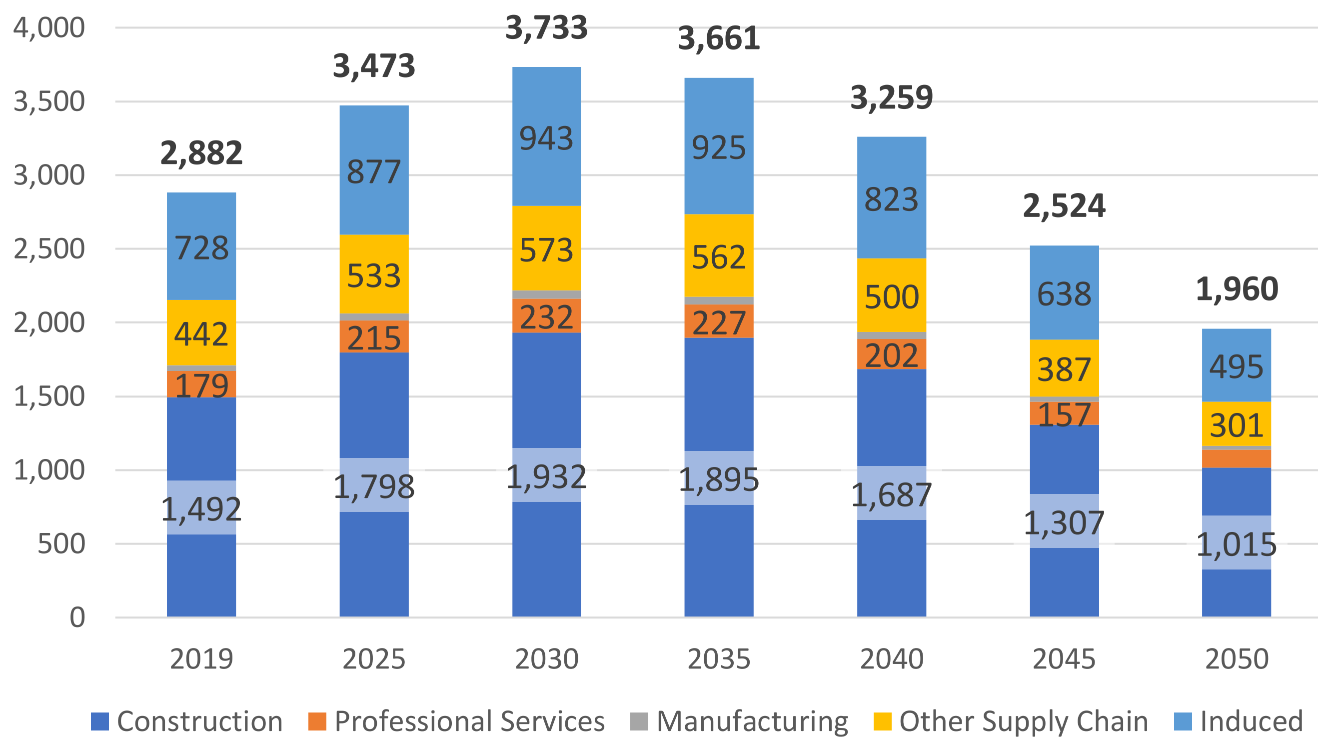


FIGURE 62. BIOENERGY: EMPLOYMENT OUTPUTS (S3: AT)



BUILDINGS SECTOR

Buildings consists of six sub-sectors: commercial HVAC, commercial shell, commercial other, residential HVAC, residential shell, and residential other.

All six sub-sectors will drive growth for the buildings sector, though residential HVAC, residential shell, commercial HVAC, and commercial shell will experience the most growth in both scenarios. In the LCF scenario, employment in the buildings sector will grow to more than 305,000 by 2030, which is almost 140,000 jobs added to 2019 figures (Table 16).

Overall employment in the buildings sector will grow to approximately 366,000 by 2040, more than doubling the 2019 workforce by adding over 200,000 new jobs. Total jobs in the buildings sector will continue to increase to approximately 408,000 through 2050, adding more than 240,000 to 2019 baseline employment.

TABLE 15. BUILDINGS: OVERALL EMPLOYMENT OUTPUTS (S2: LCF)

SUB-SECTOR	YEAR						
	2019	2025	2030	2035	2040	2045	2050
Commercial HVAC	19,699	24,180	45,099	55,419	63,122	65,014	64,402
Commercial Shell	22,687	25,884	35,706	38,580	45,202	51,701	51,043
Commercial Other	55,530	63,408	67,212	65,213	65,213	65,213	65,213
Residential HVAC	18,954	29,985	62,580	78,440	84,117	99,989	109,276
Residential Shell	20,317	36,650	63,353	71,268	73,095	73,095	84,087
Residential Other	28,045	28,896	31,176	32,219	35,426	34,256	33,941
BUILDINGS OVERALL	**165,231**	**209,003**	**305,126**	**341,138**	**366,175**	**389,267**	**407,962**
Net Change from 2019		**+ 43,772**	**+ 139,895**	**+ 175,907**	**+ 200,944**	**+ 224,036**	**+ 242,731**

In the AT scenario, employment in the buildings sector will grow to more than 318,000 by 2030, adding over 152,000 jobs to 2019 figures (Table 17). Overall employment in the buildings sector will grow to approximately 367,000 by 2040, which adds over 200,000 new jobs.

Total jobs in the buildings sector will continue to increase to approximately 405,000 through 2050, adding just under 240,000 to 2019 baseline employment.

TABLE 16. BUILDINGS: OVERALL EMPLOYMENT OUTPUTS (S3: AT)

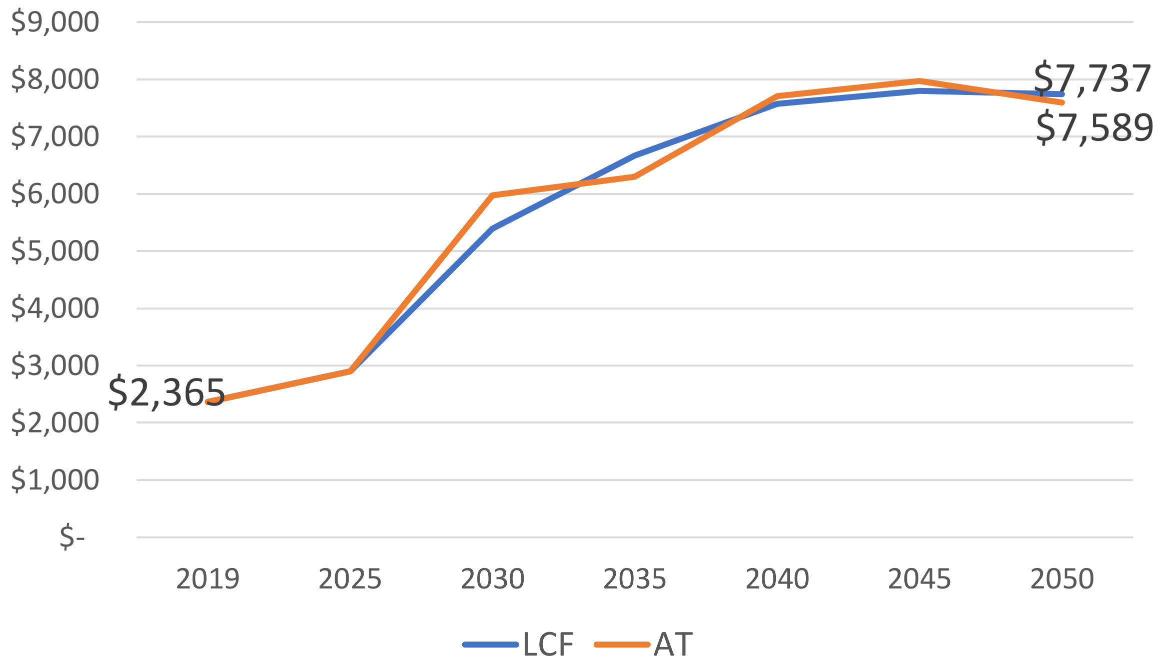
SUB-SECTOR	YEAR						
	2019	2025	2030	2035	2040	2045	2050
Commercial HVAC	19,699	24,179	49,717	52,472	64,173	66,398	63,222
Commercial Shell	22,687	25,884	35,706	38,580	45,202	51,701	51,043
Commercial Other	55,530	63,408	67,212	65,213	65,213	65,213	65,213
Residential HVAC	18,954	29,869	70,887	70,887	83,894	103,700	107,482
Residential Shell	20,317	36,650	63,353	71,268	73,095	73,095	84,087
Residential Other	28,045	28,896	31,176	32,219	35,426	34,256	33,941
BUILDINGS OVERALL	**165,231**	**208,887**	**318,050**	**330,639**	**367,003**	**394,363**	**404,988**
Net Change from 2019		**+ 43,656**	**+ 152,819**	**+ 165,407**	**+ 201,772**	**+ 229,131**	**+ 239,757**

Commercial HVAC

The commercial HVAC sub-sector consists of technologies like pipes, sheet metal, air conditioning, refrigeration, heating, power boilers, and heat exchangers (for commercial buildings).

The five-year average of overall processed investment grows from $2,365M in 2019 to separate 2050 averages of $7,737M and $7,589M for the LCF and AT scenarios, respectively (Figure 63). Investments in both scenarios peak in 2045 at $7,971M for the AT scenario and $7,798M for the LCF scenario.

FIGURE 63. COMMERCIAL HVAC: OVERALL 5-YEAR AVERAGE PROCESSED INVESTMENT STREAMS ($M)



Employment will grow across all industries between 2019 and 2050, peaking in 2045 for both scenarios; this peak coincides with peak investments processed for commercial HVAC. The nearly 45,000 overall job growth in both scenarios will be driven by construction, adding close to 30,000 jobs, and induced, adding more than 10,000 jobs. Both industries consistently maintain the largest share of the subsector from 2019 to 2050 (Figure 64 and 65).

FIGURE 64. COMMERCIAL HVAC: EMPLOYMENT OUTPUTS (S2: LCF)

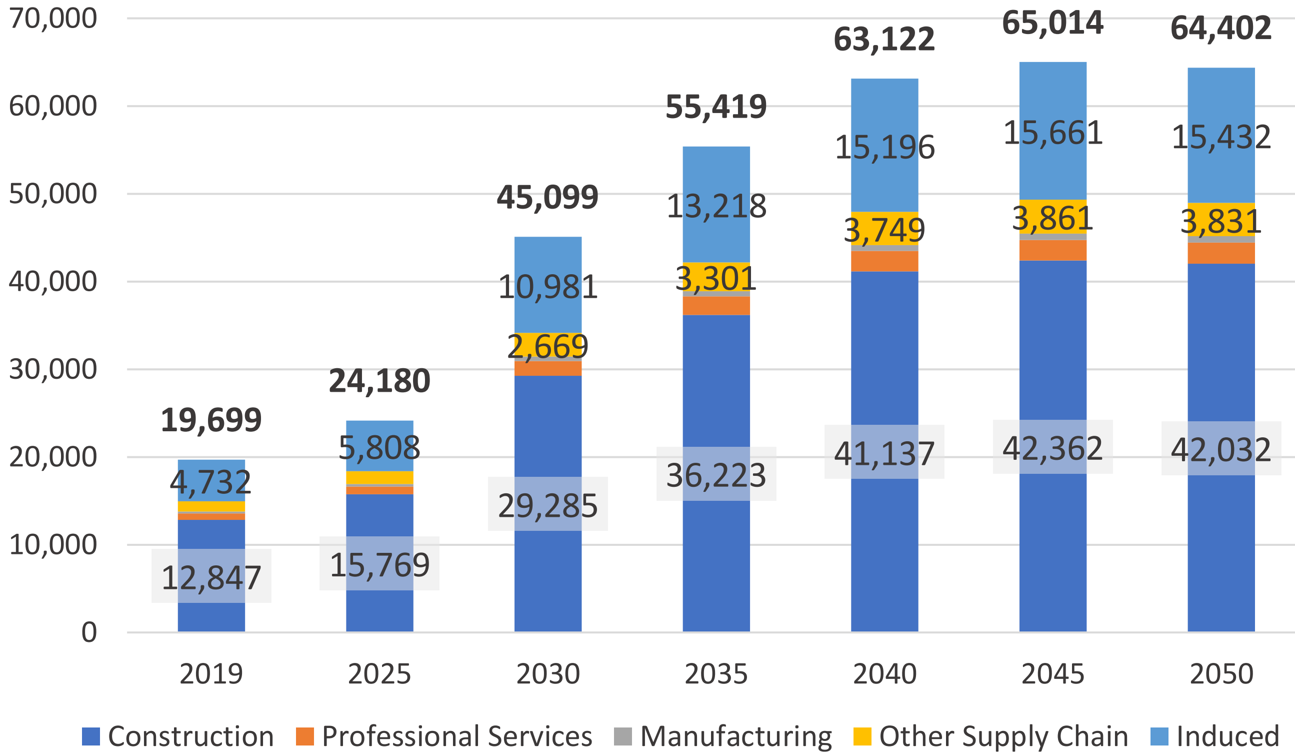
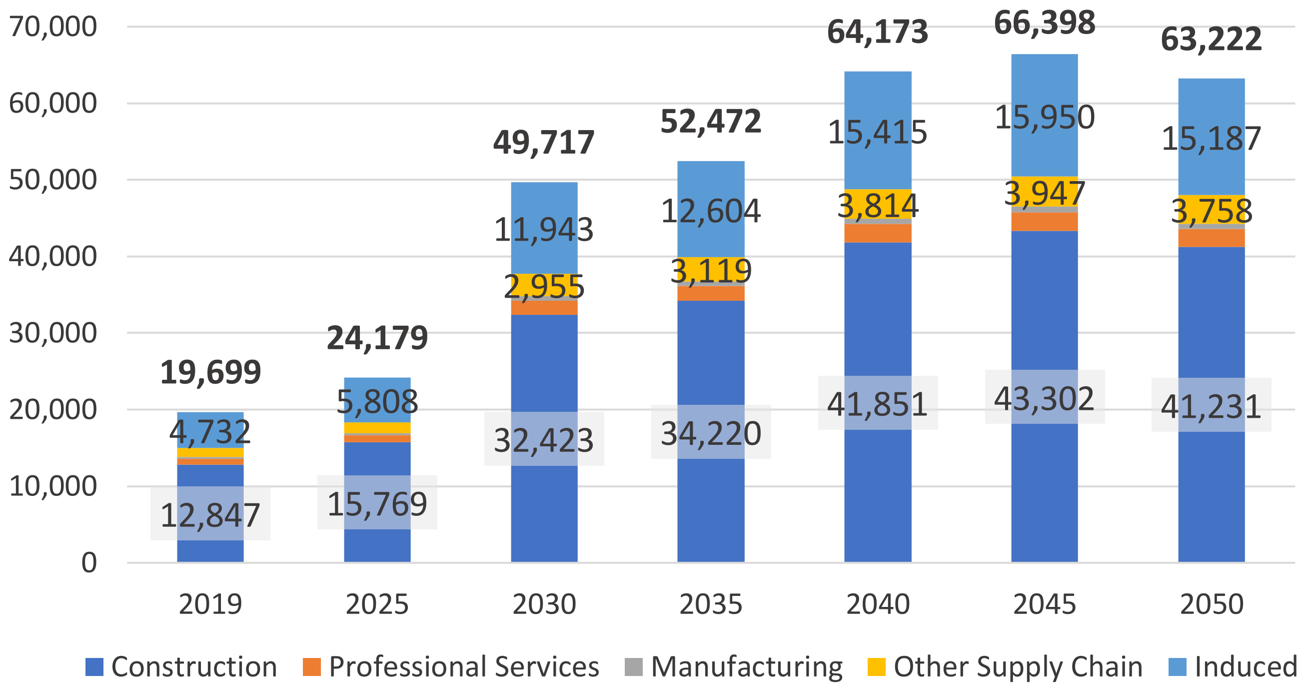


FIGURE 65. COMMERCIAL HVAC: EMPLOYMENT OUTPUTS (S3: AT)

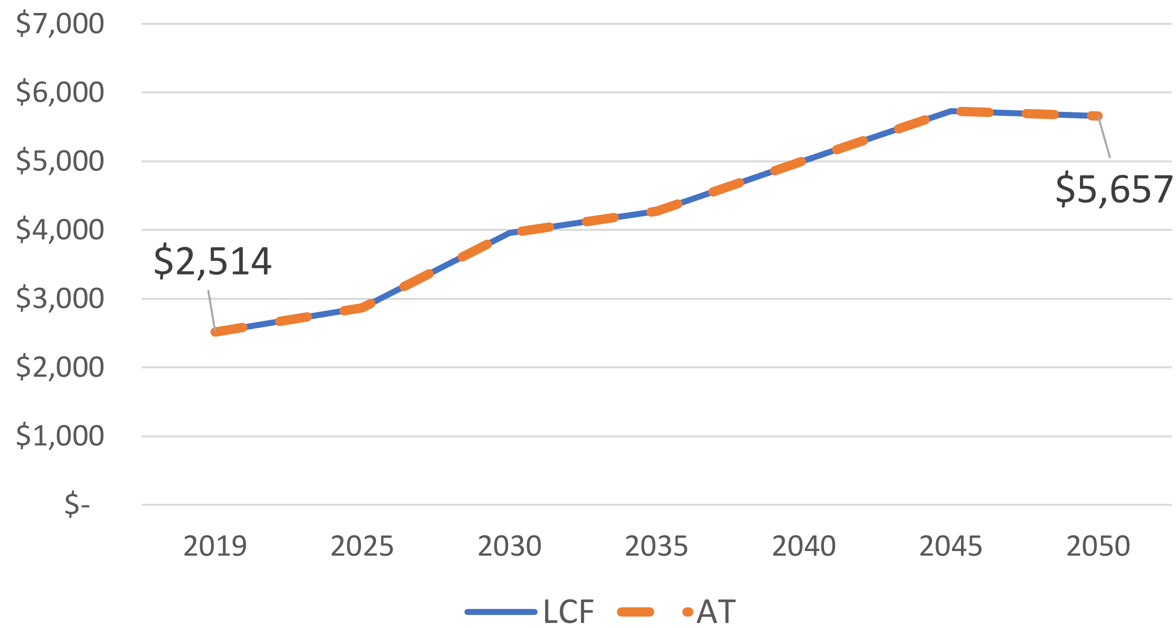


Commercial Shell

The commercial shell subsector consists of technologies like paints and coatings, windows, insulation, and doors (for commercial buildings).

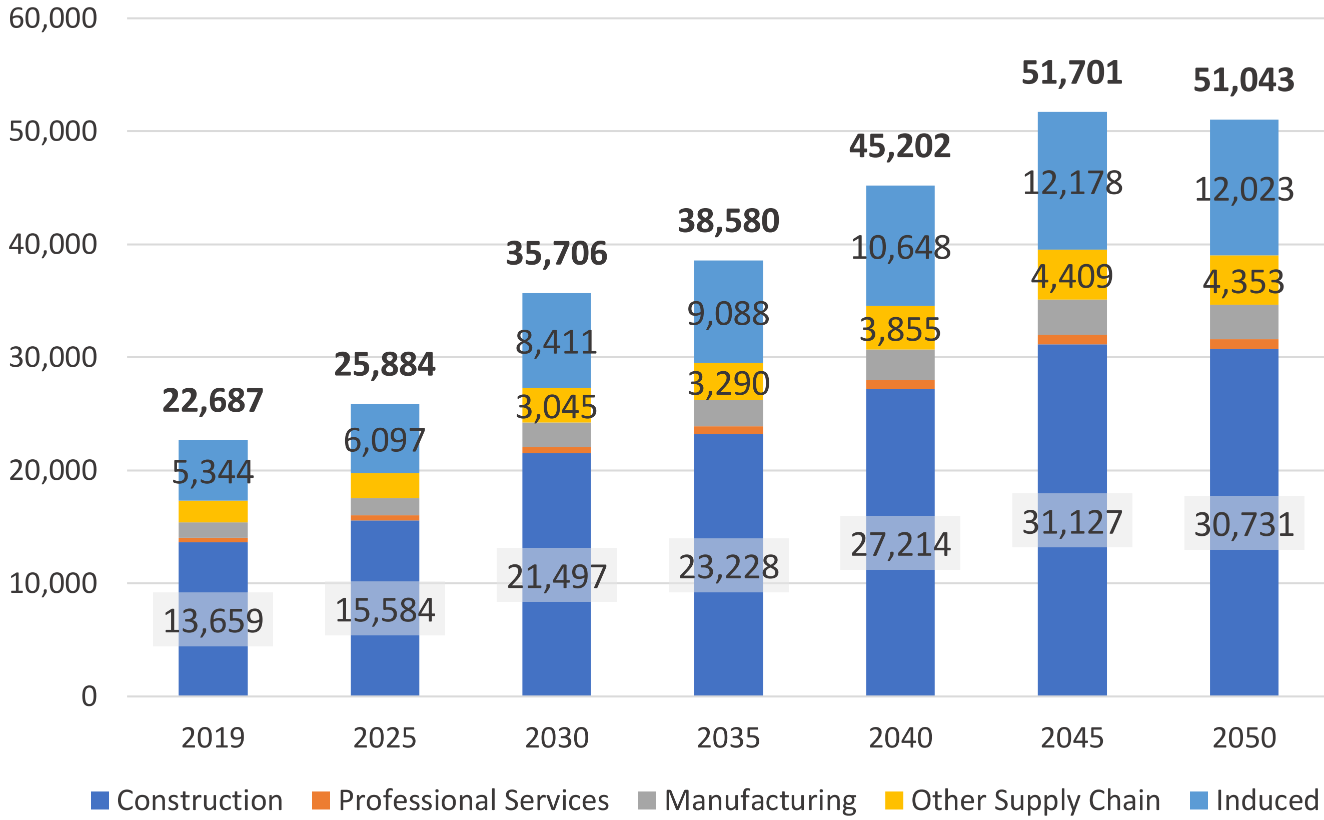
Figure 66 shows the five-year average of overall processed investments for both LCF and AT scenarios, which trend along the same line. Investment streams in commercial shell gradually grow from $2,514M in 2019 to $5,657M in 2050—a $3,143M increase by the final year.

FIGURE 66. COMMERCIAL SHELL: OVERALL 5-YEAR AVERAGE PROCESSED INVESTMENT STREAM ($M)



Commercial shell will add a total of 28,356 jobs between 2019 and 2050 for both scenarios, experiencing peak jobs added in 2045 which coincides with peak processed investments (Figure 67). Construction, which occupies about 60 percent of commercial shell, will drive this growth, adding more than 17,000 jobs by 2050. Induced employment, which represents approximately 23 percent of the subsector, will add at least 6,600 jobs in the same time frame. Manufacturing, representing less than two percent of the subsector, adds less than 500 jobs overall.

FIGURE 67. COMMERCIAL SHELL: EMPLOYMENT OUTPUTS (S2: LCF & S3: AT)

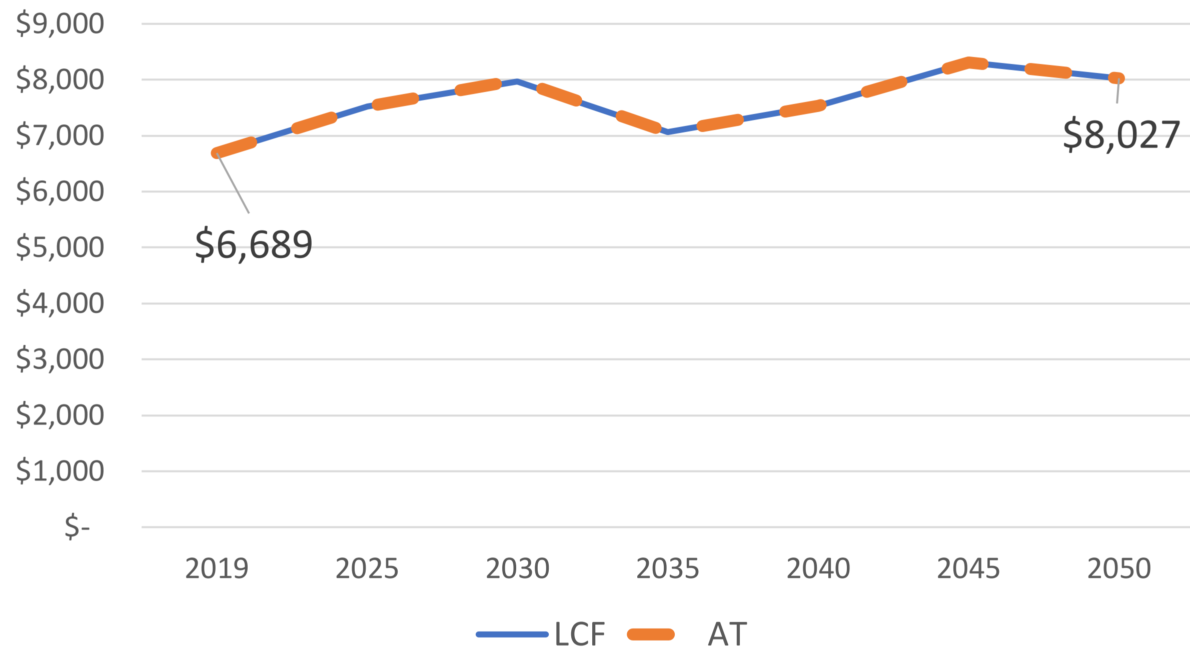


Commercial Other

The commercial other subsector consists of technologies like lighting fixtures, water heating, and cooking appliances (for commercial buildings).

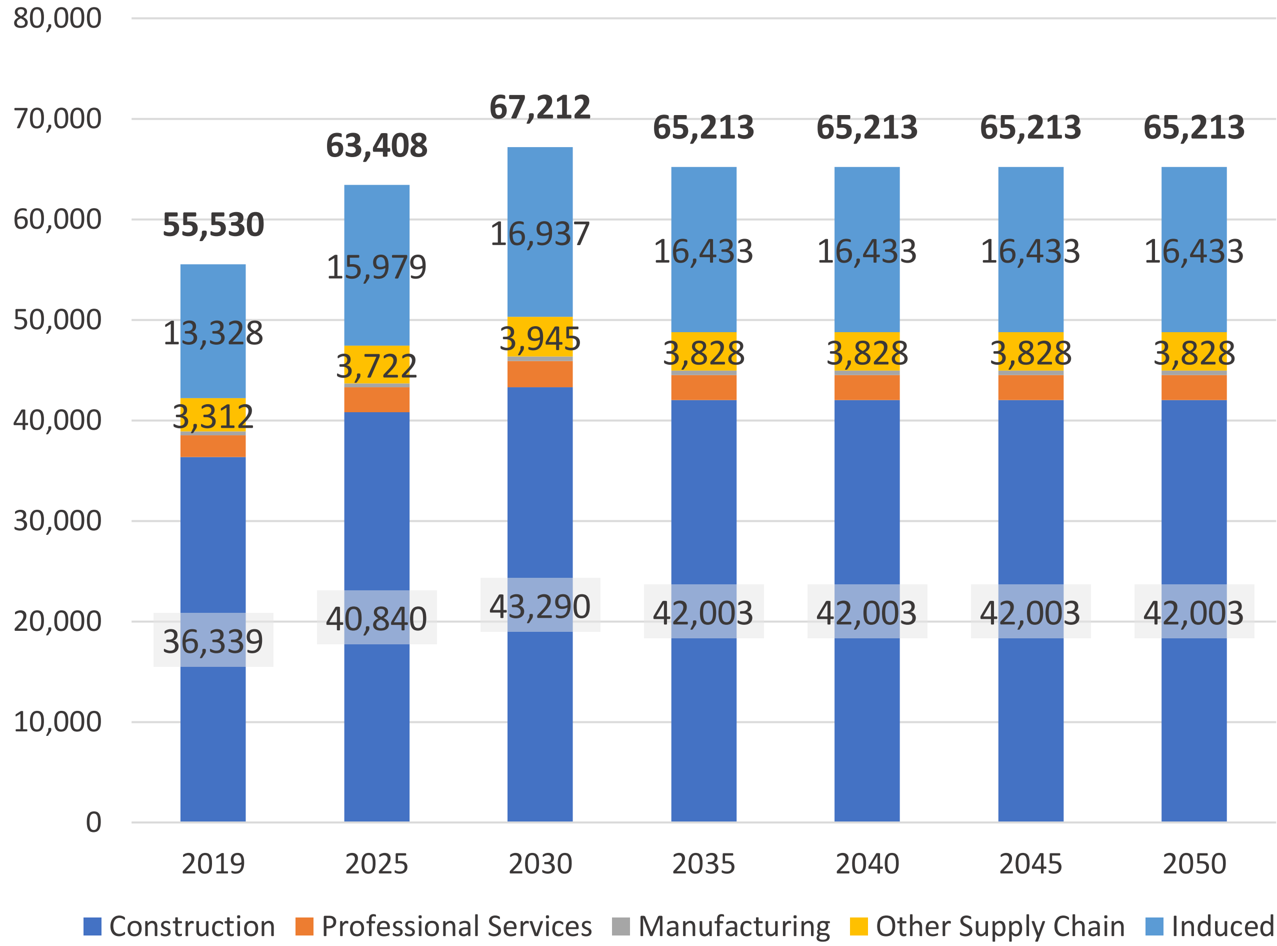
Commercial Other investments experience a $1,338M change between 2019 and 2050 for both scenarios, growing from a 2019 average of $6,689M to $8,027M in 2050. Overall average processed investments peak at $8,309M in 2045 for both scenarios (Figure 68).

FIGURE 68. COMMERCIAL OTHER: OVERALL FIVE-YEAR AVERAGE PROCESSED INVESTMENT STREAM ($M)



By the final year of analysis, commercial other industries will add a total of 9,683 jobs to baseline figures; this change will mostly be driven by the construction and induced industries, which account for approximately 90 percent of the subsector when combined (Figure 69). Peak employment outcomes will occur in 2030 for both scenarios when the subsector adds more than 11,600 jobs to baseline figures. Although employment outcomes will decline slightly after 2030, total jobs remain constant above the 2019 baseline until the final year of analysis.

FIGURE 69. COMMERCIAL OTHER: EMPLOYMENT OUTPUTS (S2: LCF & S3: AT)

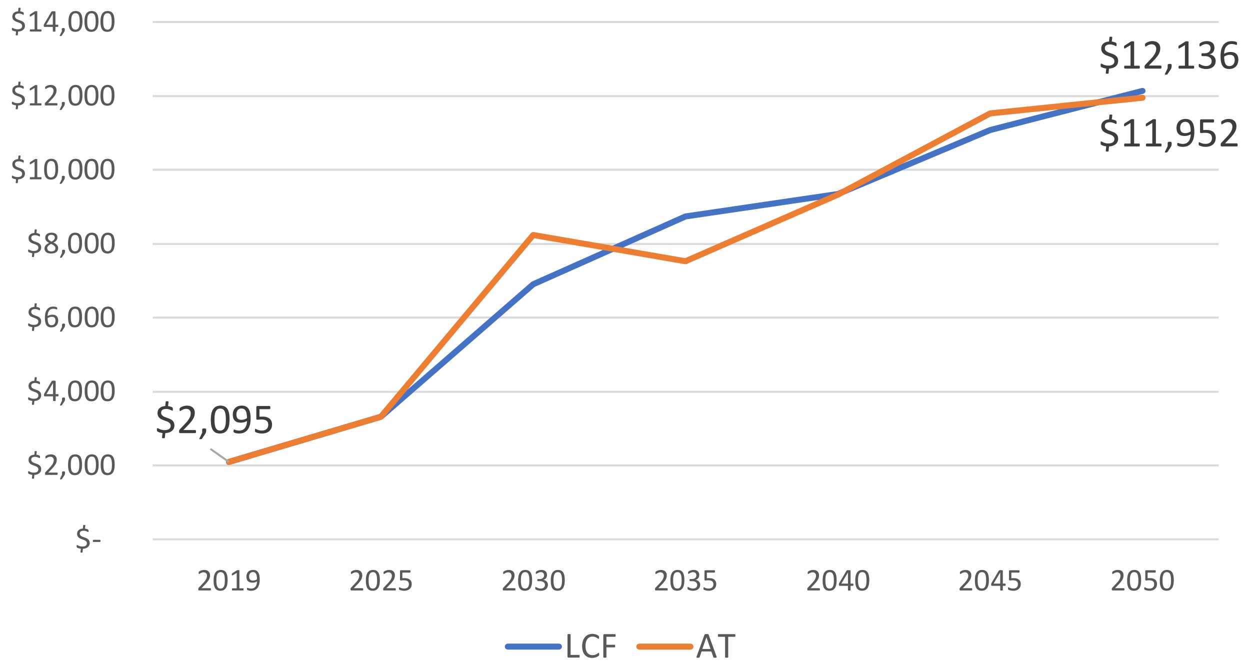


Residential HVAC

The residential HVAC subsector consists of technologies such as residential air conditioning (air source heat pumps, efficient central AC, gas heat pumps, and ground source heat pumps) and residential space heating (ductless air source heat pumps, efficient distillate boilers, and efficient gas boilers).

The five-year average of overall processed investment grows from $2,095M in 2019 to $12,136M and $11,952M, respectively, for the LCF and AT scenarios (Figure 70).

FIGURE 70. RESIDENTIAL HVAC: OVERALL FIVE-YEAR AVERAGE PROCESSED INVESTMENT STREAM ($M)



The increasing investments in residential HVAC will lead to gradual employment growth in both AT and LCF scenarios, which will add approximately 90,000 jobs by the final year of analysis (Figures 71 and 72). Construction, which represents approximately 65 percent of the subsector, adds approximately 59,000 jobs by 2050, followed by induced employment, which provides 22 percent of residential HVAC and will add at least 20,000 jobs. Professional services and manufacturing, which represent less than three percent of the subsector combined, will experience the least growth, adding just over 1,000 jobs each by 2050.

FIGURE 71. RESIDENTIAL HVAC: EMPLOYMENT OUTPUTS (S2: LCF)

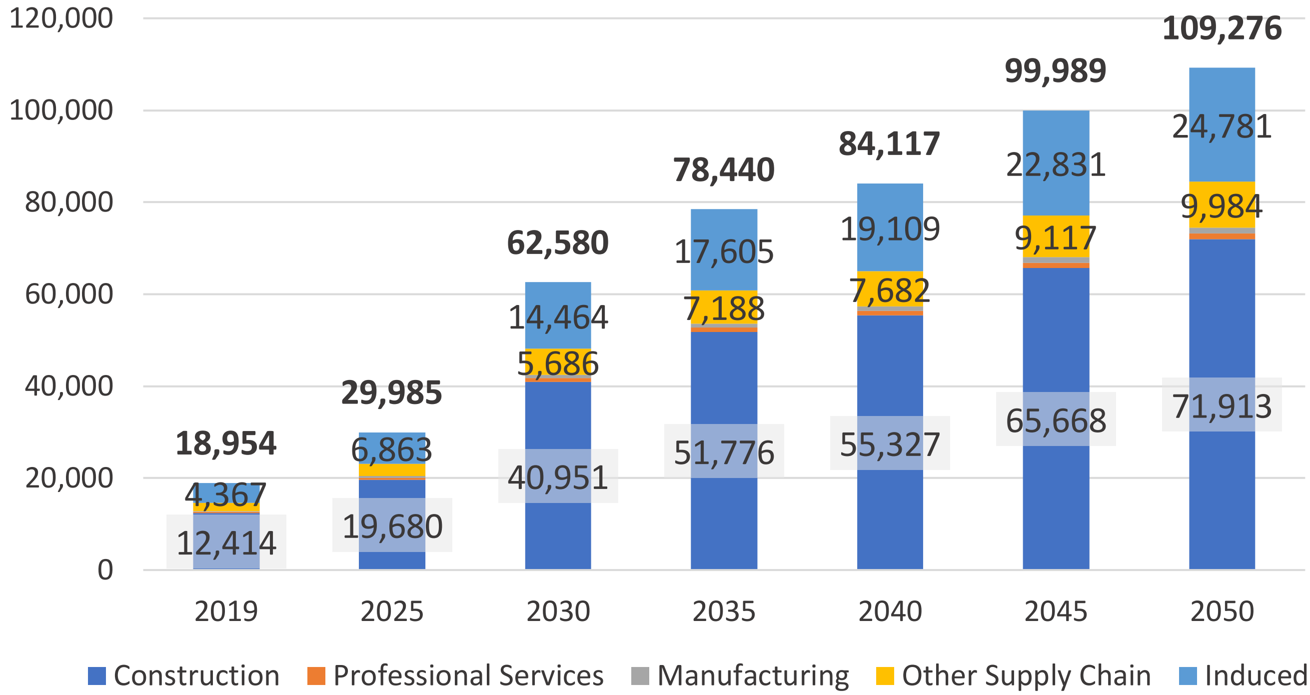
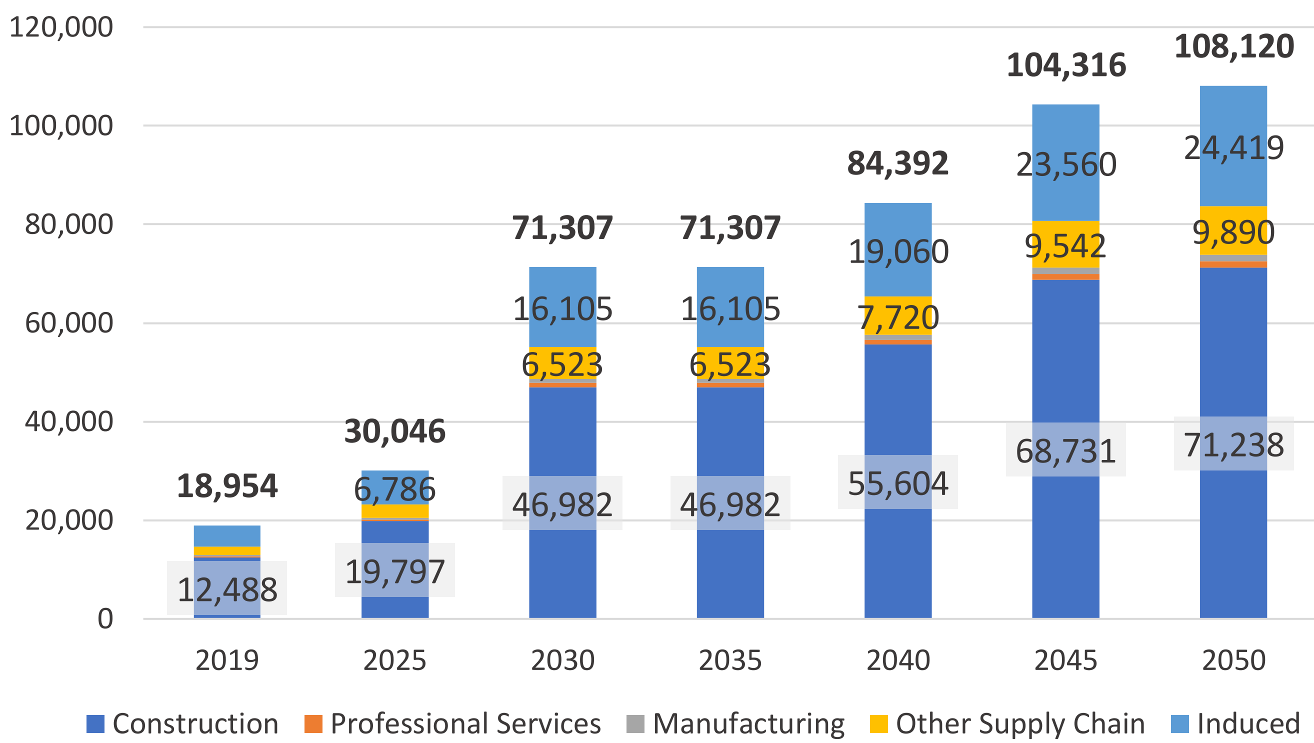


FIGURE 72. RESIDENTIAL HVAC: EMPLOYMENT OUTPUTS (S3: AT)

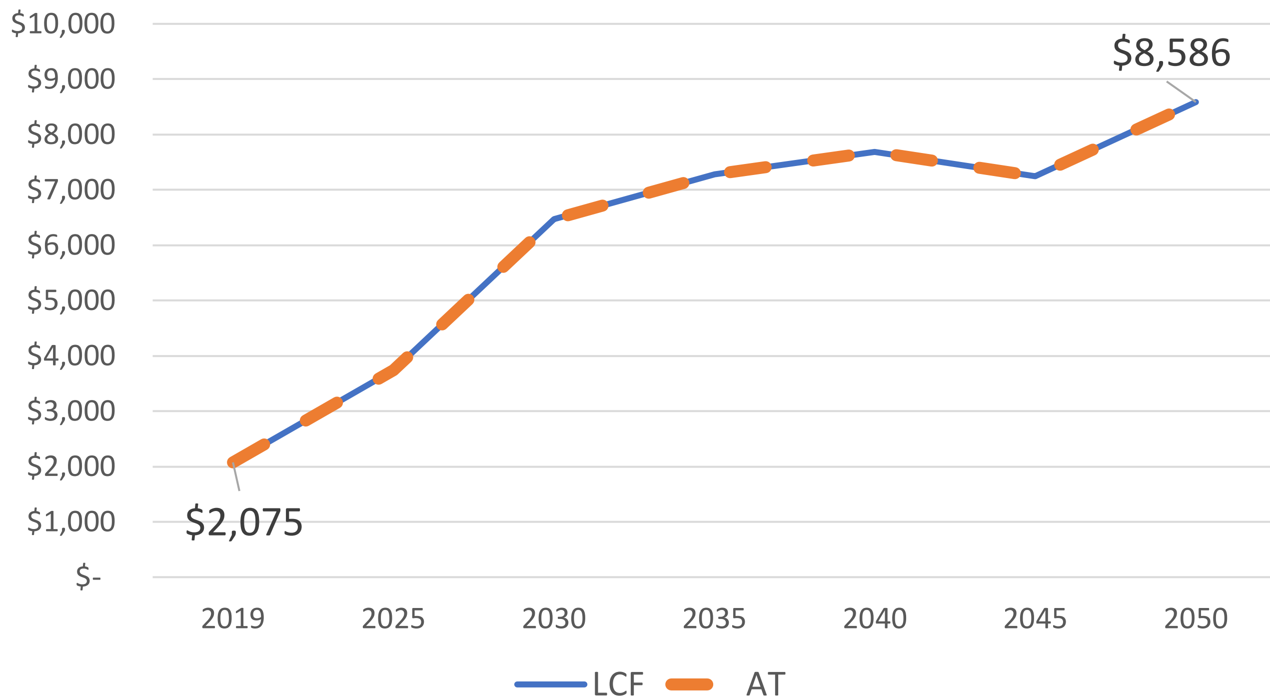


Residential Shell

The residential shell subsector consists of technologies like paint and coatings, mineral wool, and metal windows and doors, and wood windows and doors.

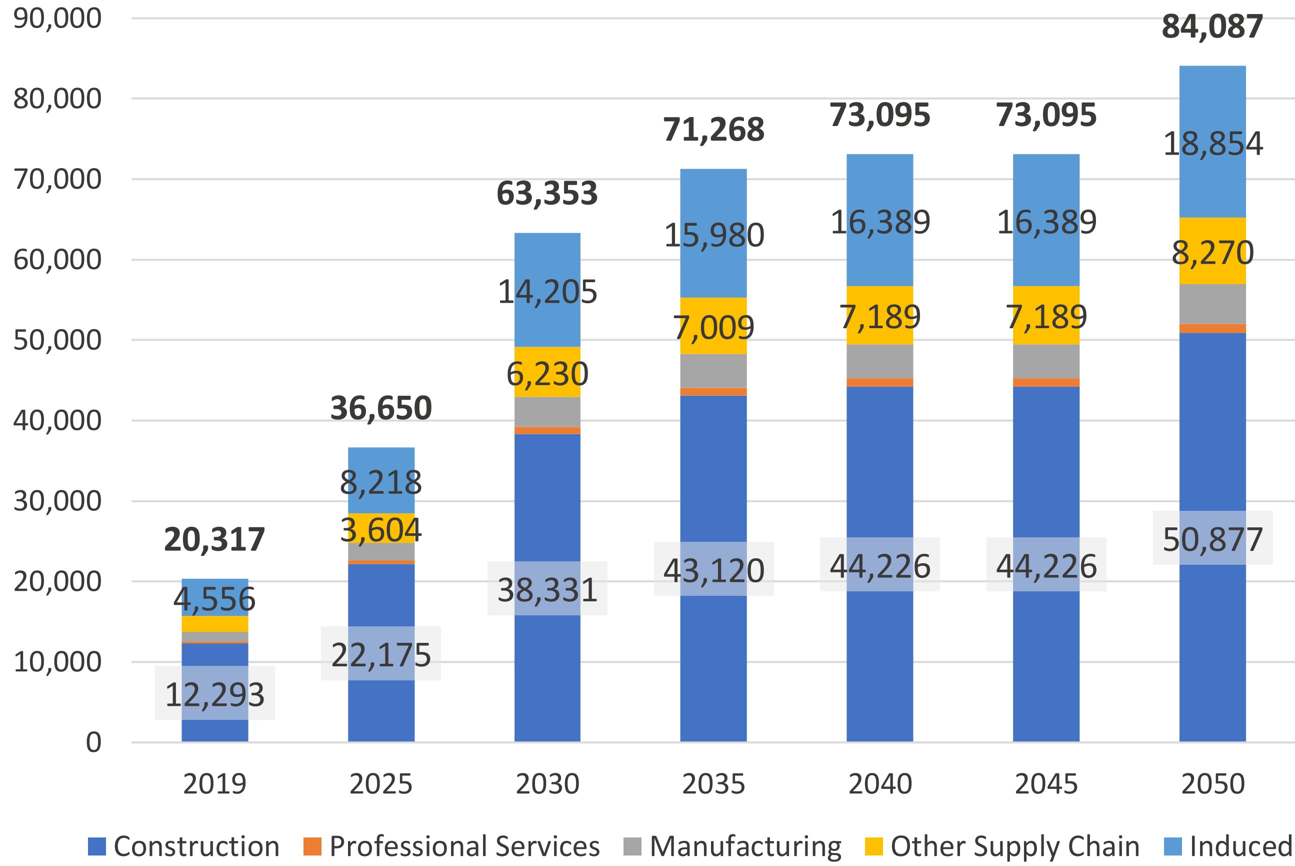
Figure 73 shows the five-year average of overall processed investments for both LCF and AT scenarios, which trend along the same line. Investment streams in residential shell gradually grow from $2,075M in 2019 to $8,586M in 2050, a $6,511M increase from baseline investments by 2050.

FIGURE 73. RESIDENTIAL SHELL: OVERALL FIVE-YEAR AVERAGE PROCESSED INVESTMENT STREAM ($M)



Residential shell employment, mostly driven by the construction and induced industries, will add a total of 63,770 jobs by 2050 for both scenarios (Figure 74). Construction, which accounts for 60 percent of residential shell employment, will add 38,584 jobs, followed by 14,298 jobs added in induced industries, representing 22 percent of the subsector.

FIGURE 74. RESIDENTIAL SHELL: EMPLOYMENT OUTPUTS (S2: LCF & S3: AT)

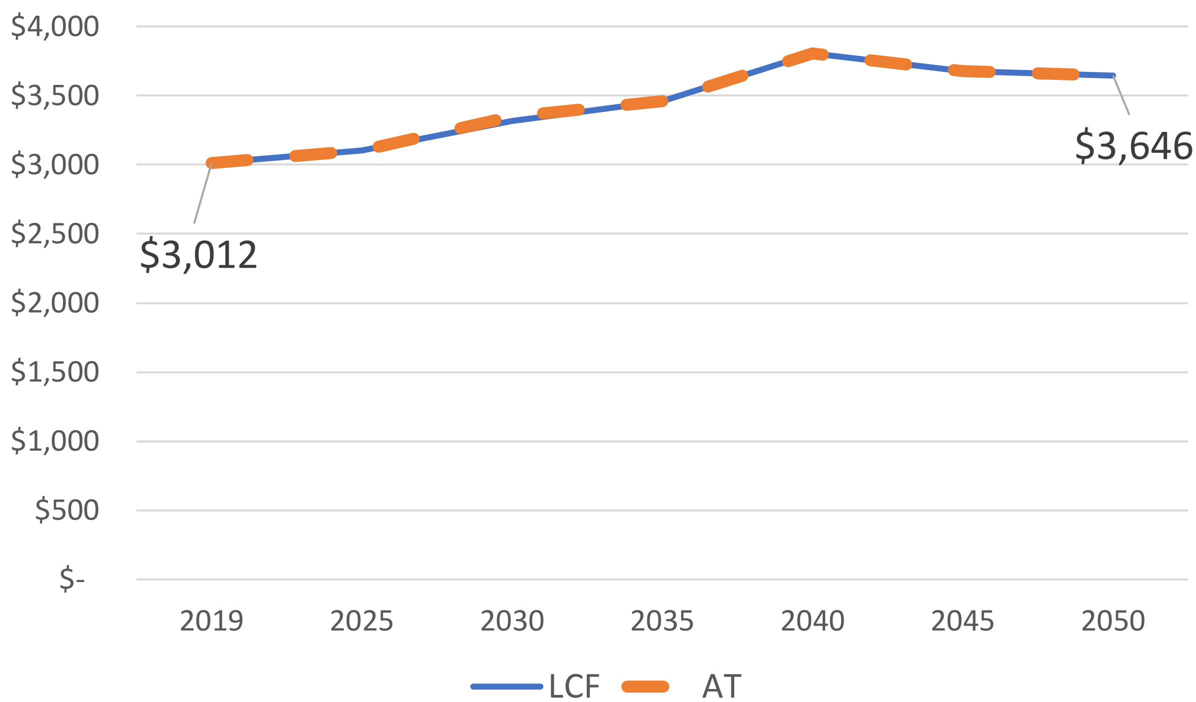


Residential Other

The residential other subsector consists of technologies like household laundry, refrigerators, lighting fixtures, water heaters, cooking appliances, and other major household appliances (for residential buildings).

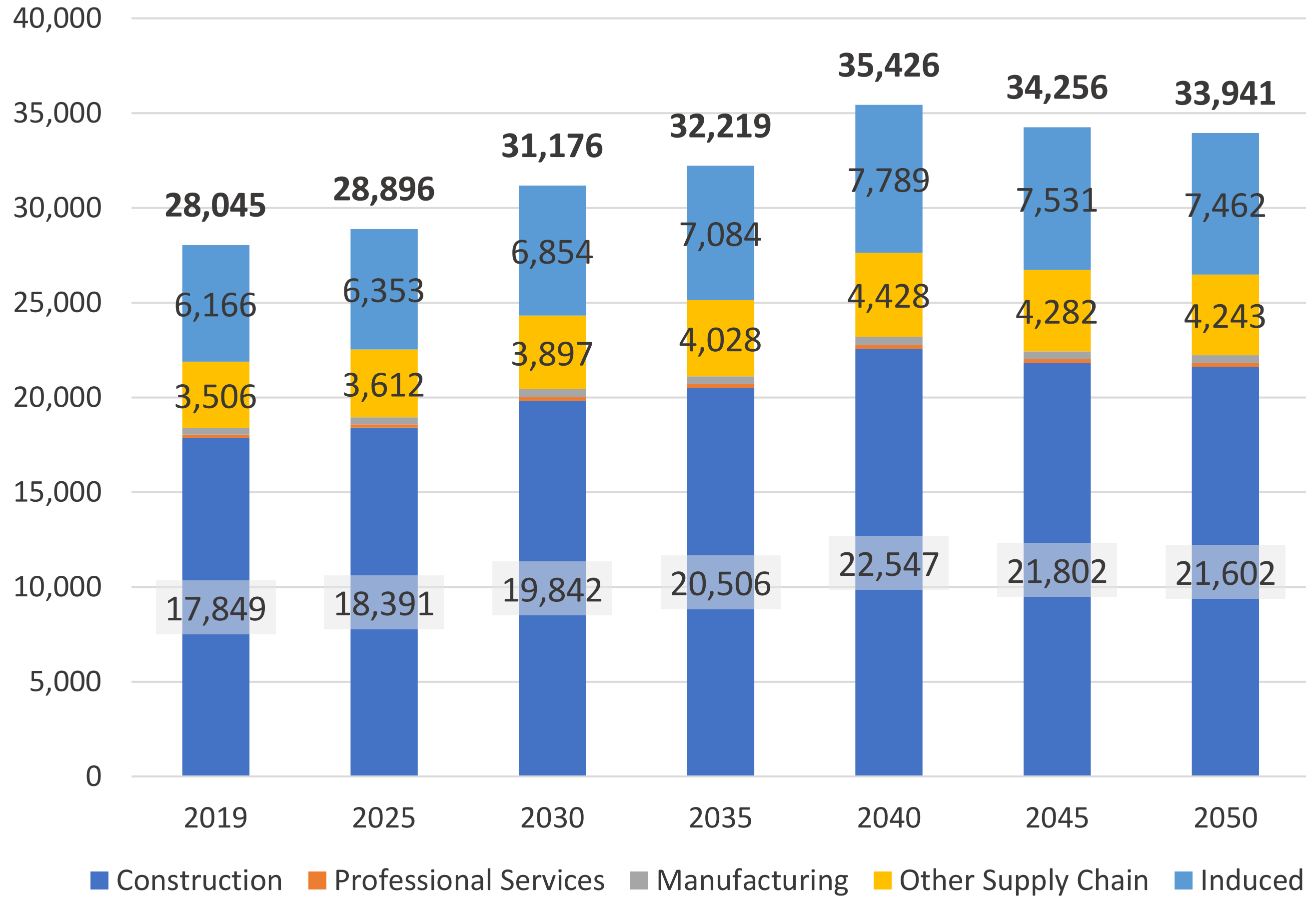
Residential other investments experience a $634M change between 2019 and 2050 for both scenarios, growing from a 2019 average of $3,012M to $3,646M in 2050. Overall average processed investments peak at $3,805M in 2040 for both scenarios (Figure 75).

FIGURE 75. RESIDENTIAL OTHER: OVERALL FIVE-YEAR AVERAGE PROCESSED INVESTMENT STREAM ($M)



Consistent with the peak in overall processed investments, peak employment outcomes in residential other will occur in 2040; this, until the last year of analysis, is driven by the construction and induced industries, which account for roughly 85 percent of the subsector (Figure 76). Construction adds approximately 3,700 jobs, while induced employment adds close to 1,300 jobs to baseline levels. Professional services and manufacturing jobs grow the least, each adding less than 100 jobs to 2019 jobs by 2050.

FIGURE 76. RESIDENTIAL OTHER: EMPLOYMENT OUTPUTS (S2: LCF & S3: AT)



TRANSPORTATION SECTOR

The transportation sector consists of five subsectors: vehicle manufacturing, vehicle maintenance, wholesale trade parts, conventional fueling stations, and charging and hydrogen fuel stations. In 2017, transportation was responsible for 43.1 percent of total GHG emissions in New York State.[45]

Overall employment in the transportation sector under the LCF scenario will stay largely flat at just over 176,000 through 2030, losing approximately 200 jobs (Table 18). Thereafter, employment declines approximately seven percent over 20 years, driven by the vehicle maintenance and conventional fueling stations subsectors. Employment in these two subsectors will drop to 75,000 by 2050—a loss of close to 40,000 jobs compared to the 2019 workforce. Compensating increases in the growth subsectors mean the transportation sector overall settles at 163,000 jobs in 2050.

TABLE 17. TRANSPORTATION: OVERALL EMPLOYMENT OUTPUTS (S2: LCF)

Scenario 2: Strategic Use of Low Carbon Fuels							
Growing Sub-sectors	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Vehicle Manufacturing	25,726	25,658	25,696	25,758	25,768	25,741	25,750
Wholesale Trade Parts	35,446	35,600	35,745	35,895	36,048	36,205	36,334
Charging and Hydrogen Fuel Stations	311	3,880	10,957	16,574	20,490	23,337	25,919
Subtotal - Growing	**61,483**	**65,138**	**72,398**	**78,227**	**82,306**	**85,283**	**88,003**
Change from 2019 - Growing	0	3,656	10,916	16,744	20,823	23,800	26,520
Displacement Sub-sectors	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Conventional Fueling Stations	49,163	45,903	39,792	31,677	25,129	20,655	18,482
Vehicle Maintenance	65,734	65,592	63,996	61,394	58,981	57,359	56,631
Subtotal - Displacement	**114,896**	**111,495**	**103,787**	**93,071**	**84,109**	**78,013**	**75,113**
Change from 2019 - Displacement		-3,402	-11,109	-21,825	-30,787	-36,883	-39,784
Totals - All Sub-sectors	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Total - All Sub-sectors	**176,379**	**176,633**	**176,186**	**171,298**	**166,415**	**163,296**	**163,116**
Change from 2019 - All Sub-sectors	0	254	-193	-5,081	-9,964	-13,083	-13,263

[45] New York State Energy Research and Development Authority (NYSERDA), 2021.

In the AT scenario, overall employment remains largely flat through 2030 before declining to about 167,900 jobs by 2040. Similar to the LCF scenario, the 11,500 jobs lost by 2050 will be driven by a loss of more than 40,000 in vehicle maintenance and conventional fueling stations (Table 19).

TABLE 18. TRANSPORTATION: OVERALL EMPLOYMENT OUTPUTS (S3: AT)

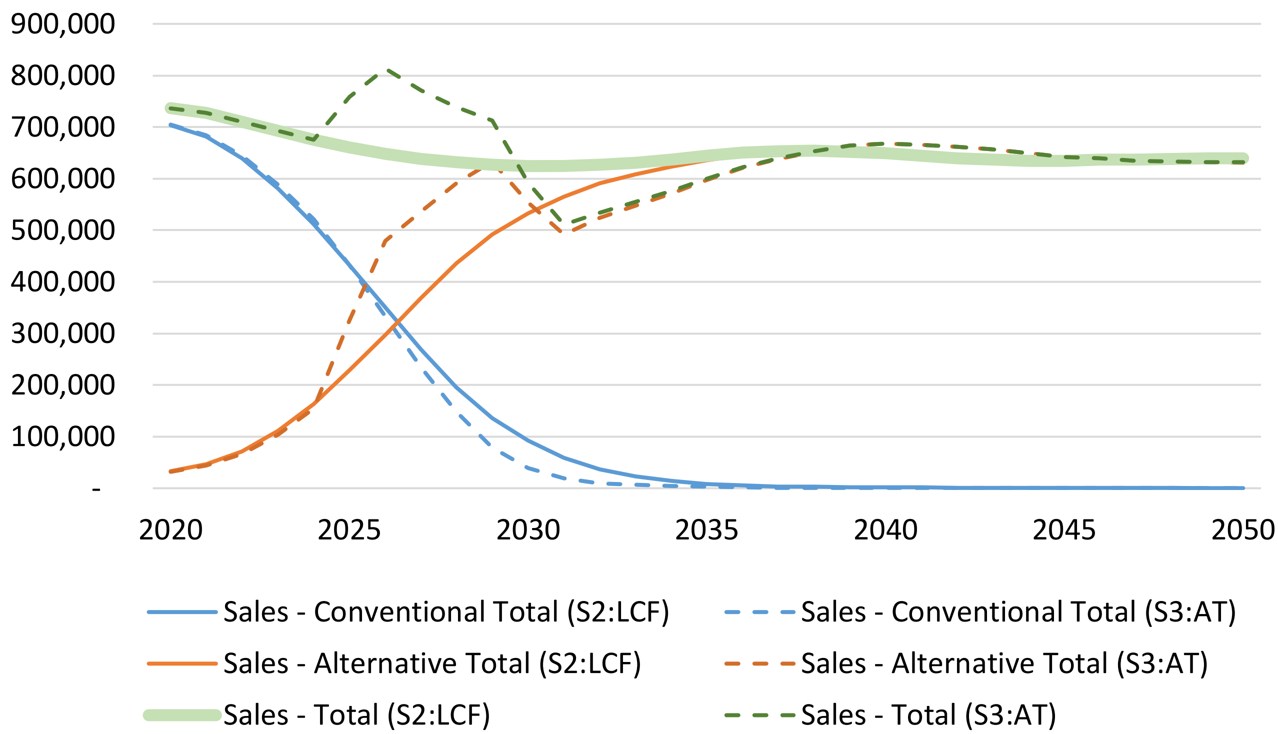
Scenario 3: Accelerated Transition Away from Combustion							
Growing Sub-sectors	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Vehicle Manufacturing	25,726	25,835	25,653	25,677	25,800	25,753	25,734
Wholesale Trade Parts	35,446	35,600	35,745	35,894	36,048	36,205	36,334
Charging and Hydrogen Fuel Stations	311	5,511	13,776	18,836	23,545	26,563	29,236
Subtotal - Growing	**61,483**	**66,946**	**75,174**	**80,407**	**85,393**	**88,521**	**91,304**
Change from 2019 - Growing	0	5,463	13,691	18,925	23,911	27,039	29,821
Displacement Sub-sectors	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Conventional Fueling Stations	49,163	45,705	38,211	30,978	24,566	20,131	18,048
Vehicle Maintenance	65,734	65,478	63,112	60,543	57,937	56,186	55,442
Subtotal - Displacement	**114,896**	**111,183**	**101,323**	**91,521**	**82,503**	**76,317**	**73,489**
Change from 2019 - Displacement		-3,713	-13,573	-23,376	-32,394	-38,579	-41,407
Totals - All Sub-sectors	**2019**	**2025**	**2030**	**2035**	**2040**	**2045**	**2050**
Total - All Sub-sectors	**176,379**	**178,129**	**176,497**	**171,928**	**167,896**	**164,838**	**164,793**
Change from 2019 - All Sub-sectors	0	1,750	118	-4,451	-8,483	-11,541	-11,585

Vehicle Manufacturing

The vehicle manufacturing subsector consists of both conventional and alternative vehicle technologies, such as electric vehicles.

In 2020, conventional vehicle sales represented much of total vehicles sales, averaging more than 700,000 vehicles (Figure 77). By 2050, alternative vehicle sales will be close to 100 percent of total vehicle sales, averaging approximately 630,000 vehicles sold.

FIGURE 77. VEHICLE MANUFACTURING: FIVE-YEAR MOVING AVERAGE OF VEHICLE SALES



Total employment in vehicle manufacturing will remain nearly constant between 2019 and 2050, remaining close to 25,700 in both scenarios.

FIGURE 78. VEHICLE MANUFACTURING: EMPLOYMENT OUTPUTS (S2: LCF)

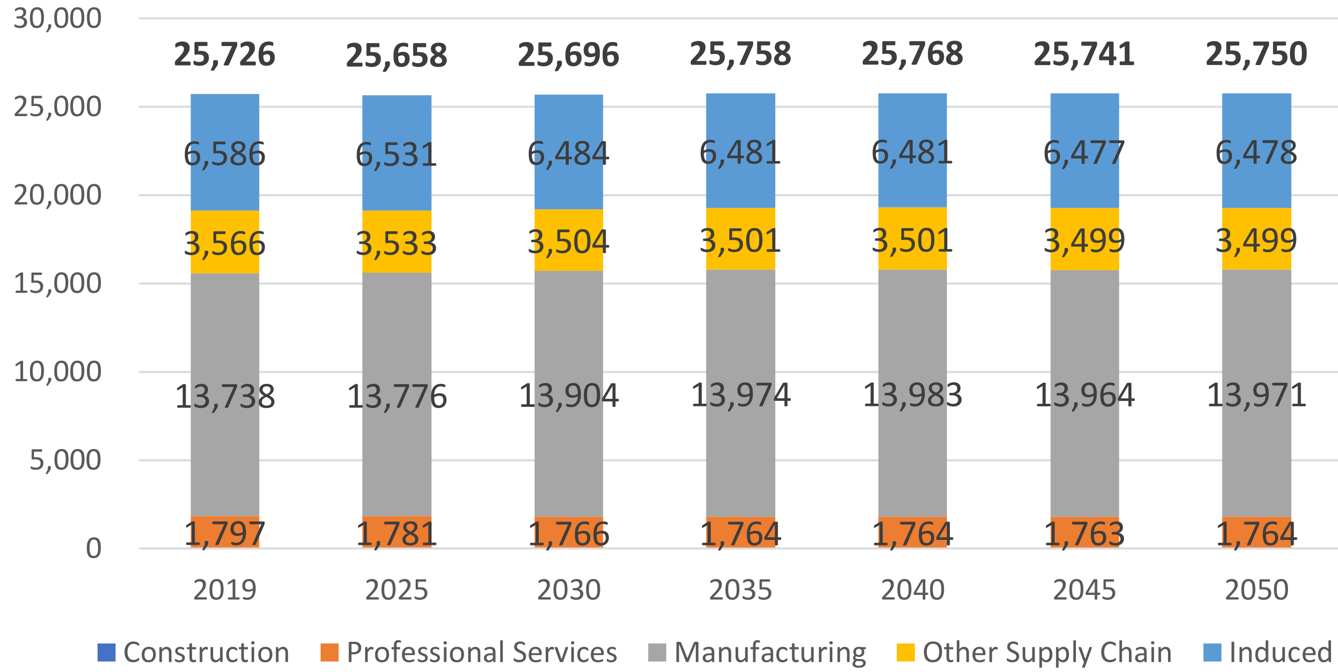
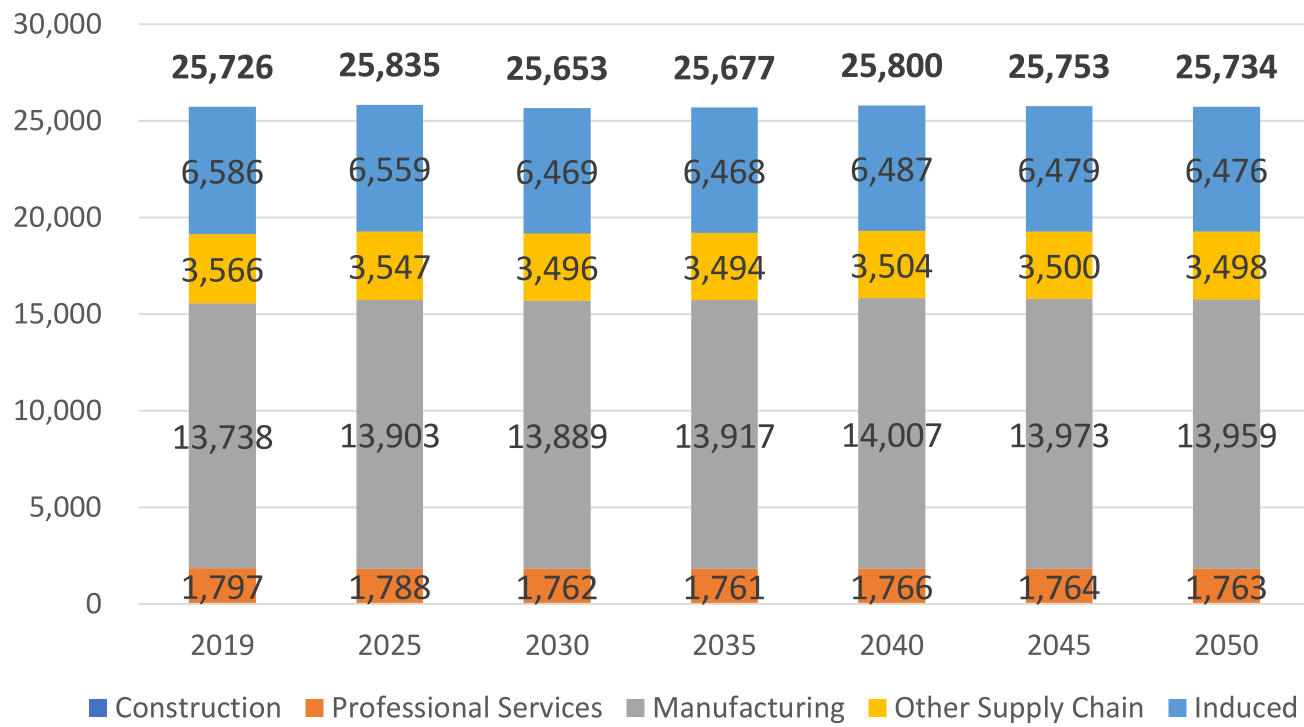


FIGURE 79. VEHICLE MANUFACTURING: EMPLOYMENT OUTPUTS (S3: AT)

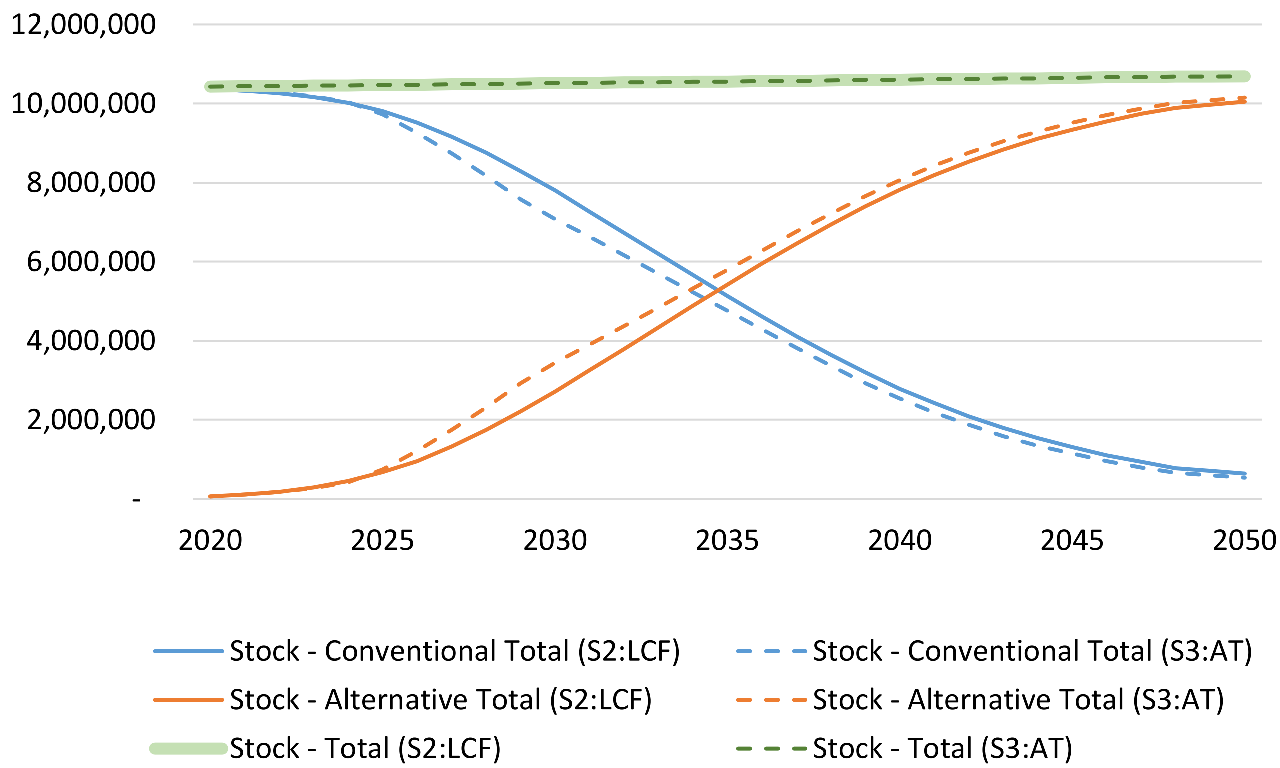


Wholesale Trade Parts

The wholesale trade parts subsector consists of consists of both conventional and alternative vehicle technologies, such as electric vehicles.

Between 2020 and 2050, total vehicle stocks remain consistent at 10,000,000, adding 200,000 total vehicles by the final year of analysis (Figure 80). However, the composition of total vehicle stocks changes over time for both scenarios—as the total stock of conventional vehicles decreases, alternative vehicle stock increases. Alternative vehicle stock overtakes conventional vehicle stock after 2035 in both scenarios.

FIGURE 80. WHOLESALE TRADE PARTS: FIVE-YEAR MOVING AVERAGE OF VEHICLE STOCKS[46]



The 558 jobs gained in other supply chain will represent the majority of the 900 jobs added in the whole trade parts subsector between 2019 and 2050 for both scenarios (Figures 81 and 82). The induced industry, which accounts for over 20 percent of the sub-sector, will add just over 200 jobs, followed by professional services, adding more than 100 jobs by 2050.

[46] Wholesale Trade Parts and Vehicle Maintenance operate under the assumption of vehicle stocks.

FIGURE 81. WHOLESALE TRADE PARTS: EMPLOYMENT OUTPUTS (S2: LCF)

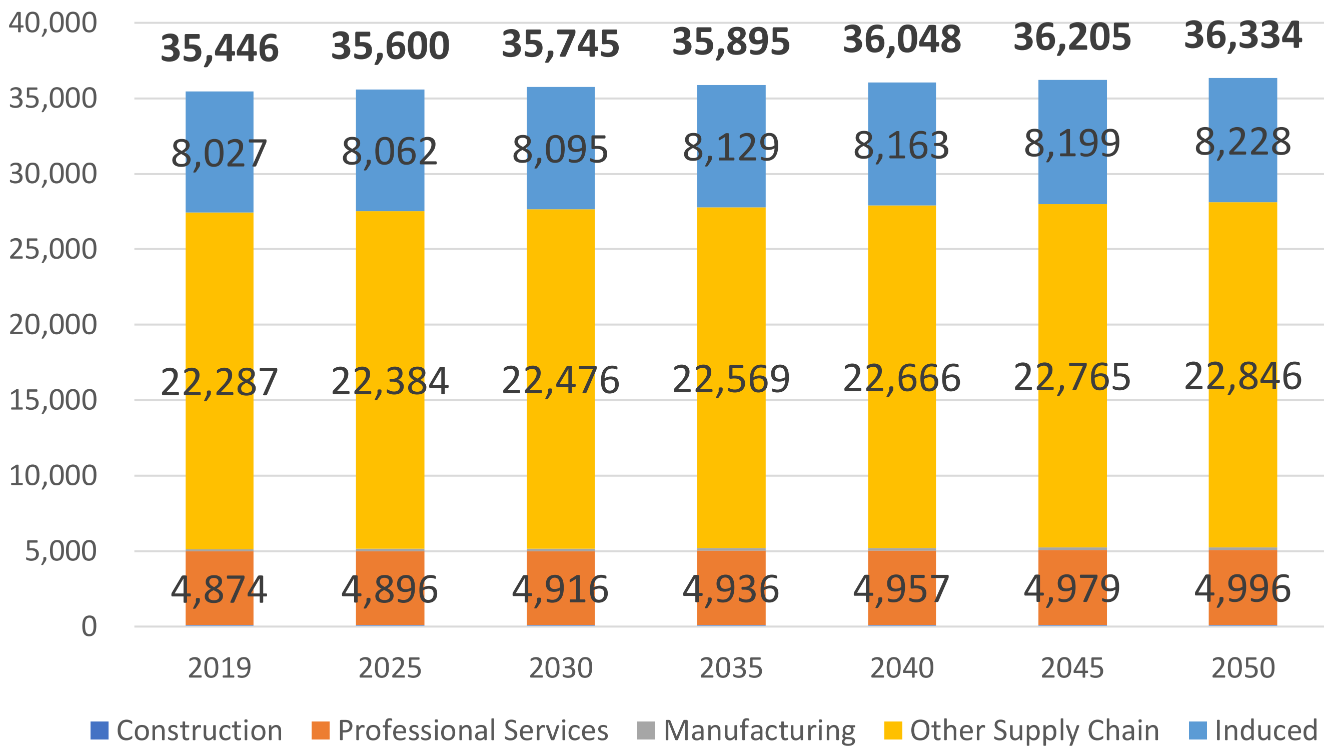
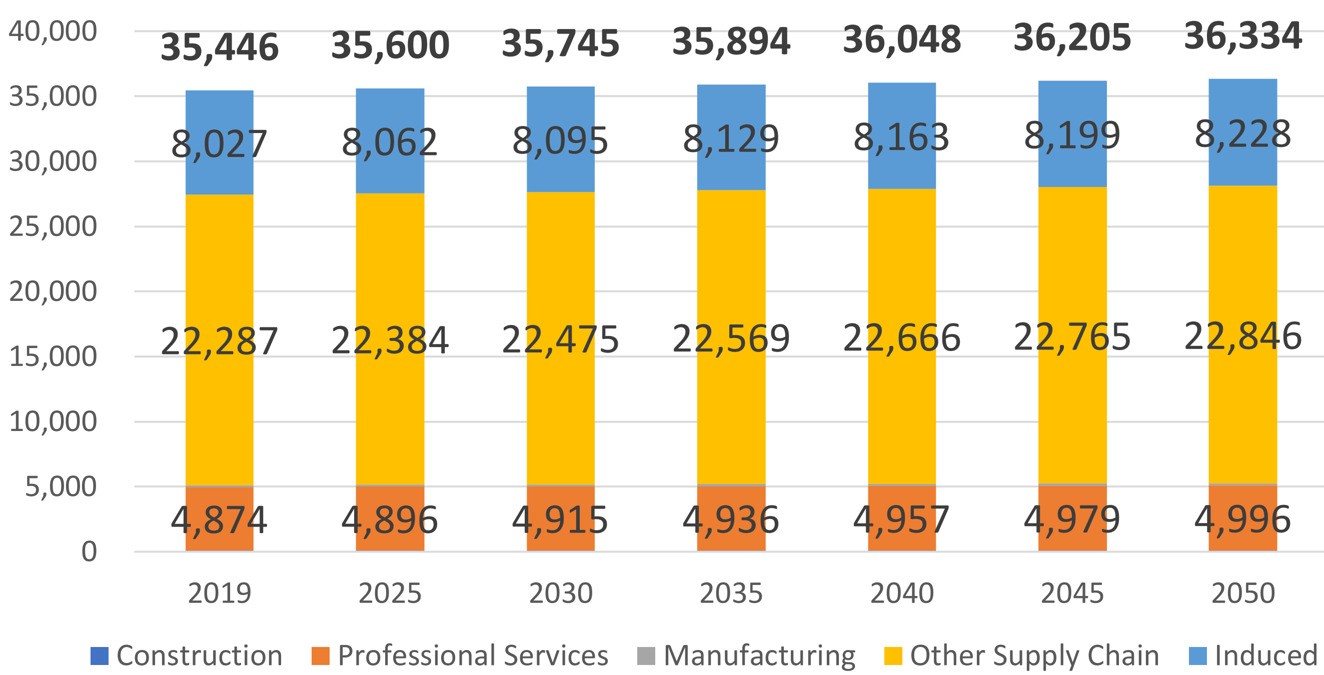


FIGURE 82. WHOLESALE TRADE PARTS: EMPLOYMENT OUTPUTS (S3: AT)

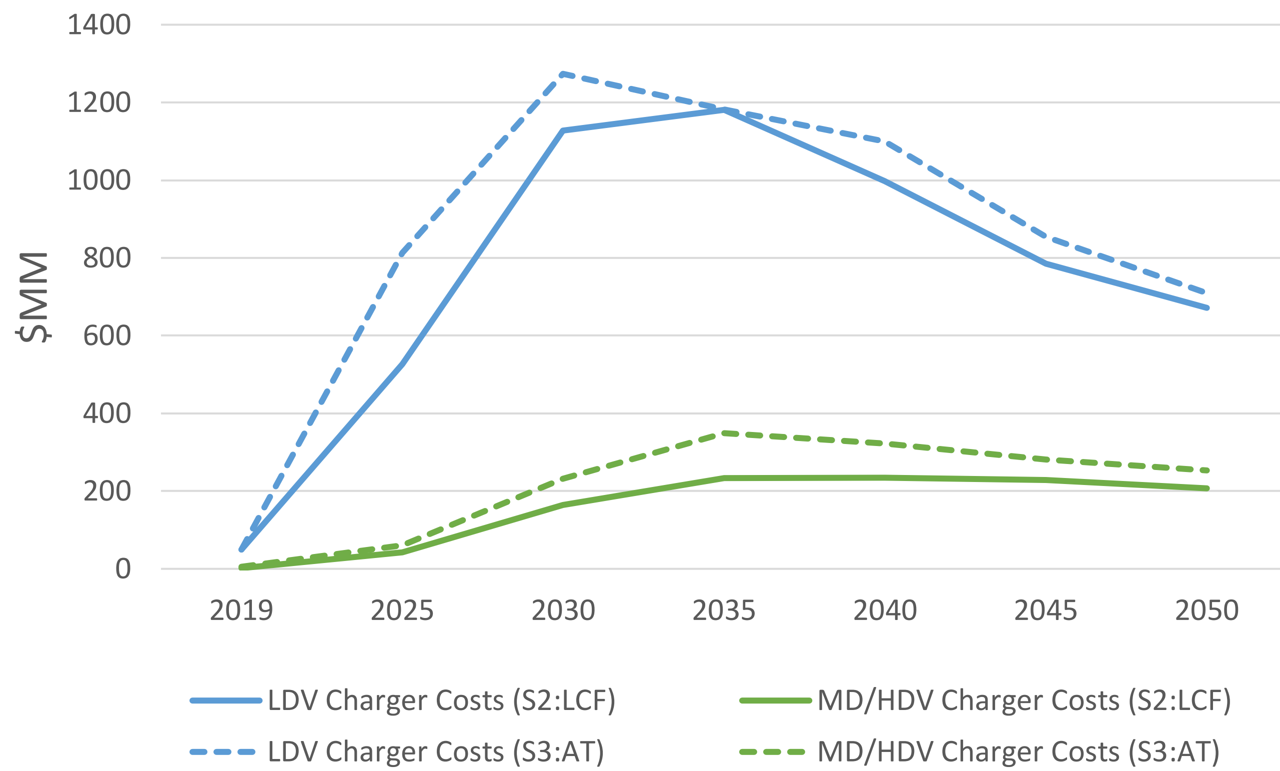


Charging and Hydrogen Fuel Stations

The charging and hydrogen fuel stations subsector consists of technologies like electric vehicle charging stations (manufacturing, installation, and maintenance employment).

Investments made into LDV chargers experience a sharp increase between 2019 and 2035, peaking in 2030 in the AT scenario and 2035 in the LCF scenario, before gradually decreasing until the last year of investment. MDV/HDV investments remain consistently lower than LDV investments between 2019 and 2050, peaking in 2035 in both scenarios before gradually decreasing until the last year of analysis (Figure 83).

FIGURE 83. CHARGING AND HYDROGEN FUEL STATIONS: FIVE-YEAR MOVING AVERAGE OF CHARGER COSTS



Total jobs in the charging and hydrogen fuel stations subsector will grow from a 2019 baseline of 311 jobs to nearly 26,000 and 30,000 jobs in the LCF and AT scenarios, respectively (Figures 84 and 85). In both scenarios, construction—which occupies 56 to 60 percent of the subsector between 2019 and 2050—will drive growth in the sub-sector, adding at least 14,500 jobs in the LCF scenario and close to 16,500 jobs in the AT scenario. The induced industry is the second highest driver of growth, adding more than 6,000 jobs in both scenarios.

FIGURE 84. CHARGING AND HYDROGEN FUEL STATIONS: EMPLOYMENT OUTPUTS (S2: LCF)

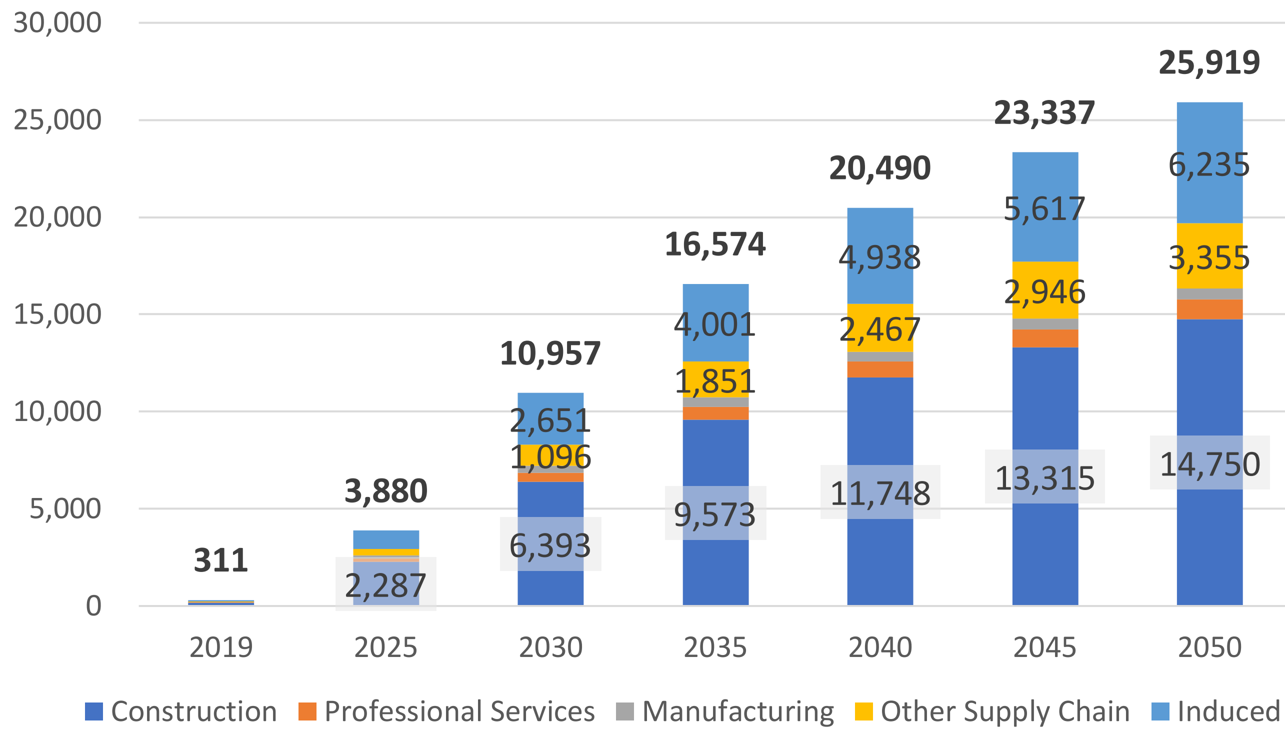
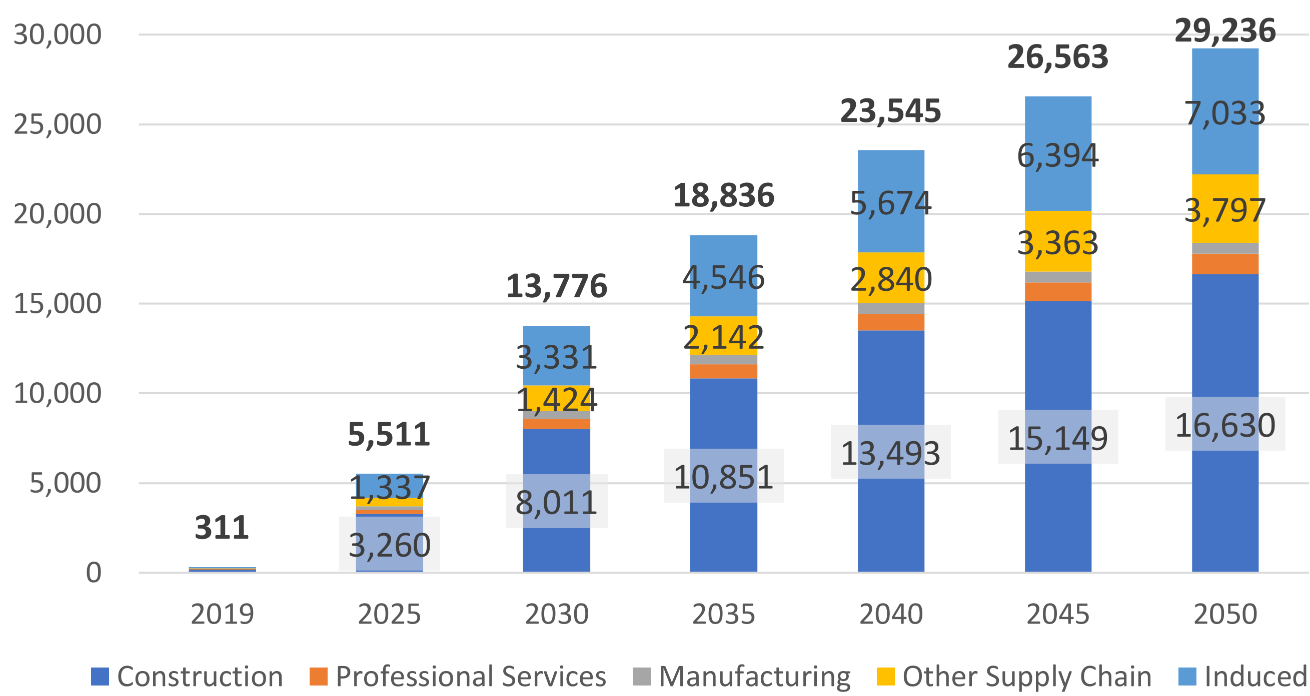


FIGURE 85. CHARGING AND HYDROGEN FUEL STATIONS: EMPLOYMENT OUTPUTS (S3: AT)

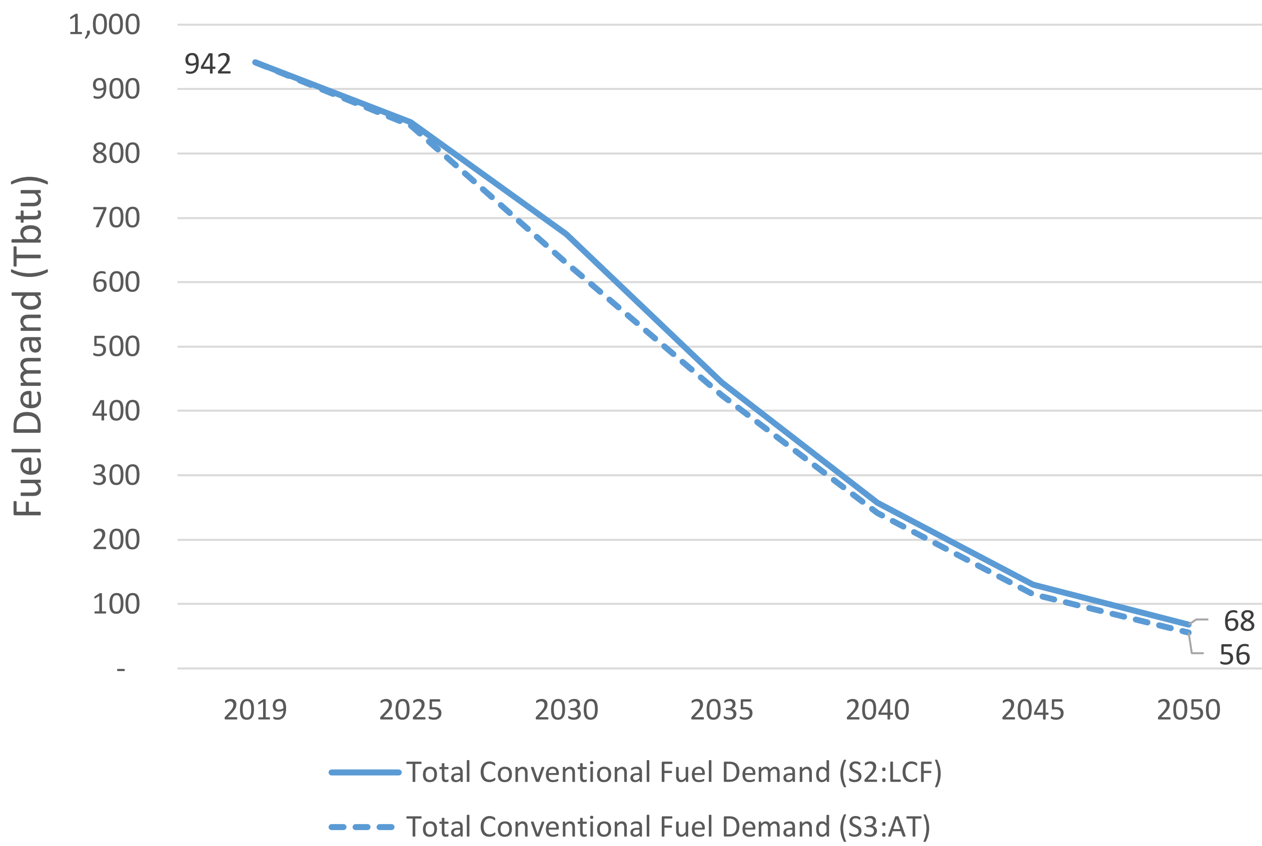


Conventional Fueling Stations

Conventional fueling stations, a displaced subsector, consists of technologies like fossil fuel fueling stations and at-risk employment, to extent these stations are closed rather than converted to AV fueling stations.

From an established baseline of 942 Tbtu total conventional fueling demand in 2019, both LCF and AT scenarios indicate a gradual decline in conventional fueling demand until 2050 (Figure 86). By 2050, total conventional fueling demand drops to 68 Tbtu in the LCF scenario and 56 Tbtu in the AT scenario.

FIGURE 86. CONVENTIONAL FUELING STATIONS: FIVE-YEAR MOVING AVERAGE OF FUEL DEMAND



Due to the declining demand in conventional fueling, total jobs in the conventional fueling stations subsector will decrease by over 30,000 jobs in 2050 (Figures 87 and 88). Other supply chain jobs, which represent more than 80 percent of the industry, will experience the most displacement, losing at least 25,000 jobs in both scenarios. The least displacement occurs in construction and manufacturing, which when combined, will lose less than 200 jobs by the final year of analysis.

FIGURE 87. CONVENTIONAL FUELING STATIONS: EMPLOYMENT OUTPUTS (S2: LCF)

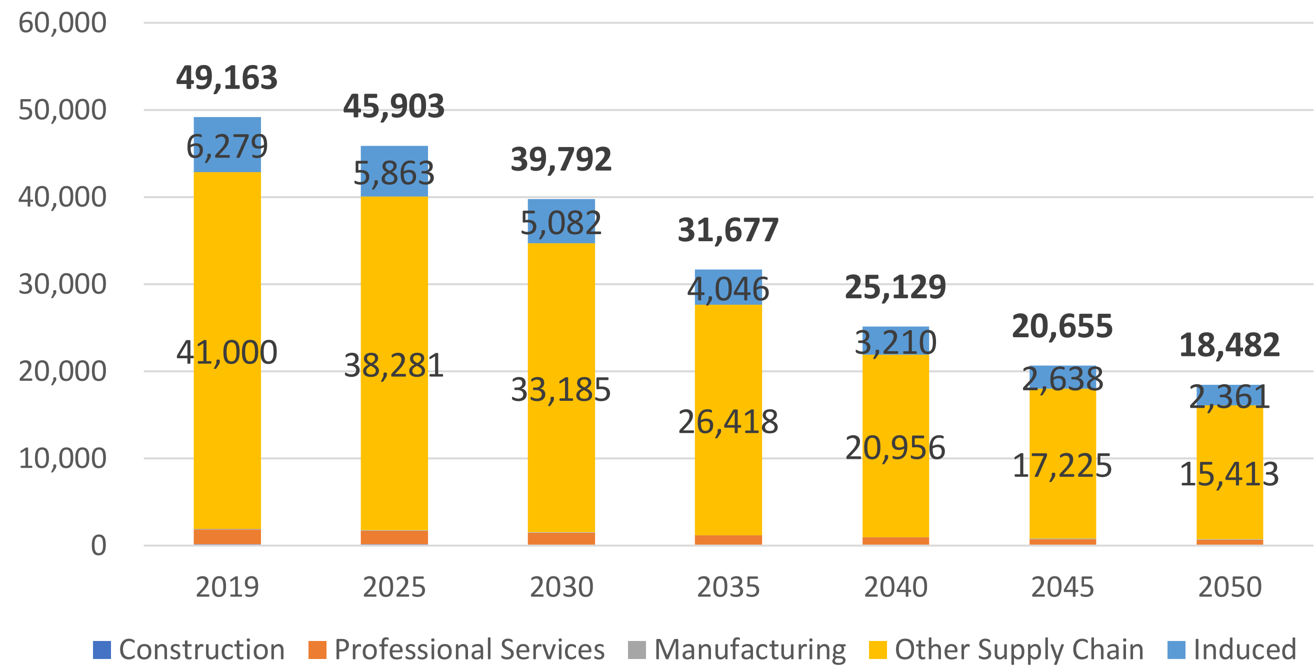
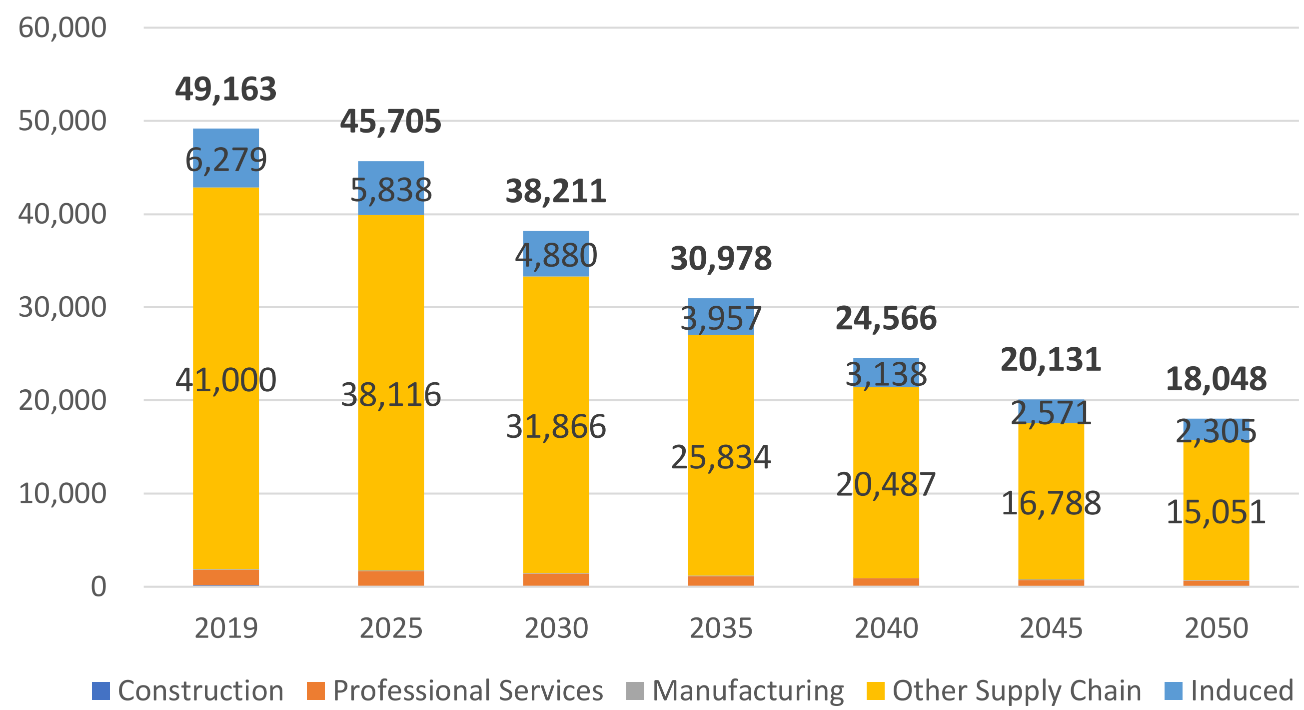


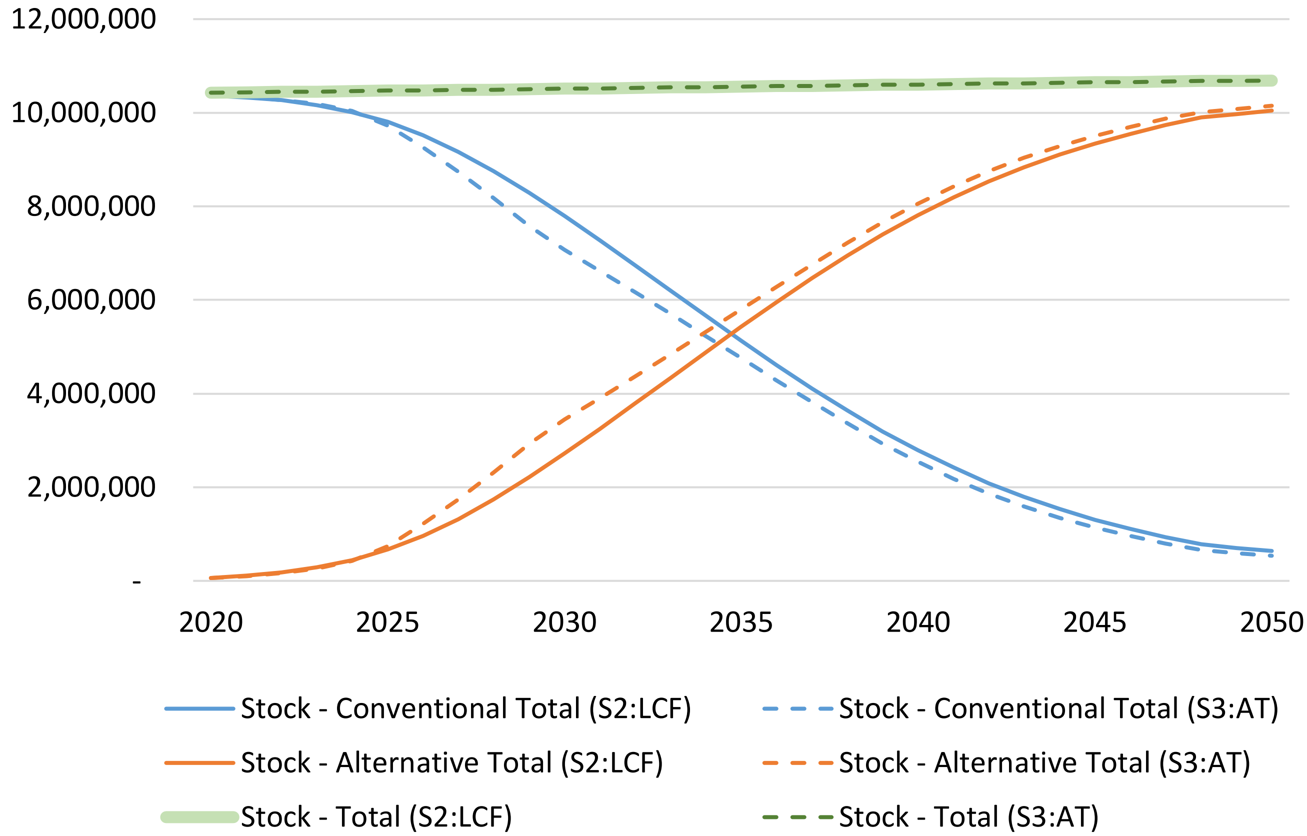
FIGURE 88. CONVENTIONAL FUELING STATIONS: EMPLOYMENT OUTPUTS (S3: AT)



Vehicle Maintenance

Vehicle maintenance, a displaced subsector, consists of at-risk employment (e.g., for repair and maintenance specific to fossil fuel vehicle components).

FIGURE 89. VEHICLE MAINTENANCE: FIVE-YEAR MOVING AVERAGE OF VEHICLE STOCKS[47]



Vehicle maintenance will lose approximately 10,000 jobs in both scenarios, driven by displacement in the other supply chain and induced industries which represent approximately 98 percent of the subsector (Figures 90 and 91). By 2050, other supply chain will be displaced by approximately 8,000 jobs, followed by induced displacement at about 2,000 jobs. Construction and manufacturing will be the least affected, experiencing a combined loss of less than 50 jobs between 2019 and 2050.

[47] Wholesale Trade Parts and Vehicle Maintenance operate under the assumption of vehicle stocks.

FIGURE 90. VEHICLE MAINTENANCE: EMPLOYMENT OUTPUTS (S2: LCF)

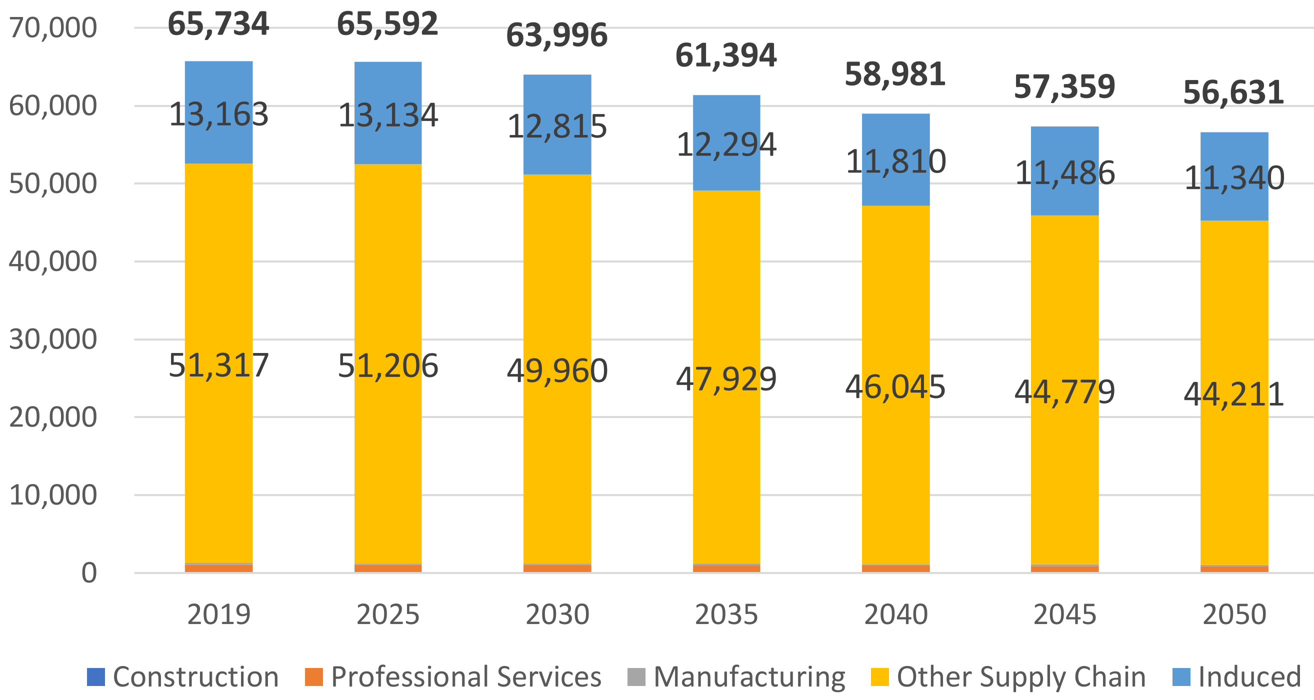
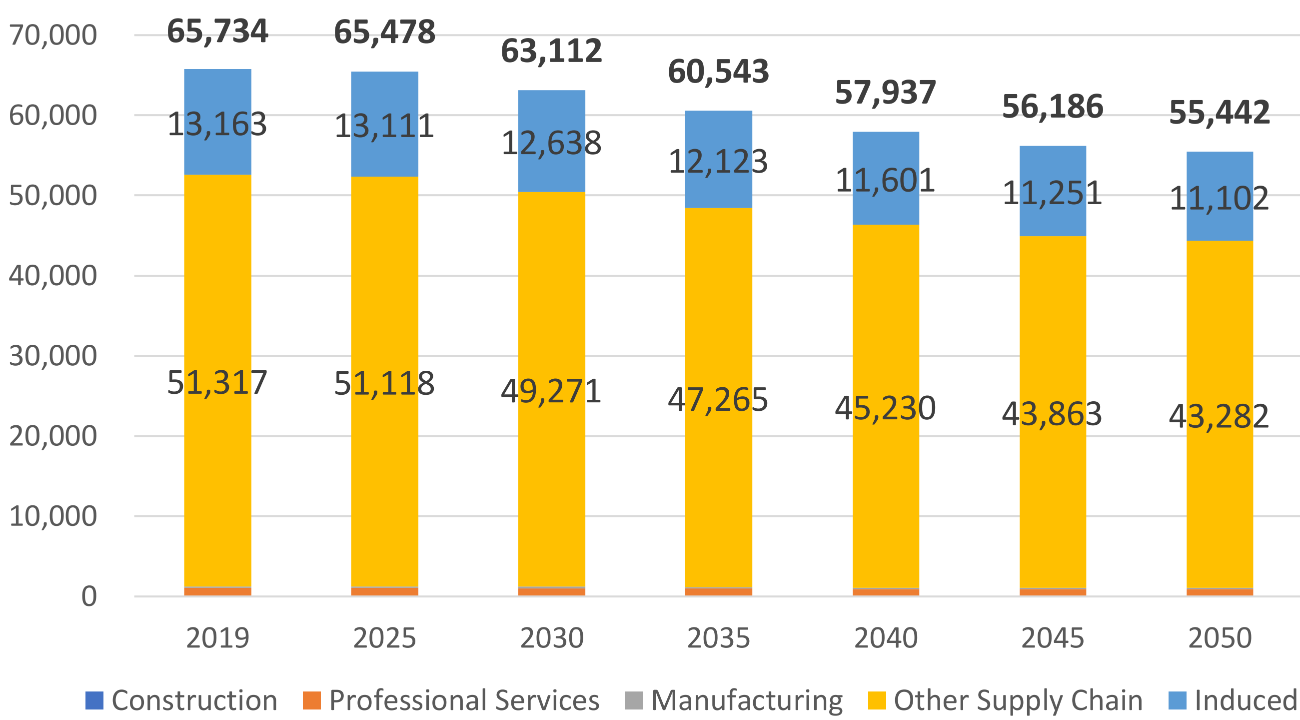


FIGURE 91. VEHICLE MAINTENANCE: EMPLOYMENT OUTPUTS (S3: AT)



Secondary Employment Outlook (SEO)

The previous section on Initial Employment Outputs, or IEOs, provided estimates of how **the quantity of jobs** will change over time from 2019 to 2050 under the two investment scenarios for the four primary sectors (buildings, electricity, fuels, and transportation).

The Secondary Employment Outlook, or SEO, is an assessment of how the **type, location, and quality of jobs**—**specifically employment by sustaining wage tier—**will change from 2019 to 2030 under the two investment scenarios for the four primary sectors.[48] IEOs were used as SEO inputs to produce detailed industry, occupation, geography, and wage profiles.[49]

For this analysis, the data is presented for both the growth and displaced sectors.

ELECTRICITY SECTOR

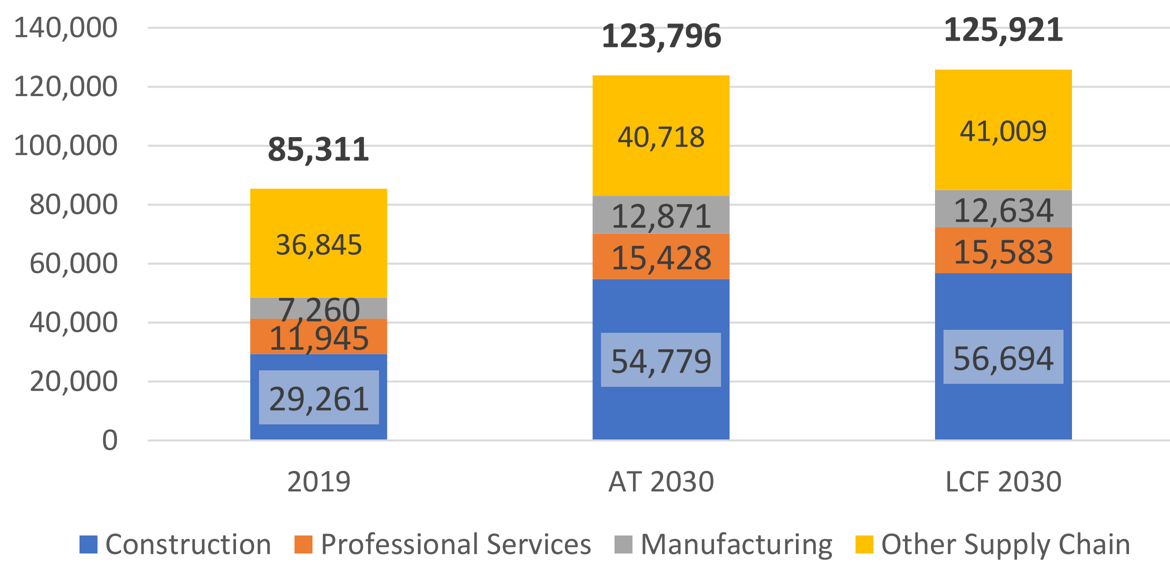
Growth Sectors

The electricity sector will experience growth in the solar, offshore wind, onshore wind, hydropower, hydrogen, biomass, distribution, transmission, and storage subsectors.

These growth subsectors in electricity will experience consistent growth in the construction, professional services, manufacturing, and other supply chain industries (Figure 92). In 2030, approximately 40,000 jobs will be added, with construction driving the growth by adding more than 25,000 jobs in both scenarios. Construction, which will nearly double by 2030, grows from a 34 percent share of electricity in 2019 to approximately 45 percent of jobs in 2030, overtaking the share of other supply chain, which decreases from 43 percent in 2019 to approximately 33 percent in 2030.

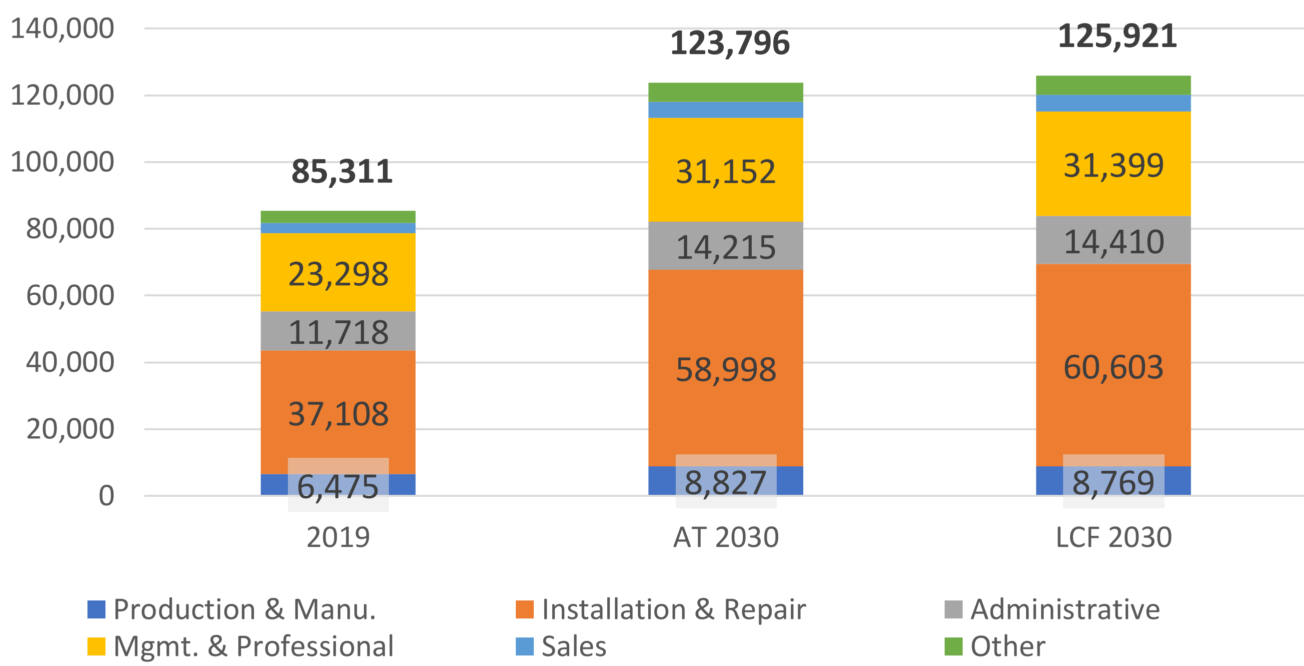
[48] It should be noted that IEOs include induced employment, whereas SEOs do not include induced employment.
[49] Wages are 2030 figures represented as 2019 dollars for both transition scenarios.

FIGURE 92. ELECTRICITY GROWTH SUB-SECTORS: INDUSTRY PROFILE



Major occupational groups in electricity growth sub-sectors will experience consistent growth with the largest increase occurring within installation and repair, which occupies more than 45 percent of electricity and add at least 20,000 jobs in both scenarios. Management and professional occupations represents more than 25 percent of electricity occupations and will experience the second largest growth, adding approximately 7,500 jobs by 2030 (Figure 93).

FIGURE 93. ELECTRICITY GROWTH SUB-SECTORS: OCCUPATIONAL PROFILE

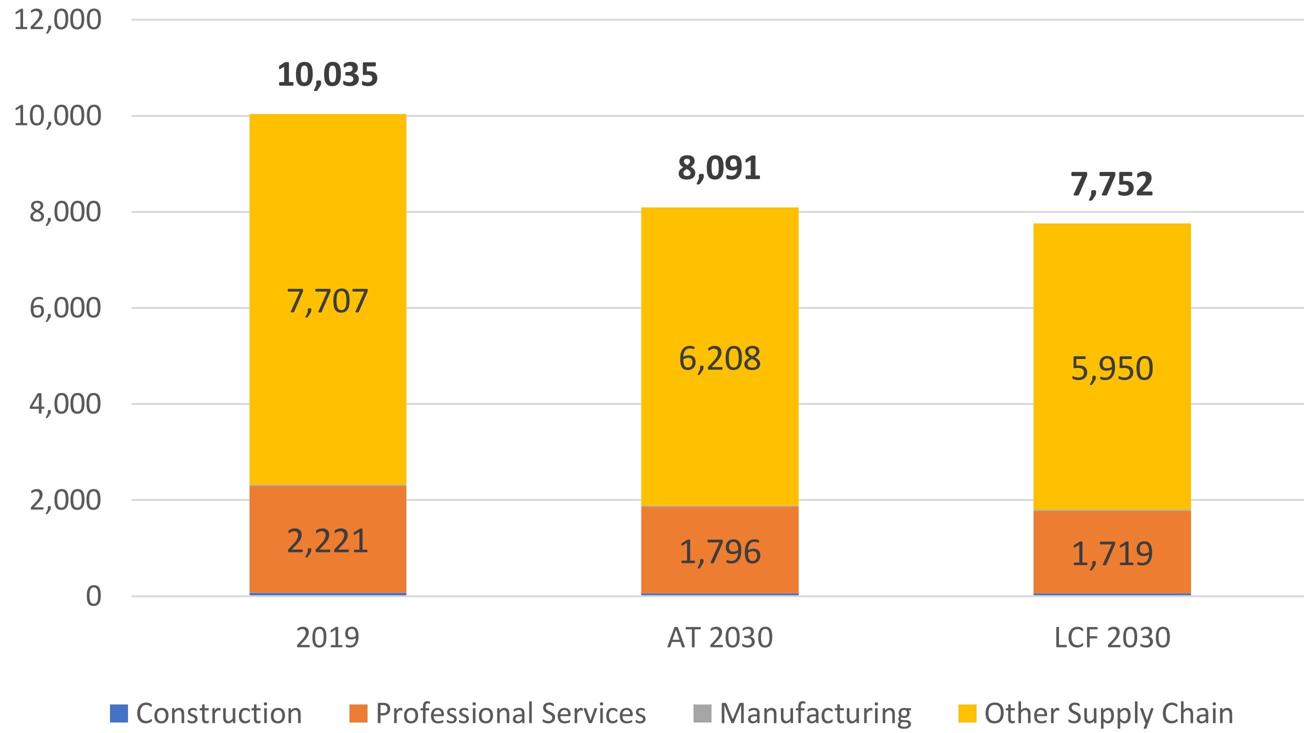


Displaced Sectors

The electricity sector will experience displacement in the natural gas generation, other fossil generation, and nuclear subsectors.

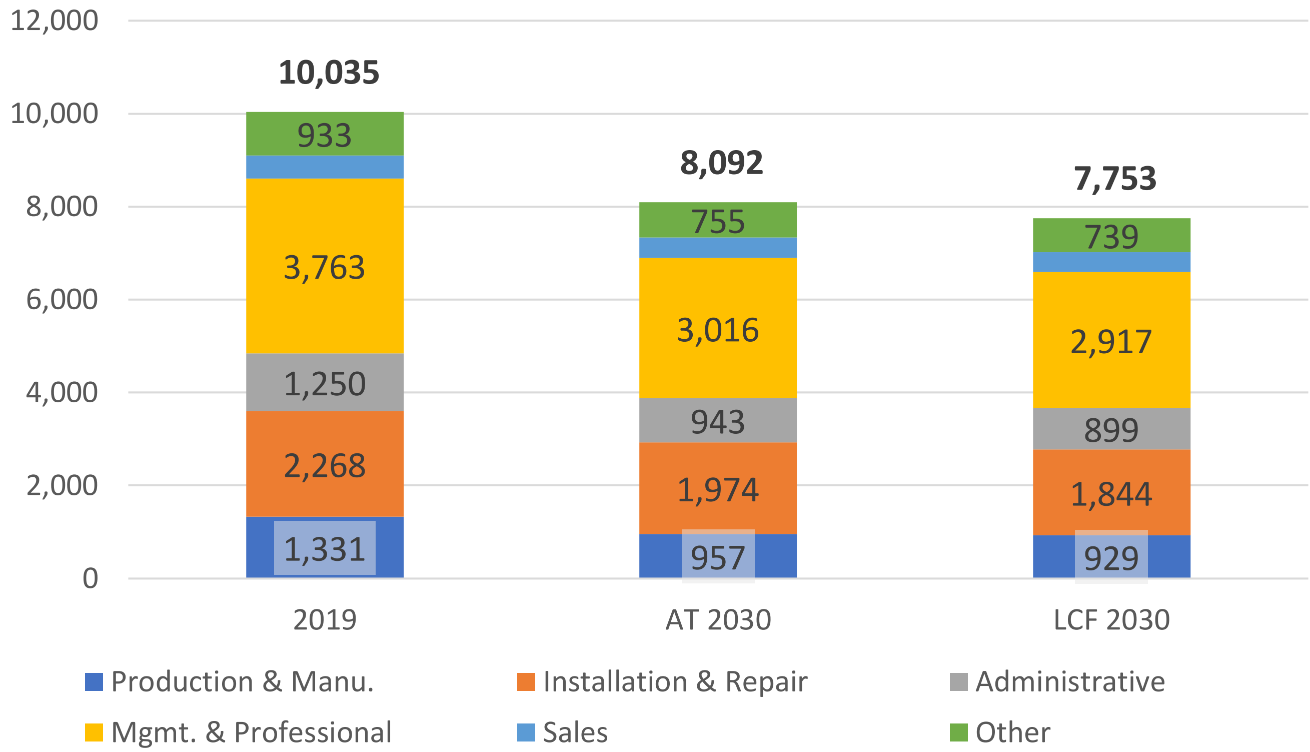
Displaced electricity subsectors will experience a loss of approximately 2,000 jobs, with most displacement in other supply chain jobs, followed by the professional services industry. Other supply chain, which occupies approximately 76 percent of displaced electricity subsectors, will lose approximately 1,500 jobs. The professional services industry, accounting for approximately 22 percent of the displaced subsectors, will lose approximately 500 jobs in the same period.

FIGURE 94. ELECTRICITY DISPLACED SUB-SECTORS: INDUSTRY PROFILE



Electricity displaced subsectors show a consistent decline of about a 20 percent in each of the occupational categories between 2019 and 2030. Of the approximately 2,000 jobs displaced in electricity subsectors, roughly 800 will be in management and professional occupations, which represent approximately 37 percent of the sector. Sales occupations, which hold the smallest share of growth subsectors at around five percent, will lose less than 100 jobs by 2030 in both scenarios.

FIGURE 95. ELECTRICITY DISPLACED SUB-SECTORS: OCCUPATIONAL PROFILE



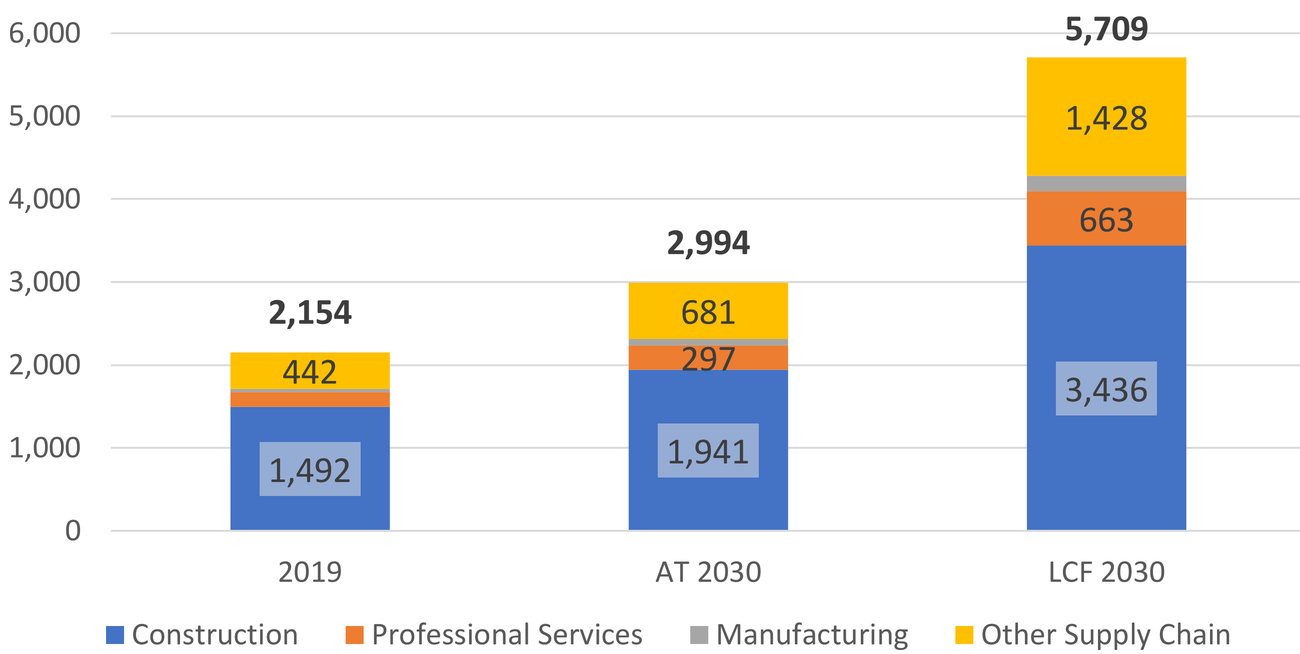
FUELS SECTOR

Growth Sectors

Fuels grew in the hydrogen and bioenergy subsectors.

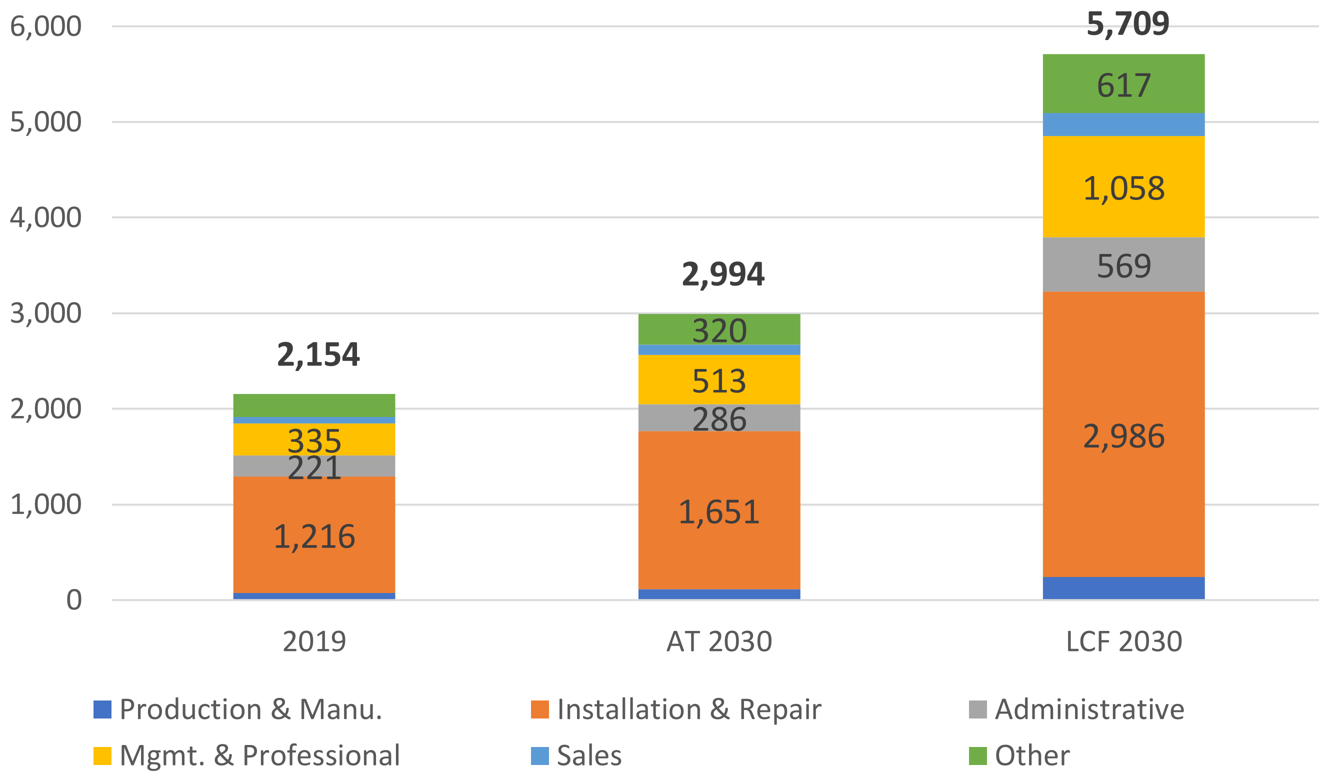
The growth subsectors in fuels will experience consistent growth across the industries, adding more than 800 jobs in the AT scenario and at least 3,500 jobs in the LCF scenario (Figure 96). The construction industry—approximately 60 percent of the growth subsectors—will double its 2019 baseline in the LCF scenario, adding more than 1,900 jobs by 2030. Other supply chain, representing about 20 percent of the growth subsectors, will triple the 2019 employment in the industry and add close to 1,000 jobs in the LCF scenario.

FIGURE 96. FUEL GROWTH SUBSECTORS: INDUSTRY PROFILE



Fuels subsectors can expect some growth in all the major occupational profiles in both the AT and LCF scenarios by 2030 (Figure 97). Installation and repair occupations—representing approximately 50 percent of the growth subsectors—will drive growth, adding more than 400 jobs in the AT scenario and at least 1,700 jobs in the LCF scenario.

FIGURE 97. FUEL GROWTH SUBSECTORS: OCCUPATIONAL PROFILE

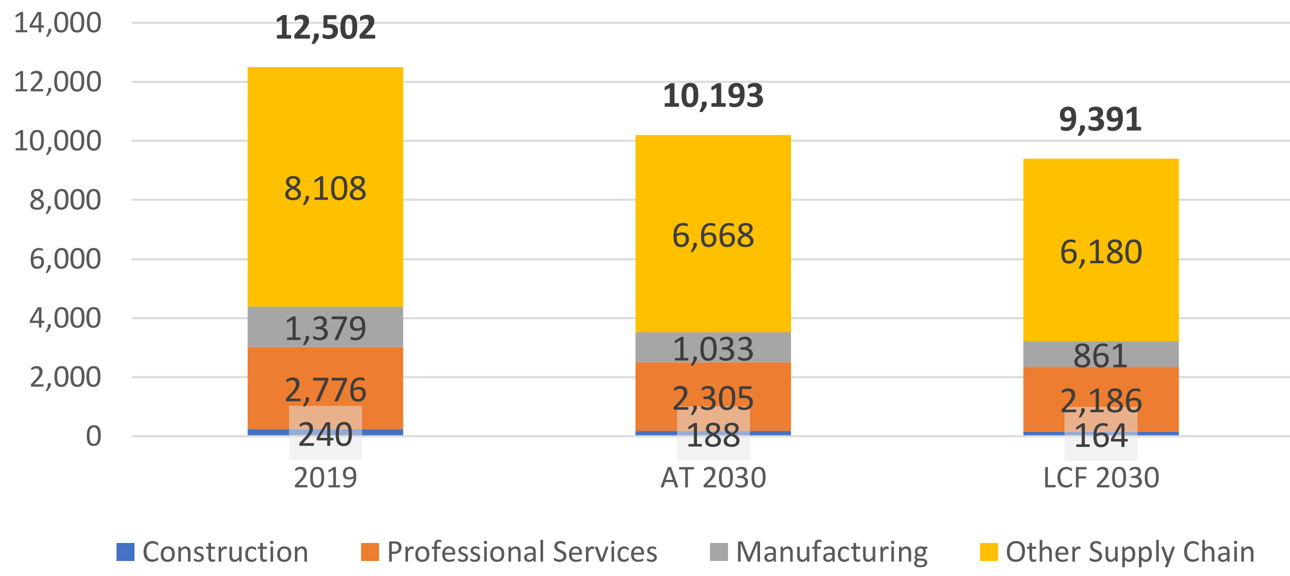


Displaced Sectors

Fuels will experience displacement in the natural gas, natural gas distribution, and petroleum fuels subsectors.

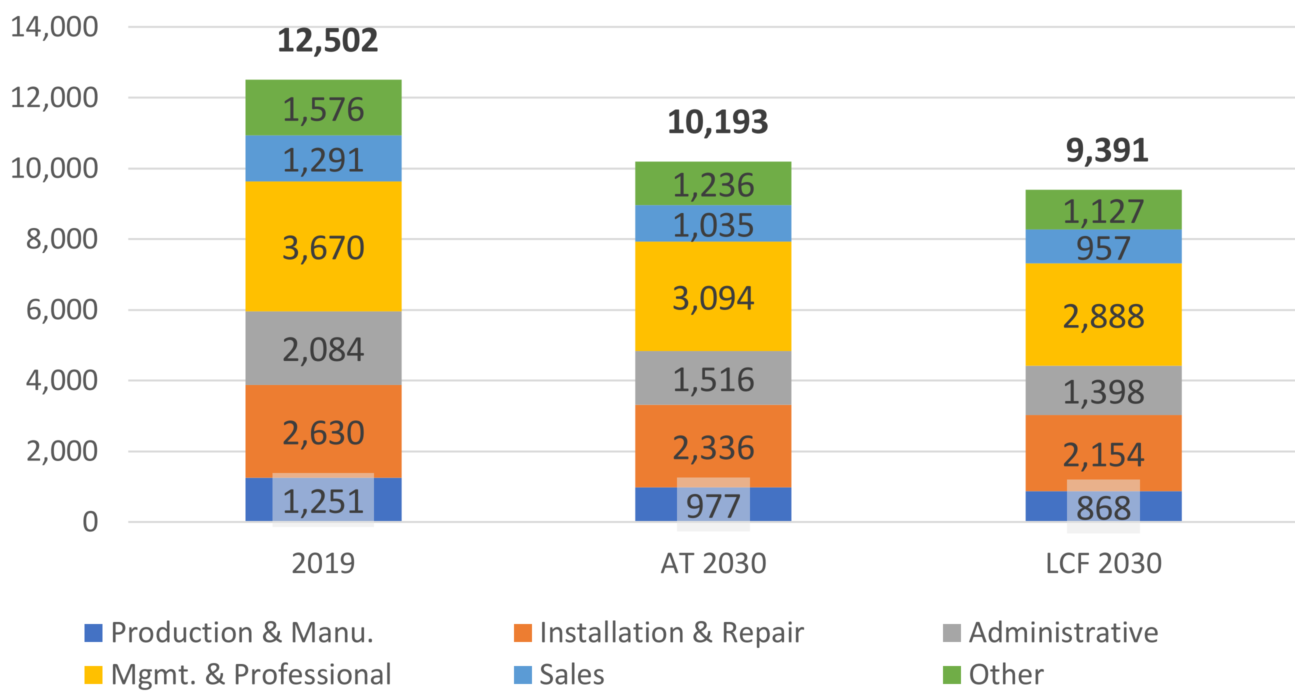
Displaced fuels subsectors will experience a loss of over 2,000 jobs in the AT scenario and over 3,000 jobs in the LCF scenario (Figure 98). The industries that will experience the most displacement in are other supply chain jobs followed by Professional Services and Manufacturing. Other supply chain, which accounts for approximately 65 percent of displaced fuels subsectors, will lose approximately 1,500 in the AT scenario and close to 2,000 jobs in the LCF scenario.

FIGURE 98. FUEL DISPLACED SUB-SECTORS: INDUSTRY PROFILE



Fuels displaced sub-sectors show a consistent decline in the occupational profile of each of the occupational categories from 2019 to 2030. In both scenarios (Figure 99), Administrative and Management and Professional occupations will drive job losses. The displacement figures in other occupational categories are comparable in both scenarios.

FIGURE 99. FUEL DISPLACED SUB-SECTORS: OCCUPATIONAL PROFILE



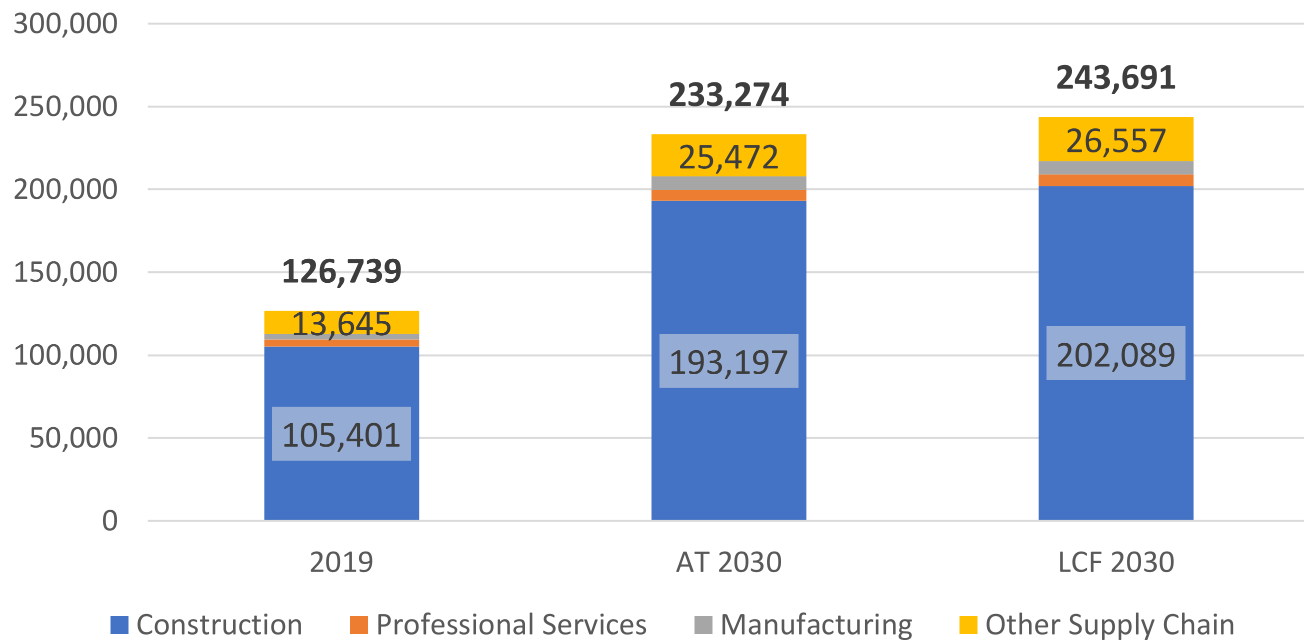
BUILDINGS SECTOR

Growth Sectors

All buildings subsectors—commercial HVAC, commercial shell, commercial other, residential HVAC, residential shell, and residential other—will experience growth between 2019 and 2030.

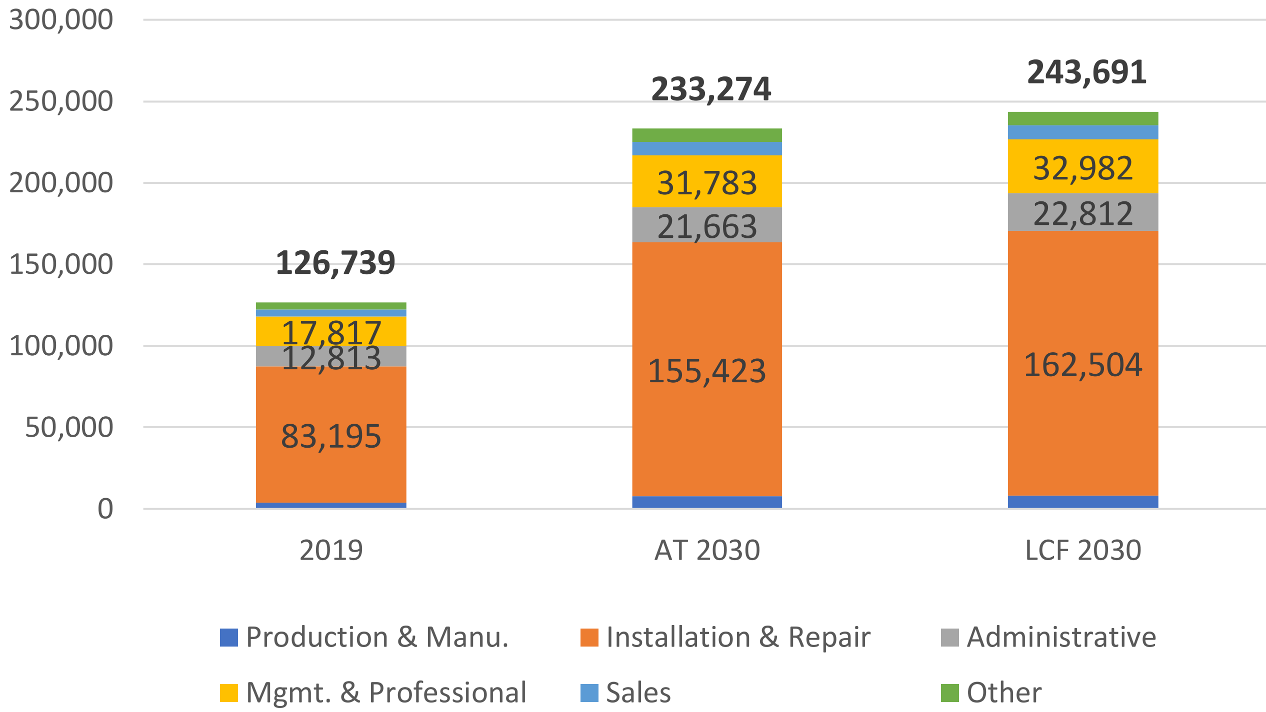
In both scenarios, the buildings sector will experience consistent growth across all industries (Figure 100). Both scenarios will add over 100,000 jobs by 2030, with construction jobs driving much of that growth. Construction, which occupies approximately 83 percent of the sector, will add around 87,000 and 96,000 to the AT and LCF scenarios, respectively. Other supply chain industries, the second largest industry in buildings, will add more than 11,000 jobs in both scenarios by 2030.

FIGURE 100. BUILDINGS GROWTH SUB-SECTORS: INDUSTRY PROFILE



Buildings growth subsectors can expect consistent growth in all major occupational groups; this growth will be driven by Installation and Repair occupations, which will add more than 70,000 jobs, followed by more than 13,000 jobs added in management and professional occupations (Figure 101).

FIGURE 101. BUILDINGS GROWTH SUBSECTORS: OCCUPATIONAL PROFILE



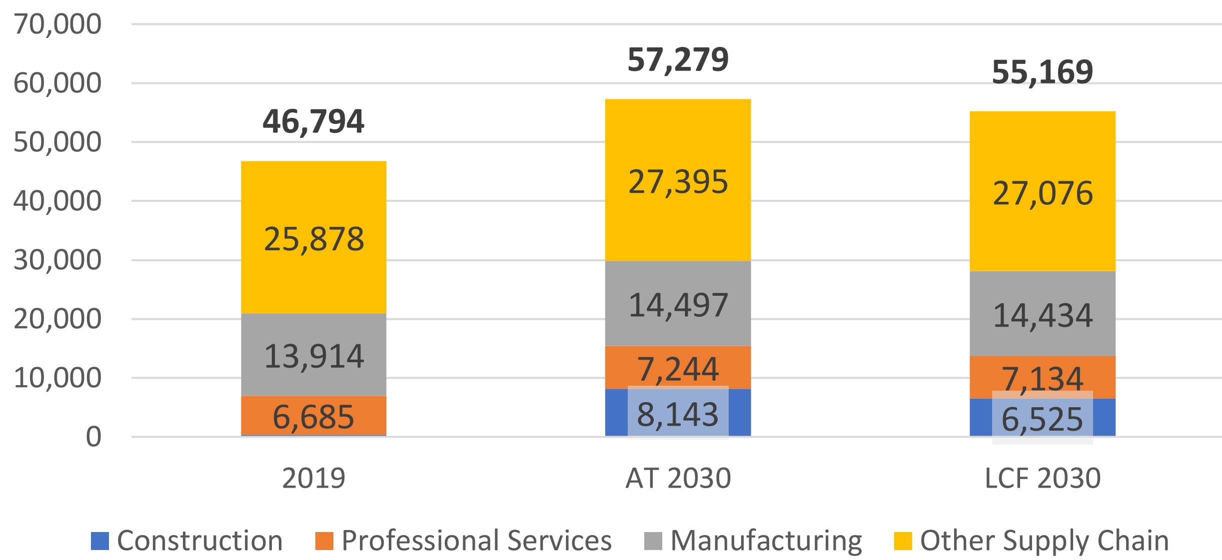
TRANSPORTATION SECTOR

Growth Sectors

The transportation sector will experience growth in vehicle manufacturing, wholesale trade parts, and charging and hydrogen fuel stations by 2030.

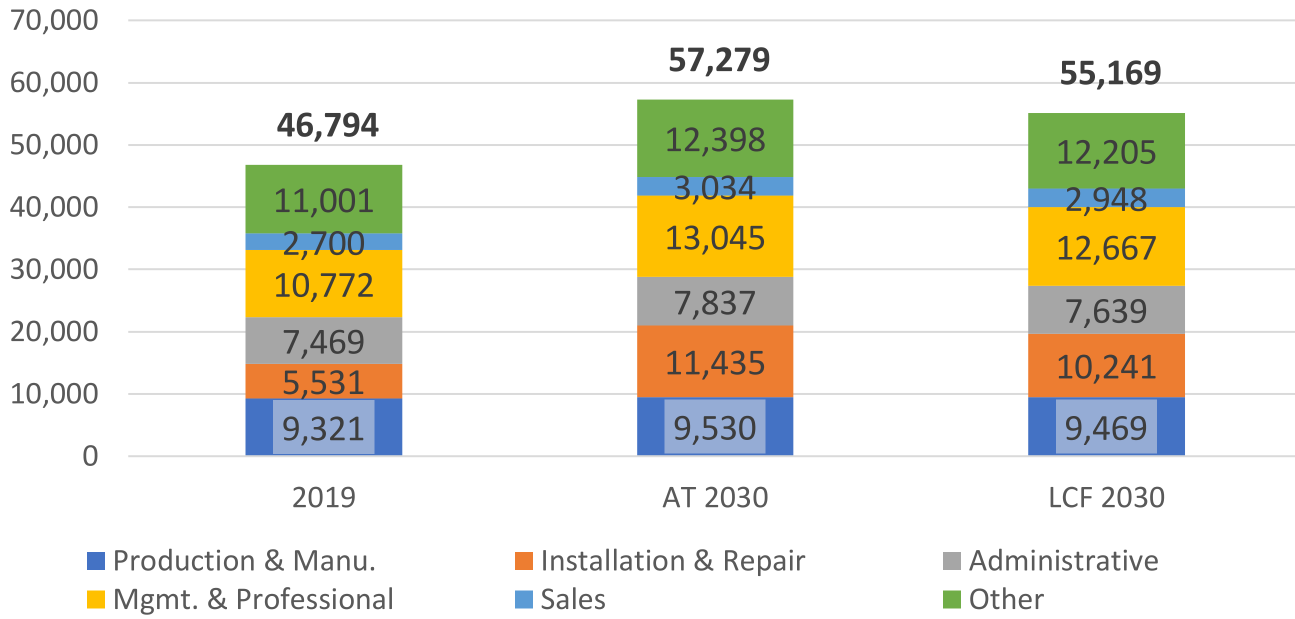
The construction industry—which will grow from 0.7% of the Transportation growth sub-sectors in 2019 to over 10 percent in 2030—will drive job growth between 2019, adding over 7,500 jobs in the AT scenario and over approximately 6,200 jobs in the LCF scenario (Figure 102). Other Supply Chain industries—which represents around half of the growth subsectors—will add the second highest number of jobs, adding over 1,000 jobs in each scenario by 2030. Both the Professional Services and Manufacturing industries will add around 500 jobs in each scenario between 2019 and 2030.

FIGURE 102. TRANSPORTATION GROWTH SUB-SECTORS: INDUSTRY PROFILE



Transportation growth sub-sectors can expect some growth in all the major occupational profiles in both the AT and LCF scenarios by 2030 (Figure 103). Installation and Repair occupations, which represent around 17 percent of the growth sub-sectors in 2030 compared to 12 percent in 2019, will add approximately 5,900 jobs in the AT scenario and over 4,700 jobs in the LCF scenario. The Management & Professional and Other occupational groups, each of which holds over 20 percent of the share of growth sub-sectors, represent the second and third highest levels of growth, respectively.

FIGURE 103. TRANSPORTATION GROWTH SUB-SECTORS: OCCUPATIONAL PROFILE

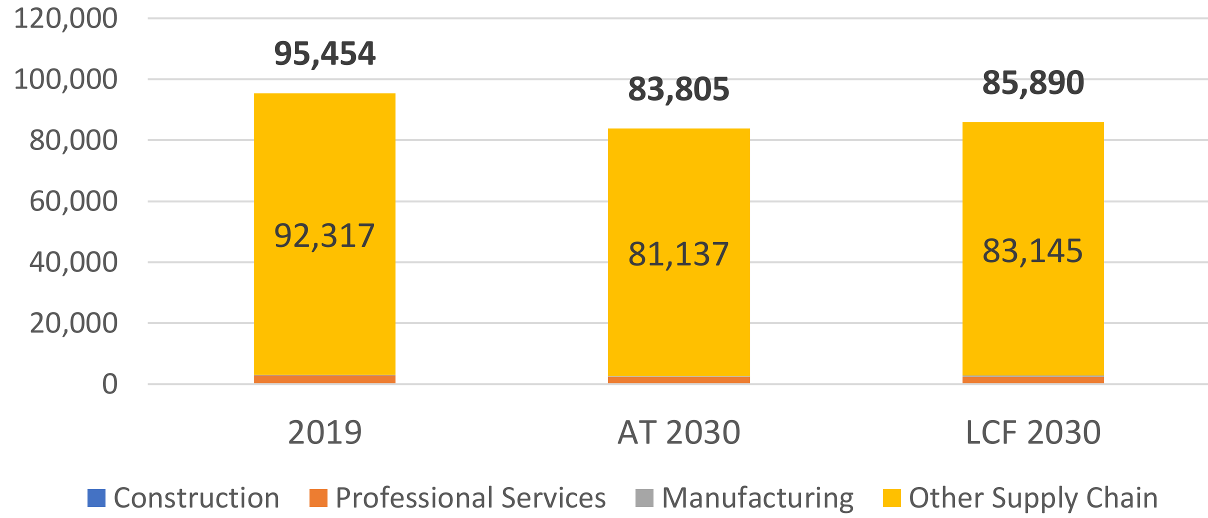


Displaced Sectors

The Transportation sub-sectors that will experience displacement include Vehicle Maintenance and Conventional Fueling Stations.

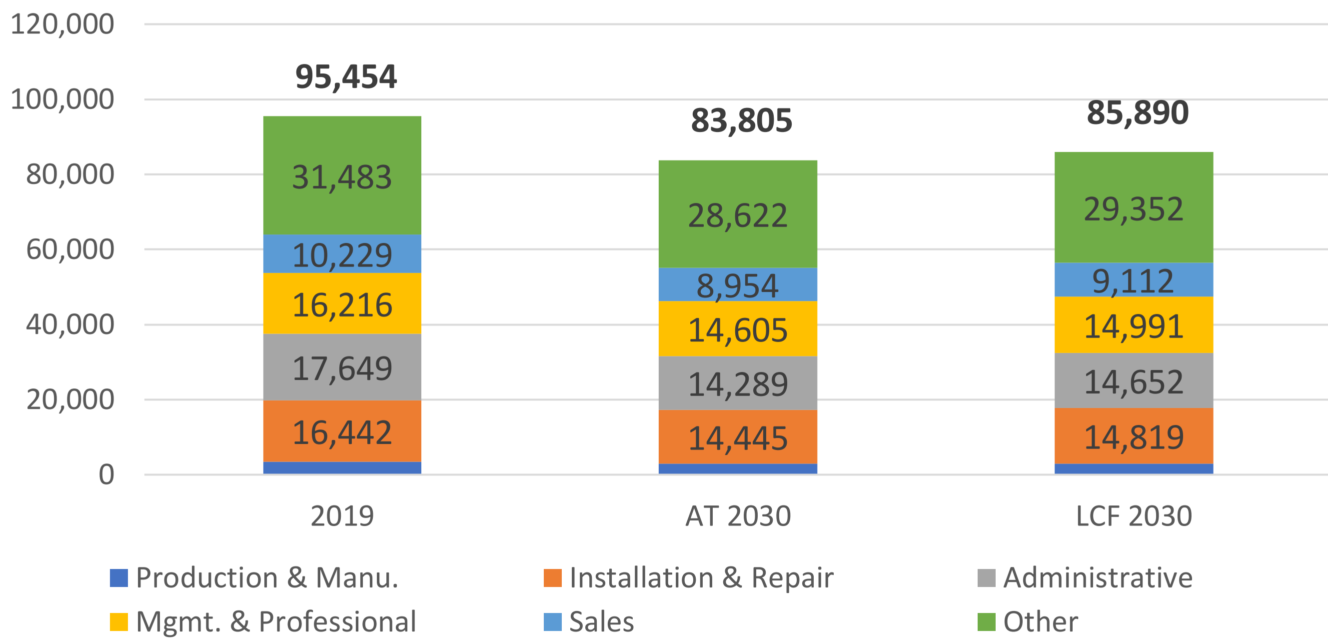
Other Supply Chain industries—which represents over 96 percent of the displaced Transportation sub-sectors and include General Automotive Repair and General Freight Tracking—will drive displacement in both scenarios, losing over 11,000 jobs in the AT scenario and over 9,000 jobs in the LCF by 2030 (Figure 104). The least represented industries, Construction and Manufacturing, will each lose less than 50 jobs in both scenarios whereas the Professional Services industry—which occupies nearly three percent of displaced sub-sectors—will lose approximately 400 and 350 jobs in the AT and LCF scenarios.

FIGURE 104. TRANSPORTATION DISPLACED SUB-SECTORS: INDUSTRY PROFILE



Transportation displaced sub-sectors will show a consistent decline across each of the occupational categories from 2019 to 2030 (Figure 105). The Administrative occupational category will experience the most displacement, followed by Other and Installation and Repair occupations. Production and Manufacturing occupations, which represent just over three percent of displaced Transportation sub-sectors, will lose around 500 jobs in both scenarios by 2030.

FIGURE 105. TRANSPORTATION DISPLACED SUB-SECTORS: OCCUPATIONAL PROFILE



V. Model Sensitivities and Workforce Analyses

IEO Model Sensitivity Analyses

OVERVIEW

The IEO Model Sensitivities examine: (A) the potential impacts to manufacturing employment in the Buildings sector as a result of higher in-state manufacturing activity, and (B) the key assumptions used for gas station closings in the Transportation sector.

A. The **In-State Manufacturing** sensitivity analysis evaluates the change in manufacturing employment for the Buildings sector by increasing in-state manufacturing capacity to 50 percent and 100 percent. This demonstrates the possibility of additional employment that could stem from policies that incentivize in-state manufacturing for Buildings.

B. The **Fueling Stations** sensitivity for the Conventional Fueling Stations sub-sector in Transportation also compares the initial case modeled in the IEOs to two different assumptions. The primary case models employment changes in fueling stations according to changes in fuel demand; this affects gas stations with convenience stores differently compared to gas stations without convenience stores. The sensitivity analysis looks at how employment in the sub-sector would be affected as the assumptions around gas stations with and without convenience stores change.

MODEL SENSITIVITY: IN-STATE MANUFACTURING (BUILDING SECTOR)

In the IEOs of the Jobs Study, the buildings sector follows the in-state manufacturing pattern from the default I/O modeling structure. This In-State Manufacturing sensitivity analysis evaluates the impact of changing the multipliers for manufacturing inputs in the model to evaluate how more in-state manufacturing impacts employment and the economy.

In the baseline employment for 2019,[50] 14 percent of manufacturing jobs created from clean energy investments in the Buildings sector are within New York State (Table 20). The sensitivity analysis estimates how many jobs would be created by 2030 assuming either a 50 percent or 100 percent in-state manufacturing workforce for Buildings.

[50] New York Clean Energy Industry Report: https://www.nyserda.ny.gov/About/Publications/New-York-Clean-Energy-Industry-Report.

TABLE 19. IN-STATE MANUFACTURING FOR BUILDINGS, 2019

In-State Manufacturing for the Buildings Sector (2019)

	Employment	In-State%
• Commercial HVAC	220	(7%)
• Commercial Shell	1,360	(29%)
• Commercial Other	360	(4%)
• Residential HVAC	230	(8%)
• Residential Shell	1,190	(29%)
• Residential Other	340	(9%)
Buildings (Manufacturing)	**3,700**	**(14%)**

Under the LCF scenario, the Buildings sector is modeled to have about 8,100 jobs in manufacturing in the IEOs. In the case where 50 percent of the manufacturing employment is in-state, the LCF scenario is modeled to have close to 19,000 manufacturing jobs in the Buildings sector by 2030, more than double the findings of the initial IEO. For the case where New York has 100 percent in-state manufacturing for the Buildings sector, there would be almost 38,000 manufacturing jobs by 2030, almost five times the initial IEO estimate (Table 21).

TABLE 20. INCREASED IN-STATE MANUFACTURING FOR BUILDINGS, 2030 (S2: LCF)

In-State Manufacturing for the Buildings Sector (2030) under S2:LCF

	50%	100%
• Commercial HVAC	2,670	5,340
• Commercial Shell	2,760	5,530
• Commercial Other	3,680	7,360
• Residential HVAC	3,320	6,630
• Residential Shell	4,910	9,810
• Residential Other	1,620	3,250
Buildings (Manu) Total	**18,960**	**37,920**
Added over 2030 Base	**10,880 (>2x's)**	**29,840 (<5x's)**

Under the AT Scenario, increased in-state manufacturing has a smaller, but still significant, impact on employment. The IEOs modeled 8,000 manufacturing jobs in Buildings by 2030, a similar number to the LCF scenario. Assuming 50 percent in-state manufacturing, the number of manufacturing jobs would double to 16,800 in 2030. With 100 percent in-state manufacturing, the state of New York will have 33,400 manufacturing jobs in the Buildings sector, slightly over four times the modeled figures in the initial IEOs (Table 22).

TABLE 21. INCREASED IN-STATE MANUFACTURING FOR BUILDINGS, 2030 (S3: AT)

In-State Manufacturing for the Buildings Sector (2030) under S3:AT

	50%	100%
• Commercial HVAC	2,950	5,910
• Commercial Shell	2,770	5,530
• Commercial Other	3,690	7,370
• Residential HVAC	3,780	7,560
• Residential Shell	1,910	3,810
• Residential Other	1,630	3,250
Buildings (Manu) Total	**16,760**	**33,430**
Added over 2030 Base	**8,810 (>2x's)**	**25,480 (>4x's)**

MODEL SENSITIVITY: GAS STATION CLOSINGS (TRANSPORTATION SECTOR)

In the primary analysis presented in the main body of this report, the research modeled employment at fueling stations by scaling 2019 baseline employment[51] by projected fossil and bio-fuel consumption relative to 2019.[52] Industry research indicates that fueling stations with convenience stores earn approximately 61 percent of their revenue from gasoline sales.[53] As a result, the research team estimated 61 percent of employment at these establishments changes proportionally with fossil and bio-fuel consumption, while the remaining 39 percent is unaffected. All employment at gasoline stations without convenience stores is also assumed to change proportionally with fossil and bio-fuel consumption.
To evaluate the sensitivity of the estimated declines in fueling station employment to the model parameters, the research team conducted two sensitivity analyses:

1. Evaluate employment impacts under the assumption that fueling stations with convenience stores are able to adapt to the changing market environment
2. Evaluate impacts under the assumption that some fueling stations are able to install electronic vehicle charging units, enabling these stations to avoid displaced employment

Sensitivity Analysis 1

In this sensitivity, it is assumed that fueling stations with convenience stores can adapt to the changing market environment and experience no job impacts. In this scenario, employment at fueling stations with convenience stores will be equal to 2019 employment in all years from 2020 to 2050.

This sensitivity analysis applies to fueling stations with convenience stores only. Fueling stations without convenience stores are estimated to experience employment losses based on projected fossil and bio-fuel consumption as in the primary analysis.

[51] Census. County Business Patterns. October 8, 2021. Accessed at https://www.census.gov/programs-surveys/cbp/data/datasets.html.
[52] CAC Integration Analysis.
[53] National Association for Convenience Stores. "Convenience Retail Industry Pivots for Long-Term COVID-19 Impact." April 14, 2020. Accessed at https://www.convenience.org/Media/Press-Releases/2020/Convenience-Retail-Industry-Pivots-for-Long-Term-C#.Ybt_D1lOlPZ.

Sensitivity Analysis 2

In this sensitivity, the research team assumed that some fueling stations with convenience stores install electronic vehicle charging equipment, enabling these stations to avoid employment losses associated with declining fossil and bio-fuel consumption.

To model the number of fueling stations that are able to install electronic vehicle charging equipment, the research team assumed 50 percent of the estimated light duty DCFC charging units (E3) are installed at fueling stations with convenience stores. The research team further assumed that four charging units must be installed at each fueling station in order to provide the requisite charging capacity. In this scenario, all employment at these fueling stations is potentially subject to impacts based on projected fuel consumption.

As an initial step in estimating employment impacts under this sensitivity, the research team modeled the number of fueling station establishments that would cease operations based only on the change in fossil and bio-fuel consumption relative to 2019; for example, if fossil and bio-fuel consumption declines five percent from 2019 to 2020, it was estimated that five percent of fueling stations would cease operations.

Simultaneously, the research team estimated the number of fueling stations that would be able to install light duty DCFC charging equipment. If the number of stations able to install charging equipment is greater than the number of stations that would be expected to cease operations based on fossil and bio-fuel demand, there is no impact on fueling station operation and employment. If, however, the number of stations expected to cease operations exceeds the number of stations that can install charging equipment, the research team estimated the decline in jobs based on the difference between these two values. Once a station ceases operations, it remains closed for the duration of the period over which impacted were analyzed. The average number of employees per fueling station was used to convert fueling stations in operation and fueling station closures to continued and lost employment, respectively.

As in the primary analysis and Sensitivity Analysis 1, fueling stations <u>without</u> convenience stores are estimated to experience employment losses based on projected fossil and bio-fuel consumption as in the primary analysis.

Results

In the primary analysis, the research team estimated 9,371 displaced fueling station jobs under S2: LCF and 10,952 displaced jobs under S3: AT.

In Sensitivity Analysis 1, the research team estimated 2,210 displaced jobs under S2: LCF and 2,583 displaced jobs under S3: AT—a reduction in displaced jobs of 76 percent. In this analysis, the total number of estimated displaced jobs by 2030 across all subsectors decreases by approximately 33 percent and 38 percent, respectively (Figure 106).

In Sensitivity Analysis 2, we estimate 4,625 displaced jobs under S2: LCF and 4,056 displaced jobs under S3: AT—a reduction of 51 percent and 63 percent, respectively. In this analysis, the total number of estimated displaced jobs by 2030 across all subsectors decreases by approximately 22 percent and 32 percent, respectively (Figure 107).

TABLE 22. SUMMARY OF FUELING STATION SENSITIVITY ANALYSES

Scenario	Baseline Jobs 2019	Displaced Jobs 2030	
		S2: LCF	S3: AT
Primary case	49,163	9,371	10,952
Sensitivity 1 *(% difference vs. primary case)*		2,210 *(-76%)*	2,583 *(-76%)*
Sensitivity 2 *(% difference vs. primary case)*		4,625 *(-51%)*	4,056 *(-63%)*

FIGURE 106. TOTAL DISPLACED JOBS COMPARISON (S2: LCF)

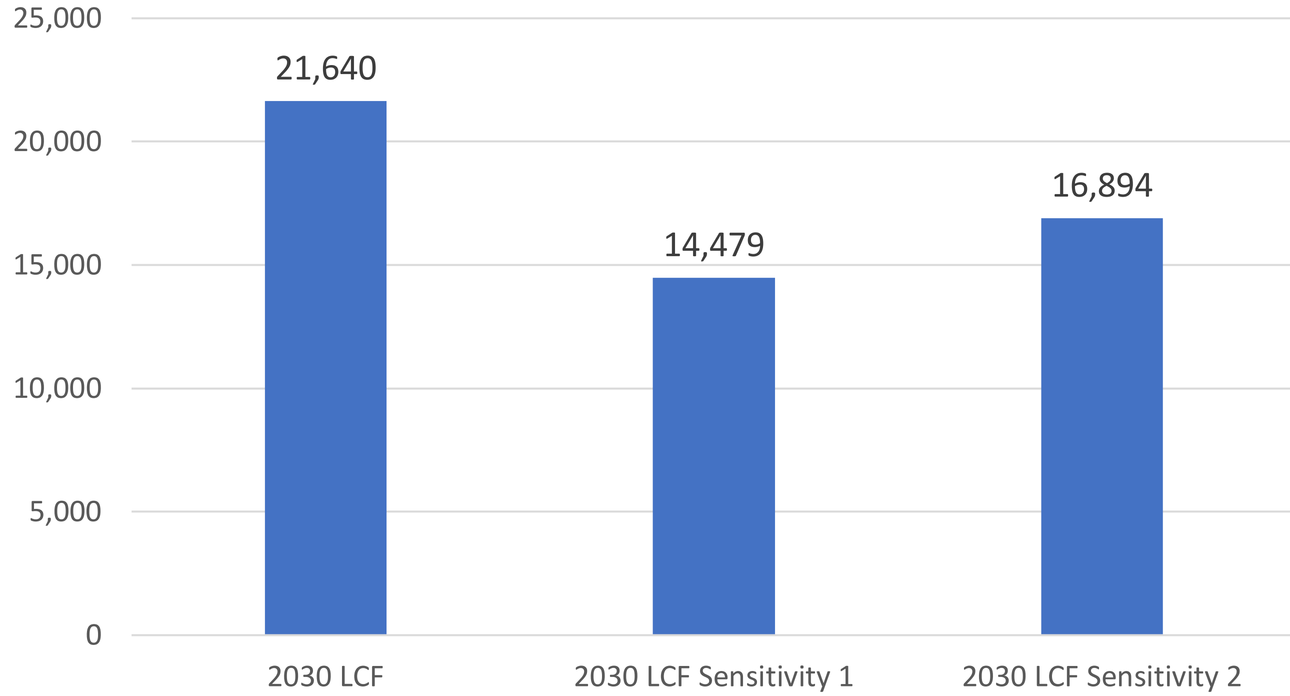
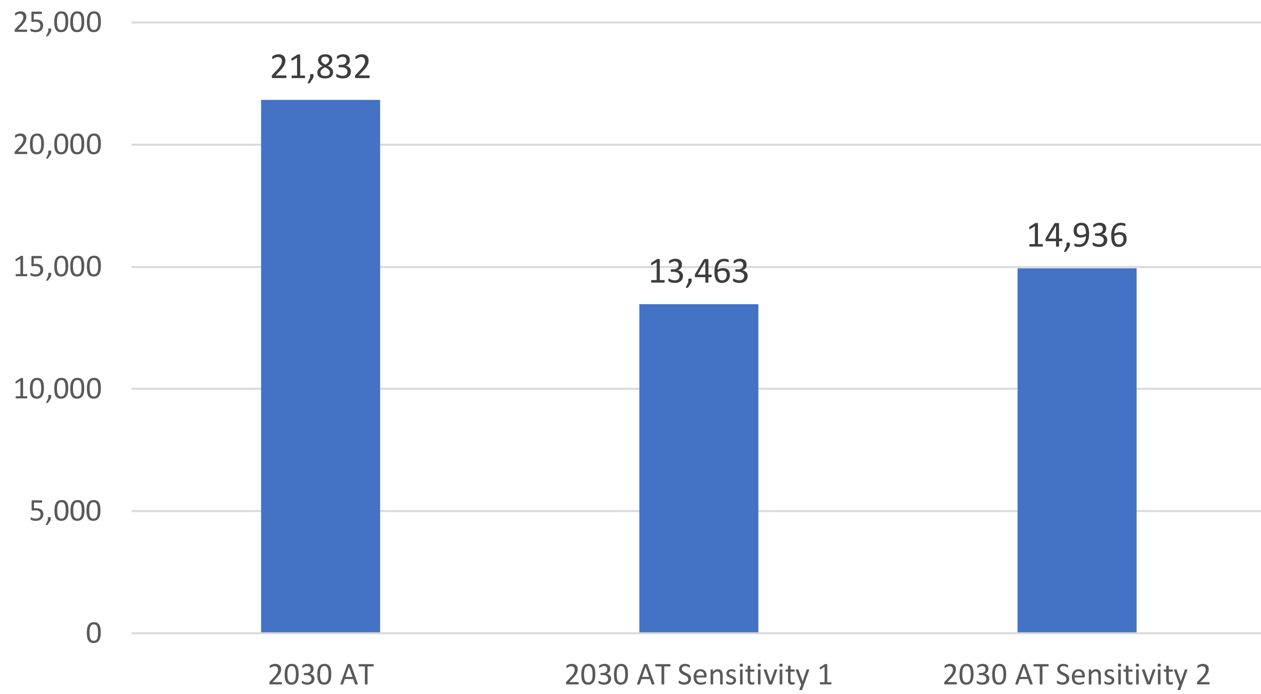


FIGURE 107. TOTAL DISPLACED JOBS COMPARISON (S3: AT)



SEO Workforce Analyses

OVERVIEW

Where the IEOs included additional sensitivity analyses (see Page 115), the SEOs include additional workforce analyses evaluating the geographic and wage distributions of jobs in all four sectors by 2030 for both transition scenarios.

1. The **Geographic Analysis** describes the impact of employment across five regions in the state of New York: Upstate A-E, Upstate F, Lower Hudson Valley, New York City, and Long Island (Figure 108**Error! Reference source not found.**). Jobs created and displaced vary across the five regions, and the existing industries in each region influence these geographical employment shifts. This analysis highlights employment changes for each region for all sub-sectors as well as for Growth and Displaced sub-sectors.

2. The **Wage Analysis** distributes New York's workforce into three wage categories[54] (Table 24) and evaluates how the model findings impact sustainable wages in the four sectors studied. The 500,000 jobs across the four sectors in 2019 are split by wage category and compared to the wage categorization for the 2030 outputs. This analysis evaluates the wage composition of the four sectors overall and compares the distribution of lower-tier jobs across the four sectors, identifying how these change over time under each transition scenario.

The SEO section begins with an overview of the geographic and wage analysis across all four sectors; throughout the remainder of the section, references will be made to both these geographic and wage analyses within each of the four sectors.

[54] These wages categories were created based on data from the 2019 MIT Living Wage Calculator for New York State: https://livingwage.mit.edu/.

Figure 108. Five Regions from the CAC Integration Analysis

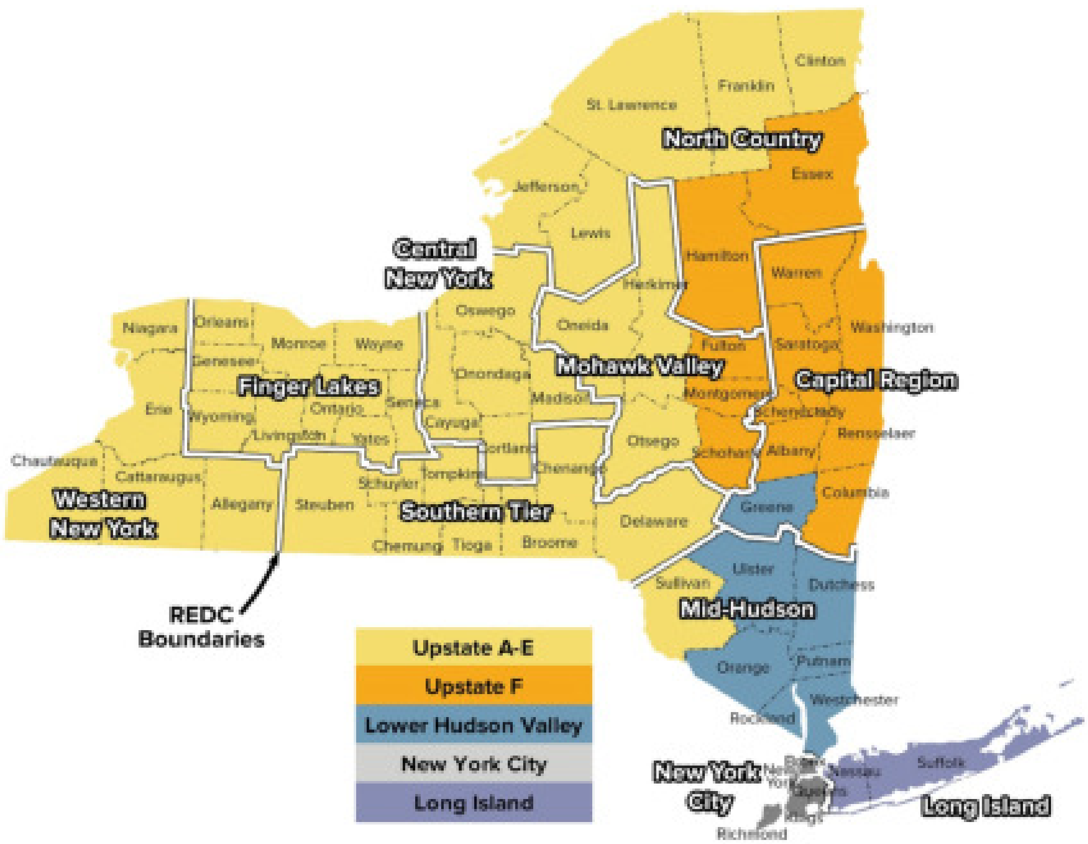


Table 23. Delineation of Wage Categories

Tier 1 – highest paying wage category	Above sustaining wage	Over $37 per hour
Tier 2 – middle paying wage category	At sustaining wage	$28 - $37 per hour
Tier 3 – lowest paying wage category	Below sustaining wage	Below $28 per hour

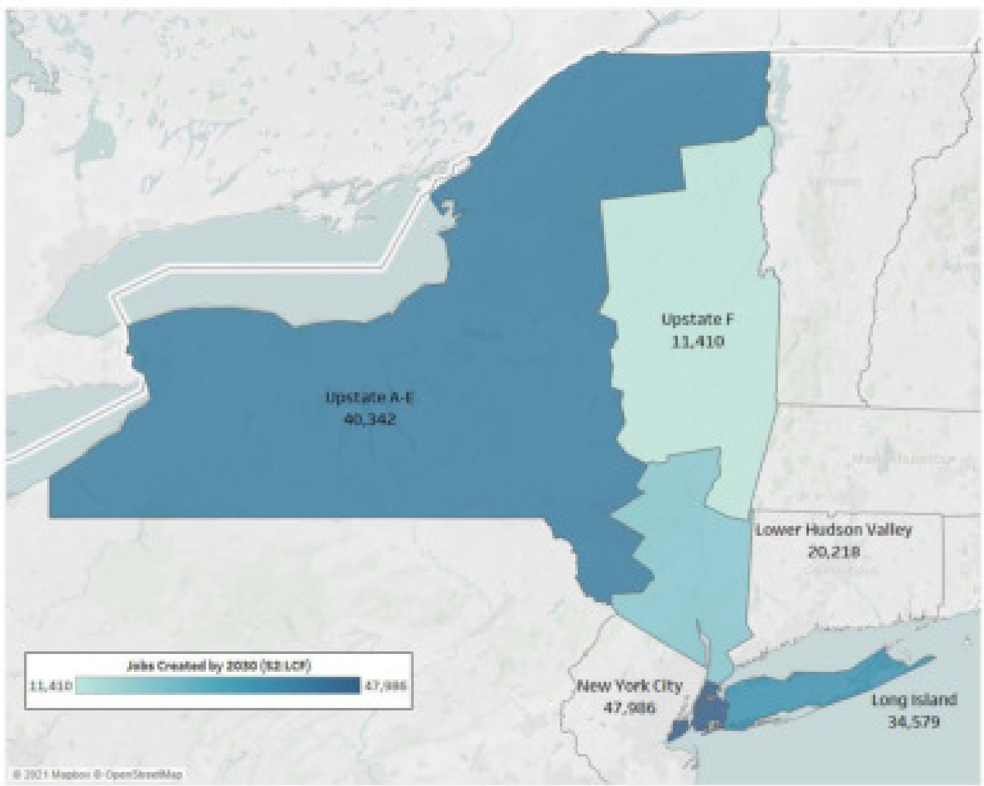
WORKFORCE ANALYSIS: GEOGRAPHIC DISTRIBUTION OF JOBS

Overall, Upstate A-E and New York City are the regions that will have the most direct and indirect jobs created under both scenarios.

Of the 155,000 net jobs added under the LCF scenario by 2030, over 30 percent (48,000 jobs) will be in the New York City region and another 26 percent (40,000) will be in the Upstate A-E region. The Upstate F region will create the least number of jobs—about seven percent (11,000) of all created jobs statewide (Figure 109).

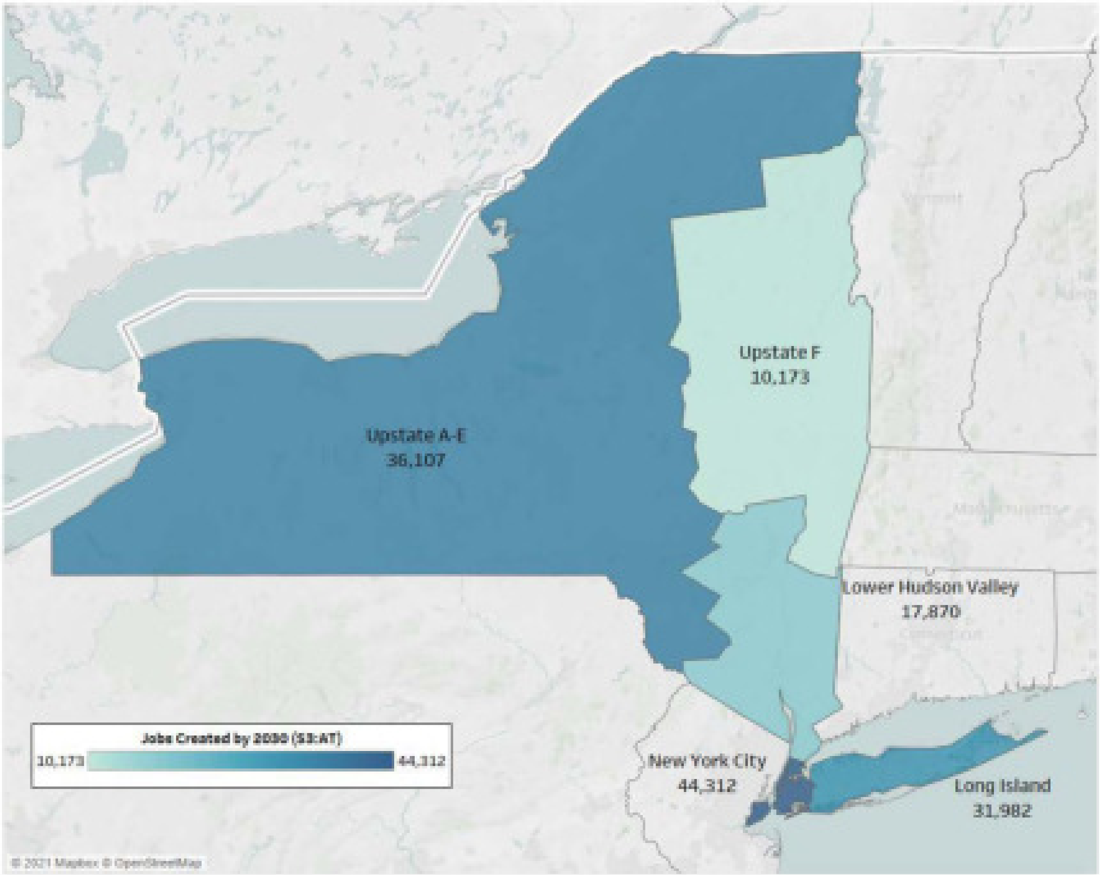
The AT scenario has a similar distribution of the 140,000 jobs created to that of the LCF scenario, with close to 60 percent of jobs created are in the New York City and Upstate A-E regions (Figure 110). Net jobs created in the New York City region will largely stem from the 36,000 jobs created in Buildings in the LCF scenario (32,000 jobs in the AT Scenario). The Upstate A-E region will add the most Electricity jobs under the LCF scenario by 2030, at almost 14,000 total workers.[55]

FIGURE 109. JOBS ADDED BY 2030 FOR EACH REGION (S2: LCF)



[55] For more information on the geographic distribution of jobs for each of the four sectors, please refer to the remainder of this section which includes employment maps for all four sectors.

FIGURE 110. JOBS ADDED BY 2030 FOR EACH REGION (S3: AT)



Among the Growth sub-sectors in the LCF scenario, the New York City region is estimated to create 51,000 jobs by 2030. The Upstate A-E region will add 45,000 jobs and Long Island will add close to 38,000 jobs in Growth sub-sectors (Figure 111**Error! Reference source not found.**). Job creation among Growth sub-sectors in the AT scenario will be the largest in the New York City, Upstate A-E, and Long Island regions; close to 80 percent of jobs added by 2030 will be in these three regions (Figure 112).

For Displaced sub-sectors, most jobs lost by 2030 will be in the Upstate A-E region, with about 4,700 displaced jobs under the LCF scenario. The New York City, Lower Hudson Valley, and Long Island regions will have about 3,000 displaced jobs each by 2030 (Figure 113**Error! Reference source not found.**).

There are close to 5,000 jobs expected to be lost by 2030 in the Upstate A-E region under the AT scenario. The other four regions will lose a similar number of jobs compared to the LCF scenario (Figure 114). The Upstate A-E region will represent over 30 percent of jobs lost in the region within Displaced sub-sectors. Most jobs lost in Displaced sub-sectors will be from Transportation, largely from the Conventional Fueling Stations and Vehicle Maintenance sub-sectors.

FIGURE 111. JOBS ADDED BY 2030 FOR EACH REGION IN GROWTH SUB-SECTORS (S2: LCF)

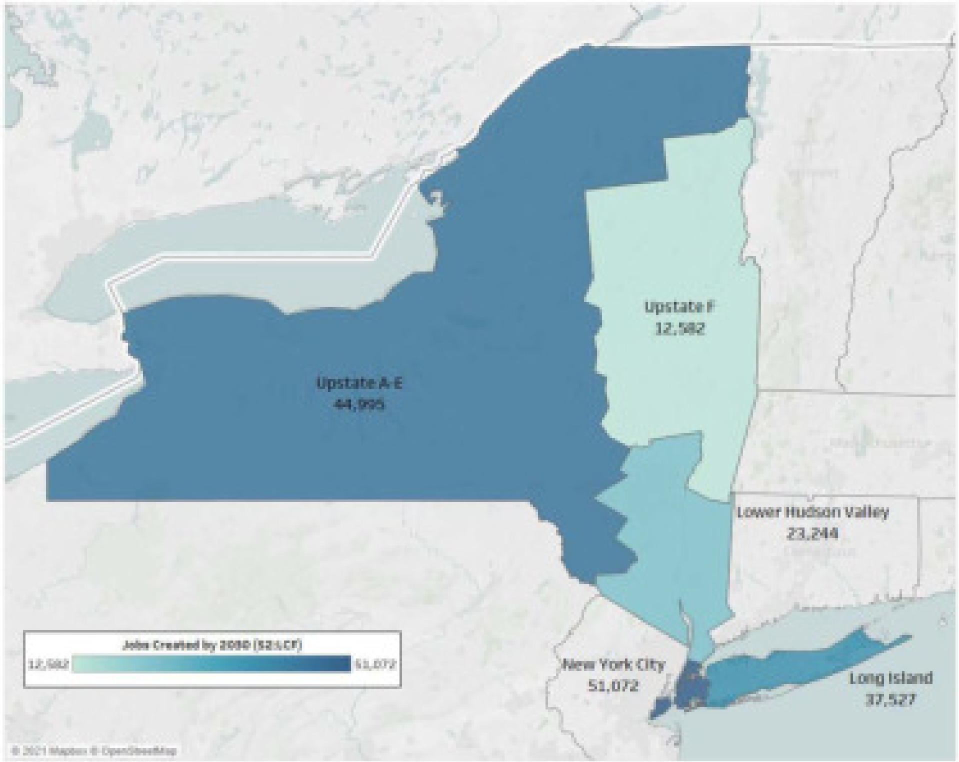


FIGURE 112. JOBS ADDED BY 2030 FOR EACH REGION IN GROWTH SUB-SECTORS (S3: AT)

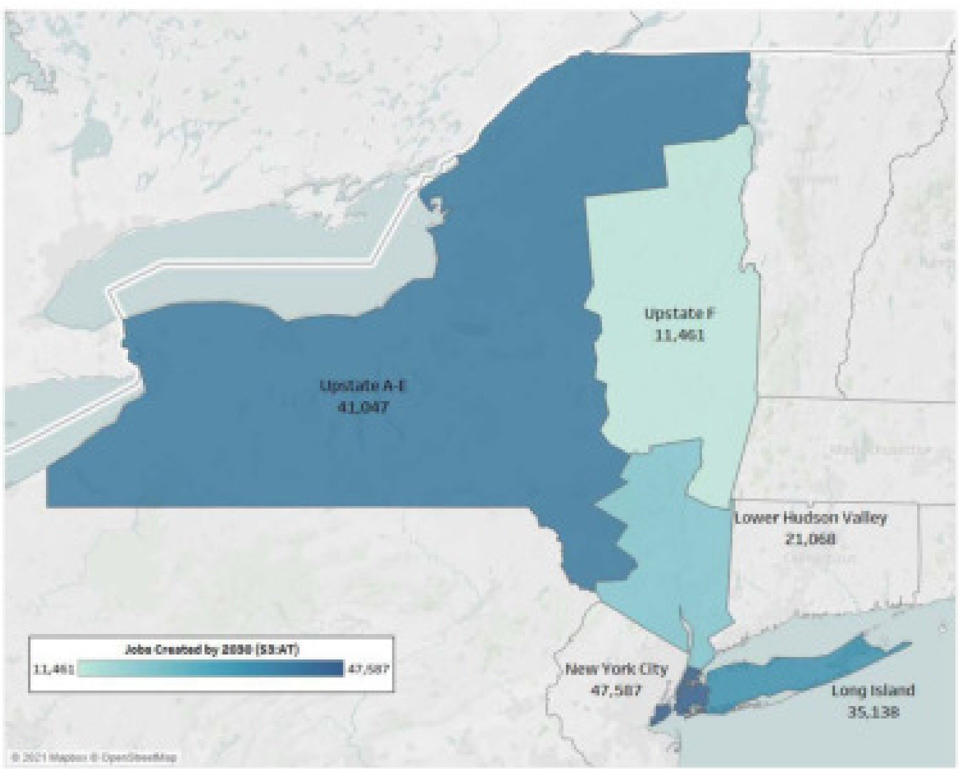


FIGURE 113. JOBS LOST BY 2030 FOR EACH REGION IN DISPLACED SUB-SECTORS (S2: LCF)

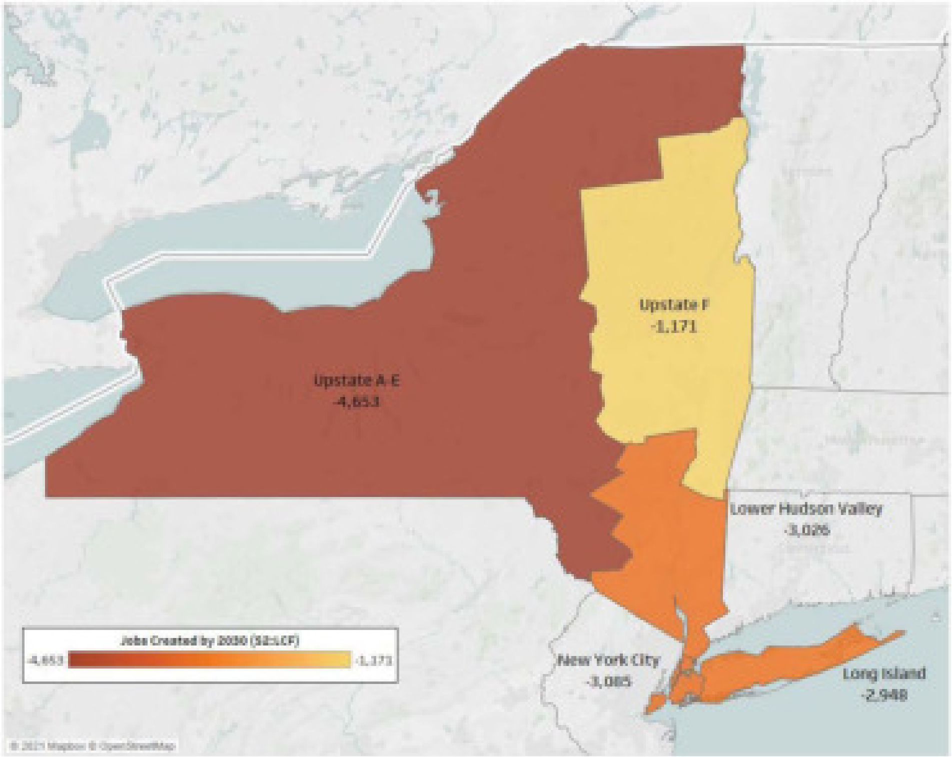
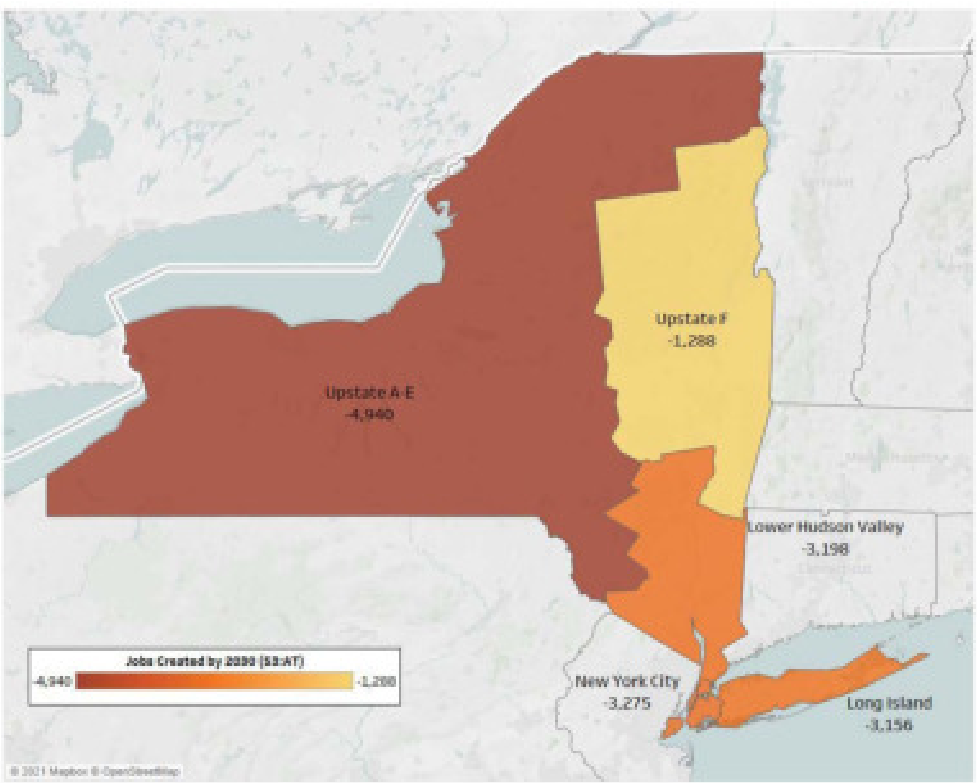


FIGURE 114. JOBS LOST BY 2030 FOR EACH REGION IN DISPLACED SUB-SECTORS (S3: AT)



WORKFORCE ANALYSIS: SUSTAINABLE WAGES

In 2019, 41 percent of jobs across all four sectors were in the lower wage category (<$28), 23 percent were in the middle wage category ($28 - $37), and 36 percent were in the higher wage category ($37). The largest share increase will occur in middle wage positions, which will increase by about five to six percentage points. Lower wage positions will have the largest decline in total share, a decrease of 4 points (Table 25).[56] The trend for both scenarios by 2030 is to see a higher share of middle wage positions and a smaller share of lower and higher wage categories, as opposed to wage trends seen nationally since 2010.[57]

TABLE 24. CATEGORIZATION OF TOTAL JOBS ACROSS FOUR SECTORS BY WAGE CATEGORY

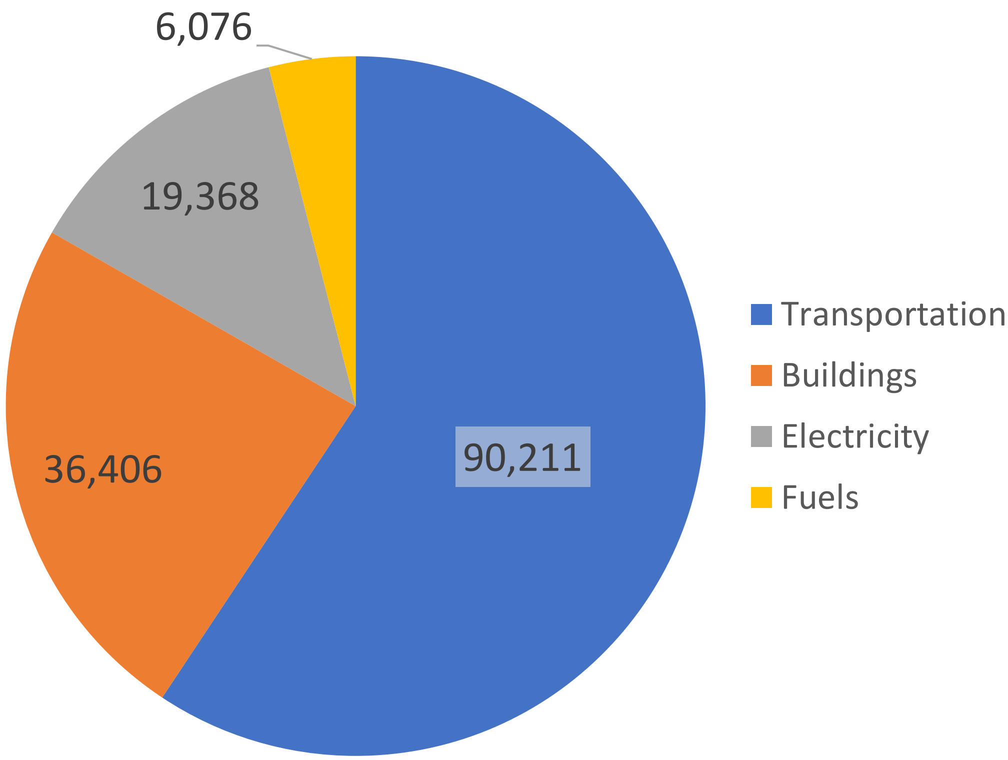
	All Four Sectors (Combined)			Change from 2019 to 2030	
	2019	AT 2030	LCF 2030	AT 2030	LCF 2030
<$28	41%	37%	37%	-4%	-4%
$28 - $37	23%	28%	29%	6%	6%
>$37	36%	34%	34%	-2%	-2%

In 2019, about 41 percent of all workers in the four sectors were in lower wage positions (<$28), and most are in the Transportation sector (Figure 115). Transportation has approximately 60 percent of employment in lower wage positions (<$28), the highest proportion of lower wage positions among the four sectors. In this wage category for the Transportation sector, common occupations are Transportation and Material Moving; Production; and Installation, Maintenance & Repair.

The Electricity sector had the highest proportion of higher wage positions (>$37), about half of employment falls in this category.

[56] For more information on the wage distribution for each of the four sectors, please refer to the remainder of this section.
[57] Bureau of Labor Statistics, Occupational Employment and Wage Statistics (BLS OEWS). Over the last decade wages have trended more towards increases in the lower and higher wage positions and decreases in the middle wage positions.

FIGURE 115. WORKERS IN LOWER WAGE POSITIONS (<$28), 2019 ALL SECTORS



By 2030, the 37 percent of workers in lower wage positions (<$28) under both scenarios are predominantly (80 percent) found in the Transportation or Buildings sectors. This represents close to 158,000 workers in the LCF scenario and 154,000 in the AT scenario that are in this wage category (Figure 116 and Figure 117).

FIGURE 116. WORKERS IN LOWER WAGE POSITIONS (<$28), 2030 (S2: LCF)

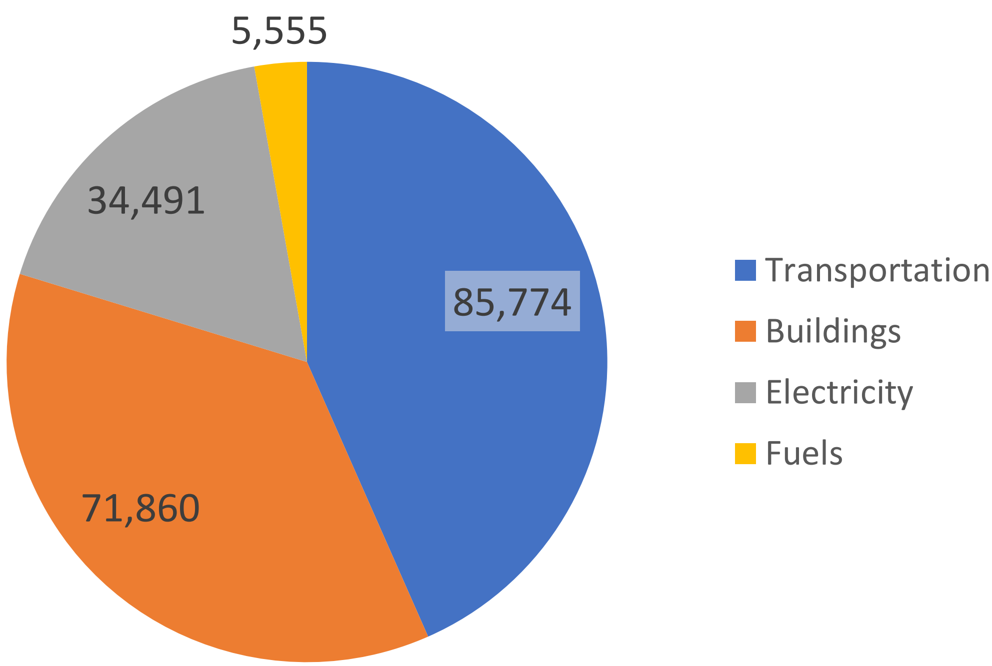
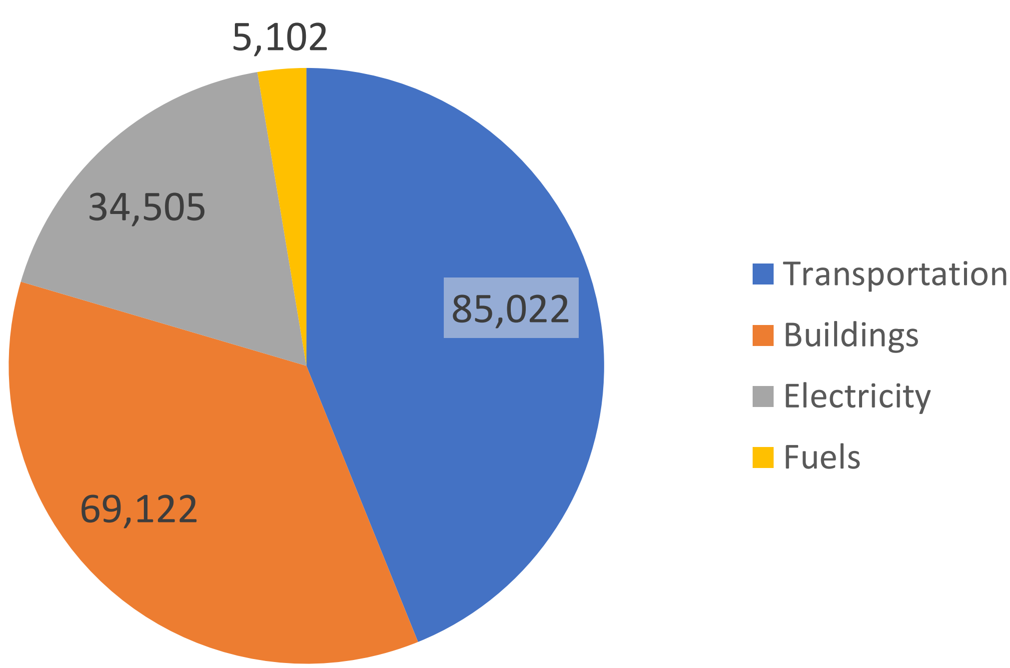


FIGURE 117. WORKERS IN LOWER WAGE POSITIONS (<$28), 2030 (S3: AT)

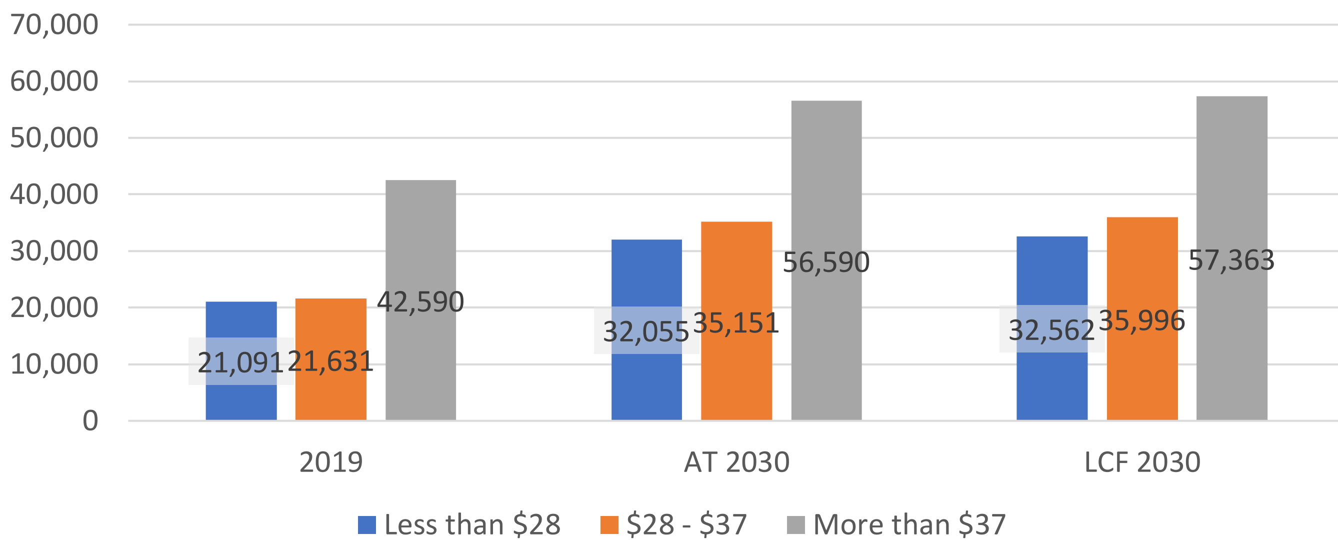


ELECTRICITY SECTOR

Growth Sectors

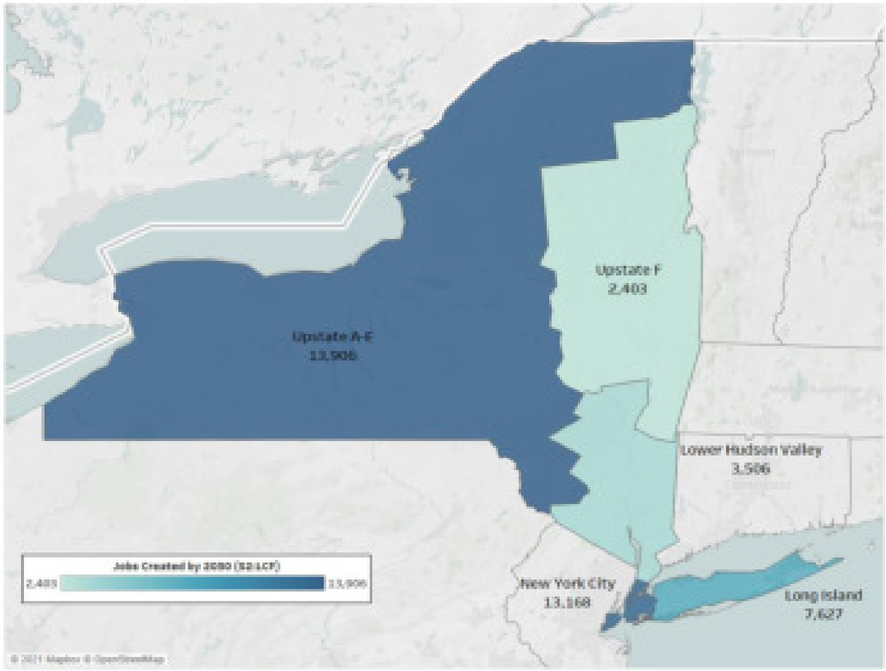
As visualized in Figure 118, Electricity growth sub-sectors will add approximately 14,000 jobs in the middle ($28 - $37) and highest (>$37) wage tiers, about 3,000 jobs more than the jobs added in the lowest paying wage category (<$28). Over 45 percent of all employment in this sector is found in the highest wage category, while the middle and lowest categories respectively occupy approximately 28 and 25 percent of the sub-sector.

FIGURE 118. ELECTRICITY GROWTH SUB-SECTORS: WAGE PROFILE



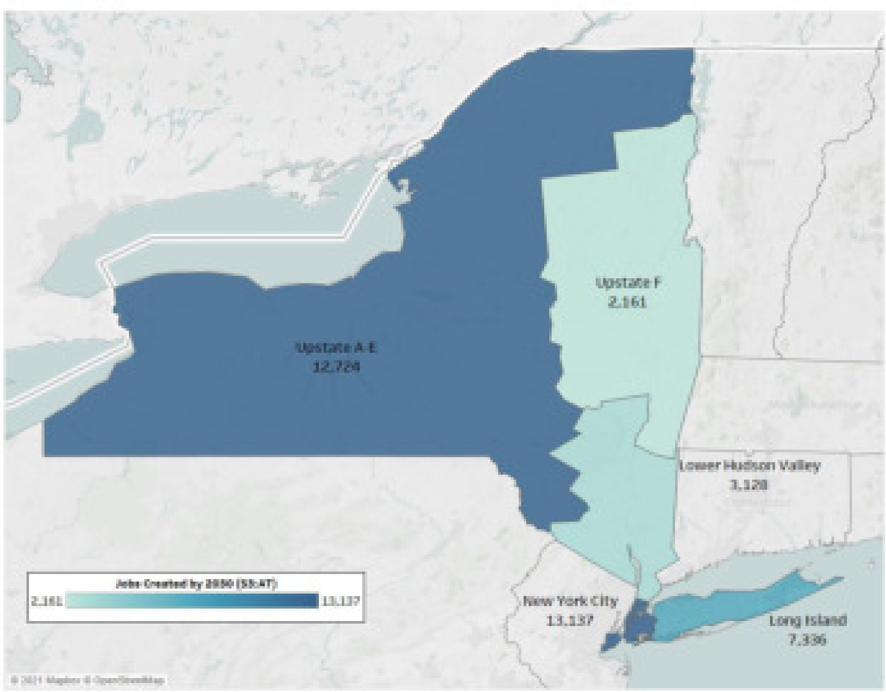
Growth sub-sectors in the Upstate A-E region in New York State will experience the highest job increase by 2030 at 13,906 jobs, followed by New York City at 13,168 jobs, Long Island at 7,627 jobs, Lower Hudson Valley at 3,506 jobs, and Upstate F at 2,403 jobs for the LCF scenario (Figure 119).

FIGURE 119. ELECTRICITY SUB-SECTOR GROWTH GEOGRAPHIC PROFILE (S2: LCF)



For the AT scenario (Figure 120), growth sub-sectors in New York City will experience the highest job increase by 2030 at 13,137; this is followed by Upstate A-E at 12,724 jobs, Long Island at 7,336 jobs, Lower Hudson Valley at 3,128 jobs, and Upstate F at 2,161 jobs.

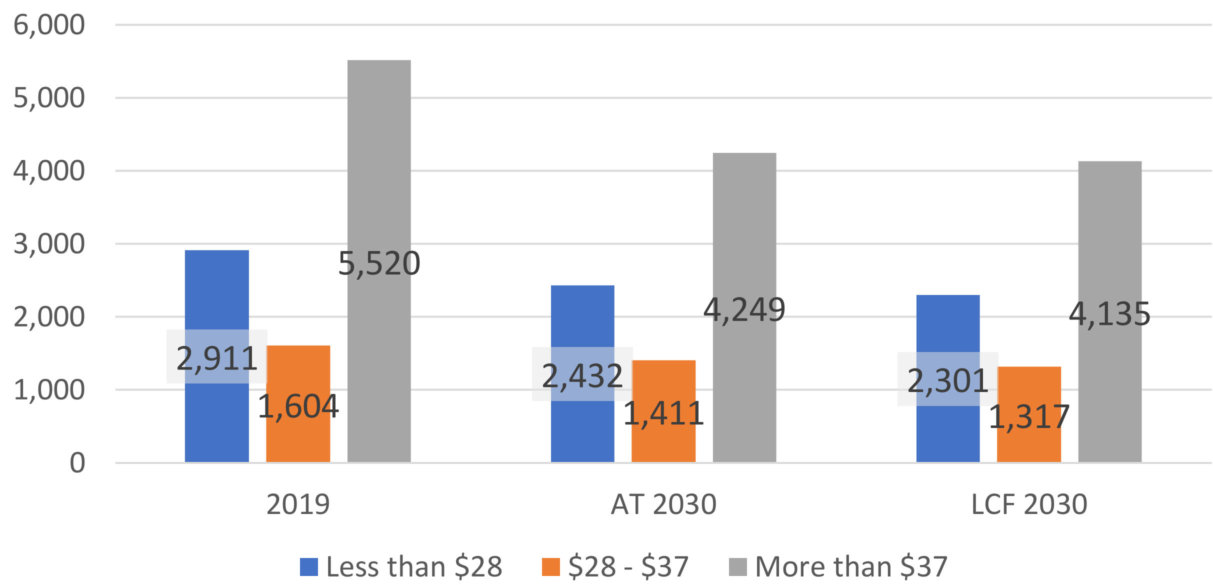
FIGURE 120. ELECTRICITY SUB-SECTOR GROWTH GEOGRAPHIC PROFILE (S3: AT)



Displaced Sectors

Electricity's displaced sub-sectors show declines in each of the wage categories. The highest wage category (>$37), which represents over 50 percent of displaced sub-sectors in Electricity, will experience the largest decline, losing approximately 1,300 jobs in 2030.

FIGURE 121. ELECTRICITY DISPLACED SUB-SECTORS: WAGE PROFILE



In the LCF scenario (Figure 122), Upstate F will not lose any jobs while Upstate A-E and Long Island will lose almost 500 jobs together; New York City will lose 590 jobs and the Lower Hudson Valley will lose over 1,200 jobs. A similar trend occurs in the AT scenario (Figure 123), albeit with lower displacement in all regions especially Upstate A-E, which will lose 18 jobs instead of 223.

FIGURE 122. ELECTRICITY SUB-SECTOR DISPLACED GEOGRAPHIC PROFILE (S2: LCF)

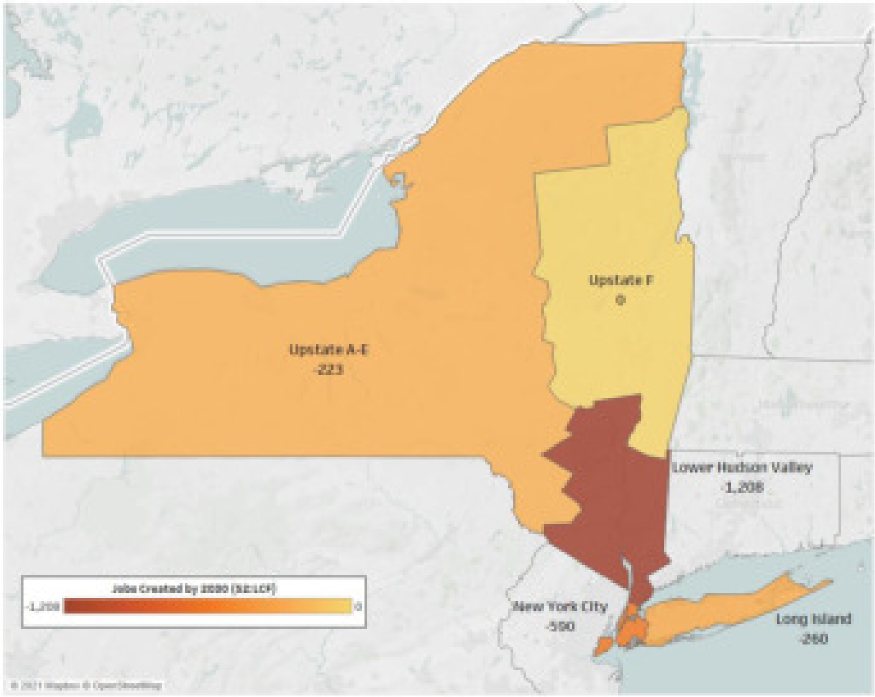
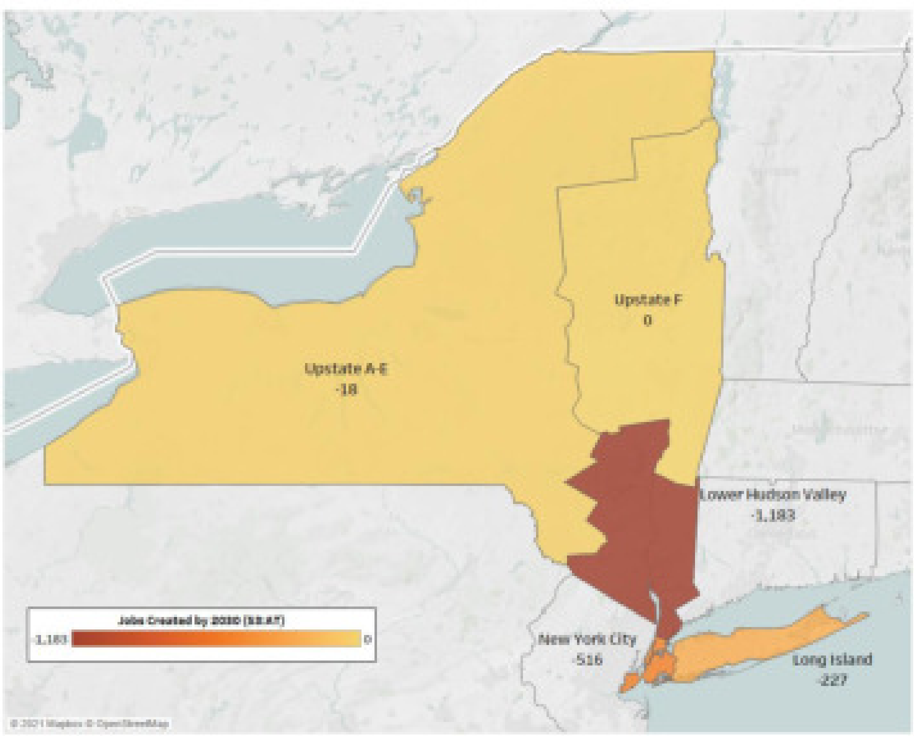


FIGURE 123. ELECTRICITY SUB-SECTOR DISPLACED GEOGRAPHIC PROFILE (S3: AT)

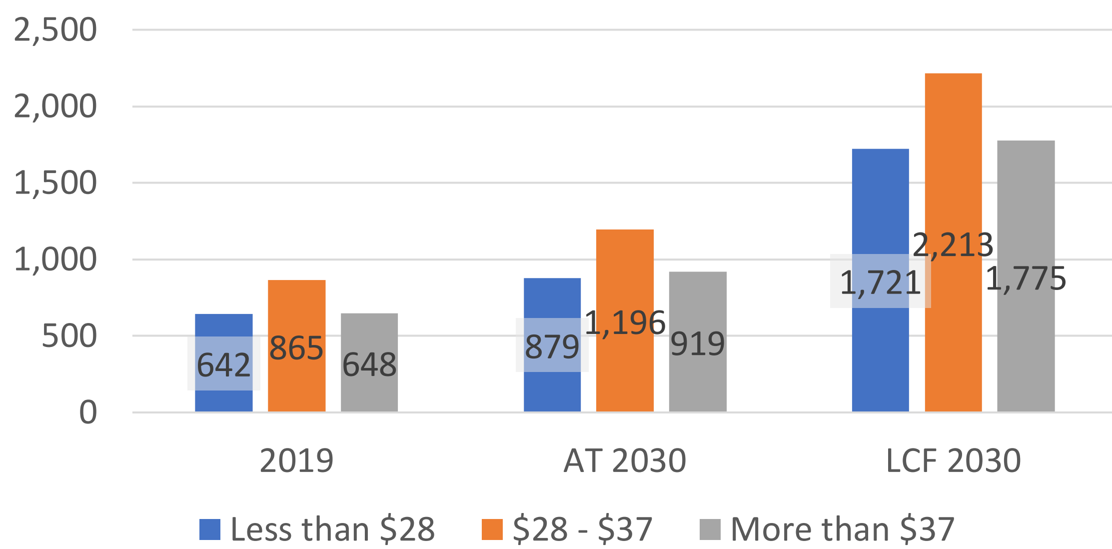


FUELS SECTOR

Growth Sectors

Between 2019 and 2030, Fuels growth sub-sectors will add the most jobs in positions from the middle wage category ($28-$37), which represent around 40 percent of jobs within these sub-sectors. The highest wage category (>$37), which represents approximately 30 percent of all jobs, will add the second largest number of jobs by 2030 (Figure 124).

FIGURE 124. FUEL GROWTH SUB-SECTORS: WAGE PROFILE



Growth sub-sectors in the Upstate A-E region in New York State will experience the highest job increase by 2030 at 1,169 jobs, followed by Long Island at 849 jobs, New York City at 753 jobs, Lower Hudson Valley at 488 jobs, and Upstate F at 297 jobs for the LCF scenario (Figure 125). A similar trend occurs in the AT scenario, albeit with lower growth estimates in all regions (Figure 126).

FIGURE 125. FUEL SUB-SECTOR GROWTH GEOGRAPHIC PROFILE (S2: LCF)

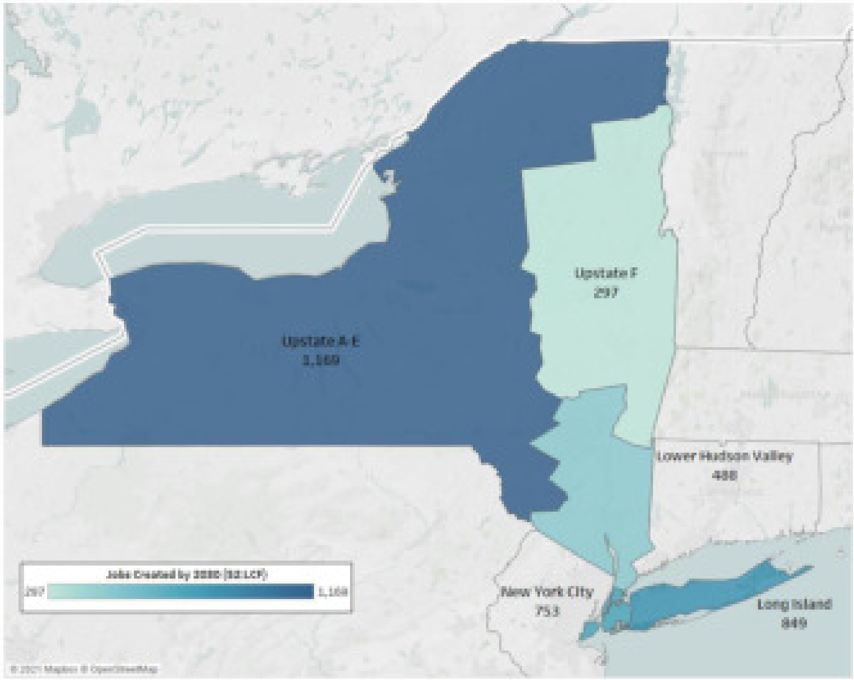
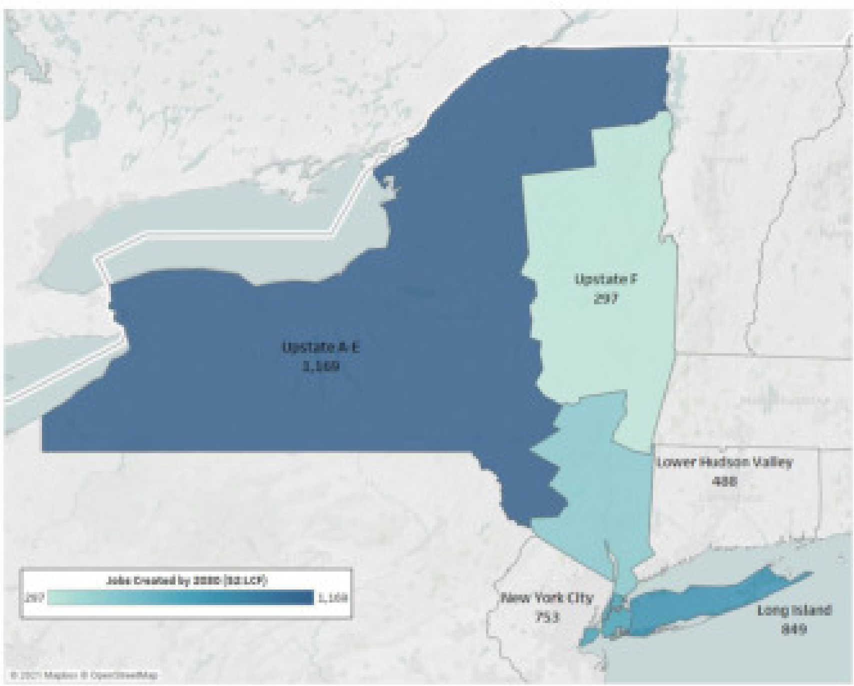


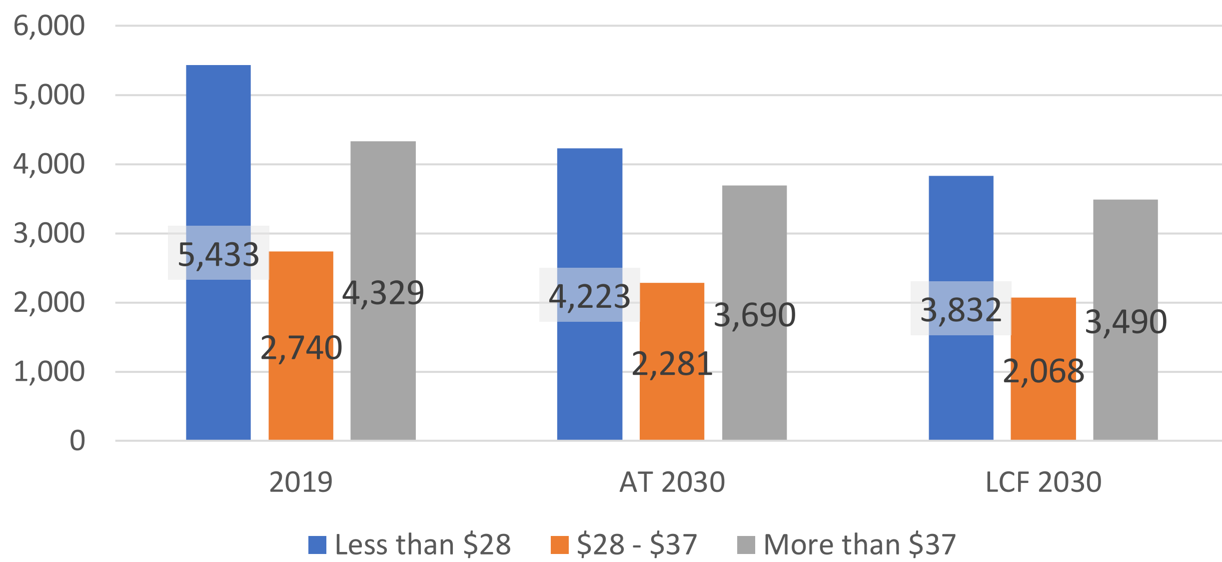
FIGURE 126. FUEL SUB-SECTOR GROWTH GEOGRAPHIC PROFILE (S3: AT)



Displaced Sectors

Displaced Fuel sub-sectors will experience jobs losses across all the wage categories between 2019 and 2030 (Figure 127). The lowest paying wage category (<$28), which represents more than 40 percent of the displaced Fuels sub-sectors, will lose over 1,200 jobs in both scenarios. The highest paying wage category, which represents over 35 percent of the displaced Fuel sectors by 2030, will lose the next highest number of jobs by 2030.

FIGURE 127. FUEL DISPLACED SUB-SECTORS: WAGE PROFILE



In the LCF scenario, the Upstate A-E region will lead displacement in the Fuels sector, experiencing over 1,000 job losses by 2030 (Figure 128). Long Island is second highest in displaced 'Fuels' subsectors, followed by New York City. Both the Lower Hudson Valley and Upstate F will lose less than 500 jobs by 2030, experiencing the least displacement. The AT scenario displays a similar trend; however, all the regions—particularly Upstate A-E—will experience fewer job losses compared to the LCF scenario (Figure 129).

FIGURE 128. FUEL SUB-SECTOR DISPLACED GEOGRAPHIC PROFILE (S2: LCF)

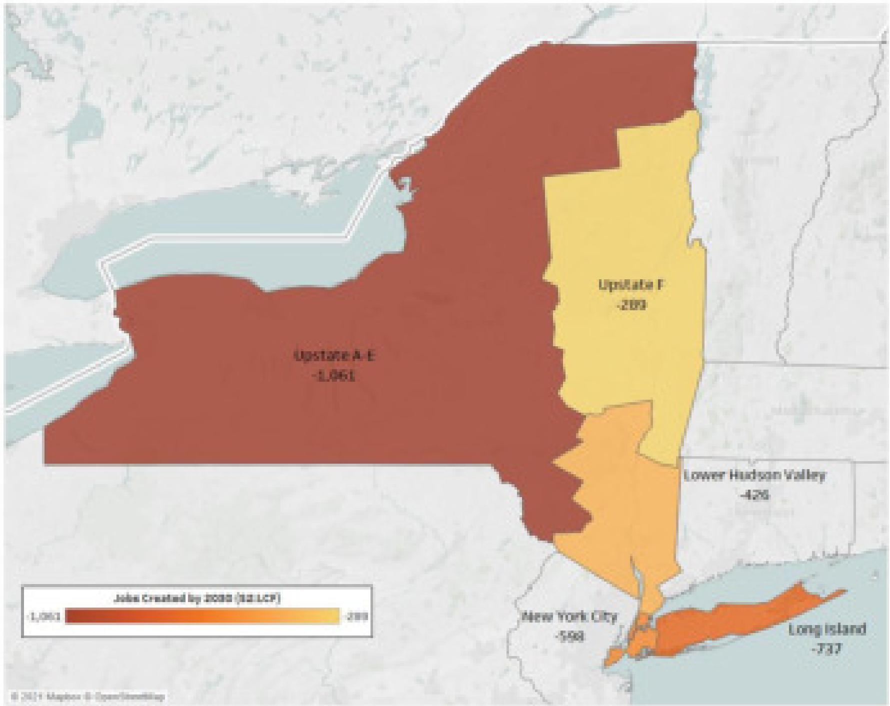
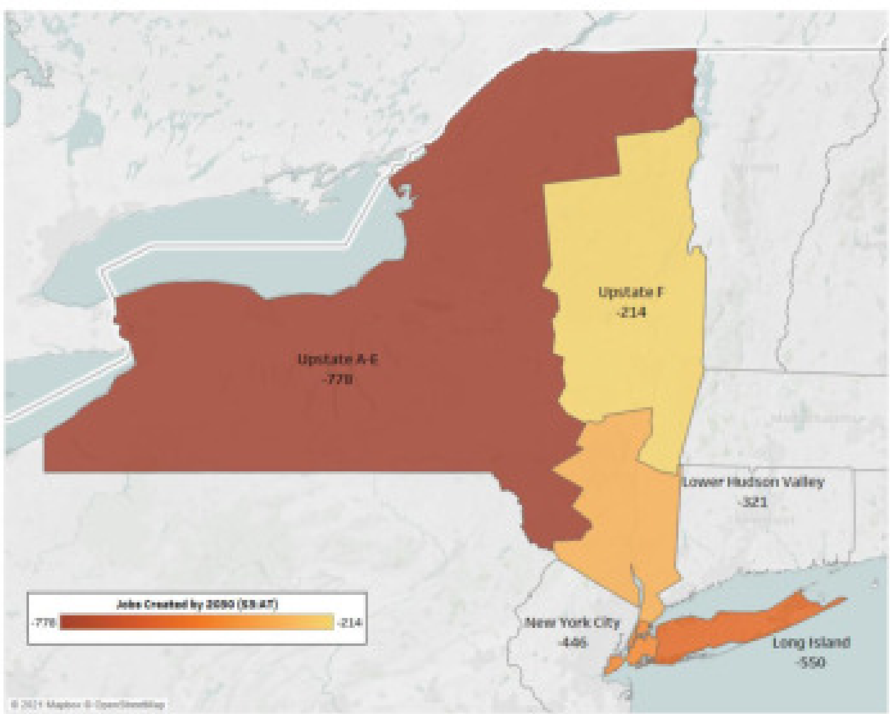


FIGURE 129. FUEL SUB-SECTOR DISPLACED GEOGRAPHIC PROFILE (S3: AT)

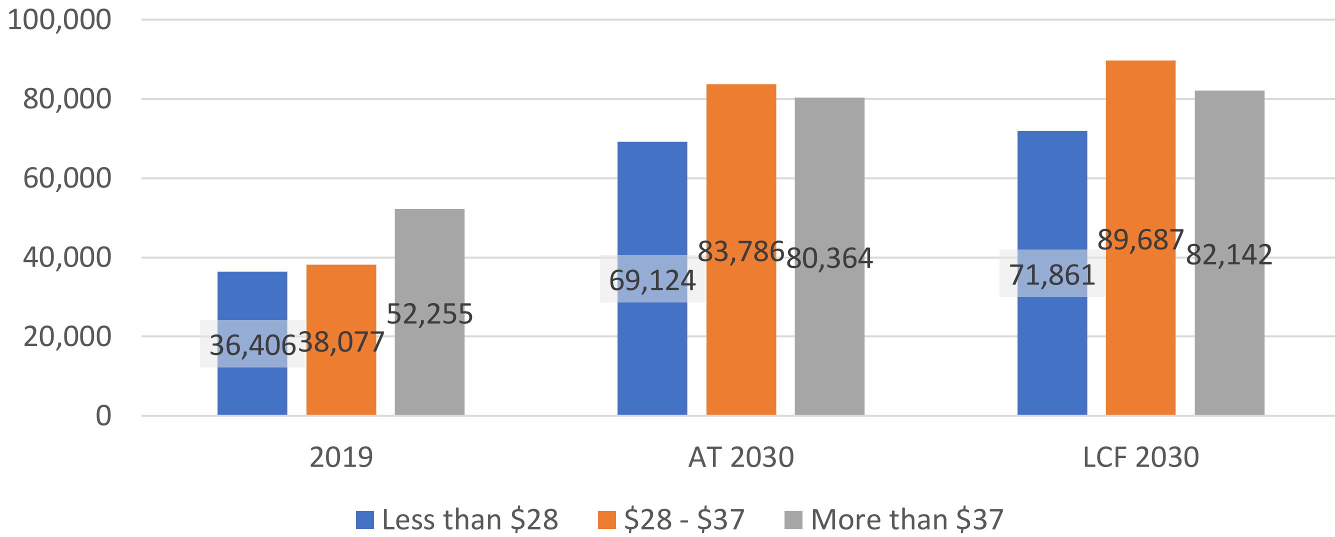


BUILDINGS

Growth Sectors

The Buildings sector will experience the most growth in the middle tier wage category compared to the lowest and highest paying wage categories (Figure 130). While the lowest paying wage category will maintain a consistent share of Buildings growth sub-sectors, the middle tier will overtake the highest tier by 2030 to represent approximately 36 percent of jobs.

FIGURE 130. BUILDINGS GROWTH SUB-SECTORS: WAGE PROFILE



In both the AT and LCF scenarios—albeit with fewer jobs added in the AT scenario—New York City will lead Buildings growth, adding over 30,000 jobs (Figure 131 and Figure 132). Upstate A-E will experience the second highest growth followed by Long Island, the Lower Hudson Valley, and Upstate F in that order.

FIGURE 131. BUILDINGS SUB-SECTOR GROWTH GEOGRAPHIC PROFILE (S2: LCF)

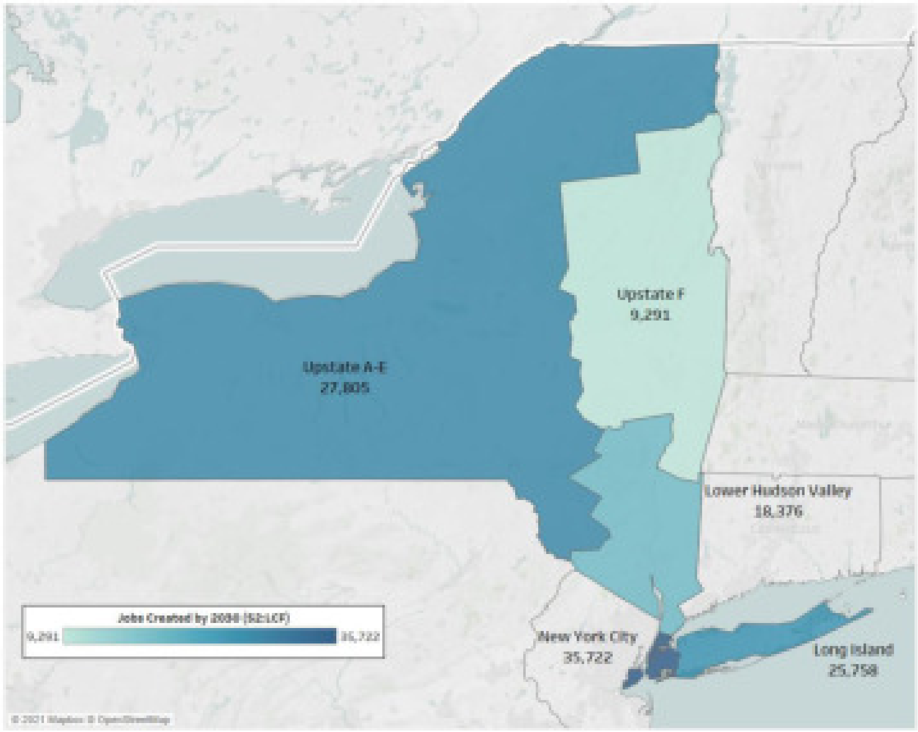
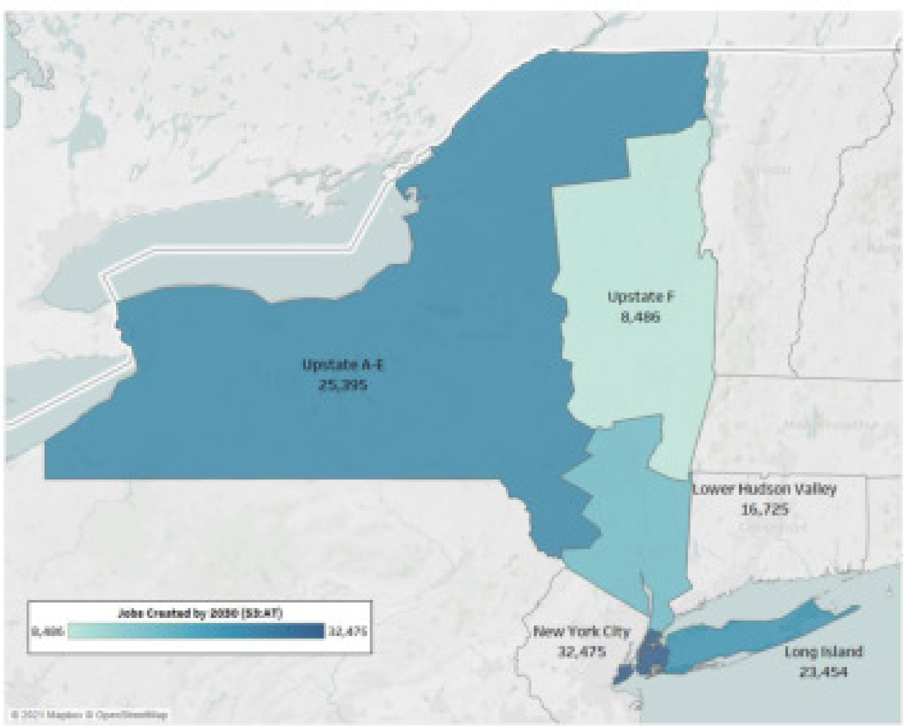


FIGURE 132. BUILDINGS SUB-SECTOR GROWTH GEOGRAPHIC PROFILE (S3: AT)

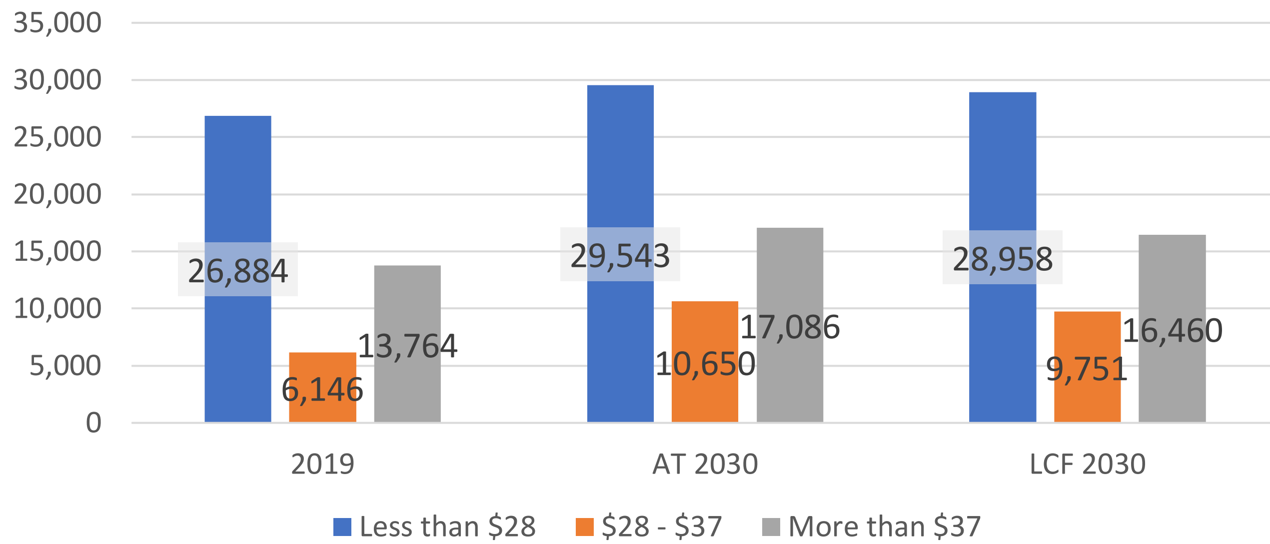


TRANSPORTATION

Growth Sectors

Transportation growth sub-sectors will show the largest proportional increase in the middle wage category ($28 to $37) from 2019 to 2030, adding over 4,500 jobs and over 3,500 jobs in the AT and LCF scenarios, respectively (Figure 133). The lowest paying wage category (<$28) will occupy over half of growth sub-sectors, followed by the highest tier at approximately 30 percent and the middle tier at approximately 18 percent of Transportation growth sub-sectors.

FIGURE 133. TRANSPORTATION GROWTH SUB-SECTORS: WAGE PROFILE



The number of jobs added will be almost the same in both scenarios; however, the AT scenario will add more regional jobs than the LCF scenario. Long Island will lead Transportation growth sub-sectors, adding 3,294 and 4,148 jobs in the LCF and AT scenarios, respectively. Upstate A-E will experience the second highest regional growth, followed by New York City. The Lower Hudson Valley and Upstate F will each add under 1,000 jobs in the LCF scenario (Figure 134); however, Lower Hudson Valley will add approximately 1,100 jobs while Upstate F will add almost 750 jobs in the AT scenario (Figure 135).

FIGURE 134. TRANSPORTATION SUB-SECTOR GROWTH GEOGRAPHIC PROFILE (S2: LCF)

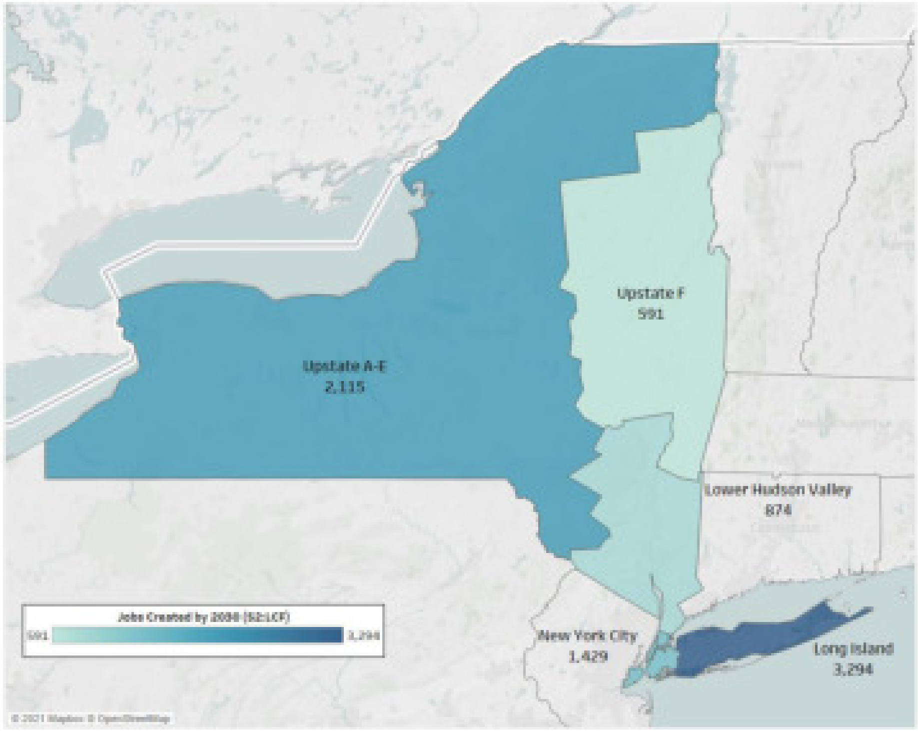
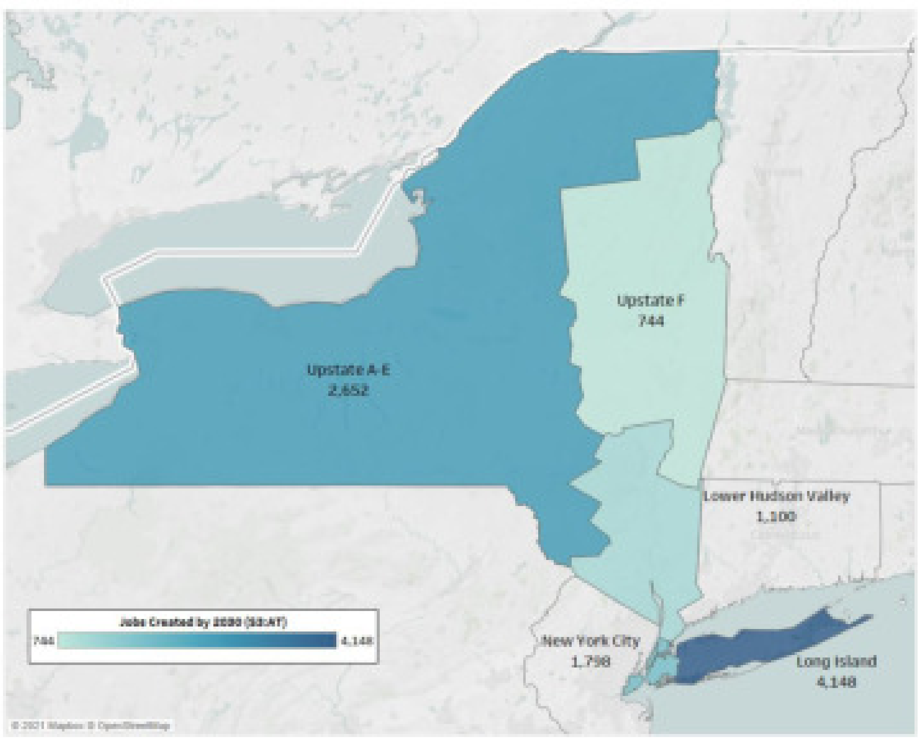


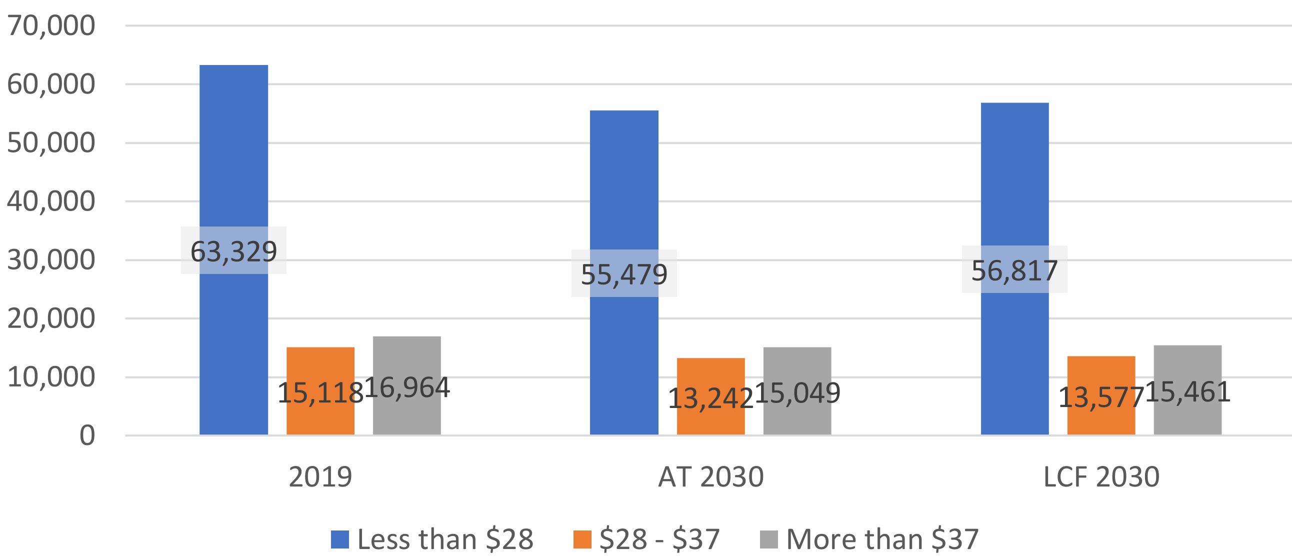
FIGURE 135. TRANSPORTATION SUB-SECTOR GROWTH GEOGRAPHIC PROFILE (S3: AT)



Displaced Sectors

Transportation displaced sub-sectors will show the largest employment decline in the lowest paying wage category which represents approximately 66 percent of the displaced sub-sectors. The middle and highest tiers—which respectively represent approximately 16 percent and 18 percent of the displaced sub-sectors—will lose approximately 1,900 and 1,500 in the AT and LCF scenarios by 2030 (Figure 136).

FIGURE 136. TRANSPORTATION DISPLACED SUB-SECTORS: WAGE PROFILE



Regional displacement will occurs similarly in the AT and LCF scenarios between 2019 and 2030; however, LCF scenario displacement will be lower than AT scenario losses (Figure 137and Figure 138). Upstate A-E will experience the highest displacement, losing over 4,000 jobs and approximately 3,400 jobs in the AT and LCF scenarios, respectively. Long Island and New York City will each lose over 2,300 jobs in the AT scenario and close to 2,000 jobs in the LCF scenario. The Lower Hudson Valley and Upstate F will experience the lowest displacement, with Upstate F losing less than 1,000 jobs in the LCF scenario.

FIGURE 137. TRANSPORTATION SUB-SECTOR DISPLACED GEOGRAPHIC PROFILE (S2: LCF)

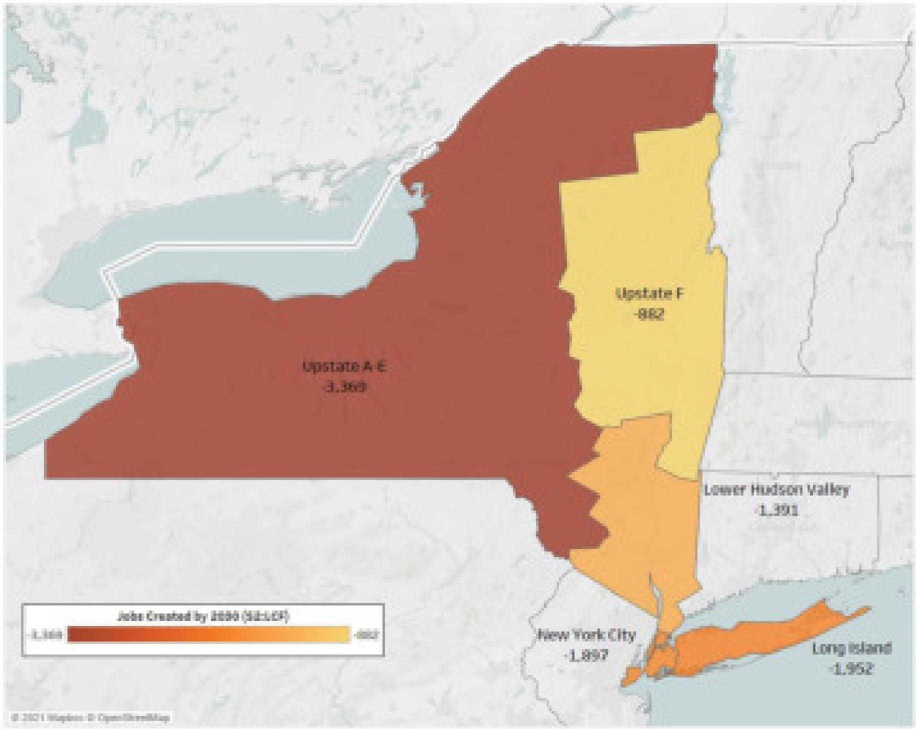
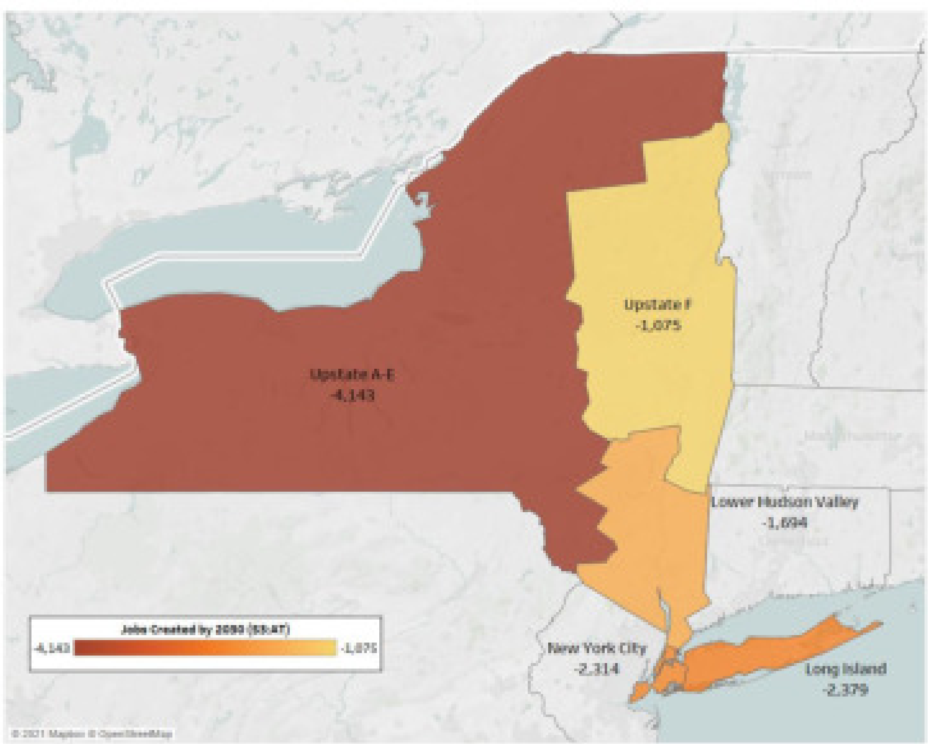


FIGURE 138. TRANSPORTATION SUB-SECTOR DISPLACED GEOGRAPHIC PROFILE (S3: AT)



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Appendix B: Literature Review Tables

TABLE 25. CAC INTEGRATION ANALYSIS: SECTOR-SPECIFIC EMISSIONS TARGETS

Sector	Strategy	Expressed as	Reference	High Technology Availability	Limited Non-Energy
Buildings	Building Shell Efficiency	Efficient shell sales share	75% by 2030	85% by 2030, 100% by 2045	*Same as HTA*
	Building Electrification	Electric heat pump sales share	6% by 2025	50% by 2030, 95% by 2050,	70% by 2030, 100% by 2045*
	Appliance Efficiency (non-HVAC)	Efficient appliance sales share	100% by 2025	90% by 2023, 100% by 2025	*Same as HTA*
Industry	Efficiency	Efficiency increase relative to baseline projection	10% by 2030, 20% by 2050	10% by 2030, 45% by 2045	*Same as HTA*
	Fuel Switching	Share of natural gas and LPG use electrified	None	60% by 2045	*Same as HTA*
Transportation	Corporate Average Fuel Economy (CAFE) Standards	LDV fuel economy	Extended 2021-2026	*Same as Reference*	*Same as Reference*
	Smart Growth	LDV VMT reduction relative to Reference	None	3% by 2030, 9% by 2050	*Same as HTA*
	Aviation Efficiency	Efficiency increase relative to Reference	None	10% by 2030, 40% by 2050	*Same as HTA*
	Vehicle Electrification	ZEV sales share	LDA: 25% by 2025; LDT: 8% by 2025; MDV/Bus: 2% by 2050	LDV: 60% by 2030, 100% by 2040; Bus: 60% by 2030, 100% by 2040; MDV/HDV: 35% by 2030; 95% by 2040	LDV: 70% by 2030, 100% by 2035; Bus: 70% by 2030, 100% by 2035; MDV/HDV: 50% by 2030; 95% by 2040*
Zero Emissions Fuels	Bioenergy Availability	Feedstocks supply	Reference Projection (~70 TBtu)	In-state feedstocks (~150-200 TBtu)	*Same as HTA*
	Biofuels Blend**	Share of conventional fuel use replaced with biofuels	7% aggregate ethanol blend for gasoline, 8.4% biodiesel blend for heating oil in Downstate model segment by 2034 to account for areas with biodiesel mandates	100% renewable gas in CNG vehicles by 2030, 40% renewable diesel by 2030, ~100% renewable diesel by 2050, 8% renewable gas in pipeline by 2050	100% renewable gas in CNG vehicles by 2030, 40% renewable diesel by 2030, 100% renewable diesel by 2050, 100% renewable gasoline by 2050, 68% renewable jet kerosene by 2050, 18% renewable gas in pipeline by 2050

TABLE 26. ZCAP: KEY BENCHMARKS FOR NATIONAL CARBON NEUTRALITY BY 2050

Sector	Indicator	2030	2040	2050
Light duty vehicles	Electric vehicle share	>50% of sales	100% of sales	100% of fleet
Medium duty vehicles	Electric and fuel cell vehicle share	>40% of sales	>80% of sales	
Heavy duty vehicles	Electric and fuel cell vehicle share	>30% of sales	>60% of sales	
Residential buildings	Electric space/water heating share	>50% of sales	100% of sales	-
Commercial buildings	Electric space/water heating share	>50% of sales	100% of sales	-
Electricity generation	Generation to meet new electric loads			>2x current level (~8000 TWh/y)
Electricity emissions	Carbon intensity	60% below current	80% below current	>95% below current
Coal power	Share of total generation	<1% of total generation	all coal retired	all coal retired
Renewable power	Wind and solar capacity	3.5x current (~500 GW)	10x current (~1500 GW)	>2500 GW total capacity
Natural gas power	Capacity	current capacity (~500 GW)	current capacity (~500 GW)	increased capacity (~600 GW)
Nuclear power	Generation	current generation (~800 TWh/y)		
Electricity storage	Capacity (diurnal storage)	>20 GW	>100 GW	
Transmission	Inter-regional capacity			2-3x current (200-300 GW)
Electrolysis	Capacity		>20 GW	>100 GW
Biofuels	Million bbls per day zero-carbon biofuel			>2 MBD
Fossil fuels	Infrastructure to transport fossil fuels	no new oil & gas pipelines		
Carbon capture & storage	CCS capacity large industrial facilities		>250 MMT/year CO_2 sequestered	>500 MMT/year CO_2 sequestered

TABLE 27. ZCAP: CENTRAL SCENARIO OUTCOMES BY 2050

Electric Generation	Fuels	Vehicles
Capacity increases by 3000 GW, almost all from wind and solar	<u>Residential Buildings</u> 1. electric heat pumps constitute 110 million out of 140 million space heating units 2. 80 million out of 150 million water heating units	260 million out of 280 million cars and light trucks are battery electric vehicles
Coal generation almost fully retired by 2030	Low-Carbon Fuels primary energy requirements are reduced by 30%.	80% of medium- and heavy-duty trucks are battery-electric or hydrogen-powered vehicles
High voltage transmission capacity between different regions increases 150% to 200 GW	Fuel use of all kinds is reduced by 60%, with fossil fuels being reduced by 85%.	Battery capacity is ~200 GW with an average duration of about 7 hours

TABLE 28. ZCAP: AVERAGE NATIONAL COSTS FOR JUST TRANSITION SUPPORT FOR DISPLACED WORKERS (2021-2052)

A. Years: 2021-2030

Year	**Income support** *(3 years of support for 12,087 coal workers/ year)*	**Retraining support** *(2 years of support for 12,087 coal workers/ year)*	**Relocation support** *(1 year of support for 12,087 coal workers/ year)*	**Total** (= Cols. 1+2+3)
Total Costs	$11.9 billion	$1.5 billion	$4.5 billion	$17.9 billion
Average Annual Costs	$991.1 million *(12 years of support)*	$131.9 million *(11 years of support)*	$453.3 million *(10 years of support)*	$1.5 billion *(12 years of support)*

B. Time Period: 2031-2052

Year	**Income support** *(3 years of support for 34,207 oil and gas workers/year)*	**Retraining support** *(2 years of support for 34,207 oil and gas /year)*	**Relocation support** *(1 year of support for 34,207 oil and gas/ year)*	**Total** (= Cols. 1+2+3)
Total Costs	$49.1 billion	$8.2 billion	25.7 billion	$82.9 billion
Average Annual Costs	$2.2 billion *(22 years of support)*	$0.4 billion *(21 years of support*	$1.3 billion *(20 years of support)*	$3.8 billion *(22 years of support)*

TABLE 29. JOB CREATION ESTIMATES ACROSS ELECTRICITY SUB-SECTORS

		Putting CA on the High Road	ZCAP	BBBF	Cornell study	UCLA study	NREL study	PERI study	2035 The Report	IEc study
		Direct jobs per $1 million spent	Direct, indirect jobs	Jobs each year for five years (direct, indirect & induced)	Total jobs (direct, indirect, induced) per $1 million	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
	Natural Gas				5					1,589; 8
	Coal				7				-122,492 O&M	
Power	Wind		Energy supply: 2.1 million per $388.7 billion	Renewable Energy: 50,000 per $13.1 in forgone tax revenue and investments	13	 Onshore: 1050	1,079 jobs per 250-MW of development and construction 5-7 O&M jobs per 100 MW	140,872 jobs per $24.4 billion	Offshore: 45,808 construction Onshore: 279,013 and 53,952 O&M	1337; 3
	Solar	SF: 4.583 			14	17,600			Distribution: -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	
Transmission, Distribution, and Storage	Battery								81,932	
	Grid Modernization			73,100 per $25.4 billion in stimulus and initiatives	Smart Grid: 12	2,450				

TABLE 30. JOB CREATION ESTIMATES ACROSS BUILDINGS SUB-SECTORS

<table>
<tr><th colspan="2" rowspan="2"></th><th>Putting CA on the High Road</th><th>ZCAP</th><th>BBBF</th><th>Cornell study</th><th>UCLA study</th><th>PERI study</th></tr>
<tr><td>Direct jobs per $1 million</td><td>Direct jobs</td><td>Jobs each year for five years (direct, indirect & induced)</td><td>Direct jobs per $1 million spent</td><td>Construction jobs (annual average, 2020-2045)</td><td>Total Direct, Indirect, Induced (annually, 2021-2030)</td></tr>
<tr><td rowspan="13">Retrofits</td><td>SF/Small MF EE and Solar Water Heating:</td><td>10.896</td><td></td><td rowspan="14">737,200 per $60.7 billion in stimulus</td><td></td><td rowspan="12">Residential: 32,650
Small and Medium Commercial: 3,100
MUSH: 20,950</td><td rowspan="14">71,990 jobs per $7.4 billion</td></tr>
<tr><td>Large MF EE and Renewables:</td><td>4.664</td><td></td><td></td></tr>
<tr><td>HVAC</td><td></td><td>97,117 per $32.4 billion</td><td>5.3</td></tr>
<tr><td>Other commercial and residential</td><td></td><td>47,913 per $15.3 billion</td><td></td></tr>
<tr><td>Appliances</td><td></td><td>5,722 per $3.1 billion</td><td></td></tr>
<tr><td>Refrigeration</td><td></td><td>8,058 per $2.8 billion</td><td></td></tr>
<tr><td>Lighting</td><td></td><td>-1,874 per -$739.5 million</td><td>5.1</td></tr>
<tr><td>Environmental Controls</td><td></td><td></td><td>3.8</td></tr>
<tr><td>Envelope Improvements</td><td></td><td></td><td>7.7</td></tr>
<tr><td>Office Equipment</td><td></td><td></td><td>3.8</td></tr>
<tr><td>Motors and Drivers</td><td></td><td></td><td>4.5</td></tr>
<tr><td>Water Heating</td><td></td><td></td><td>5.0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>New Construction</td><td></td><td></td><td>35,698 per $10.9 billion</td><td></td><td>All-Electric Residential: 3,350</td></tr>
</table>

TABLE 31. JOB CREATION ESTIMATES ACROSS TRANSPORTATION SUB-SECTORS

	Putting CA on the High Road	**ZCAP**	**Cornell**
	Direct jobs per $1 million spent	**Direct jobs**	Per $million (direct, indirect, induced)
Mass Transit/ Freight Rail	High Speed Rail: 4.528	Vehicles: 97,117 per $79.8 billion	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:	4.200		
Public Fleet Pilot:	2.154		
Financing Assistance Pilot	14.500		
Zero-Emission Truck and Bus Pilot	2.913		
Multi-Source Facility Demonstration	3.255		
Zero-Emission Drayage Truck Demonstration	0.634		

TABLE 32. JOB CREATION ESTIMATES ACROSS OTHER SUB-SECTORS

		Putting CA on the High Road	ZCAP
		Direct jobs per $1 million spent	Direct jobs per spending
Materials	Greenhouse Gas Reduction Loan Program	1.33	
	Recycled Fiber, Plastic, and Glass Grant Program	:.230	
	Organics Grant Program	3.744	
Industry	Manufacturing		40, 382 per $16.9 billion
Land Sector	Agriculture	Dairy Digester Research and Development Program: 2.810	6,196 per $542.6 million
	Forestry	Urban and Community Forestry Program: 9.268	
		Forest legacy program: 0.036	
		Delta and Coastal Wetlands Restoration: 6.377	
		Ecosystem Restoration: 6.153	
		Forest Health Program: 13.434	
	Mining		2,974 per $1.6 billion
Water	Water-Energy Grant Program	6.850	
	State Water Project Turbines	2.538	
	State Water Efficiency and Enhancement Program	2.165	

FIGURE 139. PROJECTED WAGE INCREASES ACROSS ENERGY SECTORS IN HIGH ELECTRIFICATION SCENARIO

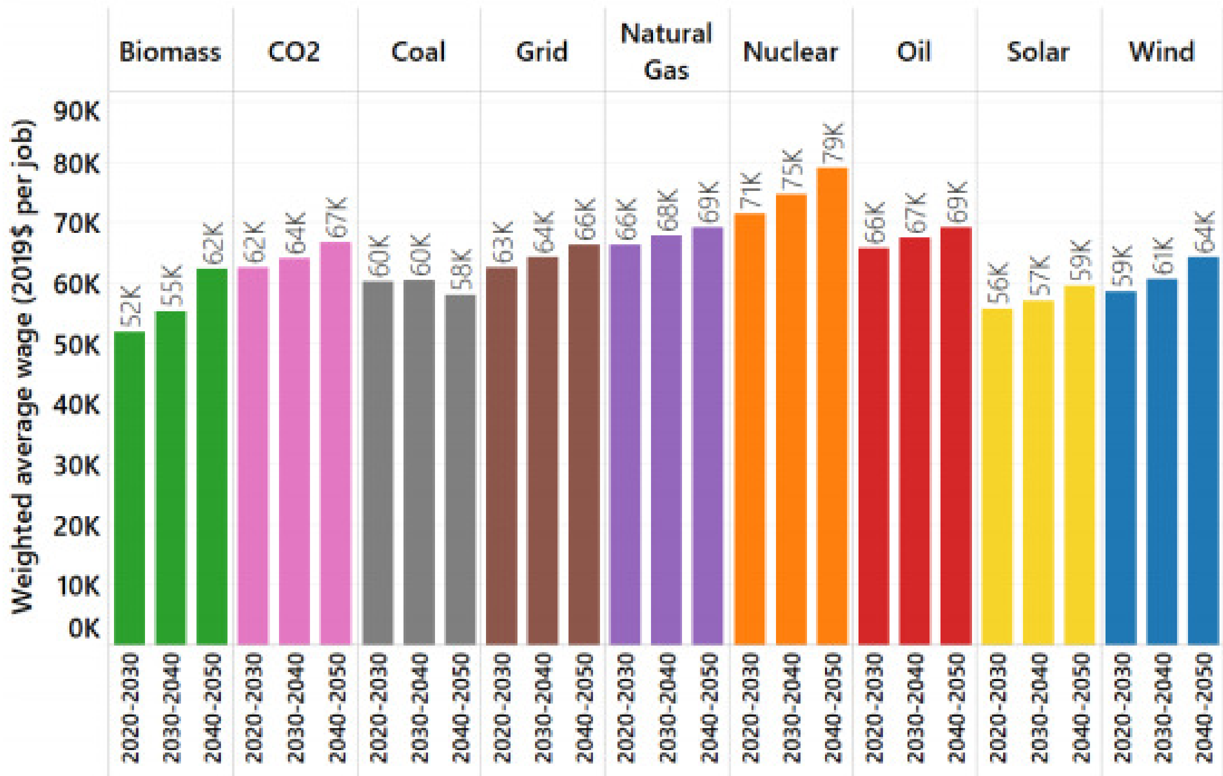


TABLE 33. CEIR: NY CLEAN ENERGY MEDIAN HOURLY WAGE PREMIUMS OVER NON-CLEAN ENERGY IN 2019

		Construction Managers	Sales Reps	Construction Laborers	Electricians	HVAC Installers	Mechannical Insulation Workers	Team Assemblers	First-Line Supervisors of Mechanics, Installers, & Repairers
Energy Efficiency	Entry	39%	-15%	16%	9%	25%	22%	13%	5%
	Mid	-2%	-19%	8%	7%	-6%	10%	6%	2%
	High	-23%	-28%	-1%	4%	-11%	-0%[10]	-2%	-4%
Renewable Electric Power Generation	Entry	50%	-6%	15%	8%	24%	24%	8%	12%
	Mid	3%	-13%	9%	8%	12%	-5%	6%	2%
	High	-21%	-24%	-3%	2%	-1%	-12%	-2%	-1%
Grid Modernization & Energy Storage	Entry	37%	-11%	18%	11%	n/a	27%	9%	12%
	Mid	0%[11]	-17%	8%	7%	n/a	-5%	2%	0%[12]
	High	-19%	-27%	2%	7%	n/a	-8%	-5%	-1%
Renewable Fuels	Entry	46%	-7%	16%	10%	n/a	n/a	13%	17%
	Mid	4%	-14%	5%	4%	n/a	n/a	7%	3%
	High	-22%	-24%	-2%	4%	n/a	n/a	0%[13]	-3%
Clean and Alternative Transportation	Entry	n/a	-11%	32%	24%	11%	42%	5%	7%
	Mid	n/a	-17%	26%	25%	-5%	11%	3%	2%
	High	n/a	-28%	14%	20%	-14%	3%	-2%	-6%

TABLE 34. CEIR: BENEFITS BREAKDOWN IN SAMPLE OCCUPATIONS

	Clean Energy Benefits		Overall Benefits[15]		Union Benefits[16]	
Occupation	Health Insurance[17]	Retirement	Health Insurance	Retirement	Health Insurance	Retirement
Construction Managers	85%	75%	81%	72%	90%	85%
Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	84%	74%	74%	69%	88%	84%
Construction Laborers	81%	70%	77%	67%	89%	84%
Electricians	81%	71%	78%	68%	89%	84%
Insulation Workers, Mechanical	85%	75%	78%	69%	90%	84%
Solar Photovoltaic Installers	81%	68%	77%	66%	89%	84%
Heating, Air Conditioning, and Refrigeration Mechanics and Installers	81%	69%	77%	67%	89%	84%
Wind Turbine Service Technicians	84%	79%	80%	74%	91%	86%
Assemblers and Fabricators, All Other, Including Team Assemblers	83%	75%	81%	74%	91%	87%
First-Line Supervisors of Mechanics, Installers, and Repairers	87%	79%	82%	74%	91%	87%

Appendix C: Model Inputs & Data Sources

Overview

The methodology for the 2021 JTWG Jobs study was continually revised and refined throughout the project work period, January 2021 to December 2021. At its foundation, the methodology was developed from three pillars:

1. **The literature review**: The early compilation and analysis of comparable research and modelling efforts provided a comprehensive view of the different approaches to modeling employment scenarios in response to lowering greenhouse gas emissions and mitigating climate change.

2. **The combined experience of the BW Research contractor team**: The literature review demonstrated that a large proportion of the work done on modeling employment under different climate change mitigation scenarios has been done by members of the BW Research contractor team, including BW Research, Industrial Economics, and Inclusive Economics. The contractor team worked collaboratively to share their experience and build upon the findings from the literature review to develop the initial and refined project methodology.

3. **The direction provided by NYSERDA staff and JTWG advisors**: Early in the project, after presenting the initial project work plan to JTWG, and later in the project after the project team presented early iterations of different employment outputs, the methodology was refined by the input and priorities of JTWG advisors and NYSERDA staff who had specific expertise on given sectors or sub-sectors that were being modeled.

These pillars produced a project methodology that was responsive to the nuances of each sector and sub-sector and were further refined through several iterations of examining results from scenarios[58] that were modeled but not included in the final presentation of results.

[58] The 'dry-run' scenarios that were modeled included the E3 Pathway scenarios and CAC Draft One, AP Scenario.

Sector Structure

One of the first requirements of the Jobs Study was to determine what employment categories would and would not be modeled. The industry sector structure also went through an iterative process to determine how the economy would be categorized for the Jobs Study. Ultimately, the project team agreed upon a structure that identified three general categories, with 2 to 3 sectors in each category, and up to 12 sub-sectors in each sector, as show in the tables below.

TABLE 35. PRIMARY SECTORS

PRIMARY SECTORS			
Category	**Sector**	**Sub-Sector**	**Growth or Displaced**
Energy Supply	**Electricity**	Solar	Growth
		Offshore Wind	Growth
		Onshore Wind	Growth
		Hydropower	Growth
		Hydrogen	Growth
		Biomass	Growth
		Distribution	Growth
		Transmission	Growth
		Storage	Growth
		Natural Gas Generation	Displaced
		Other Fossil Generation	Displaced
		Nuclear	Displaced
	Fuels	Hydrogen	Growth
		Bioenergy	Growth
		Natural gas	Growth
		Natural gas distribution	Displaced
		Petroleum Fuels	Displaced
Energy Demand	**Buildings**	Commercial HVAC	Growth
		Commercial Shell	Growth
		Commercial Other	Growth
		Residential Shell	Growth
		Residential HVAC	Growth
		Residential Other	Growth
	Transportation	Vehicle Manufacturing	Growth
		Wholesale Trade Parts	Growth
		Charging & Hydrogen Fuel Stations	Growth
		Vehicle Maintenance	Displaced
		Conventional Fueling Stations	Displaced

TABLE 36. SECONDARY SECTORS

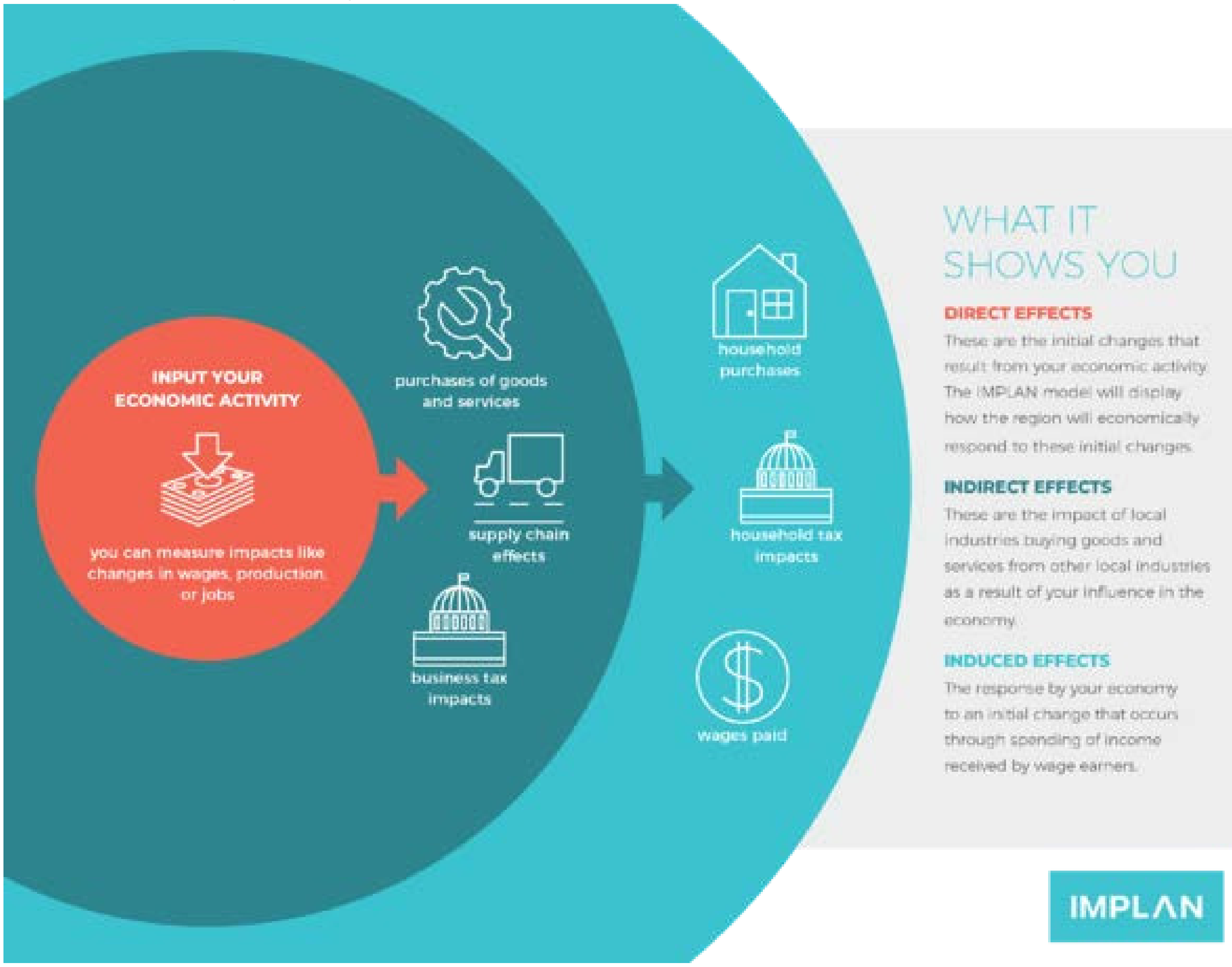
SECONDARY SECTORS	
Category	**Sector**
Energy Demand	Industry
Non-Energy	Waste
	Non-Energy Emissions Activities
	Agriculture and Working Lands

It is important to note that the Jobs Study was never intended to model the entire economy, but instead focused only on those 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. Ultimately, the project only modeled the primary sectors, but would consider modeling the secondary sectors as time and resources become available.

Summary of Input-Output Models

Input-output (I/O) modeling is used to generate employment estimates based on different investments or changes in a given economy over time. The research team used two different I/O models, **IMPLAN** and the National Renewable Energy Laboratory's (NREL) **JEDI** (Jobs and Economic Development Impact) model software for this purpose. Input-output models illustrate the interdependent relationships between different sectors of a region's economy. 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.

Figure 140. Direct, Indirect, and Induced Effects



IMPLAN is not an energy-specific industry analysis, but instead is focused on the overall employment impacts that would be felt across a given economic region, in this case the State of New York. JEDI estimates the local economic impacts of the construction and operation of power generation and biofuel plants. NREL provides JEDI models for various energy sub-sectors, including onshore and offshore wind, biomass, and hydropower. JEDI estimates job creation by running user input of project location facility size, and year of construction, 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 both onshore and offshore wind electricity sub-sectors.

Initial Employment Output (IEO) Methodology

The initial employment outputs (IEO) generated for the JTWG Jobs Study follow the same general methodological approach across the four primary sectors, with the most relevant tools and data sources based on what is appropriate for each sub-sector. Assumptions made within specific sub-sectors vary due to the nature of the different activities, however the general structure remains consistent.

The IEO's are meant to produce the quantity of jobs that change over time for each of the sectors and sub-sectors. The IEO's were generated for 2019 (Baseline year[59]) and for both the scenarios (AT & LCF) for 2025, 2030, 2035, 2040, 2045, and 2050.

The IEO methodology follows 6 steps.

1. Initially, the research team determines the unit inputs for the model. Unit inputs typically come from the CAC Integration Analysis data and take the form of device stocks and sales, MW of electric capacity, and fuel demand.

2. Next, the research team determines the unit and total investments. Investment inputs come from the CAC Integration Analysis data where provided, and any additional investments are assumed from secondary sources that have been noted.

3. Next, the research team processes the investment data to levelized inputs that reduce inter-annual variation as needed.

4. Next, the research team allocates the processed investment data into the relevant industry categories based on the activities associated with the investments by using technical cost data from secondary sources.

5. Next, the research team applies IMPLAN/JEDI industry employment multipliers based on the allocation described in step 4 to calculate employment outputs.

6. Finally, employment outputs are reported by industry category (Construction, Professional Services, Manufacturing, Other Supply Chain, and Induced). The 2019 baseline employment is derived from the 2019 NYCEIR unless otherwise stated.

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[59] 2019 was determined to be the baseline, rather than 2020, because the employment numbers would not be impacted by the pandemic.

Sector Specific Assumptions & Sources

The following assumptions and data sources were used in the modeling of each of the primary sectors, electricity, fuels, buildings, and transportation.

ELECTRICITY

The electricity growth sub-sectors—solar, hydropower, hydrogen, biomass, distribution, transmission, and storage—use investment data derived from the CAC Integration Analysis.

Solar & Storage

Solar and storage use technical cost data from NREL's U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020 to split investment data into industry inputs.

- Storage uses the 60MW, 2hr standalone Li-ion model.
- Distributed solar CAPEX investments are input into data derived from a weighted average of the 7kW mixed residential model and the 0.2MW commercial ground mount model, and O&M investments are input into data derived from the weighted average of the residential and commercial ground mount models.
- Utility solar CAPEX investments are input into data derived from the single axis tracker 100MW model, and O&M investments are input into data derived from the tracking model.

Hydrogen

Hydrogen investments include hydrogen fuel cell investments, hydrogen combustion investments, and investments in hydrogen-compatible combustion systems originally running on natural gas. Hydrogen under the LCF scenario refers to hydrogen combustion and hydrogen-compatible resources, while hydrogen under the AT scenario refers to hydrogen fuel cell resources.

Transmission & Distribution

2019 baseline transmission and distribution employment figures are based on 2019 NY Energy Industry Traditional Transmission and Distribution. Distribution is split from transmission using 2019 employment in NAICS 221121—Electric Bulk Power Transmission and Control and NAICS 221122—Electric Power Distribution.

Offshore & Onshore Wind

Offshore wind outputs are generated using NREL's JEDI Offshore Wind Model Rel. 2021-1, using installed capacity from the CAC Integration analysis as input. 2019 baseline employment for offshore wind is derived from the proprietary NYSERDA wind jobs tool built by BW Research. Onshore wind outputs are generated using NREL's JEDI Land Based Wind Model Beta rel. W10.30.20, using installed capacity from the CAC Integration analysis as input.

Electricity Displacement

The electricity displaced sub-sectors, natural gas generation, other fossil generation, and nuclear use scaled 2019 baseline utilities employment as input into IMPLAN multipliers. 2019 baseline utilities employment is scaled by capacity retirements as detailed in the CAC Integration Analysis data. Employment associated with decommissioning nuclear generation facility is included in the employment outputs.

FUELS

Fuels Growth

The fuels growth sub-sectors, hydrogen, and bioenergy, use investment data derived from the CAC Integration Analysis. Industry allocation of investments for bioenergy fuels are derived from the NREL JEDI Biorefinery Sugars to Hydrocarbon Model rel. SH1.13.17.

Fuels Displacement

The fuels displacement sub-sectors, natural gas and petroleum fuels, scale 2019 baseline NYCEIR data based on declining fuel investments from the CAC Integration Analysis. Natural gas distribution 2019 baseline employment is derived from NAICS 221210—Natural Gas Distribution. 2019 baseline employment is scaled by the change in residential buildings with Natural Gas connections provided by the CAC Integration Analysis.

BUILDINGS

The buildings sub-sectors use investment data derived from the CAC Integration Analysis. Buildings sector data was also calibrated by an analysis of data on New York State's building electrification activities.

Commercial & Residential HVAC

Commercial and residential HVAC sub-sector industry spending patterns are adjusted based on BEEM and Integration Analysis 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.

Commercial & Residential Shell

Commercial and residential shell sub-sector industry spending patterns are adjusted based on BEEM and Integration Analysis 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 & Residential Other

Commercial and residential other sub-sector industry spending patterns are adjusted based on BEEM and Integration Analysis 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 subsector, the research team scales baseline 2019 employment by projected vehicle sales data provided by the CAC Integration 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 vehicle manufacturing that is “dual-technology” (i.e., serving both conventional and alternative vehicles). In addition, the research team distinguishes between employment related to vehicles sold in the New York market and employment related to vehicles sold outside the New York market. The research team assumes that the former scales with New York 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 CARB and research published at the International Battery, Hybrid and Fuel Cell Electric Vehicle Symposium. Based on this information and projected changes in the size and composition of the vehicle stock over time as obtained from the CAC Integration Analysis, the research team adjusts 2019 NYCEIR 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. As a starting point for the analysis, the research team obtained baseline employment data from the 2019 NYCEIR, distinguishing between wholesale employment related to conventional vehicles and employment related to alternative vehicles. The research team also distinguishes between wholesale employment serving the New York market and employment serving other markets. To project changes in employment over time, the research team scales wholesale employment serving the New York market based on projected changes in New York’s conventional vehicle stock and alternative vehicle stock over time, as obtained from the CAC

Integration Analysis. The research team assumes no change in employment serving non-NY 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 2019 baseline employment at fueling stations using U.S. Census Bureau data. These data 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% of baseline employment scales proportionately with projected changes in fossil fuel and biofuel consumption over time, based on fuel consumption projections from the CAC Integration 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 growth 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 CAC Integration 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 European Association of Electrical Contractors (AIE/EuropeOn). The research team assumes MD/HD vehicles exclusively use DC Fast chargers, the share of LD vehicles using DC Fast chargers remains constant (17 percent DC Fast, 83 percent Level 2), 100 percent of maintenance and installation labor is in-state, and ~10 percent of charger materials and hardware manufacturing is in-state. The research team assumes hydrogen refueling stations follow the same installation and maintenance investments as EV chargers, due to a lack of available data and low share of total investment; hydrogen refueling stations represent seven percent of cumulative investments in the LCF scenario and two percent in the AT scenario.

Model Sensitivities Methodologies

From the results of the IEO came two immediate model sensitivities, the first that examined the possibility of additional employment by increasing manufacturing within the state of New York for the Building sector, and the second, how the loss of employment in fueling stations could be impacted by different assumptions around how fueling stations respond to the changing environment. Below is a description of how the two model sensitivities were completed.

BUILDINGS: DOMESTIC CONTENT

The Buildings Model Sensitivity for Domestic Content in Manufacturing was based upon the employment data generated from the IEO. The Domestic Content sensitivity includes a comparison between the baseline Manufacturing employment modeled for 2030 under the LCF and AT scenarios, and the potential employment if 50 percent or 100 percent of the manufacturing for Buildings was produced in the state of New York.

Examples of products and devices in the Buildings sub-sectors that could potentially be manufactured in-state include:

- For the HVAC sub-sectors: Air conditioners, heat pumps, furnaces, and boilers
- For the Shell sub-sectors: Paints, coatings, windows, and doors
- For the Other sub-sectors: Stoves, lighting, water heating equipment, washers, dryers, and refrigerators

Using the IEO employment estimates for Buildings, the research team created the Domestic Content Model Sensitivity in 4 steps:

1. First, the research team determines the industry employment multipliers from IMPLAN for the six Buildings sub-sectors to obtain the percentage of in-state manufacturing that stems from New York's investments in Buildings.

2. Next, the research team creates the two hypothetical scenarios where 50 percent and 100 percent of the manufacturing employment is within the state.

3. Next, the research team processes the data and modifies the model's multipliers to reflect these two hypothetical scenarios.

4. Finally, the research team reports the new manufacturing employment outputs for the two hypothetical scenarios for the year 2030 and compares job creation with the initial manufacturing employment in New York.

The research team determined that the manufacturing baseline employment for 2019[60] in Buildings represents 14 percent of all employment generated by investments in the Buildings sector. The 50 percent and 100 percent sensitivities yield higher employment numbers to further examine the potential impact of moving more of the manufacturing industry to New York.

TRANSPORTATION: FUELING STATION

The research team modeled employment at fueling stations by scaling 2019 baseline employment from projected fossil and bio-fuel consumption relative to 2019 from the CAC Integration Analysis. Industry research indicates that fueling stations with convenience stores earn approximately 61 percent of their revenues from gasoline sales (National Association of Convenience Stores). The research team therefore estimates that 61 percent of employment at these establishments changes proportionally with fossil and bio-fuel consumption, while the remaining 39 percent is unaffected. All employment at gasoline stations without convenience stores is assumed to change proportionally with fossil and bio-fuel consumption. There is no prevailing growth rate in employment based on projected population increases or any other factors, only fuel consumption.

To evaluate the sensitivity of the estimated declines in fueling station employment to our model parameters, the research team conducts two sensitivity analyses. First, the research team evaluates employment impacts under the assumption that fueling stations with convenience stores are able to adapt to the changing market environment; second, the research team evaluates impacts under the assumption that some fueling stations are able to install electronic vehicle charging units, enabling these stations to avoid displaced employment.

Sensitivity Analysis 1

In this scenario, the research team assumes that fueling stations with convenience stores adapt to the changing market environment and experience no job impacts. In this scenario, employment at fueling stations with convenience stores is thus equal to 2019 employment in all years from 2020 to 2050.

This sensitivity analysis applies to fueling stations with convenience stores only. Fueling stations without convenience stores are estimated to experience employment losses based on projected fossil and bio-fuel consumption as in the primary analysis.

[60] Employment data from the Clean Energy Industry Report.

Sensitivity Analysis 2

In this scenario, the research team assumes that some fueling stations with convenience stores install electronic vehicle charging equipment, enabling these stations to avoid employment losses associated with declining fossil and bio-fuel consumption.

To model the number of fueling stations that are able to install electronic vehicle charging equipment, the research team assumes that 50 percent of the estimated light duty DCFC charging units (E3) are installed at fueling stations with convenience stores. The research team further assumes that four charging units must be installed at each fueling station in order to provide the requisite charging capacity. In this scenario, the research team assumes that all employment at these fueling stations is potentially subject to impacts based on projected fuel consumption.

As an initial step in estimating employment impacts under this sensitivity scenario, the research team models the number of fueling station establishments that would cease operations based only on the change in fossil and bio-fuel consumption relative to 2019 (e.g., if fossil and bio-fuel consumption declines five percent from 2019 to 2020, the research team estimates that five percent of fueling stations would cease operations). Simultaneously, the research team estimate the number of fueling stations that are able to install light duty DCFC charging equipment. If the number of stations able to install charging equipment is greater than the number of stations that would be expected to cease operations based on fossil and bio-fuel demand, there is no impact on fueling station operation and employment. If, however, the number of stations expected to cease operations exceeds the number of stations that can install charging equipment, the research team estimates the decline in jobs based on the difference between these two values. Once a station ceases operations, it remains closed for the duration of the period over which the research team analyzes impacts. The research team uses the average number of employees per fueling station to convert fueling stations in operation and fueling station closures to continued and lost employment, respectively.

As in our primary analysis and Sensitivity Analysis 1, fueling stations without convenience stores are estimated to experience employment losses based on projected fossil and bio-fuel consumption as in the primary analysis.

Secondary Employment Outlook (SEO) Methodology

The SEO's were generated from the finalized IEO's and took the overall quantity of jobs for the baseline year (2019) and generated occupational, wage, and geographic distributions of employment for 2030 under both scenarios. Where the IEO focused on the quantity of jobs the SEO was focused on understanding the type of jobs that were changing from 2019 to 2030 under the two transitionary scenarios.

OCCUPATION

The secondary employment outlooks (SEOs) were generated from the total direct and indirect employment totals by sub-sector provided the 2019 New York Clean Energy Industry Report (NYCEIR) and the initial employment outputs (IEOs) for 2030 (for each scenario) completed in a prior step of the JTWG Jobs Study. SEOs include total 2019 and 2030 employment by the following six (6) occupational categories as defined by the Bureau of Labor Statistics (BLS) Standard Occupational Classification (SOC) codes:

- Production and/or manufacturing occupations
- Installation or repair occupations
- Administrative occupations
- Management and/or professional occupations
- Sales occupations
- Other occupations (i.e. transportation and material moving, farming, fishing, and forestry, protective service, etc.)

WAGES

Additional analysis provides wage data for all sectors for 2019 and 2030 (all in 2019$). The wage brackets that serve as the basis for the sustainable wage analysis, less than $28 (tier 3), $28 to $37 (tier 2), and greater than $37 (tier 1), are based on living wage data from the Massachusetts Institute of Technology (MIT) Living Wage Calculator. The parameters used to generate the 3 brackets in this analysis are the living wage for 2 adults (1 working) with 1 child in the state of New York, cited at $32.29.[61] Since the technical documentation included with the MIT Living Wage Calculator data advises against reporting specific wage data at the state level, BW Research devised a margin around the $32.29 figure to allow for differences in living conditions and costs.

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[61] Glasmeier, Amy K. Living Wage Calculator. 2020. Massachusetts Institute of Technology. https://livingwage.mit.edu/states/36.

GEOGRAPHIC DISTRIBUTION OF JOBS

The CAC integration analysis provided investment activity by the five regions in the state of New York which were used to determine where employment would grow or be displaced by 2030 under both scenarios.

IEO TO SEO PROCESS

The methodology for conversion of IEO data to SEO outputs includes three (3) steps and both primary (2019 NYCEIR) and secondary (IMPLAN, BLS, OEWS, etc.) data sources. The steps are as follows:

1. Complete a crosswalk of IMPLAN industry categories to 6-digit North American Industry Classification System (NAICS) codes for each of the 28 sub-sectors by each of the value chain categories as defined in the IEOs:

    a. Construction
    b. Professional services
    c. Manufacturing
    d. Other supply chain (i.e. utilities, wholesale trade, repair and maintenance, etc.)

2. Run staffing patterns (NAICS to SOC) in New York for each of the value chain categories within each sub-sector for 2019. Augment staffing patterns for 2030 using occupational forecasts by 6-digit SOC categories for the state of New York. Outputs include total employment by aggregated occupational categories for each of the 28 sub-sectors for 2019 and 2030 scenarios.

3. Using finalized staffing patterns and proportional employment within sub-sector and value chain categories, wages provided by the BLS Occupational Employment and Wage Statistics (OEWS) data series are grouped into three tiers: tier 1 or above a sustaining wage (under $28/hr), tier 2 or at a sustaining wage (between $28 and $37/hr), and tier 3 or below a sustaining wage (more than $37/hr). Proportional employment by wage tier is presented for 2019 and 2030 scenarios using 2019$.