

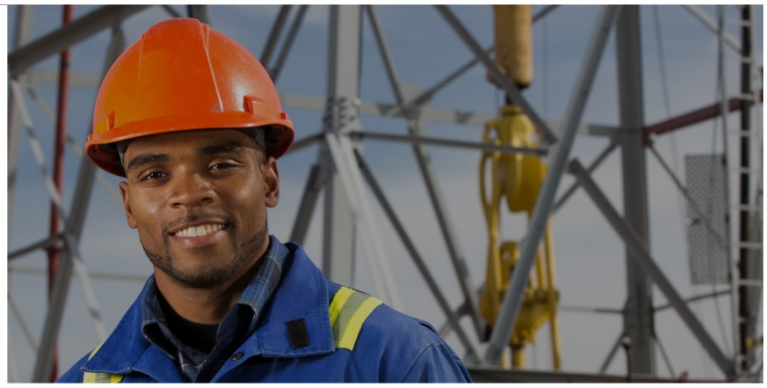

U.S. Energy and Employment Report





A report prepared for DOE by BW Research

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Preface

Among the recommendations in the U.S. Department of Energy's (DOE) recently published Quadrennial Energy Review (QER) was Recommendation 8.6 entitled, Reform Existing Energy Jobs Data Collection Systems. Specifically, Recommendation 8.6 reads:

> ***DOE should establish an interagency working group—including the Departments of Labor and Commerce—to reform existing data collection systems and provide consistent and complete definitions and quantification of energy jobs across all sectors of the economy.***

An interest in a more detailed assessment of energy jobs, as well as the rapidly changing energy landscape including the development of new energy technologies, such as hydraulic fracturing and horizontal drilling, and the wide scale deployment of wind and solar have challenged our traditional methods of counting jobs in the energy sector.

Over the last year, the DOE Data Working Group has conferred with numerous federal agencies and departments, including the Department of Labor (DOL), Department of Commerce, Bureau of Labor Statistics, US Census Bureau, and DOE's Energy Information Administration. The rapidly changing energy landscape including the development of new energy technologies such as hydraulic fracturing and horizontal drilling, and the wide scale deployment of wind and solar have challenged our traditional methods of counting jobs in the energy sector.

Four major gaps exist in current energy employment data. These include 1) business activities essential to the operation of traditional energy companies classified by the North American Industry Classification System (NAICS) within the business activities of other sectors, 2) jobs associated with the production of renewable energy such as wind, solar, geothermal, etc., 3) jobs associated with energy efficiency, and 4) jobs associated with energy efficiency in manufacturing processes.

Today DOE is releasing the first annual United States Energy and Employment Report (USEER) as an initial step toward providing a more complete definition and quantification of energy employment across the economy. The USEER presents direct employment data for the first three of the gaps identified; the fourth will be addressed in future reports. Additional work between DOE and other federal agencies will continue to refine the necessary data collection methodologies.

What is an energy job? Traditional energy employment encompasses all jobs necessary for the production, transmission, distribution, or storage of the energy that fuels economic and social activities.

In recent years, however, the manner in which society consumes energy has created a new category of energy jobs—an energy efficiency job. As there is no commonly accepted definition of an energy efficiency job, for the purpose of this study, the Department has chosen to define energy efficiency employment as the production or installation of energy efficiency products certified by the Environmental Protection Agency's Energy Star program or installed pursuant to the Energy Star program guidelines. Thus, the USEER energy efficiency employment figures include only work with efficient technologies or building design and retrofits. The report does not capture employment related to energy efficient manufacturing processes or employees associated with combined heat and power (CHP) or waste heat to power (WHP).

In addition, the USEER includes a baseline analysis of employment in the motor vehicles industry. However, this is not a redefinition of motor vehicle jobs as either energy or energy efficiency work. Transportation consumes 28% of all energy used in the United States and 50% of US oil consumption on a daily basis; for this reason, a complete report on energy and employment should describe how the motor vehicle industry is changing by vehicle fuel type and efficiency. We expect future reports to provide yet more detail on the transportation industry.

We want to thank our colleagues at the Bureau of Labor Statistics for their review of the survey methodology that underlies the BW Research Energy Employment Index as well as our colleagues within the DOE.

Executive Summary

The U.S. Department of Energy's (DOE) first annual U.S. Energy and Employment Report (USEER) provides a quantitative lens with which to evaluate the employment impact of new energy technologies, shifting fuels deployment, and evolving transmission and distribution systems during a period of rapid change. It also presents a unique snapshot of energy efficiency employment in key sectors of the economy, including construction and manufacturing. Finally, the report illustrates how fuel efficiency and new technologies and materials affect employment in the motor vehicle industry.

The USEER examines four sectors of the economy – "Electric Power Generation and Fuels", "Transmission, Distribution, and Storage", "Energy Efficiency", and "Motor Vehicles". The first two of these sectors, "Electric Power Generation and Fuels" and "Transmission, Distribution, and Storage" make up what are generally considered the traditional energy sectors. "Energy Efficiency" cuts across a range of occupations, especially construction and professional services, but includes manufacturing as well. The "Motor Vehicle" industry is included because its products play a special role in modern society's use of energy with transportation representing 50% of the country's daily domestic oil consumption and 28% of overall energy usage.

Current Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW) labor market data tracks employment across many energy production, transmission, and distribution subsectors. These include utility generation; oil, gas and coal extraction; electrical generation manufacturing; and transmission, for instance. However, the industry classification structure used in data collection assigns a portion of the nation's energy and energy efficiency work to broad categories of non-energy specific industry classifications, including construction, wholesale trade, and professional services. Within these classifications, certain subsectors contain both energy and non-energy related jobs. Analyzing these industry subsectors is particularly important in understanding employment trends in emerging technologies such as wind, solar, geothermal, and biomass, as well as new energy infrastructure, including storage and smart grid. These subsector analyses also provide insight into the distribution of the energy efficiency workforce as well as the role of new technologies in a rapidly evolving motor vehicle industry.

In order to better enhance QCEW data, BLS conducts two supplemental surveys. The first is the Multiple Worksite Report (MWR), which is collected each quarter to disaggregate the employment and wages of numerous establishments owned by a single employer into their individual worksite locations. This survey allows the employment and wages for each worksite location to be placed in their correct industrial and geographical category, thereby improving the accuracy of QCEW data. Thus, with the MWR, new business births and deaths, and their associated employment are identified each quarter in a timely manner. This rapid identification of births and deaths improves the QCEW. The second survey is the Annual Refiling Survey (ARS), which is conducted each year to update the classification codes

(industrial, geographical, and ownership) currently assigned to the establishments on the QCEW which ensures the accuracy of detailed industry and geographic (such as county level) data. In a time of rapid technological change that affects how society produces and uses energy, such an approach is especially helpful in understanding the relationship between energy and employment. The Energy Employment Index (EEI), independently designed and carried out by BW Research, is such a supplemental survey. It is used in the USEER to identify energy-related employment within key subsectors of the broader BLS industry classifications and assign them into their component energy and energy efficiency sectors. This analysis is not a replacement for existing BLS employment data; instead, it provides an additional lens with which to refine and evaluate the role of energy and energy efficiency within the labor market as a whole. In combination, the employment figures reported in the USEER refer only to direct employment and not to indirect employment or induced employment[1]. All employment figures in this report are in reference to 2015 Q2.

With the combination of EEI survey data and existing BLS surveys, the USEER finds that Electric Power Generation and Fuel technologies directly employ 1.6 million workers, almost double the 935,000 covered in the BLS direct industry classifications. Within this traditional energy sector, nearly 63% of employees work with fossil fuel technologies. This approach also identifies an additional 280,000 workers across Transmission, Wholesale Trade and Distribution, and Storage technologies, for a total of more than one million jobs. Retail sales and distribution in this sector—primarily gasoline stations—employ another 990,000 individuals. In total, approximately 3.64 million Americans work in our traditional energy industries, when including the 990,000 working in retail sales and distribution.

Today, 600,000 workers are employed within the Electric Power Generation and Fuels sector in low carbon emission generation technologies, including renewables, nuclear, and advanced/low emission natural gas. Just under 300,000 individuals work, in whole or in part, for solar firms, with over 200,000 of those employees spending the majority of their time on solar. There are an additional 77,000 workers employed at wind firms across the nation.

EEI and BLS data show that 1.9 million Americans[2] are employed, in whole or in part, in the design, installation, and manufacture of energy efficiency products and service; almost 1.2 million efficiency jobs are in the construction industry. Of the 6.8 million total construction jobs in the U.S., about 30% of construction jobs are directly supported by energy or energy efficiency firms.

The motor vehicle industry employs 2.4 million workers[3], exclusive of auto dealerships. Currently, over 190,000 employees work with alternative fuels vehicles, including natural gas, hybrids, plug-in hybrids, all electric, fuel cell and hydrogen vehicles. Hybrids, plug-in hybrids, and all electric vehicles make up over half of this number, supporting 108,000 employees.

Across the nation, firms in these four sectors anticipate roughly 7% employment growth for 2016. Energy Efficiency employers expect to supply an additional 260,000 new jobs, for a growth rate of 14%. Transmission, Wholesale Trade and Distribution, and Storage firms project to grow employment by 5%,

[1] A direct job is created by the firm specific to the industry, while indirect jobs support these firms via supply or contracting services. Induced jobs are a result of the economic impact of direct and indirect employees spending their earnings.
[2] Energy Employment Index
[3] Energy Employment Index

followed by Electric Power Generation and Fuels at 4%. Motor Vehicle firms project just under one percent employment growth over the next 12 months.

These four sectors are relatively less diverse compared to the overall national workforce. Employers across all four sectors report that about a quarter of their workers are ethnic or racial minorities, compared to a national average of 34%. Women are significantly underrepresented in these sectors, ranging from18-26%, compared to the overall economy, where women make up almost 47% of the workforce. Veterans, however, comprise about one in ten workers, higher than the national average of 7%, with slightly higher employment across Fuels and Motor Vehicles compared to the Electric Power Generation or Energy Efficiency sectors.

Almost three-quarters of employers across these sectors (72%) reported difficulty hiring qualified workers over the last 12 months; 26% note it was very difficult.

The USEER provides a unique, but time sensitive, snapshot of the intersection of our energy and employment systems. Future reports will be adjusted, as necessary, to record this dynamic interaction of technology with our nation's economy.

Introduction

The U.S. energy production and distribution system is undergoing rapid technological change. National energy employment and economic impacts have traditionally been difficult to define given the diversity and breadth of energy industries across the United States.[4] While many of its segments, such as utility scale power generation, fossil fuel extraction, electric and gas transmission and distribution, are inarguably part of the energy sector, other activities that include storage technologies and energy efficiency products and services are difficult to define and isolate from other sectors of the economy. Given the complex relationship between energy and the overall economy, the USEER does not attempt to redefine the term "energy job". Instead, it investigates, with a special supplemental survey, two traditional energy sectors—Electric Power Generation and Fuels (Generation and Fuels) and Transmission, Wholesale Trade and Distribution, and Storage—followed by individual analyses of employment in two important energy end-use sectors—Energy Efficiency and Motor Vehicles.

Employment data collected by the Bureau of Labor Statistics (BLS) provides information on many, but not all, energy-related job categories. Most notably, BLS does not filter by energy technology across business segments. For instance, residential solar installation establishments are typically labeled as electrical contractors (together with all other traditional electrical outfits) without being identified specifically as solar companies. Petroleum-engineering firms are included in engineering services, with civil, mechanical, and other engineers, while electric vehicle prototype manufacturers are combined with gasoline and diesel-fueled vehicle manufacturing. As a result, data that differentiates between new technologies and old has been difficult to capture.[5]

The spread of business activities within each of the four analyzed sectors presents additional taxonomic challenges, as early stage research and development, repair and maintenance, or professional and technical services vary across energy, energy efficiency, and manufacturing. Natural gas business activities, for instance, differ from those of advanced building materials and solar photovoltaics.

Historically, supplemental surveys have been conducted by BLS to acquire more complete information on new industries, specific demographic profiles within the work force, or new labor force trends such as the role of contingent workers. Thus, significant modification to the current BLS structure of industry and occupational classifications is avoided by capturing the required energy employment data using a supplemental survey tool based on existing BLS data and classifications.

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[4] *See generally*; Robert Bacon and Masami Kojima, Issues in Estimating the Employment Generated by Energy Sector Activities, The World Bank Sustainable Energy Department, 2011.
[5] *Id*.

The BW Research Energy Employment Index (EEI), independently developed, but reviewed by BLS for consistency, includes survey data from nearly 20,000 U.S. businesses engaged throughout more than 150 industries (at the 6-digit NAICS level).[6] These responses are used to analyze the concentration, intensity, and allocation of various energy technologies and activities throughout traditional industry sectors, using 2015 Q2 employment data from the Bureau of Labor Statistics (BLS) Quarterly Census of Employment and Wages (QCEW). EEI data also provides an additional layer of information to track sector-specific growth potential, obstacles, and opportunities. The data presented in the Index is not intended to remove, replace, or replicate existing data from the BLS QCEW but instead reorganize categories and provide insight for policymakers and the public regarding shifts in energy production and consumption across the United States. Within the definitions below, the EEI provides data for direct employment only and does not attempt to estimate indirect employment or induced employment related to the analyzed sectors.

Many employment studies such as that included in Chapter 8 of the Quadrennial Energy Review: First Installment (DOE 2015) generate employment estimates that rely on input/output modeling. These studies typically define an activity based on reported expenditures or expenditures and associated levels of employment reported by a defined industry or activity (e.g., U.S. solar PV installation). In this example, solar PV installation firm employment would be the "direct" jobs. Most studies go at least one step further, identifying "indirect" employment, which includes the supply chain or other support services to the industry. In the solar example, these would include U.S. manufacturing jobs related to producing PV equipment used in domestic installations (and their suppliers and vendors) as well as consulting, tax, legal, and other professional services to support domestic PV installation companies. Another typical calculation is "induced" jobs, which includes jobs created or supported by wages paid and other benefits provided by employers of direct and indirect employees.

In the USEER, by comparison, the direct job category of interest is defined as the solar industry generally, including utility scale solar, residential and commercial installations, as well as the manufacturing, professional services, management and sales that make up the totality of this industry. However, the indirect jobs that support this industry are not included, such as polysilicon production (the raw material used in solar panels), aluminum production and extrusion activities for frame manufacturing, or other aspects of the solar value stream, etc. Nor are the induced jobs included, i.e. those created throughout the economy as the result of the spending of wages by the 300,000 employees whose income derives, in whole or part, from this industry.

For this survey, a Qualifying Firm is:

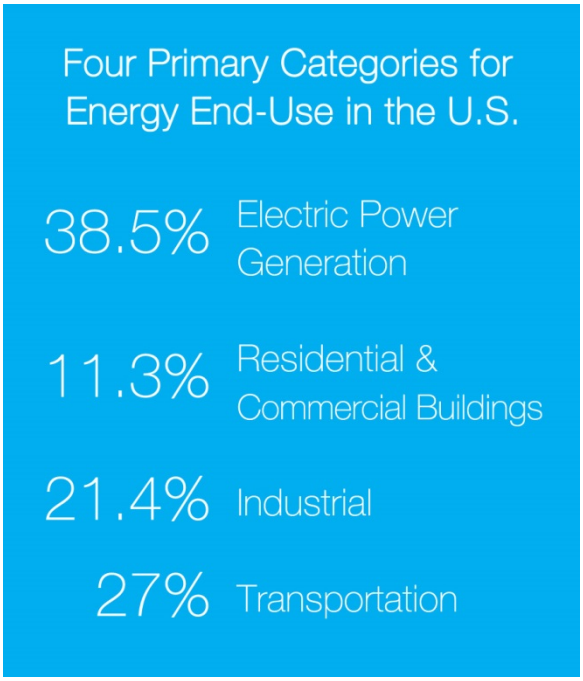
> "An organization with employees in the United States that is directly involved in the research, development, production, manufacture, distribution, sales, implementation, installation, or repair of components, goods or services related to Electric Power Generation, Electric Power Transmission, Wholesale Trade and Distribution, and Storage, Energy Efficiency, including Heating, Cooling and Building Envelope, Fuels, and Motor Vehicles, including supporting services such as consulting, finance, tax, and legal services related to energy."

[6] NAICS, or North American Industrial Classification System, is the official way to categorize industries in the United States, Canada, and Mexico.

Qualifying Workers are:

> "Employees of a qualifying firm that spend some portion of their time supporting the qualifying energy, energy-efficiency, or motor vehicle portion of the business."[7]

It is important to note that EEI data provides an insight into levels of employment activity that include both "a portion of their time" and "a majority of their time" when referencing qualifying employees. This is especially true within the energy efficiency sector where the employing construction or repair firms frequently are engaged in both traditional energy related construction or installation as well as high efficiency activities that qualify for Energy Star designation. Where less than full-time employment is referenced in the USEER, it is labelled as such.



Energy end-use in the U.S. is divided into four primary categories: 1) Electric Power Generation (38.5%), 2) Residential and Commercial Buildings (11.3%), Industrial (21.4%), and Transportation (27%). In 2015 electricity, in turn, was consumed 74.1% by Residential and Commercial Buildings, 25.7% by Industrial, and .2% by Transportation. Thus, Residential and Commercial Buildings were the end-use consumers of approximately 39.8% of all energy production (direct end-use + electricity).[8]

In order to ensure consistent responses and measurement across the United States related to energy efficient products, this report captures only energy efficiency products certified by the Environmental Protection Agency's Energy Star program or installed pursuant to the Energy Star program guidelines. Thus, the following energy efficiency employment figures encompass work with efficient technologies or building design and retrofits. The Index does not capture employment related to energy efficient manufacturing processes or workers associated with combined heat and power (CHP) or waste heat to power (WHP). Future U.S. Energy and Employment Reports may address some of these gaps; in the meantime, the recently released Energy Productivity and Economic Prosperity Index[9] provides insight into these areas.

[7] Data presented in this report excludes retail employees. Qualifying Energy Workers will be referenced as energy-related jobs. Where "portion of their time" includes employees whose activities are less than 50% of their time, specific reference will be noted.

[8] U.S. Energy Information Administration, Electric Power Monthly, November 2015 YTD. Solar photovoltaic includes both utility and distributed generation.

[9] Blok, Kornelis, et al. *The 2015 Energy Productivity and Economic Prosperity Index*.

Motor vehicles are included in this report primarily due to their intensive use of energy and contribution to carbon emissions.[10] According to the Energy Information Administration (EIA), 28% of domestic energy is used for transportation, and more than half of the oil consumed in the U.S. on a daily basis.[11] This report delineates employment between traditional gas and diesel motor vehicles, hybrid and plug-in hybrid, electric, natural gas, hydrogen, and fuel cell technologies. It does not, however, cover all sectors of transportation, such as aviation and maritime.

BW Research Partnership, an independent research organization, collected and analyzed the data that this report is based on. The firm's proprietary "Energy Employment Index" is based on a comprehensive survey effort of U.S. employers and current BLS data. The data set includes technology, value-chain, and energy employment data to the county-level in all 50 U.S. states. In a time of rapid change in energy technologies across the board, continued refinement of supplemental surveys will continue to be an important tool in analyzing existing BLS data sets.

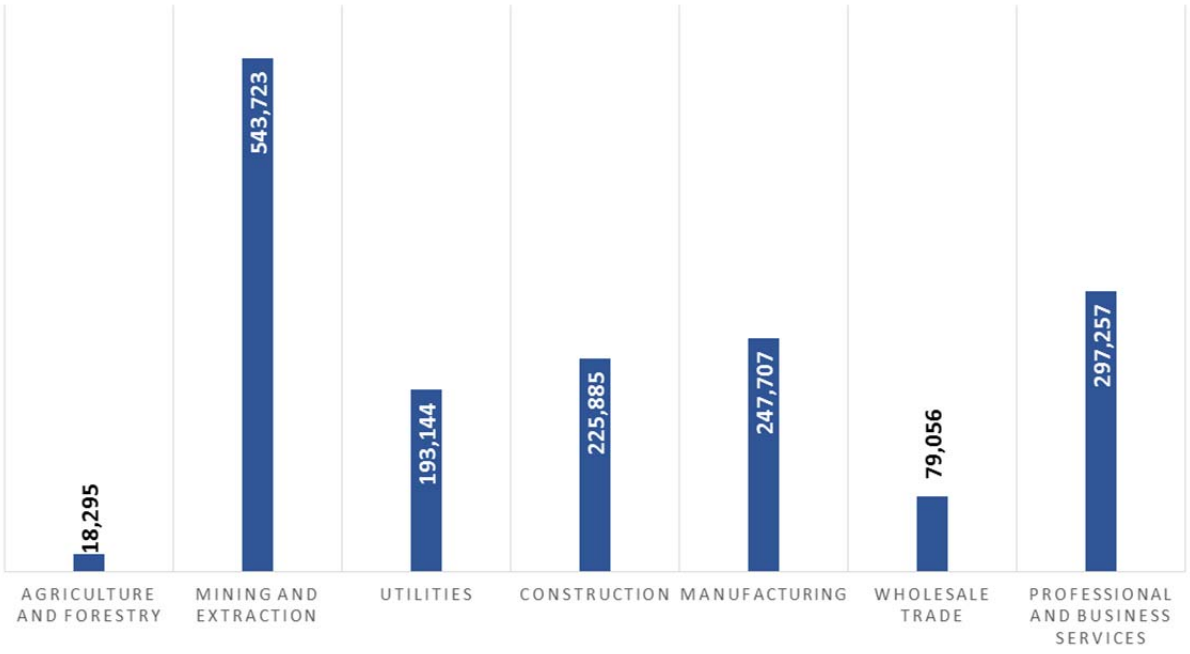
[10] The Index covers motor vehicle employment across vehicle parts manufacturing, automotive repair and maintenance, as well as vehicle, parts, and supplies wholesalers, including air, rail, water, and truck transportation of motor vehicle parts and supplies. It does not capture jobs associated with the final assembly of some transportation equipment such as forklifts and golf carts.

[11] U.S. Energy Information Administration, Annual Energy Outlook, 2015.

Electric Power Generation & Fuels

Electric Power Generation and Fuels technologies employ more than 1,600,000 Americans. About a third of these jobs belong to mining and extraction workers, while professional and business services roughly comprise one-fifth of this sector's workforce (19%). BLS Quarterly Census of Employment and Wages (QCEW) data identifies 936,000 Generation and Fuels workers, while the EEI survey identifies the remaining 730,000 individuals across six major industry sectors. A detailed analysis of this process is contained below along with an analysis of Generation and Fuel jobs by fuel source.

Figure 1. Generation and Fuels Employment by Industry Sectors (BLS and EEI data combined) Q2 2015



Traditional Industry Definitions

Electric Power Generation and Fuels encompass the entire range of business activities that support both fuel extraction and production as well as utility generation.[12] Also included are any firms engaged in facility construction, turbine manufacturing, and parts distribution of all electric generation technologies. Though sometimes referenced in tandem with transmission and distribution, employment in this chapter delineates only those workers focused primarily on electric power and fuel production technologies.[13]

BLS labor market data from the QCEW[14] partially captures employment across these technologies through industries that encompass power plant operations and fossil fuel extraction firms (Table 1). Industries directly examined using traditional North American Industry Classification System (NAICS) codes, such as oil and gas extraction, coal mining, or machinery manufacturing provide total employment for fuel mining and extraction industries. Similarly, utility generation workers across hydroelectric, nuclear, fossil fuel, and renewable technologies are captured by the traditional NAICS presented in Table 1.

Table 1. Generation and Fuels, North American Industry Classification (NAICS)[15] Q2 2015

NAICS Codes	Sector	Electric Generation and Fuels Employment (QCEW)
211	Oil and Gas Extraction	195,604
2121	Coal Mining	65,180
213112	Support Activities for Oil and Gas Operations	275,430
213113	Support Activities for Coal Mining	7,509
	Total Mining and Extraction:	**543,723**
221111	Hydroelectric Power Generation	17,129
221112	Fossil Fuel Electric Power Generation	114,351
221113	Nuclear Electric Power Generation	51,537

[12] Fuel extraction and production for all purposes, not only electricity.
[13] For information on Transmission, Distribution, and Storage technologies, please see chapter 2 of this report.
[14] QCEW covers employment from establishments which report to the Unemployment Insurance (UI) programs in the United States; exclusions from UI coverage include self-employed workers, most agricultural workers on small farms, members of the Armed Forces, elected officials in most states, most employees of railroads, some domestic workers, most student workers at schools, and employees of certain small nonprofit organizations.
[15] Bureau of Labor Statistics, Quarterly Census of Employment and Wages (QCEW) 2015 Q2 all ownerships

221114	Solar Electric Power Generation	2,023
221115	Wind Electric Power Generation	4,316
221116	Geothermal Electric Power Generation	1,089
221117	Biomass Electric Power Generation	1,544
221118	Other Electric Power Generation	1,155
	Total Utilities:	**193,144**
324	Petroleum and Coal Products Manufacturing	112,562
33313	Mining and Oil and Gas Field Machinery Manufacturing	86,235
	Total Manufacturing:	**198,797**
	Total Generation and Fuels:	**935,664**

However, the employment figures in Table 1 provide only a partial illustration of the generation and fuels sector. Additional employment is embedded within a broad range of other NAICS industry categories that are directly related to electricity and fuel production, but not found in the industries included in Table 1. A portion in each of these industries contributes to the array of business activities that constitute electric power generation and fuel production, but these additional employees are difficult to separate because they do not have energy-specific industry delineations.

Such industries are particularly important in understanding components of the emerging generation and fuel technology spheres that are not captured through generation and fuel extraction NAICS alone. For example, a subset of semiconductor manufacturers produce solar panels, while others assemble computer components or medical equipment. Consequently, federal labor market data alone presents an incomplete picture of generation and fuel sector employment. This is particularly true of renewable electricity generation. In the wind and solar industries, for instance, much of the generation capacity is owned by development companies or by building owners, not utilities. Thus, the employment related to this generation appears under other NAICS codes than those that typically capture utility employment. However, inclusion of these additional industries in their entirety would result in exaggerated employment figures, while their exclusion would underestimate the sector's workforce. The supplemental survey utilized by the EEI provides a tool to measure the actual energy-related employment within these broader NAICS codes.

Electric Power Generation and Fuels – Identifying Additional Employment

To better understand electric generation and fuels employment in the United States, the following figures were derived using the Energy Employment Index to apportion employment from these broad industry classifications into their relevant component subsectors. This level of granularity provides a

more accurate depiction of the nation's generation and fuels economy. As of 2015, the sector employs about 1.6 million workers, nearly double the number of employees identified through BLS data. Approximately 63% of these employees, or 1.0 million, work with fossil fuel technologies, while another 37% work with low-carbon electricity generation and production, including renewables, nuclear, and advanced/low emission natural gas. Eight in ten of these energy workers spend the majority of their time working with low emissions energy technologies; over half (60%) spend all of their time on this work. Data collected through the Index reveals that employers in generation and fuels anticipate the sector will grow by about 4% over the coming 12 months, creating an additional 57,395 jobs. The following breakdown of EEI survey data identifies the location of these additional jobs within each of six NAICS industry sectors.

A note on how to interpret the industry employment figures:

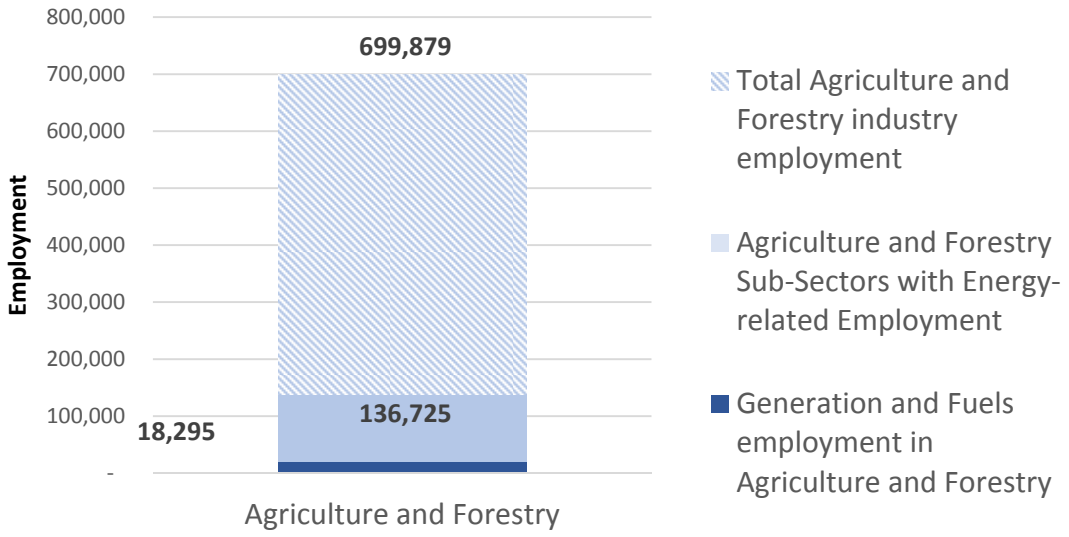
The figures in the following four chapters that delineate overall BLS QCEW employment in traditional NAICS-defined sectors such as agriculture, construction, or manufacturing are used to illustrate relevant energy-related employment. The cross-hatched bars provide nationwide employment for a traditional industry sector (i.e. in Figure 2 below, almost 700,000 Americans work in agriculture and forestry), while the light blue bar shades off the percentage of this larger industry sector that may be related to energy technologies (Generation and Fuels,; Transmission, Wholesale Trade and Distribution and Storage; Energy Efficiency: or Motor Vehicles). Finally, the dark blue bars illustrate actual sector employment; using Figure 2 below as an example, just over 18,000 individuals within the Agriculture and Forestry industry work to support Generation and Fuel technologies.

1. Agriculture and Forestry

The entire Agriculture and Forestry industry employs about 700,000 workers across the nation[16]; about 20% of these jobs are contained within "detailed" energy-related industry sub-sectors that could include businesses directly working with Generation and Fuel technologies. These detailed industries include corn and sugarcane farming, used for ethanol and biodiesel production, and logging or other forestry services, which contribute to woody biomass and pellet fuel. Of these industries, about 18,000 Agriculture and Forestry employees work to support electric power generation and fuel production.

[16] Agricultural employment data is from BLS QCEW 2015 Q2; data was retrieved in February 2015.

Figure 2. Agriculture and Forestry Employment (Q2 2015)



2. Mining, Extraction, and Utility Generation

Unlike agriculture, energy-related BLS Mining and Extraction sub-sectors that contain generation and fuel production are wholly dedicated to these activities. For example, the oil and gas extraction and coal mining industries are included in totality. About 72% of all mining and extraction firms support fossil fuel production, and federal QCEW labor market data captures the 544,000 employees in these detailed sub-sectors. Similarly, utility generation employment is captured entirely by electricity generation firms and their related sub-technology NAICS codes. Excluding those utilities that work with water and sewage treatment and energy distribution and transmission (such as natural gas companies), electric power generation companies employ about 193,000 individuals.

Figure 3. Mining and Extraction Employment (Q2 2015)

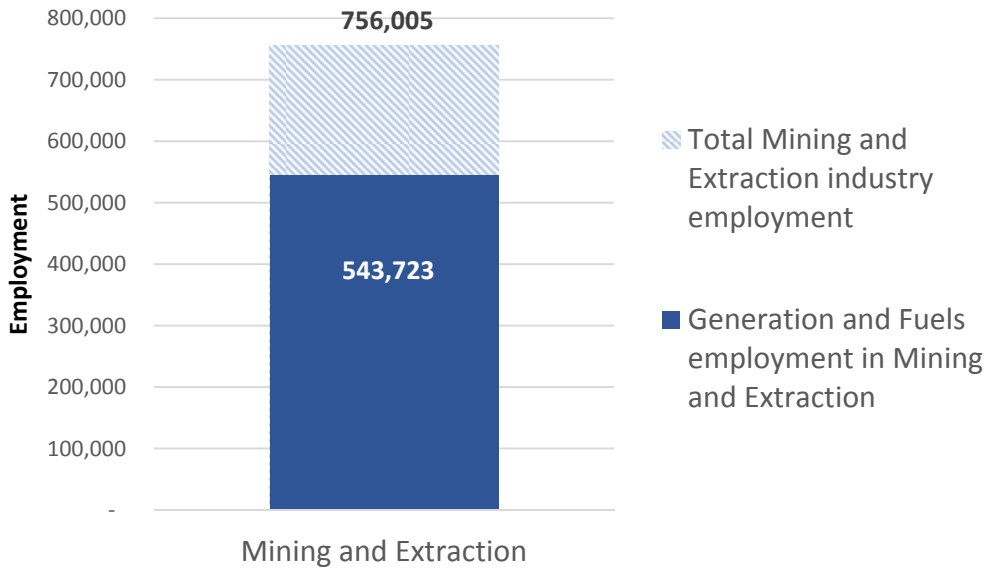
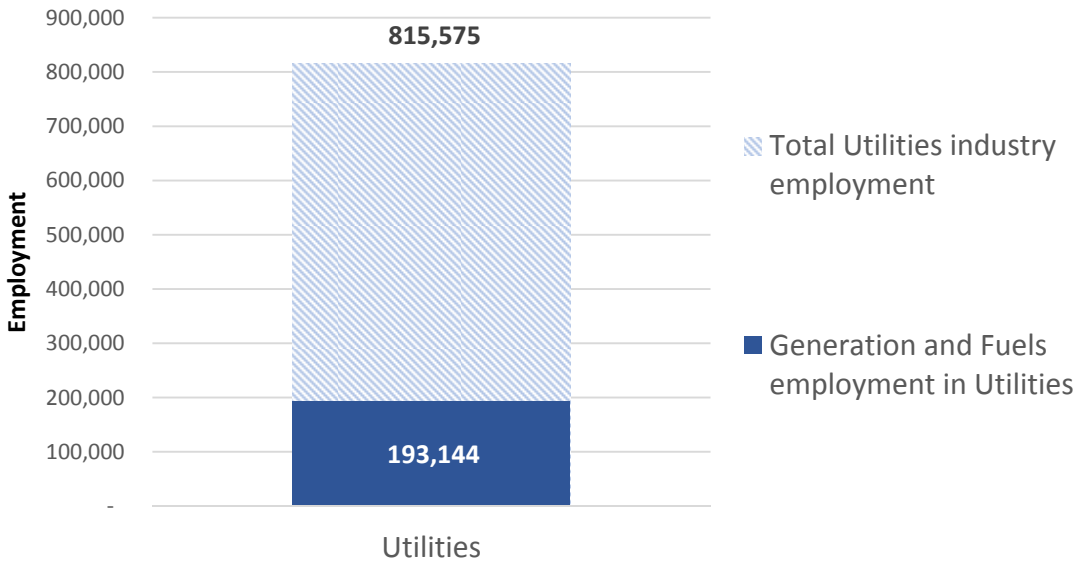


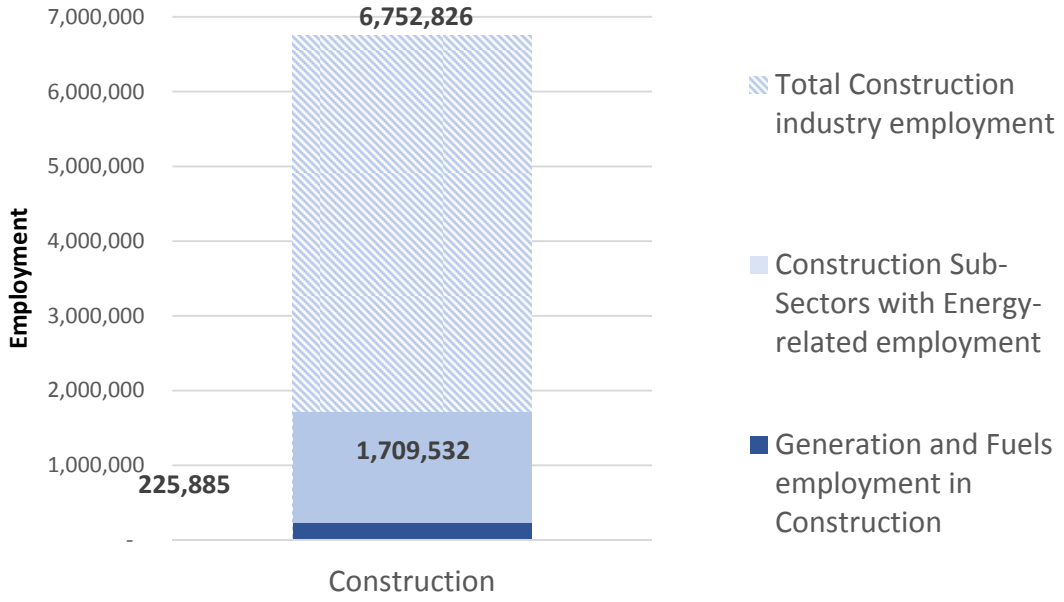
Figure 4. Utilities Employment (Q2 2015)



3. Construction

According to the BLS QCEW, employment across all construction firms in the United States totals almost 6.8 million workers. About 30% of total construction employment exists in detailed sub-sector industry classifications that contain some level of Generation and Fuels-related employment. For example, a subset of the construction industry supports Generation and Fuels through power plant construction. Of the roughly 1.7 million jobs in these detailed energy-related industries, EEI data reveals that 226,000 employees work for businesses directly engaged in Generation and Fuels construction projects.

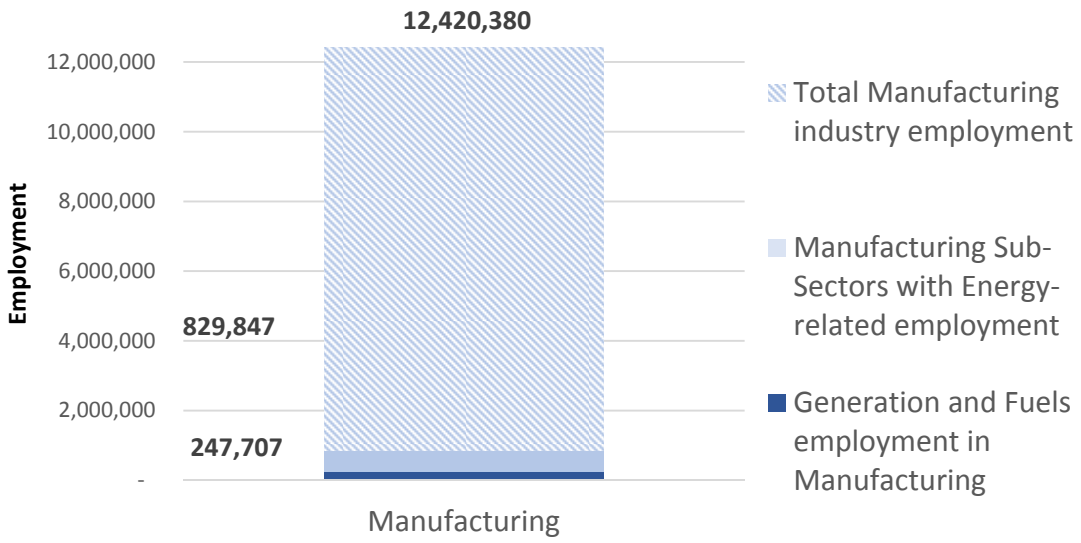
Figure 5. Construction Employment (Q2 2015)



4. Manufacturing

Using BLS QCEW data, the national manufacturing industry employs just over 12.4 million workers. About 6% of overall manufacturing employment is comprised of energy-related subsectors, including petrochemical, turbine, and generator manufacturing. These detailed industry sub-sectors account for nearly 700,000 workers, and of these, about four in ten (36%) support Generation and Fuels activities, including photovoltaic, turbine generator, petroleum product, motor, or engine equipment manufacturing.

Figure 6. Manufacturing Employment (Q2 2015)

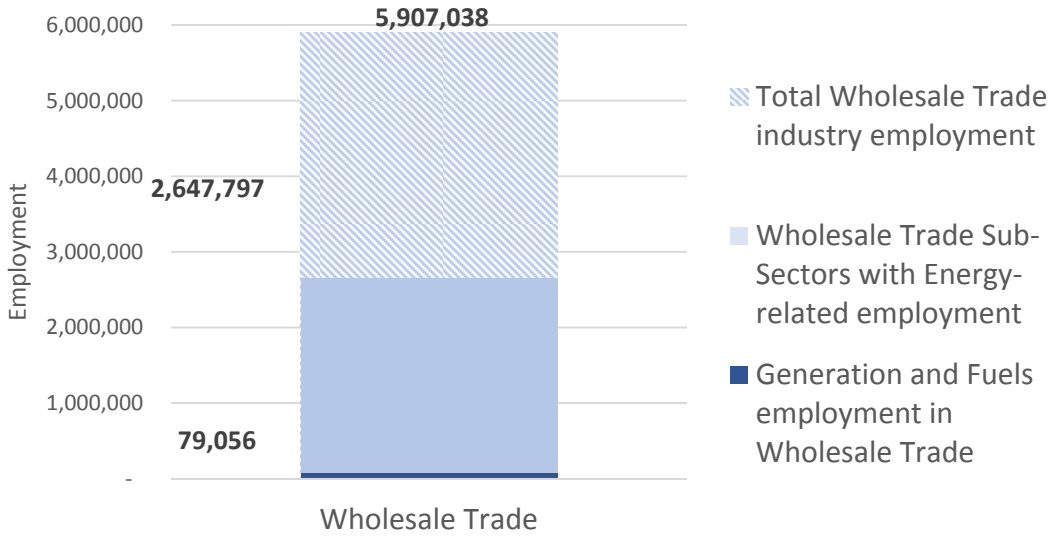


5. Wholesale Trade

Of the almost 6 million wholesale trade employees identified by the BLS QCEW, about 45% are part of detailed energy-related sub-sectors that support electric generation and fuel activities, including electric equipment, chemical, and petroleum merchant wholesalers. Of these energy-related trade sub-sectors, about 80,000 spend some amount of their time supporting the wholesale trade of Generation and Fuels technologies.[17]

[17] Transmission and trade of fuels are included in the Transmission, Distribution, and Storage chapter.

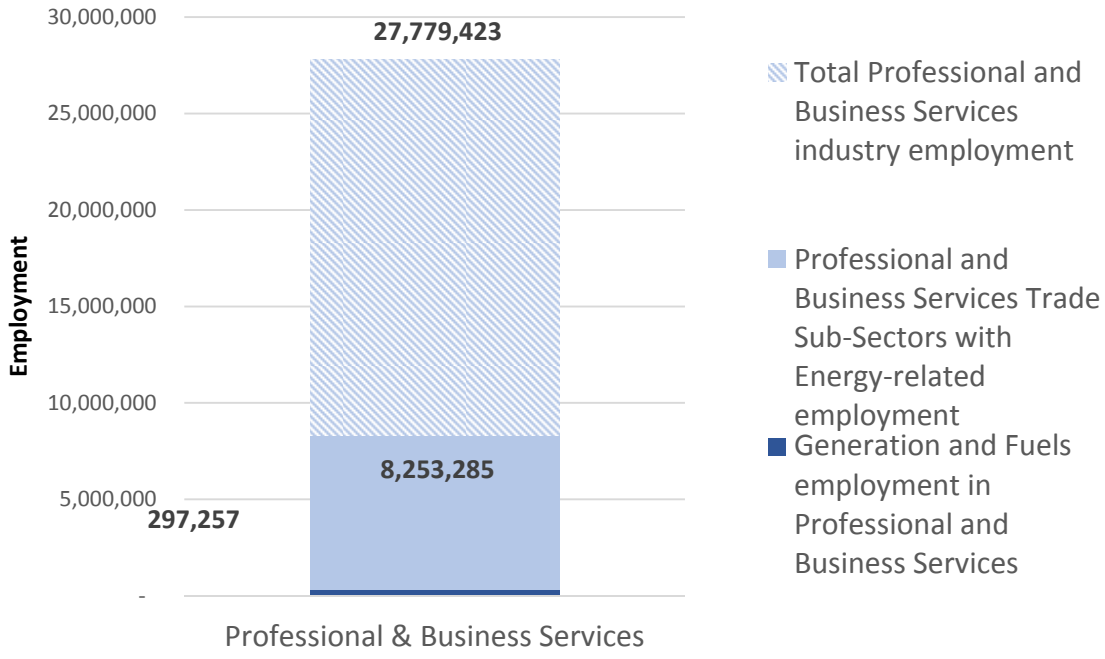
Figure 7. Wholesale Trade, Distribution, and Transport Employment (Q2 2015)



6. Professional and Business Services

The professional and business service industry in the United States employs almost 28 million workers, using NAICS industry classifications. Within this aggregate industry, several detailed sub-sectors support energy operations with legal services, biotechnology research, architecture, and engineering. Of the 8.3 million jobs in these energy-related professional service sub-sectors, just over 297,000 workers support Electric Power Generation and Fuels production.

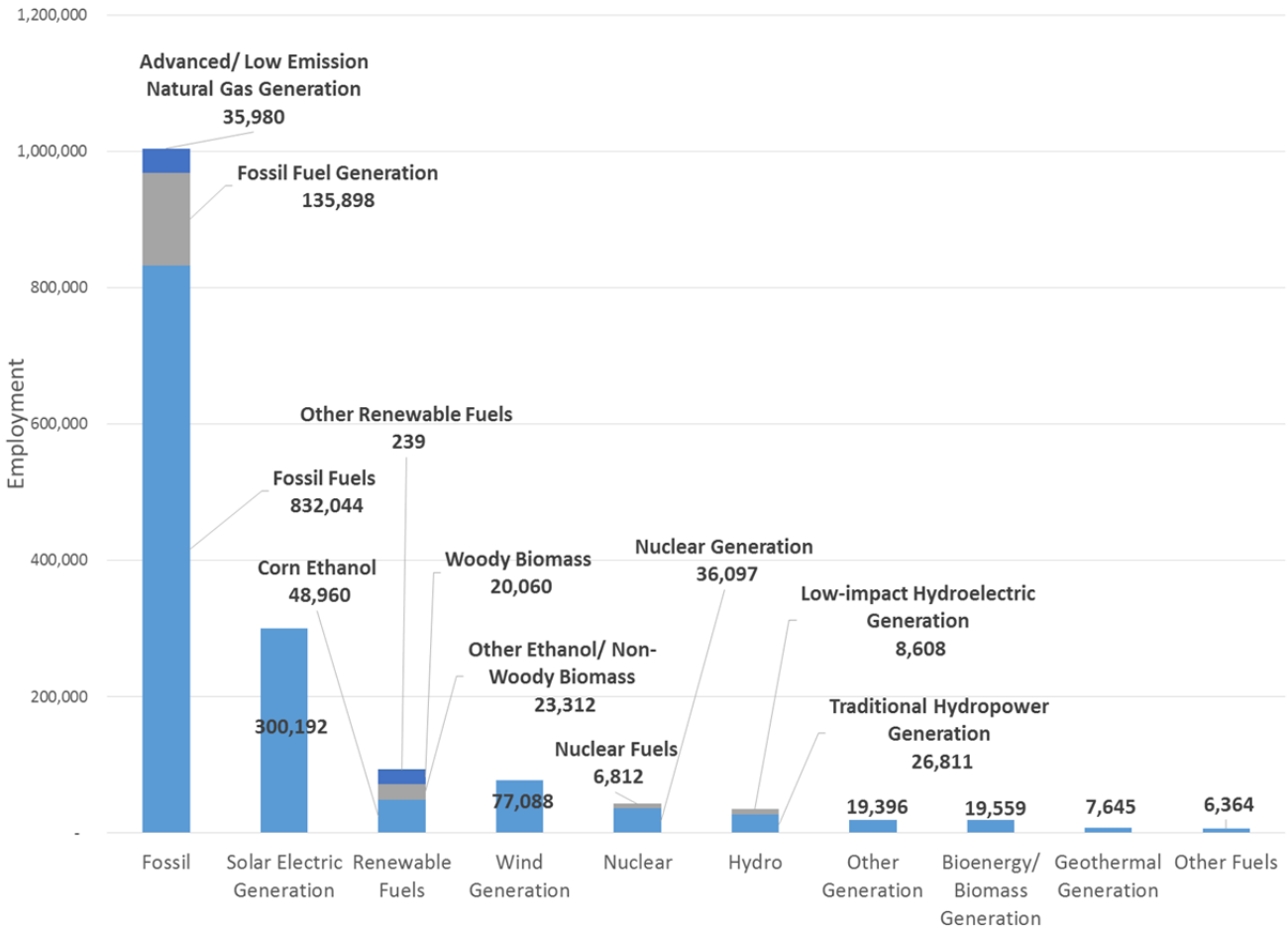
Figure 8. Professional and Business Services Employment (Q2 2015)



Electric Power Generation and Fuels by Sub-Sector

The following employment figures provide detail both within fossil fuel generation and across emerging generation technologies. Of the 1.6 million Electric Power Generation and Fuels employees, fossil fuel technologies account for about 63% of employment. Fossil fuels production, processing, and related activities support the majority of jobs in this sector (52%), at just over 832,000 workers, while fossil fuel-based electric power generation employs 136,000 individuals. Although oil and gas extraction firms employ 185,000 workers, employment in this sector has shrunk by 8% since 2014.[18] Figure 9 illustrates the breakdown of electric generation and fuels employment by sub-technology.[19]

Figure 9. Generation and Fuels Employment by Sub-Sector (Q2 2015)

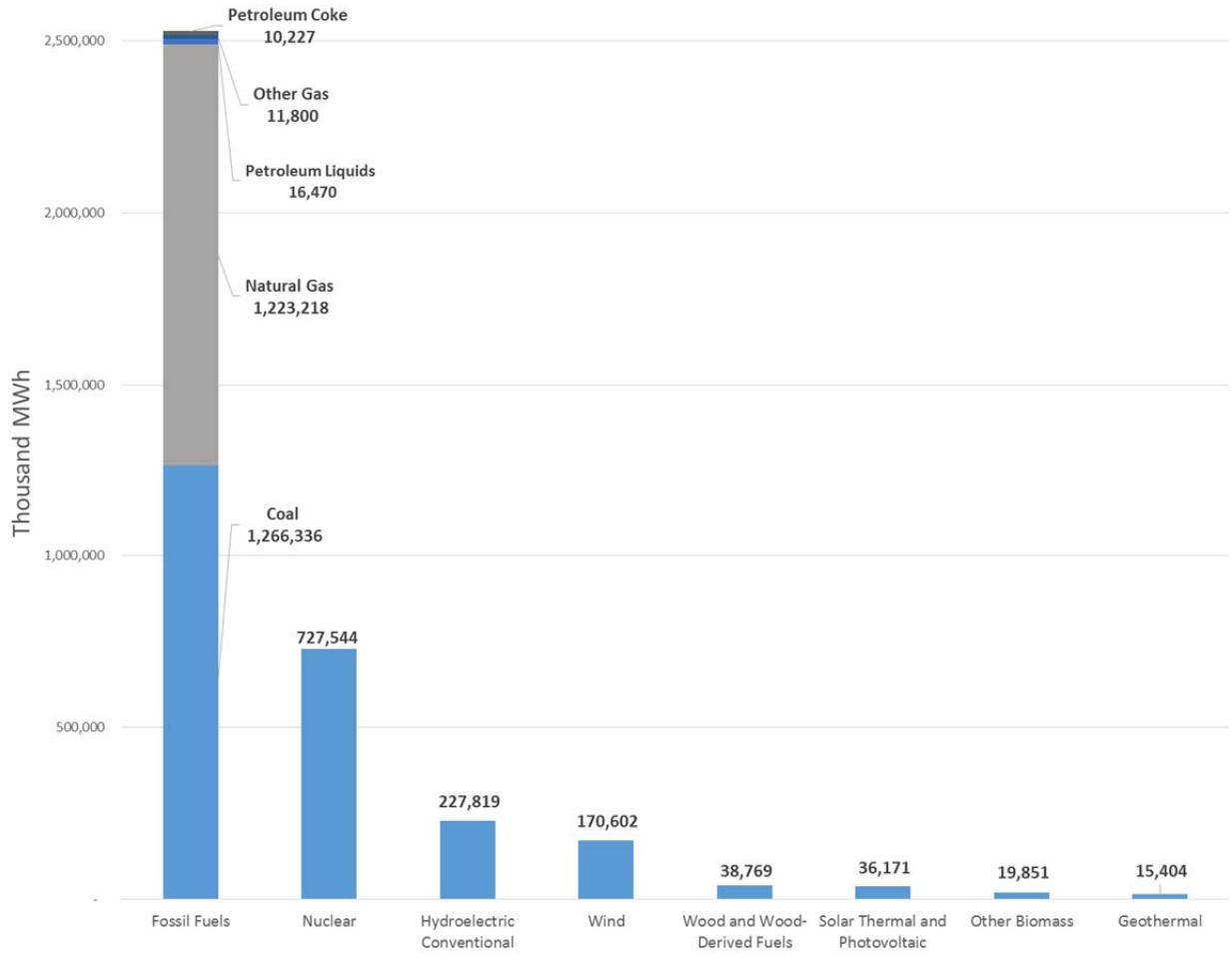


[18] Bureau of Labor Statistics, Current Employment Statistics, November 2014 – November 2015

[19] It is important to note that each technology within generation and fuels is comprised of different business activities. Electric generation, including all utilities as well as distributed generation, have inextricably linked retail sales employment that is included in their total. For all other technologies listed in this report, the retail sales component is provided separately, but not included in the totals within each chart and table.

For comparative purposes, Figure 10 below illustrates electric power generation in the United States by the fuel sources listed above. While employment in Generation and Fuels is split 63%-37% between fossil fuels and low carbon sources, actual electricity production is produced in different ratios.

Figure 10. Electricity Generation by Fuel, (Thousand MWh)[20] (November 2015 YTD)



Generation and Fuels – Workforce Characteristics

Generation and Fuels extraction firms employ more women compared to the Motor Vehicles (18%) and Transmission, Wholesale Trade and Distribution, and Storage (21%) firms studied in this report. Almost a quarter (23%) of Fuels employees are 55 years or older. Although comparable to the Motor Vehicle industry, this is significantly higher than Energy Efficiency (18%), Transmission and Wholesale Trade and Distribution (18%), and Generation (8%). Though the Electric Power Generation workforce appears young given the figures in Table 2, this result is partially skewed by emerging Generation technologies

[20] U.S. Energy Information Administration, *Electric Power Monthly,* November 2015 YTD. Solar photovoltaic includes both utility and distributed generation.

like the solar workforce. For utility generation firms, the demographic composition shifts, as 24% of workers are 55 years or older; the median age for utility employees is 47.[21]

Table 2. Demographics – Electric Power Generation and Fuels Q4 2015

	Women	Ethnic or Racial Minorities	Veterans	55 and older
National Average[22]	**46.8%**	**34.0%**	**6.9%**	**22.5%**
Electric Power Generation	24.5%	25.2%	8.4%	8.1%
Fuels	25.7%	24.6%	11.5%	23.3%

More Generation employers reported hiring difficulty compared to the Fuels sector (71% vs. 68%). Almost half of Generation firms (46%) mentioned lack of experience, training, or technical skills. The two most difficult occupations to hire include managers, directors, and supervisors (26%) and sales, marketing, and customer service representatives (25%). About three in ten Fuels employers noted insufficient qualifications, certifications, and education (35%), location (32%), and lack of soft skills (30%); just under a quarter report difficulty hiring sales, marketing, and customer service representatives (25%), followed by managers, directors, and supervisors (21%).

Table 3. Reported Occupations and Reasons for Hiring Difficulty (Q4 2015)

Technology	Reported Occupations with Hiring Difficulty	Reported Reasons for Hiring Difficulty
Electric Power Generation	Managers, directors, and supervisors (26%)	Lack of experience, training, or technical skills (46%)
	Sales, marketing, and customer service representatives (25%)	Insufficient qualifications, certifications, education (29%)
	Installation workers (19%)	Competition/ small applicant pool (19%)
Fuels	Sales, marketing, and customer service representatives (25%)	Insufficient qualifications, certifications, education (35%)
	Managers, directors, and supervisors (21%)	Lack of non-technical skills – work ethic, critical thinking, etc. (30%)
	Technician/ technical support (16%)	Lack of experience, training, or technical skills (20%)

[21] Bureau of Labor Statistics, Labor Force Statistics from the Current Population Survey, 2013 annual average
[22] Current Population Survey, Bureau of Labor Statistics, 2015

Figure 11. Hiring Difficulty – Electric Power Generation (Q4 2015)

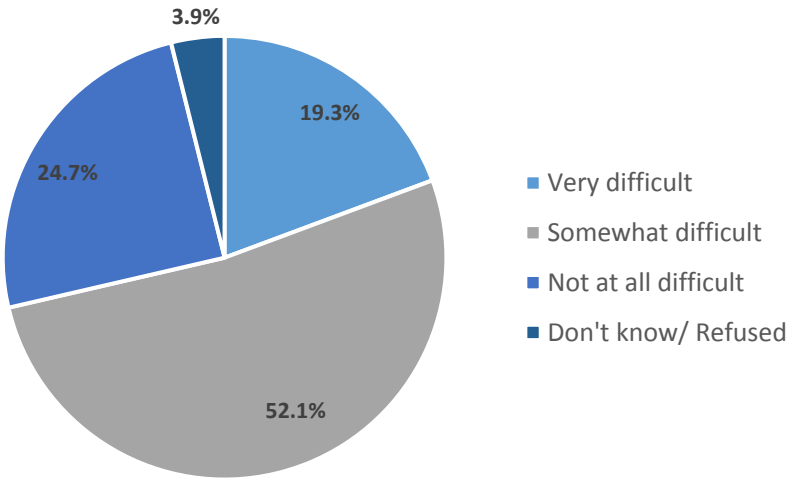
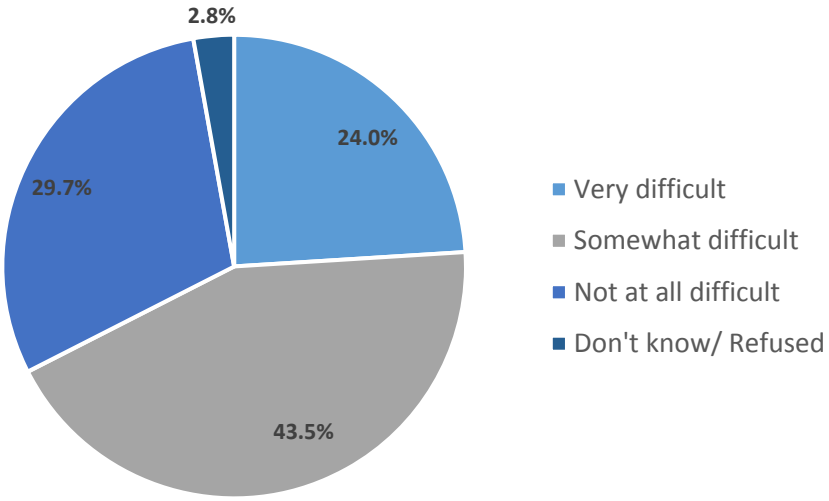
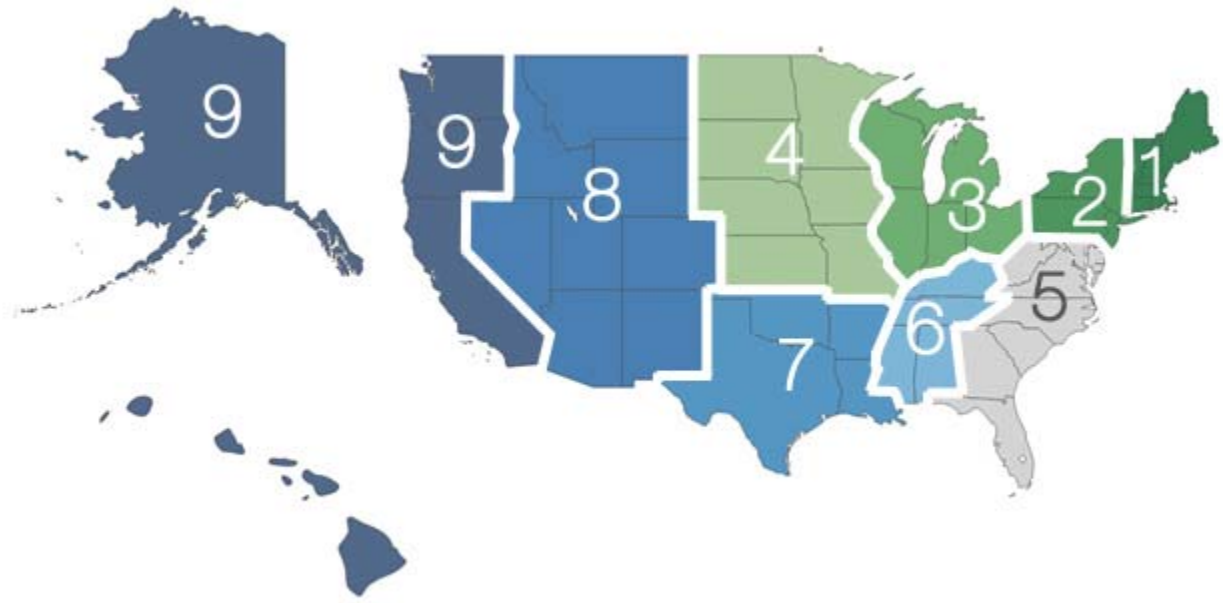


Figure 12. Hiring Difficulty – Fuels (Q4 2015)



Generation and Fuels Employment by Census Region

The following map identifies the U.S. Census Bureau Divisions for the United States – employment by census division for each of the four sectors is constructed based on these census regions.



Generation and Fuels employment is most heavily concentrated in Census Division 7; this region encompasses Arkansas, Louisiana, Oklahoma, and Texas. However, these states collectively project about 3% employment growth for 2016. States across Census Division 3 expect to see the greatest growth in employment.

Figure 13. Generation and Fuels Employment by Census Region (Q2 2015)

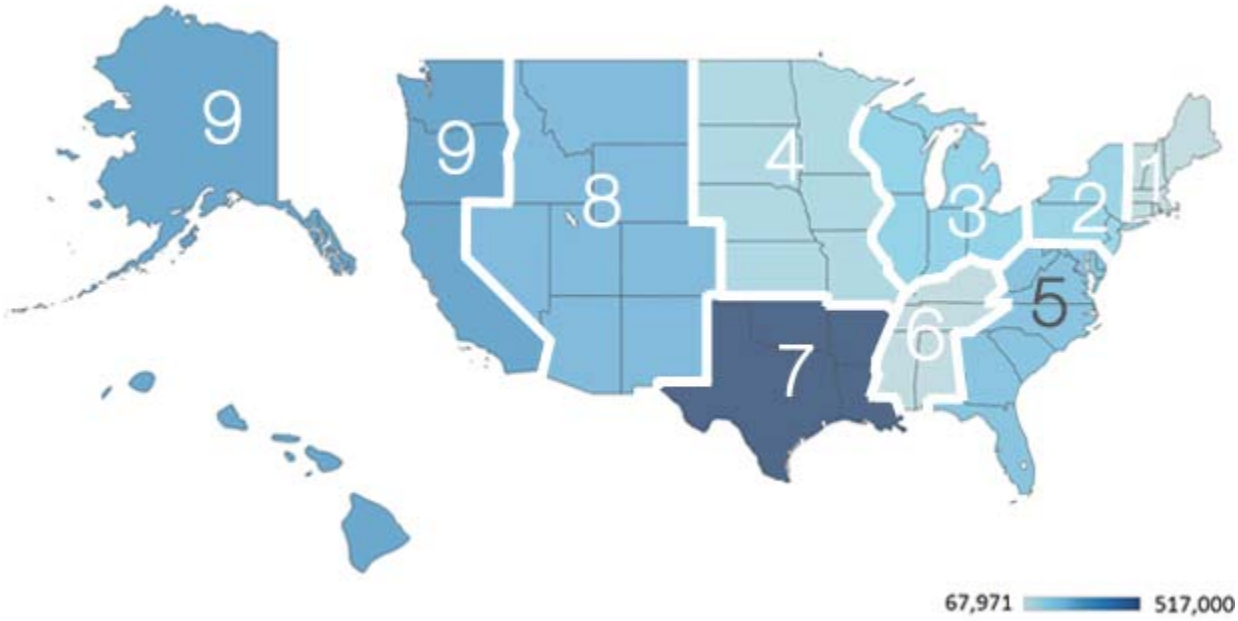
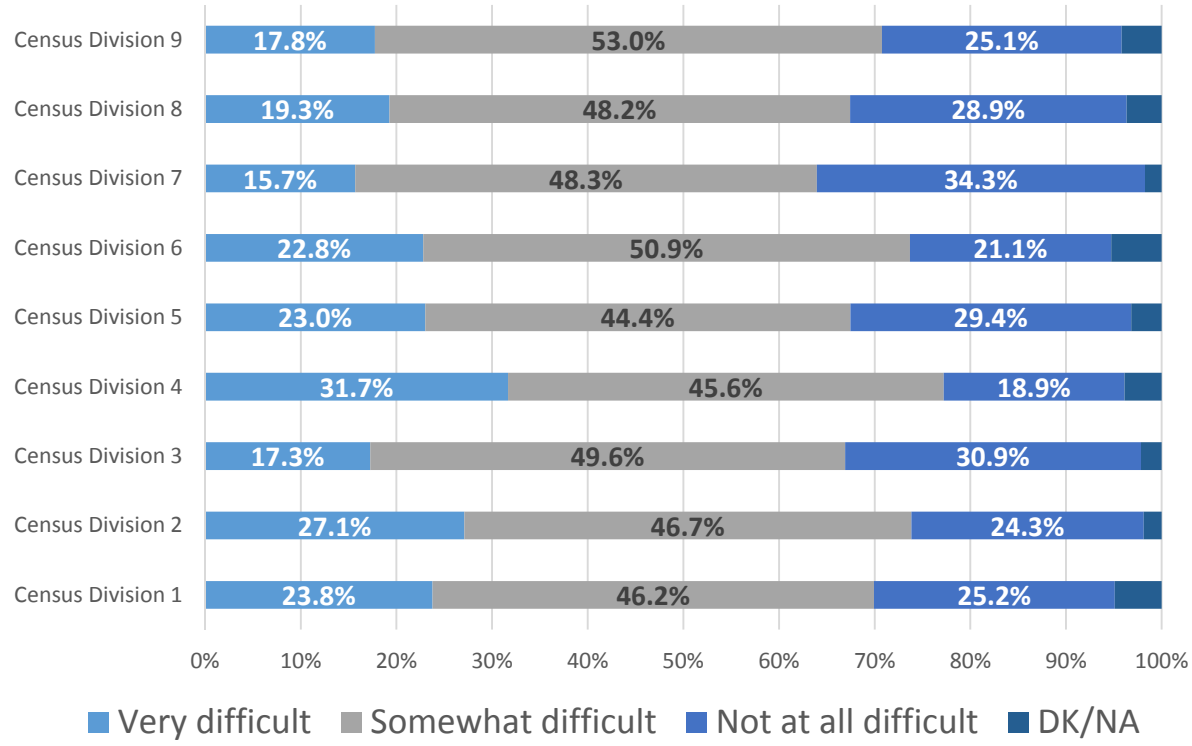


Table 4. Generation and Fuels Projected Employment Growth by Census Region (Q4 2015)

	Generation and Fuels Projected Growth
Census Region 1	8.9%
Census Region 2	6.8%
Census Region 3	10.9%
Census Region 4	7.4%
Census Region 5	9.8%
Census Region 6	-1.3%
Census Region 7	2.9%
Census Region 8	9.5%
Census Region 9	6.9%

Figure 14. Generation and Fuels Hiring Difficulty by Census Region (Q4 2015)



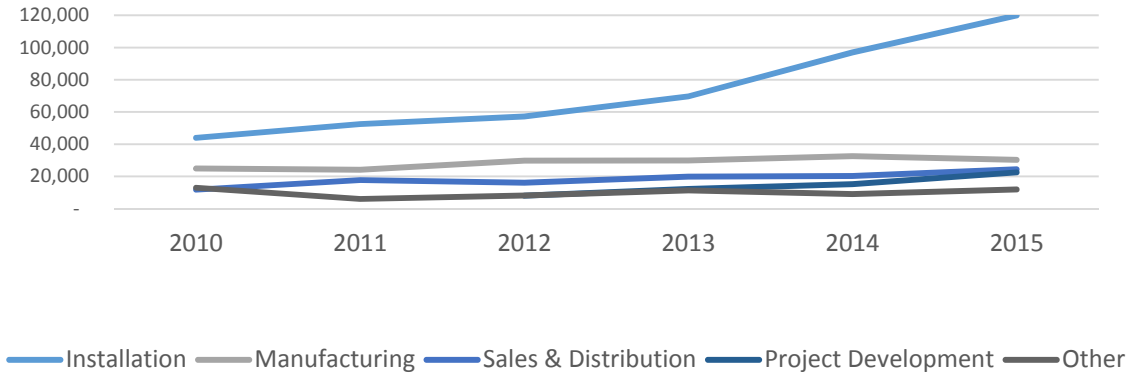
Solar Electric Generation

Solar employment presents perhaps the best example of the limitation of existing labor market data for the industry. While the QCEW has been updated to cover solar electric generation at utilities, the vast majority of installed capacity is owned by independent project developers, residential and commercial building owners, or other distributed generation. As a result, the BLS currently reports 2,023 workers at solar utilities[23], but solar electric generation technologies employ about 209,000 workers across the nation; an additional 91,000 workers also spend some amount of time working with solar technologies.[24] The United States' solar sector has grown by just over 20% between November 2014 and November 2015, and employers expect to increase total employment by another 15% over the coming 12 months.[25] In fact, 2015 was the third consecutive year in which solar employment grew by approximately 20%; since 2010, solar firms have created an additional 115,000 new jobs (123% employment growth).

Installation firms employ the majority – 57% – of the nation's solar workforce, while equipment manufacturing represents about two in ten solar jobs (15%). With the exception of manufacturing, all business activities increased employment over the course of 2015. Solar installation employers are creating jobs at a faster rate than the industry's other business segments. Since 2010, solar installation firms have increased employment by 173%, from 44,000 to 120,000 workers. Roughly one in five employers reported hiring as "very difficult" this past year; experience was cited as the most important hiring requirement across all business activities.

The proportion of women in the solar industry has increased since 2013 from about 19% to just under a quarter (24%). Veterans have declined by two percentage points, and now comprise about 8% of the solar workforce. Ethnic or racial minorities represent about a quarter (26%) of the nation's solar workforce.[26]

Figure 15. Solar Employment Growth by Business Activity, 2010-2015



[23] Bureau of Labor Statistics, Quarterly Census of Employment and Wages 2015 Q2, All Ownerships.
[24] Solar data for this section is in reference to employees that spend the majority of their time working with solar technologies. There are 208,859 workers that spend at least 50% of their time working with solar technologies; 300,192 solar employees spend at least some of their time on solar work.
[25] The U.S. solar industry has grown by 123% since 2010, resulting in over 115,000 new jobs.
[26] All solar data is from The Solar Foundation/BW Research

Wind Electric Generation

Wind generation firms employ just over 77,000 workers. The majority of employers reported difficulty hiring qualified workers over the past 12 months; about seven in ten reported hiring difficulty, while 18% note it was very difficult to find qualified applicants. The most cited reason for difficulty was lack of experience, training, or technical skills (44%), followed by insufficient qualifications, certifications, or education (33%) and competition or a small applicant pool (19%). Firms report the most difficulty in hiring for management positions (27%), as well as engineers (27%) and sales, marketing, or customer service representatives (16%).

Just about half of surveyed wind employers report primarily in-state customers, though the majority of firms are supplied by vendors within the United States but outside of a bordering state (52%). About 6% of firms report primarily international suppliers. Six in ten wind firms (63%) receive the majority of their revenue from wind-related activity, while over a third (38%) report all of their revenue is attributable to wind technologies.

Wind employment reporting faces similar challenges to the solar industry. While the utility-owned wind generation facilities and their 4,316 workers[27] are included in the QCEW under "Wind Electric Power Generation," the remainder of the value chain is buried within a disparate set of more general NAICS codes.

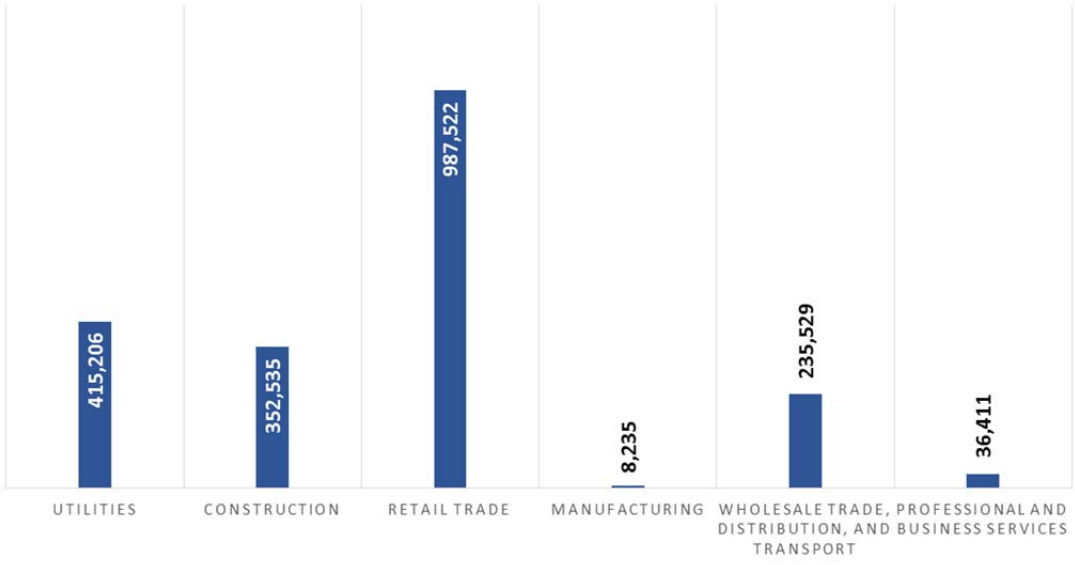
[27] Bureau of Labor Statistics, Quarterly Census of Employment and Wages 2015 Q2, All Ownerships.

Electric Power and Fuel Transmission, Distribution & Storage

Electric power and fuel Transmission, Wholesale and Retail Trade and Distribution, and Storage technologies employ more than two million workers across the nation, with approximately one-fifth of all employment contained across utility distribution firms.[28] In addition, nearly 990,000 employees work in retail trade and distribution in this sector, with about 915,000 of these working at gasoline stations.[29]

Just over 17% of the 2.04 million workers are employed by construction companies to construct pipeline and other infrastructure that supports the Transmission, Wholesale and Retail Trade and Distribution, or Storage sector, including both fuels and electricity. BLS data identifies 767,000 workers, and the EEI identifies an additional 280,000.[30]

Figure 16. Transmission, Distribution (both Wholesale and Retail Trade and Distribution), and Storage Employment by Industry Sectors[31] (Q2 2015)



[28] Fuel cell technologies are split among motor vehicles, storage, and other generation, depending on application – however, the numbers were too small to report separately within the latter two.
[29] Bureau of Labor Statistics, Quarterly Census of Employment and Wages 2015 Q2, All Ownerships.
[30] This includes transportation employment which is calculated using commodity flow data and employment data on rail, truck, air, and sea transportation.

The subsequent analysis of this chapter is focused only on Transmission, Wholesale Trade and Distribution and Storage and did not provide additional analyses of this retail subsector.

Traditional Industry Definitions

Electric power transmission and distribution, often referenced as "the grid", is the bulk transfer of electricity from power plant supply to centers of demand. Electric Power and Fuel Transmission, Wholesale Trade and Distribution, and Storage encompasses the entire network of power lines that transmit electricity from generating stations to customers as well as activities that support power and pipeline construction, fuel distribution and transport, and electrical transmission equipment manufacturing. Since electric provision is fundamentally dependent on source of supply, transmission and distribution is often thought of in conjunction with utility generation. However, the designation of business activity is variable across these sectors. While Generation and Fuels rely more heavily on mining, agriculture, and semiconductor manufacturers, electrical supply depends on fuel transport and power line construction. In addition, fuels transportation also supports non-electric heat production for commercial and residential use and motor vehicle usage.

Several NAICS codes actively track employment across utility transmission, including natural gas distribution and steam and air-conditioning supply, as well as electrical transmission line construction and fossil fuel pipeline transportation. The sector's remaining employment is found within energy-related industry subsectors in construction, manufacturing, trade, distribution, and transport. The following BLS employment figures encompass traditional transmission and wholesale distribution, captured by those industry NAICS, as well as employment across emerging smart grid and energy storage technologies.

Table 5. Transmission and Distribution, North American Industry Classification (NAICS)[32] (Q2 2015)

NAICS Codes	Sector	Transmission, Wholesale Trade and Distribution, and Storage Employment (QCEW)
22112	Electric Power Transmission, Control, and Distribution	293,786
2212	Natural Gas Distribution	119,592
221330	Steam and Air-Conditioning Supply	1,828
	Total Utilities:	**415,206**
23712	Oil and Gas Pipeline and Related Structures Construction	135,294
23713	Power and Communication Line and Related Structures Construction	169,226
	Total Construction:	**304,520**
4861	Pipeline Transportation of Crude Oil	10,730

[32] Bureau of Labor Statistics, Quarterly Census of Employment and Wages (QCEW) 2015 Q2 all ownerships

4862	Pipeline Transportation of Natural Gas	30,658
4869	Other Pipeline Transportation	8,357
	Total Wholesale Trade, Distribution, and Transport:	**49,745**
	Total Transmission and Distribution:	**767,471**

Transmission, Wholesale Trade and Distribution, and Storage – Identifying Additional Employment

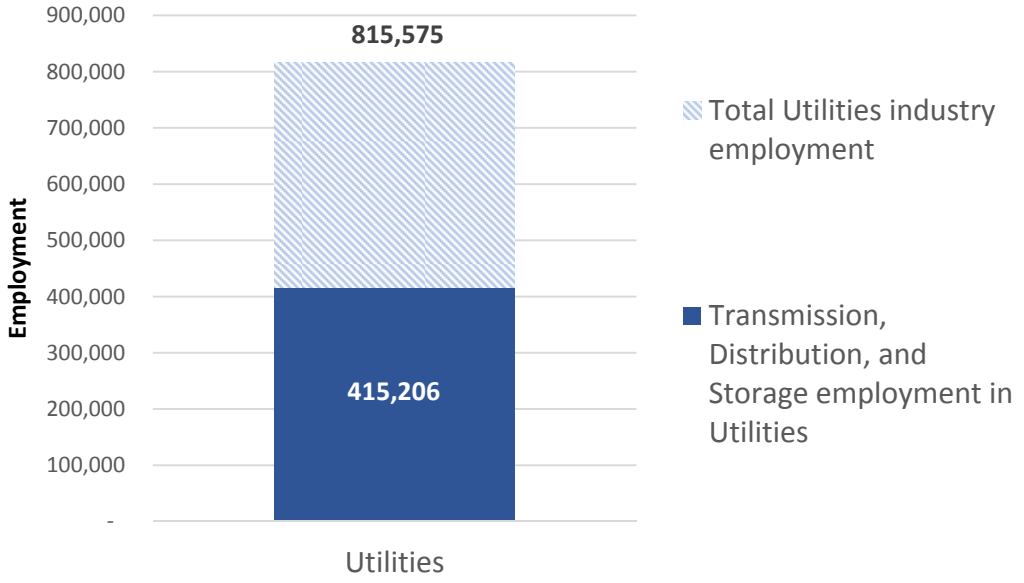
Transmission, Wholesale Trade and Distribution, and Storage, a key segment of the nation's energy infrastructure, employs 1,045,000 workers, or an additional 280,000 employees compared to traditional BLS sector classifications. An additional 990,000 work in retail industries such as fuel dealers (74,000), gasoline stations with convenience stores (800,000) and other gasoline stations (115,000).[33]

Using EEI survey data, the following sections illustrate a breakdown of sector-wide employment within five broad high-level industry classifications, including construction and manufacturing.

1. Utilities

Utility companies that employ transmission and distribution workers are captured entirely by their respective sub-sector NAICS classifications by BLS. Electric power transmission, control, and distribution, natural gas distribution, and steam and air-conditioning supply together employ just over 415,000 transmission and distribution workers across the nation's utility generation firms.

Figure 17. Utilities Employment (Q2 2015)

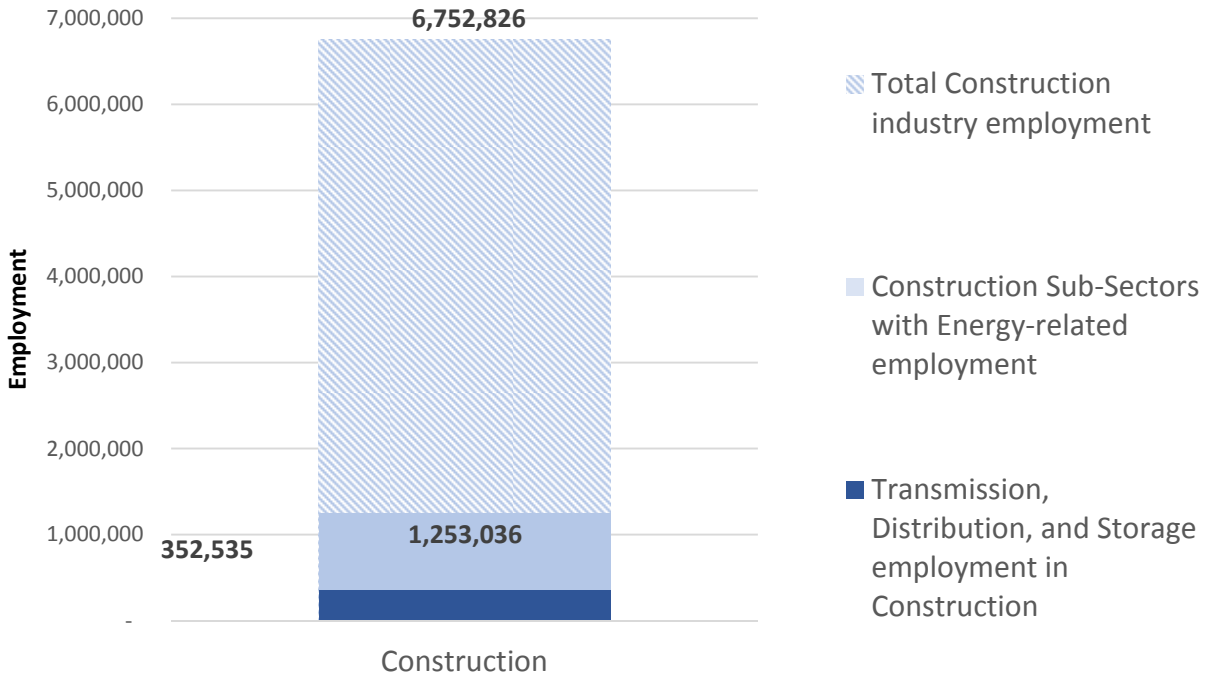


[33] Bureau of Labor Statistics, Quarterly Census of Employment and Wages 2015 Q2, All Ownerships.

2. Construction

In addition to the roughly 305,000 construction employees identified by BLS in Table 5 above, Transmission, Wholesale Trade and Distribution, and Storage employment also exists within several other construction industry sub-sectors including electrical and wiring contractors and other heavy construction. According to EEI data, these additional industries provide about 48,000 additional construction jobs related to energy transmission and distribution, bringing total construction employment to nearly 353,000 workers.

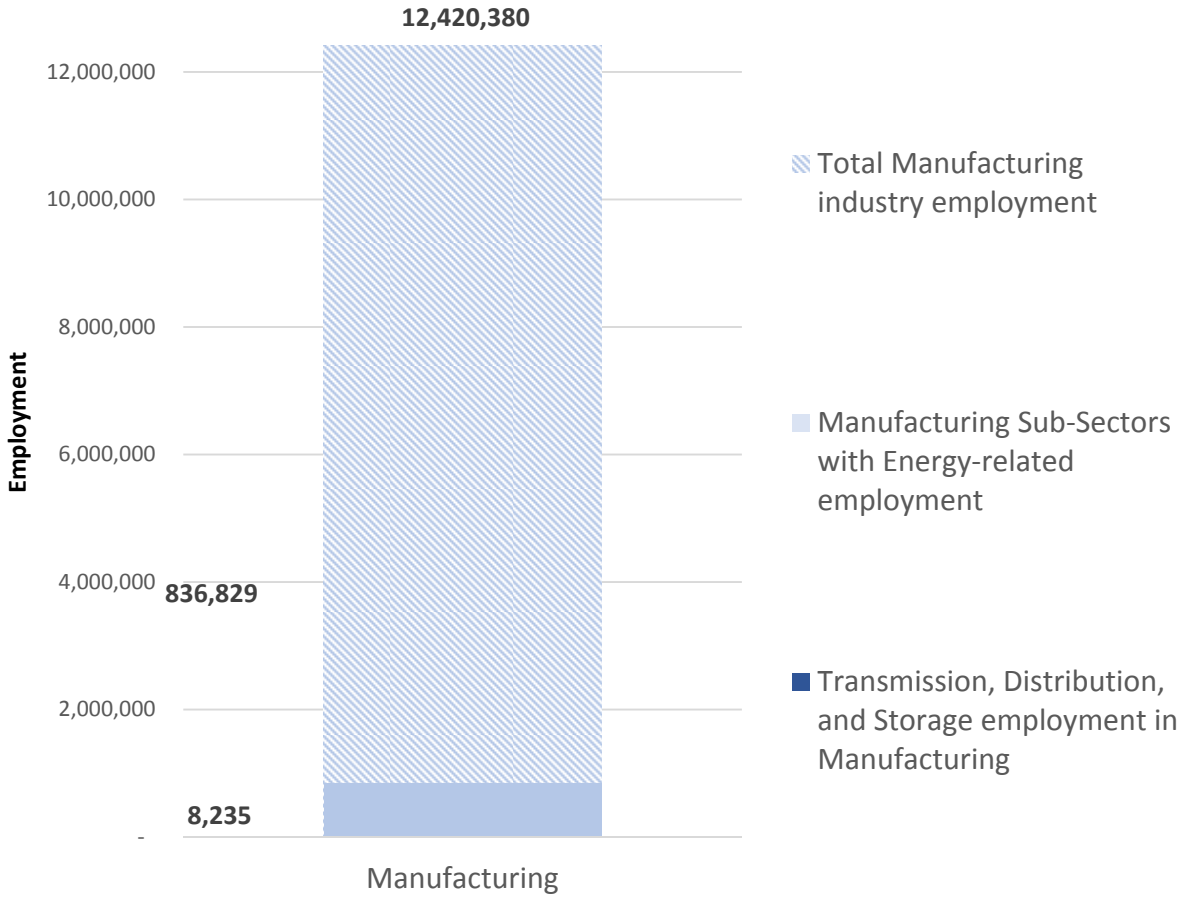
Figure 18. Construction Employment (Q2 2015)



3. Manufacturing

The manufacture of Transmission, Wholesale Trade and Distribution, and Storage technologies is not entirely captured by a single NAICS classification in BLS data. Instead, these jobs are found within several energy-related manufacturing subsectors. These include bulk manufacturing firms that assembly storage batteries, current-carrying wiring devices, air and gas compressors, sheet metal, and other electrical and non-electrical equipment or components. Of the nation's total 12.4 million manufacturing jobs, almost 7% are contained within such energy-related subsectors that may support transmission-related infrastructure. Of these, about 8,200 employees manufacture Transmission, Wholesale Trade and Distribution, and Storage products.

Figure 19. Manufacturing Employment (Q2 2015)

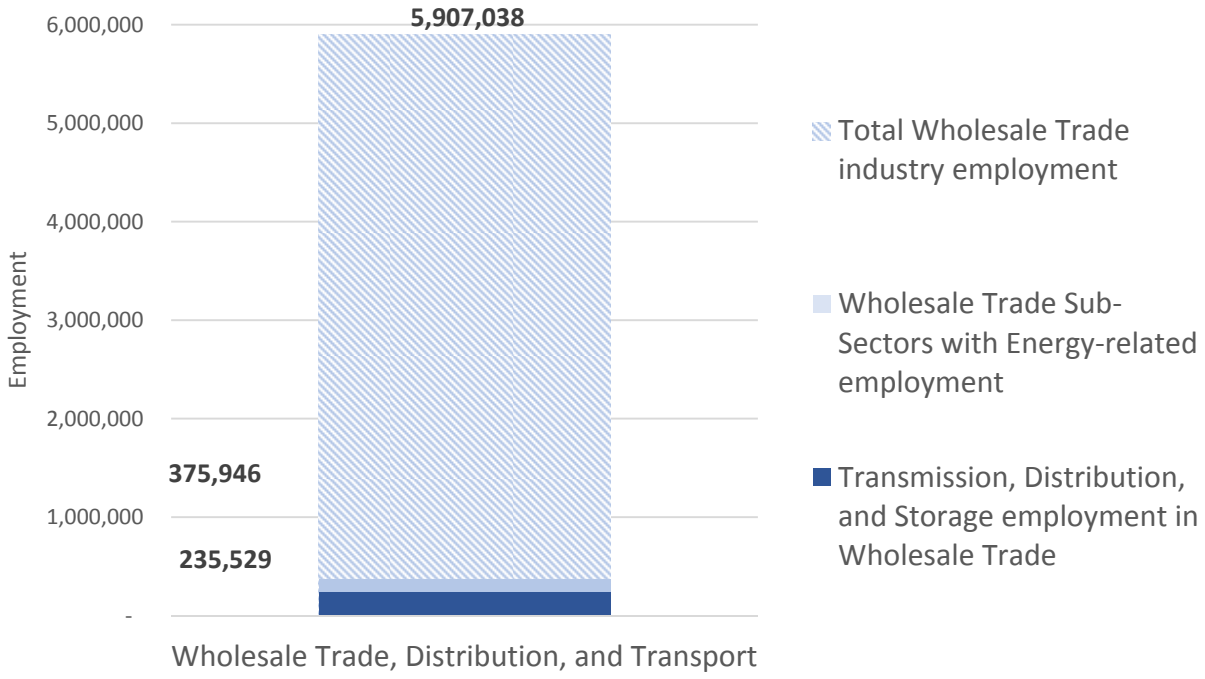


4. Wholesale Trade, Distribution, and Transport

Several industry codes used by BLS capture employment entirely dedicated to the transport of crude oil, natural gas, and other refined petroleum products. Approximately 164,000 jobs were included by identifying proportional employment from energy related commodity data for truck, rail, air, and water transport using the Quadrennial Energy Review's (QER) methodology.[34] An additional 22,000 jobs identified by the EEI survey are contained within detailed industry subsectors such as electrical equipment, wiring, appliance, and electronics merchant wholesalers. Together, fossil fuel transport and electrical equipment wholesalers employ almost 236,000 transmission and distribution workers.[35]

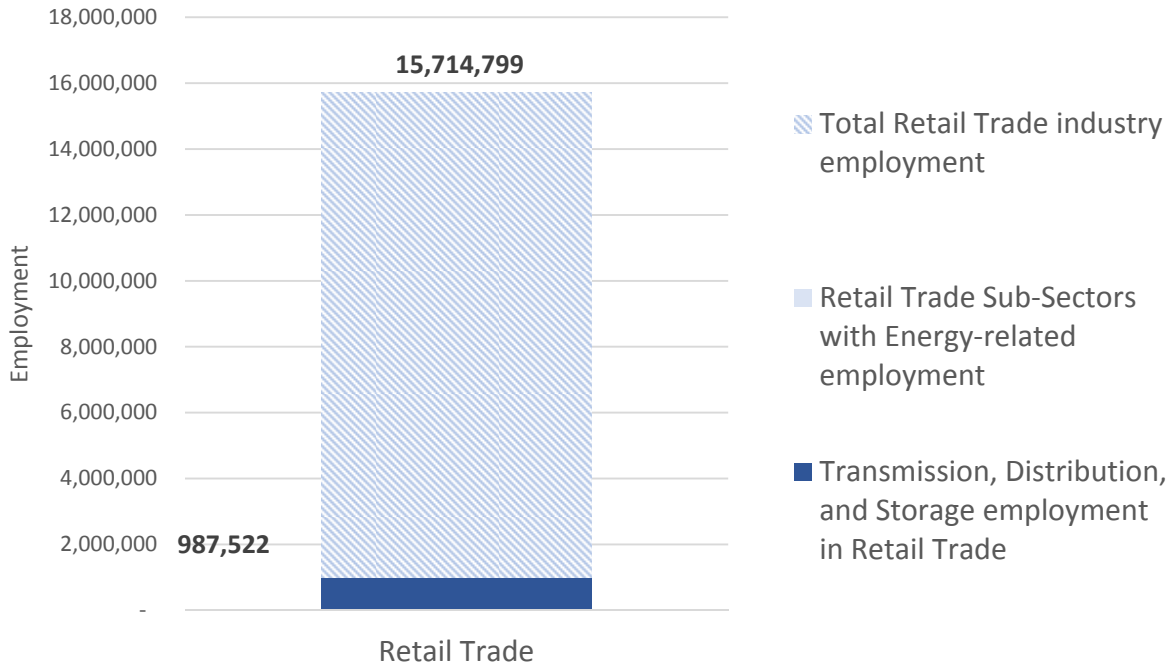
[34] See the Survey and Analysis Methods section for methodology.
[35] This employment figure excludes raw material and component manufacturers; the limitations of a survey-based approach prevents accurate data collection for suppliers that are significantly upstream.

Figure 20. Wholesale Trade, Distribution, and Transport Employment (Q2 2015)



Though the Energy Employment Index does not cover retail trade, BLS employment data captures several industries, such as gas stations and fuel dealers, which employ just over 987,000 workers.

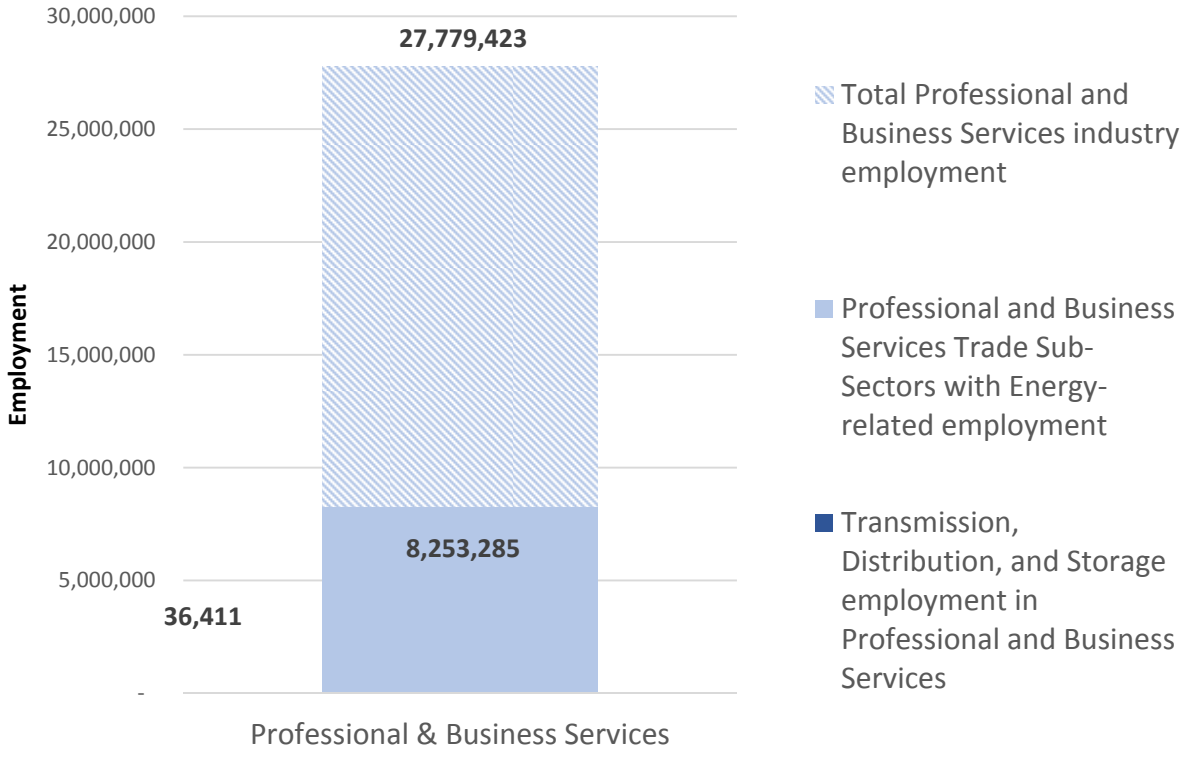
Figure 21. Retail Trade Employment (Q2 2015)



5. Professional and Business Services

A very small portion (0.4%) of energy-related professional and business services support Transmission, Wholesale Trade and Distribution, and Storage infrastructure and technology. Of the 8.3 million workers in these detailed industry codes, EEI survey data identifies about 36,400 workers who spend some of their time supporting these technologies. Seven in ten professional and business service employees spend the majority of their time on work related to Transmission, Wholesale Trade and Distribution, and Storage; about 60% spend all of their time supporting these technologies.

Figure 22. Professional and Business Services Employment (Q2 2015)



Transmission, Wholesale Trade and Distribution, and Storage by Sub-Technology[36]

Four in five Transmission, Wholesale Trade and Distribution, and Storage employees (80%) work to manufacture, construct, repair, and operate traditional electrical and gas transmission and distribution. This includes not only fossil fuel transportation, but also pipe- and powerline construction as well as natural gas distribution, steam and air-conditioning supply.[37] About 164,000 work transporting fuel via

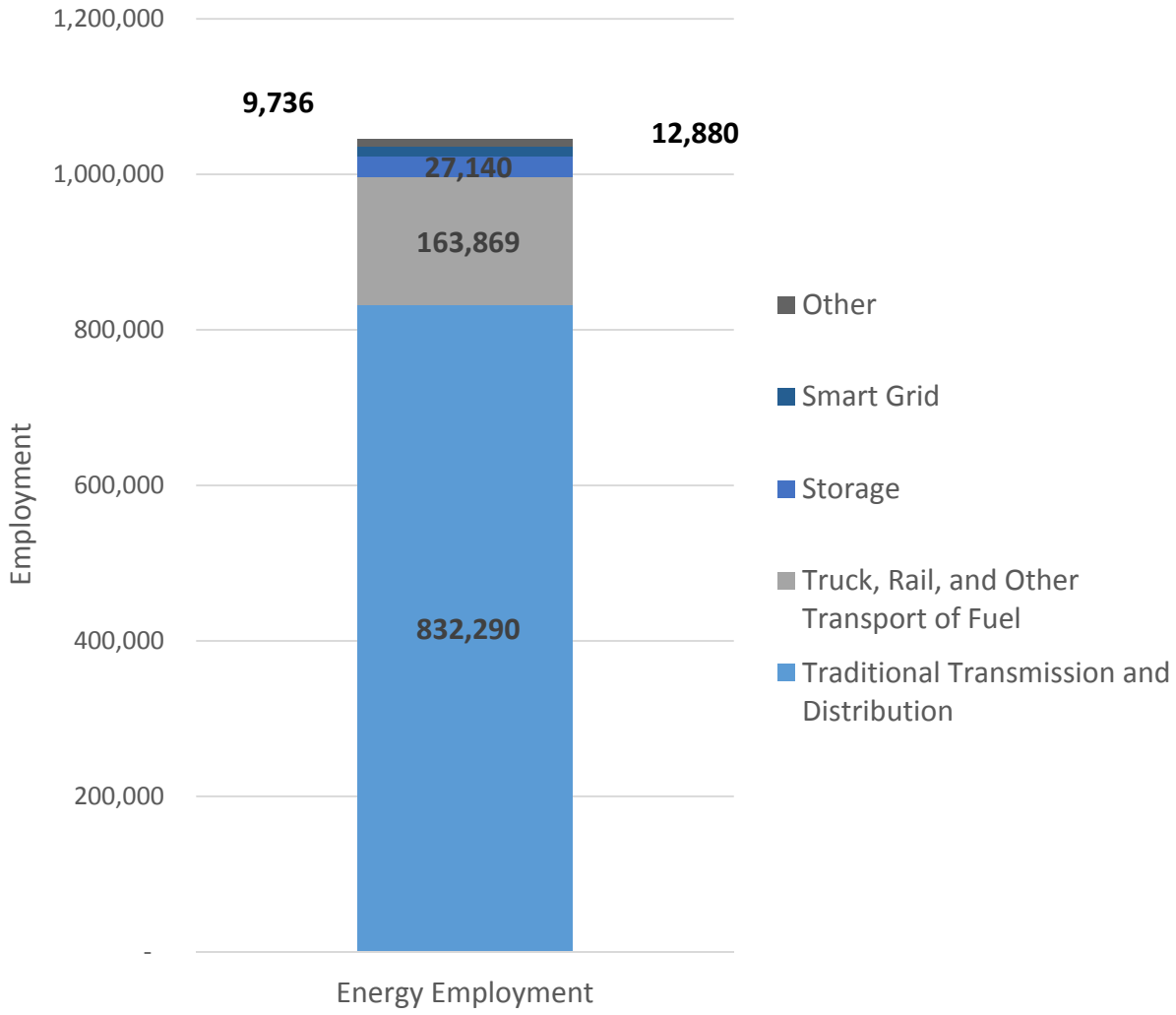
[36] Because the index excludes retail trade in all segments, the following data do not include responses from fuel dealers or gasoline stations.

[37] Fossil fuel commodity flows via air, rail, water, and truck transportation are included using the Quadrennial Energy Review methodology – these employment figures are relative to the percentage of fuels being transported. These include jobs supported by oil and coal train and truck transportation, for instance.

rail, air, truck, or other means, and an additional 27,000 workers are employed with storage technologies (including hydro-storage)[38], while 12,900 work with smart grid technologies. Though the EEI excludes retail employment in this sector report, BLS QCEW data reports that fuel dealers and gasoline stations employ about 987,500 additional individuals across the nation.[39]

Electric Power and Fuels Transmission, Wholesale Trade and Distribution and Storage employers are expecting 5% growth over the next 12 months, for an additional 52,000 jobs.

Figure 23. Employment by Transmission, Wholesale Trade and Distribution, and Storage Sub Technologies (Q2 2015)



[38] Hydro-storage is included in this section when it is separate from hydropower generation, which is included in the generation and fuels chapter.
[39] Bureau of Labor Statistics, Quarterly Census of Employment and Wages, 2015 Q2

Transmission, Wholesale Trade and Distribution, and Storage – Workforce Characteristics

Roughly two in ten Transmission, Wholesale Trade and Distribution, and Storage employees across the nation are women. Though not as low as the Motor Vehicle industry (18%), this is less than the Generation (25%), Energy Efficiency (25%), and Fuels (26%) sectors.

Table 6. Demographics (Q4 2015)

	Women	Ethnic or Racial Minorities	Veterans	55 and older
National Average[40]	**46.8%**	**34.0%**	**6.9%**	**22.5%**
Transmission, Wholesale Trade and Distribution, and Storage	21.4%	26.5%	9.5%	17.7%

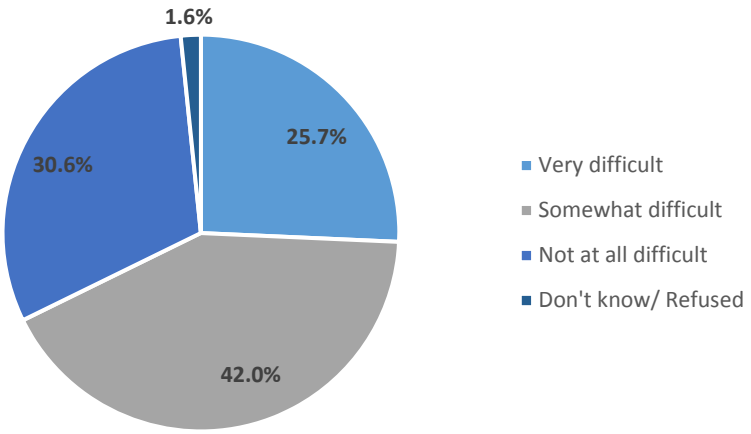
Almost seven in ten firms reported hiring difficulty (68%), citing insufficient qualifications, certifications, or education (38%) and lack of experience, training, and technical skills (36%) as the most reported reasons for difficulty. About a quarter of firms note difficulty hiring engineers (25%) and sales, marketing, or customer service representatives (25%). Just over two in ten firms also had difficulty finding managers, directors, or supervisors (23%).

Table 7. Reported Occupations and Reasons for Hiring Difficulty

Reported Occupations with Hiring Difficulty	Reported Reasons for Hiring Difficulty
Engineers (25%)	Insufficient qualifications, certifications, or education (38%)
Sales, marketing, or customer service representatives (25%)	Lack of experience, training, or technical skills (36%)
Managers, directors, or supervisors (23%)	Location (17%)

[40] Current Population Survey, Bureau of Labor Statistics, 2015

Figure 24. Hiring Difficulty (Q4 2015)



Transmission, Wholesale Trade and Distribution, and Storage Employment by Census Region

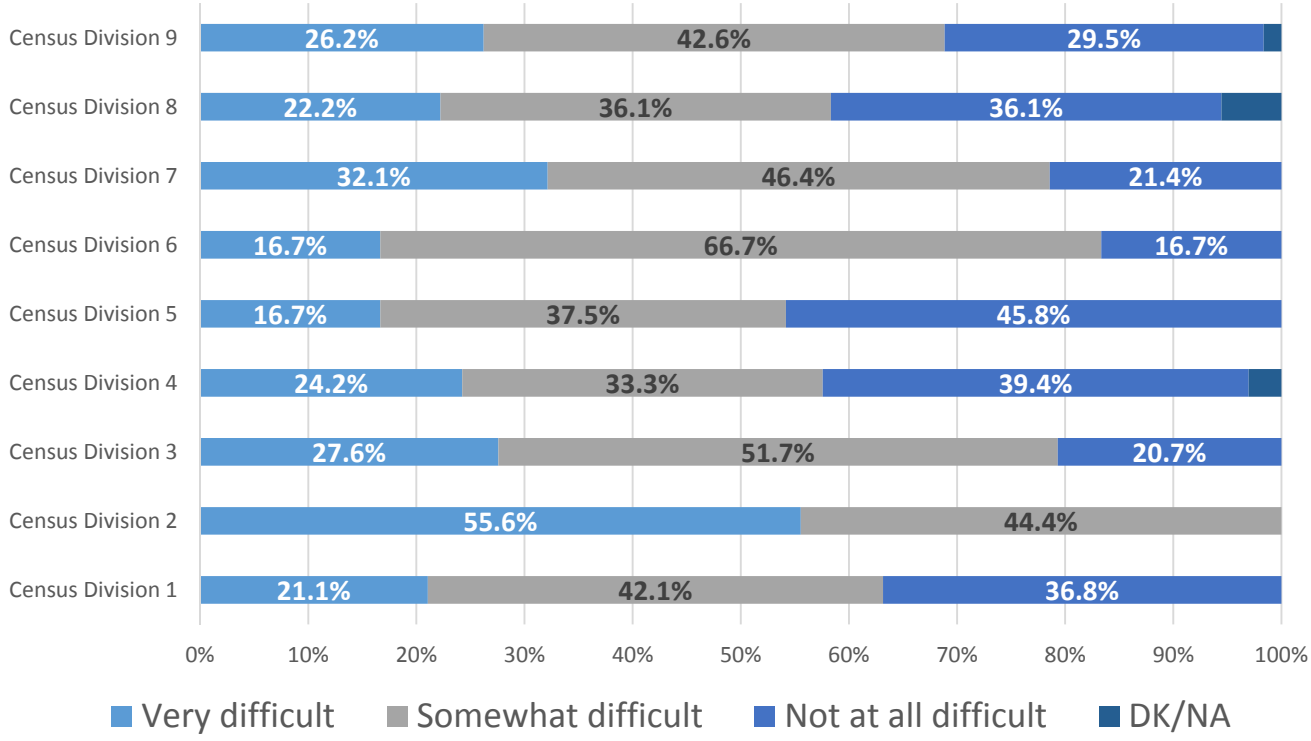
Similar to Generation and Fuels, Transmission, Wholesale Trade and Distribution, and Storage employment is most heavily concentrated in Census Division 7 for Arkansas, Louisiana, Oklahoma, and Texas. At about 2%, these states project low employment growth for this energy sector; the Mountain states across Division 8 expect to increase jobs by almost 19% over the next 12 months.

Figure 25. Transmission, Wholesale Trade and Distribution, and Storage Employment by Census Region (Q2 2015)

Table 8. Transmission, Wholesale Trade and Distribution, and Storage Projected Employment Growth by Census Region (Q4 2015)

	Transmission, Wholesale Trade and Distribution, and Storage Projected Growth
Census Region 1	0.4%
Census Region 2	7.8%
Census Region 3	8.5%
Census Region 4	3.8%
Census Region 5	9.2%
Census Region 6	-6.2%
Census Region 7	1.7%
Census Region 8	18.6%
Census Region 9	6.9%

Figure 26. Transmission, Wholesale Trade and Distribution, and Storage Hiring Difficulty by Census Region (Q4 2015)

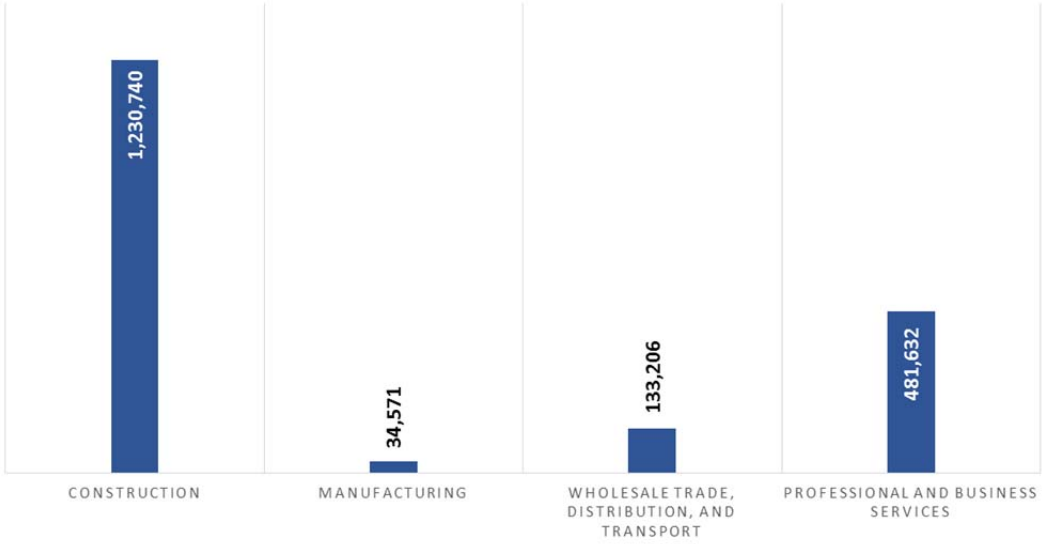


Energy Efficiency

With almost 1.9 million jobs, Energy Efficiency firms are a significant and growing segment of the national energy economy. The majority, almost seven in ten, of Energy Efficiency employees work at construction firms installing building control equipment. Just over a quarter of the Energy Efficiency sector is supported by individuals who work in professional and business services. The manufacture of Energy Efficiency certified products represents a small portion of employment, with just under 2% of the total Energy Efficiency workforce.

The Energy Employment Index does not cover retail trade, but BLS data finds that retail trade industries that sell and distribute Energy Star appliances and building materials employ almost 2.9 million Americans across several different sectors.[41]

Figure 27. Energy Efficiency Employment by Industry Sectors (Q2 2015)



[41] These industries include Household Appliance Stores (443141), Electronics Stores (443142), Building Material and Supplies Dealers (4441), and Department Stores (45211). These are retail establishments that are not defined by their sale of Energy Star appliances or EE products. Some are defined by their sale of appliances in general (i.e., those under NAICS 4431) but even these are not the sole retailers of EE products – they could be general retailers as well such as big box stores that sell wide varieties of items.

Energy Efficiency – Identifying Employment

There are no single NAICS codes that can be entirely allocated as Energy Efficiency employment. Thus, BLS has no specific data sets that exclusively count jobs in this sector. The Energy Employment Index has identified approximately 1.9 million workers across the construction, manufacturing, trade, and professional service sectors that spend some of their time working with energy efficient technologies and services as defined earlier in this report.

Energy Efficiency employment covers both the production of energy-saving products and provision of services that reduce end-use energy consumption. These services include not only the manufacture of Energy Star appliances, but also building design and contracting services that provide insulation and improve natural lighting that reduces overall energy consumption across homes and businesses. However, the Energy Employment Index only captures employment with certified[42] energy efficiency products or those installed according to Energy Star guidelines. Employment figures only encompass these output efficiency measures and do not delineate between employment related to energy efficient manufacturing processes and those workers associated with the design, installation and operation of combined heat and power and waste heat to power. Future U.S. Energy and Employment Reports will address some of these gaps. In the meantime, please see the recently released Energy Productivity and Economic Prosperity Index.[43]

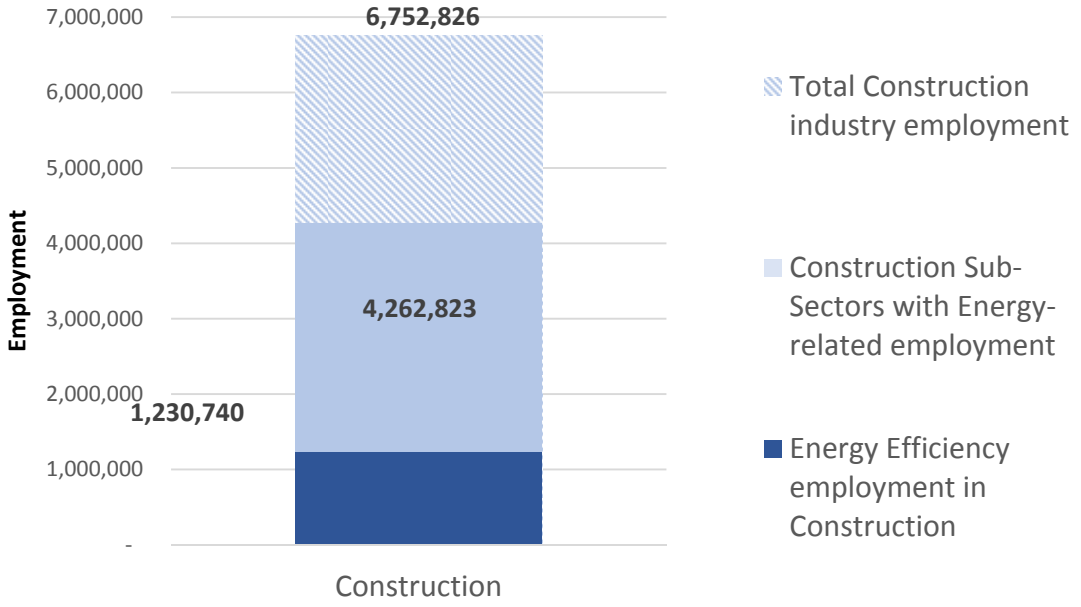
Demand growth for efficient technology and building upgrades has driven expansion across many traditional industries including construction trades, appliance manufacturing, building materials, lighting, and other energy-saving goods and services. As such, Energy Efficiency workers are found across many subsets of traditional industries. Energy Efficiency firms project the highest growth rate of the four analyzed sectors over the coming 12 months, expecting to add another 257,000 jobs to the sector for a projected growth of 14%.[44]

1. Construction

The majority of Energy Efficiency employment (65%) identified with EEI data is found across construction firms. Of the 6.8 million construction workers in the United States, roofing, drywall, insulation, and building equipment contractors comprise detailed energy-related subsectors that employ just over 1.2 million Energy Efficiency workers.

[42] Environmental Protection Agency's Energy Star Program certification
[43] Blok, Kornelis, et al. *The 2015 Energy Productivity and Economic Prosperity Index*.
[44] Note that unlike some other sectors, employment in energy efficiency can increase without net job creation. This is because firms can begin producing, installing, or repairing Energy Star appliances at any time without additional hiring of workers.

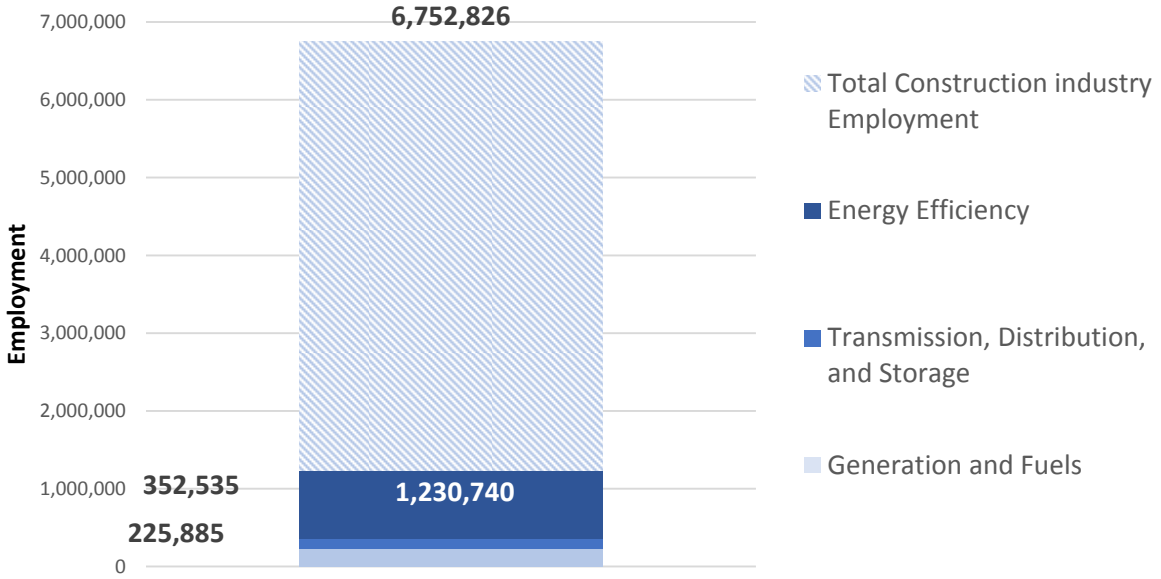
Figure 28. Construction Employment (Q2 2015)



Construction and Installation

Of the 6.8 million construction jobs in the nation, roughly three in ten workers (27%) support the energy industry through Generation and Fuels, Transmission, Wholesale Trade and Distribution, and Storage, and Energy Efficiency technology construction. Of these 1.8 million workers, over two-thirds (68%) are employed by Energy Efficiency firms.

Figure 29. Construction Employment by Energy Technology (Q2 2015)



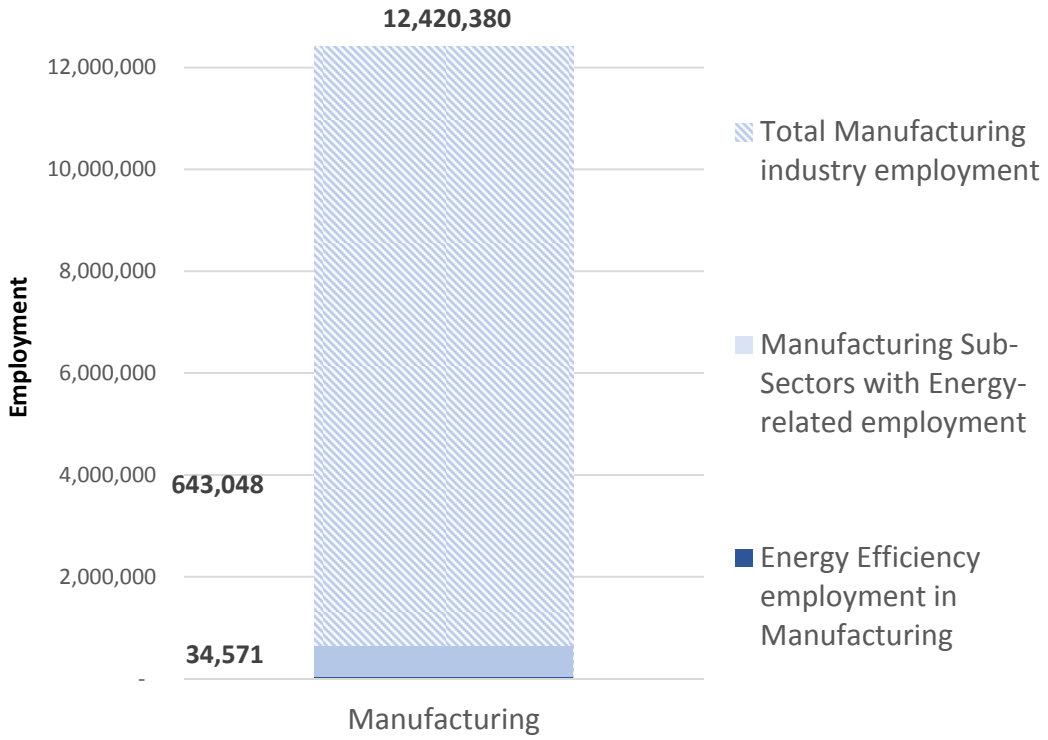
Over three-quarters of construction and installation firms (77%) report hiring difficulty over the past 12 months; three in ten (32%) note it was very difficult to find qualified applicants. Almost half of all firms surveyed note that lack of experience, training, or technical skills (43%) was a significant reason for hiring difficulty, as well as insufficient qualifications, certifications, or education (33%). Constructions firms encountered difficulties trying to find installation workers (30%), technicians or technical support (26%), and electricians or general construction workers (25%).

2. Manufacturing

Manufacturing activity is a much smaller portion of the nation's energy efficiency sector; this is partially definition and scope-related. The jobs included in this chapter refer only to the manufacture of Energy Star rated products or other energy efficient building and lighting services. They do not include process efficiency (e.g., manufacturers that produce goods using energy efficient equipment, machinery, or processes). Additionally, as with the other chapters, raw material production and refining for manufactured goods are excluded from this category (e.g., mining, steel or aluminum rolling mills, etc.). Finally, the manufacturing figures listed in this chapter exclude workers who are counted in other chapters, such as those that produce renewable electric generation products or motor vehicles.

Of the 643,000 jobs found in energy-related manufacturing subsectors such as lighting, household appliances, or HVAC equipment, about 35,000 workers manufacture energy efficient products.

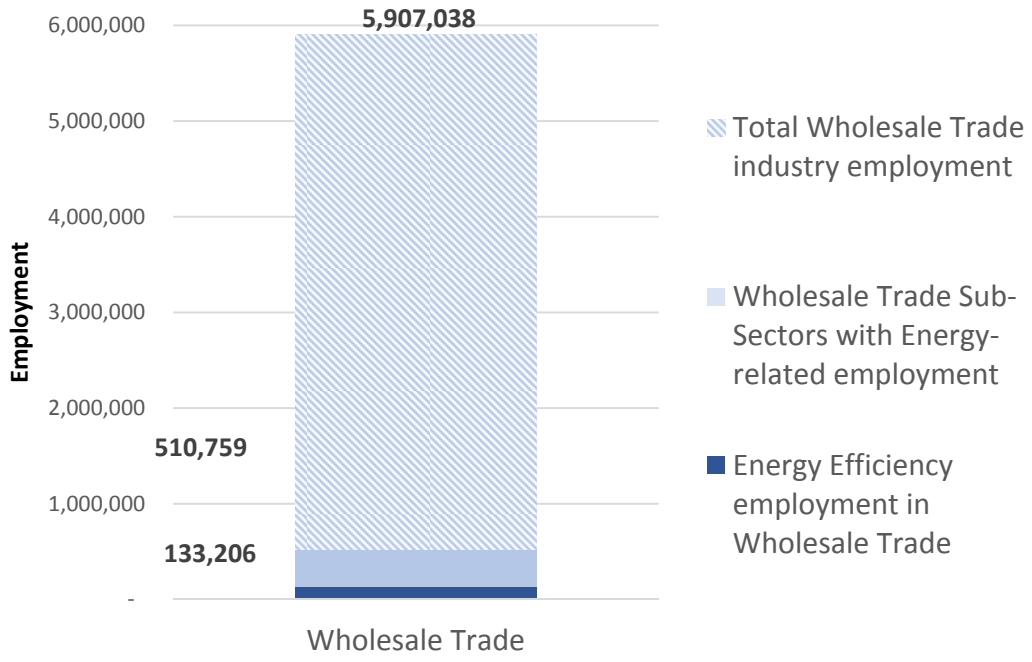
Figure 30. Manufacturing Employment (Q2 2015)



3. Wholesale Trade, Distribution, and Transport

A small subset of the almost 6 million BLS QCEW trade, distribution, and transport jobs across the nation support energy-related subsectors that may contribute to efficiency products and services. Such industry subsectors include roofing, siding, and insulation material, household appliance, plumbing and heating, or HVAC equipment wholesalers. Of these 511,000 jobs, EEI survey data identifies about a quarter (26%) to be Energy Efficiency workers.

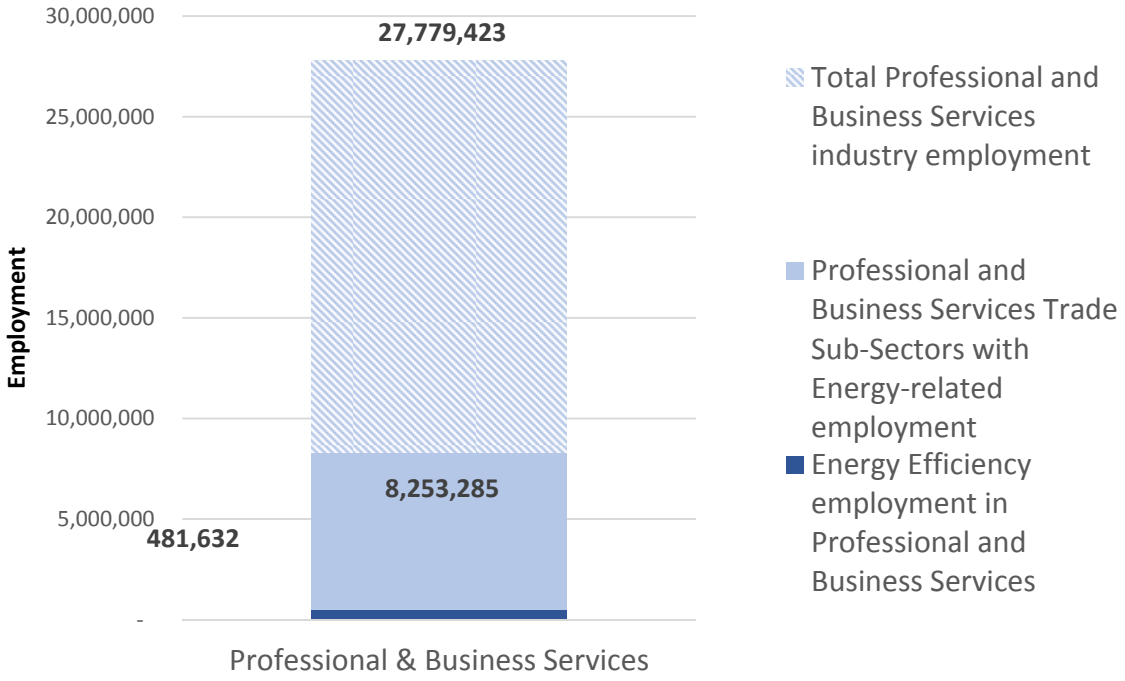
Figure 31. Wholesale Trade, Distribution, and Transport Employment (Q2 2015)



4. Professional and Business Services

Almost three in ten professional and business service jobs may support the Energy Efficiency industry through finance, management, and legal services. Of these detailed subsectors, EEI survey data identifies 6% of employees, or 482,000, work to support energy efficient products and services.

Figure 32. Professional and Business Services Employment (Q2 2015)



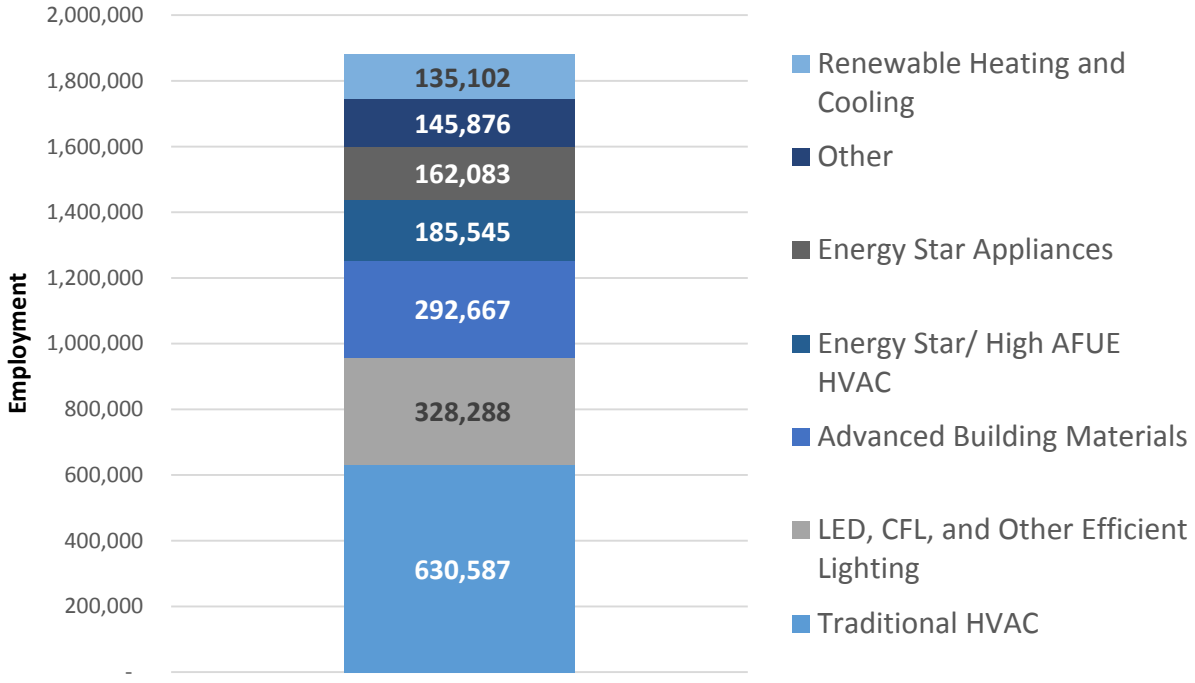
Energy Efficiency by Sub Technology

Just over a third (34%) of the Energy Efficiency sector is employed by the traditional heating, ventilation, or air-conditioning (HVAC) industry. These employees spend a majority of their time working with traditional HVAC goods and services, but a portion of their time is also dedicated to Energy Efficient technologies. This is an important distinction, particularly with installers, because the majority of these employees would also have specific training in high efficiency HVAC systems.[45] The second largest category of employment is found in energy efficient lighting, followed by advanced building materials, and Energy Star high Annual Fuel Utilization Efficiency (AFUE) HVAC technologies. Almost half (47%) of energy efficiency workers[46] spend the majority of their time on Energy Efficient goods and services; one-third spend all of their time providing Energy Efficiency services.

[45] Unlike with the installation and repair of Energy Star appliances such as ranges, dishwashers, or appliances, or other energy efficient products largely dealing with electricity (lighting, etc.), high efficiency HVAC systems often have very specific certifications or training requirements in order to properly install and maintain. Manufacturers often require such certifications for warranty purposes, and EPA has a specific credentialing program for Energy Star heating and cooling (see: http://www.energystar.gov/index.cfm?c=bldrs_lenders_raters.nh_hvac_contractors_become).

[46] Analysis excludes traditional HVAC employment.

Figure 33. Energy Efficiency Employment by Sub Technologies (Q2 2015)



Energy Efficiency – Workforce Characteristics

The Energy Efficiency workforce is less diverse than the national workforce; roughly a quarter of firms reported employing women (25%) or ethnic and racial minorities (24%).

Table 9. Demographics (Q4 2015)

	Women	Ethnic or Racial Minorities	Veterans	55 and older
National Average[47]	**46.8%**	**34.0%**	**6.9%**	**22.5%**
Energy Efficiency	24.9%	23.6%	8.9%	17.6%

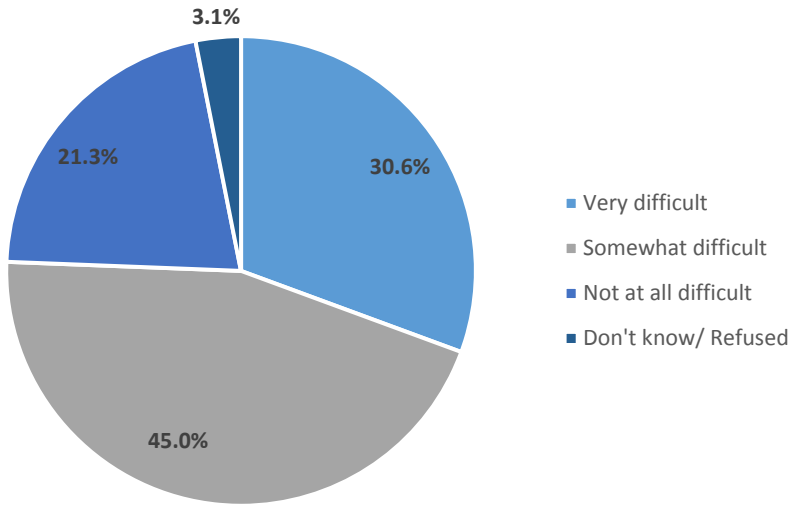
Just over three-quarters of energy efficiency employers (76%) reported hiring difficulty over the past 12 months. About two in ten employers report difficulty finding qualified technicians or technical support (23%), managers, directors, or supervisors (22%), installation workers (21%). Most reported reasons for hiring difficulty include lack of experience, training, or technical skills (35%) and insufficient qualifications, certifications, or education (31%).

[47] Current Population Survey, Bureau of Labor Statistics, 2015

Table 10. Reported Occupations and Reasons for Hiring Difficulty (Q4 2015)

Reported Occupations with Hiring Difficulty	Reported Reasons for Hiring Difficulty
Technicians or technical support (23%)	Lack of experience, training, or technical skills (35%)
Managers, directors, or supervisors (22%)	Insufficient qualifications, certifications, or education (31%)
Installation workers (21%)	Lack of non-technical skills – work ethic, critical thinking, etc. (23%)

Figure 34. Hiring Difficulty (Q4 2015)



Energy Efficiency Employment by Census Region

The Pacific states across Division 9 as well as the South Atlantic states in Division 5 employ the most Energy Efficiency workers in the United States. These states are also expecting high employment growth for 2016, 16% for Division 5 states and 11% for states across Division 9.

Figure 35. Energy Efficiency Employment by Census Region (Q2 2015)

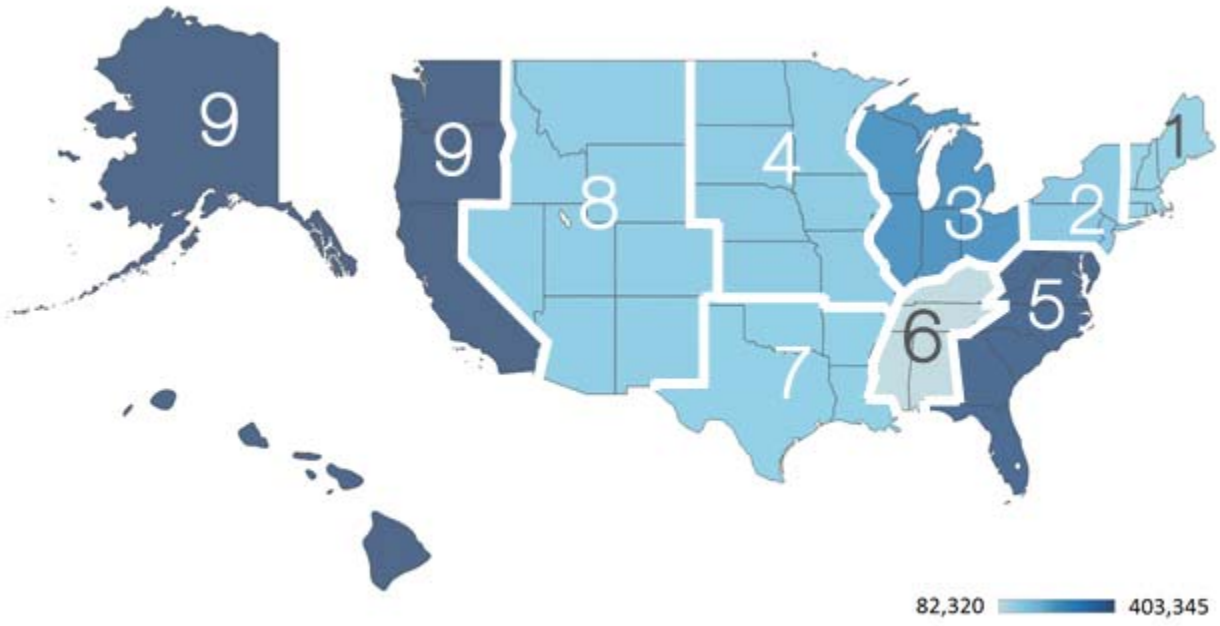
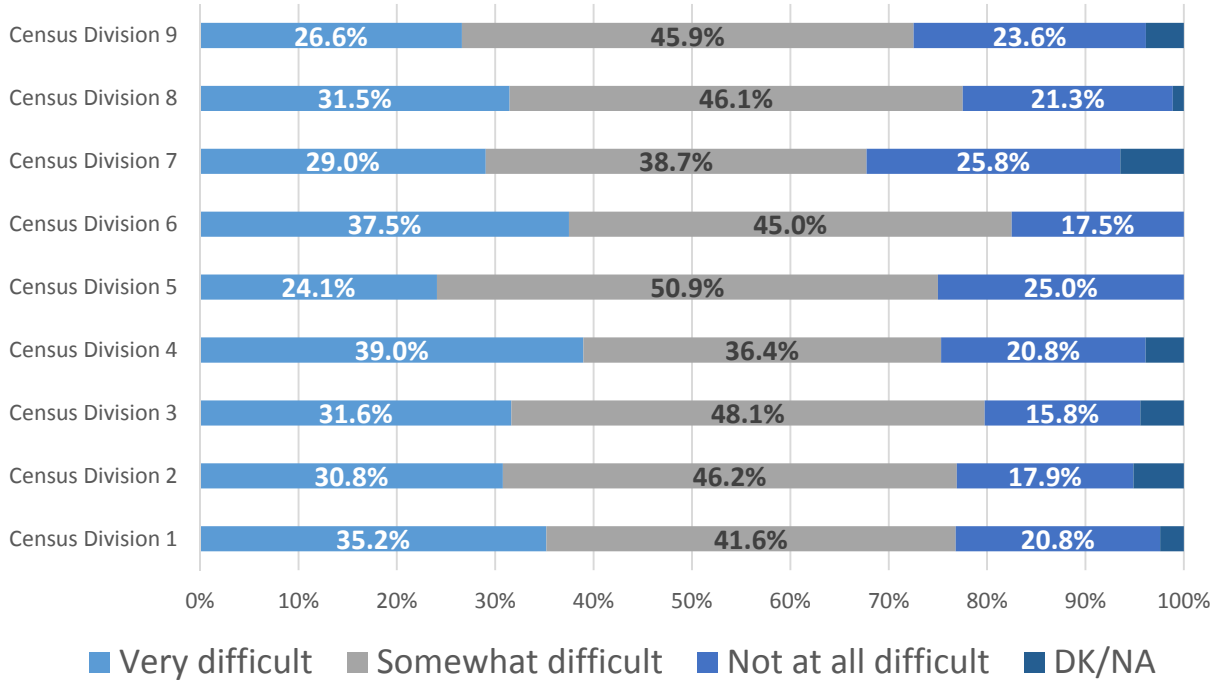


Table 11. Energy Efficiency Projected Employment Growth by Census Region (Q4 2015)

	Energy Efficiency Projected Growth
Census Region 1	11.3%
Census Region 2	5.0%
Census Region 3	15.2%
Census Region 4	9.9%
Census Region 5	16.4%
Census Region 6	8.4%
Census Region 7	18.9%
Census Region 8	12.0%
Census Region 9	10.9%

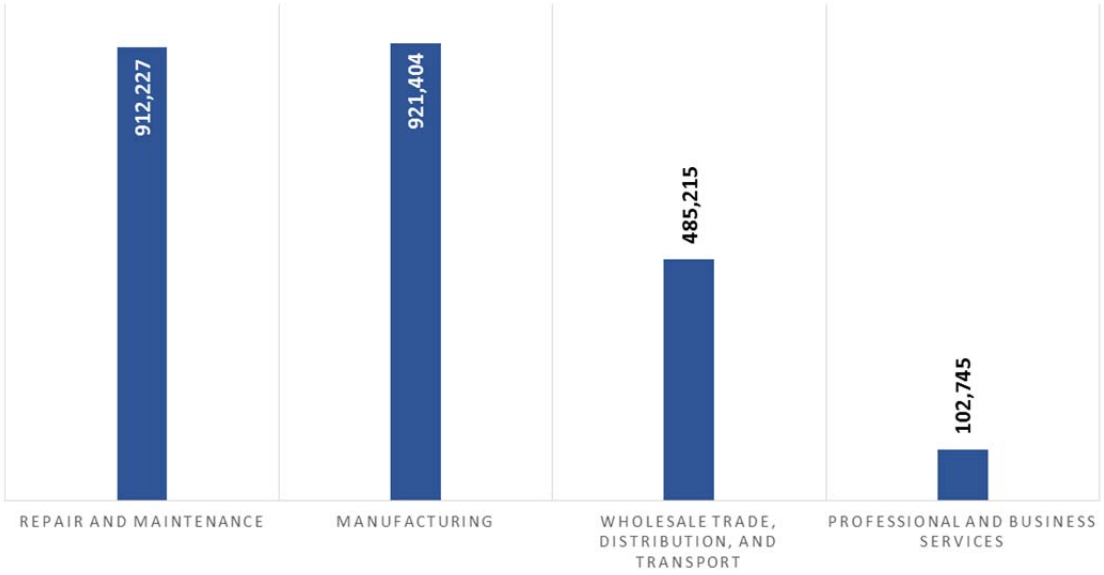
Figure 36. Energy Efficiency Hiring Difficulty by Census Region (Q4 2015)



Motor Vehicles

According to the BLS QCEW, the nation's Motor Vehicle sector employs roughly 2.4 million Americans. This is exclusive of dealerships and retailers, which employ approximately 1.9 million additional workers. Three-quarters of employment in the Motor Vehicle sector is concentrated in the repair, maintenance, and manufacture of traditional and advanced vehicle technologies. About two in ten employees support the sector through wholesale trade, distribution, and transportation services; these include both direct transport of motor vehicle parts and supplies via air, rail, water, or truck as well as motor vehicle parts and supplies merchant wholesalers.

Figure 37. Motor Vehicle Employment by Industry Sectors (Q2 2015)



Though not traditionally considered a sector of the energy industry, Motor Vehicle[48] employment is included in this report, given both high energy consumption during production and end-use energy dependence. Several NAICS industry codes capture motor vehicle and parts manufacturing, automotive

[48] Motor vehicle employers are defined as any firm that contributes to the manufacture, wholesale distribution, transport, and repair and maintenance of gas and diesel, hybrid, electric, natural gas, hydrogen, fuel cell, or other vehicle technologies.

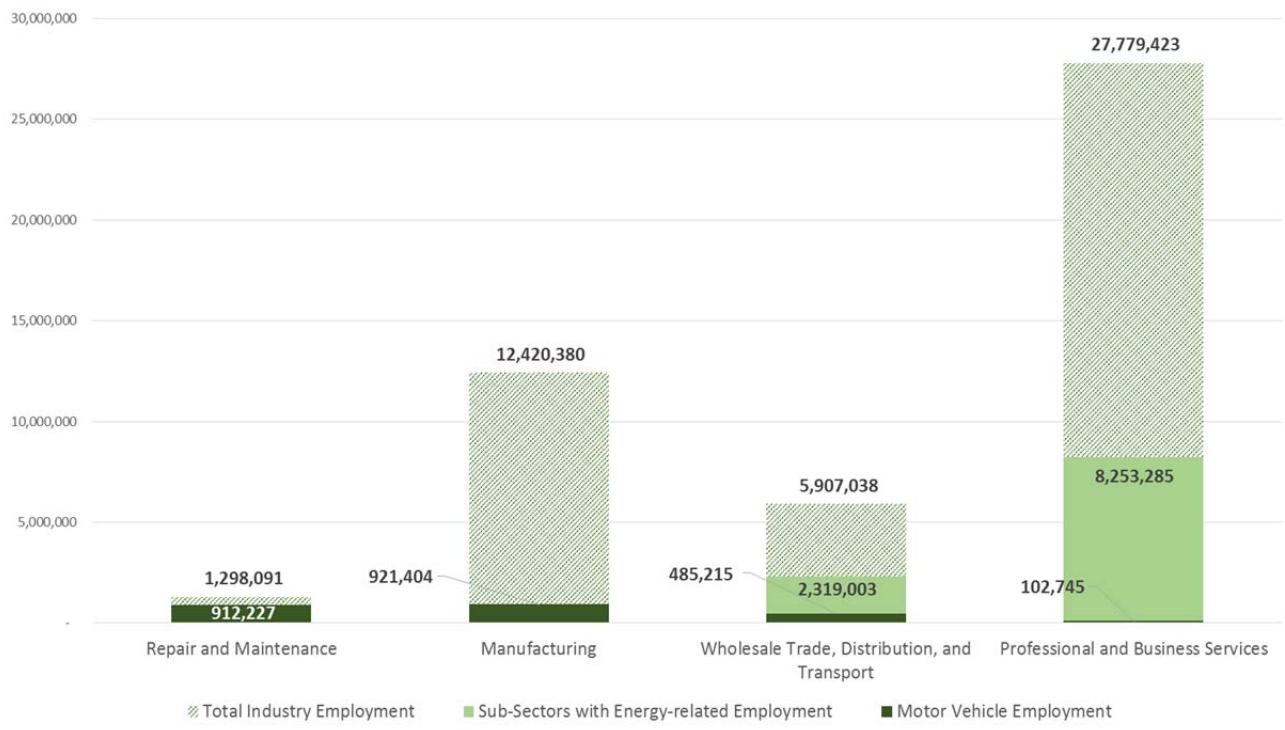
repair and maintenance, and wholesale trade. However, some employment is also embedded within industry subsectors including goods transportation and warehousing and professional services. The EEI delineates Motor Vehicle employment by several subsectors, including gas and diesel vehicles, hybrid, electric, natural gas, hydrogen, and fuel cell technologies.

Traditional Industry Definitions

NAICS Codes	Sector	Motor Vehicles Employment (QCEW, Q2 2015)
3361	Motor Vehicle Manufacturing	204,253
3362	Motor Vehicle Body and Trailer Manufacturing	150,138
3363	Motor Vehicle Parts Manufacturing	567,013
	Total Manufacturing	**921,404**
4231	Motor Vehicle and Motor Vehicle Parts and Supplies Merchant Wholesalers	330,221
	Total Wholesale Trade, Distribution, and Transport	**330,221**
8111	Automotive Repair and Maintenance	912,227
	Total Repair and Maintenance	**912,227**
	Total Motor Vehicles	**2,163,852**

Three NAICS subsectors capture motor vehicle manufacturing entirely, including vehicle, parts, body, and trailer manufacturing; together these detailed industry sectors employ 921,404 workers. Motor vehicle and parts dealers represent another detailed NAICS subsector within wholesale trade, and the QCEW reports about 330,000 workers are employed by these firms. Similarly, automotive repair and maintenance is captured by a single NAICS industry code within the overall repair and maintenance industry sector; automotive repair and maintenance firms employ just over 912,000 workers. Professional and business services are not motor vehicle-specific, but within the energy-related industries subsector, the Energy Employment Index identifies almost 103,000 workers who spend their time supporting the Motor Vehicle sector. About four in ten (38%) spend the majority of their time supporting motor vehicle subsectors, while a quarter spend all of their time on this work.

Figure 38. Motor Vehicle Employment in Traditional Industry[49] (Q2 2015)

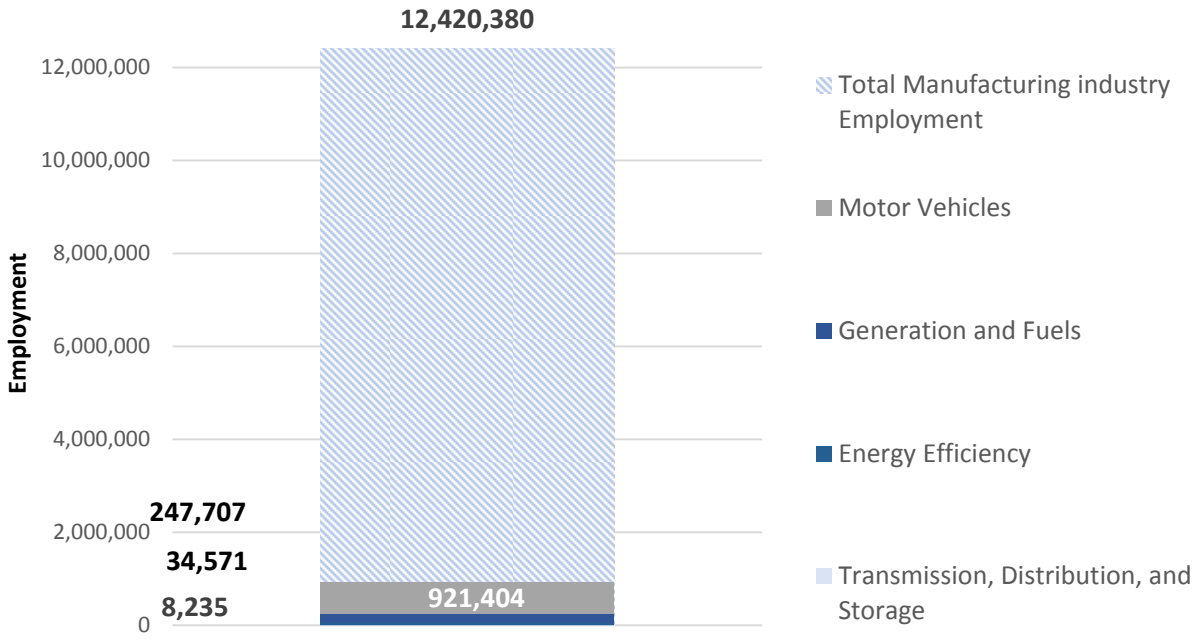


Manufacturing

The motor vehicle industry dominates energy-related manufacturing. Just over three-quarters (76%) of all energy-related manufacturing employment identified in this report is contained within the motor vehicle industry sector. Generation and Fuels comprise about two in ten manufacturing jobs, followed by Energy Efficiency manufacturers at three percent and Transmission, Wholesale Trade and Distribution and Storage at barely one percent. Please note that this report did not include the jobs associated with the manufacturing of primary materials such as steel, aluminum or glass.

[49] Automotive Repair and Maintenance (8111) is a subset of the larger Repair and Maintenance (811) industry. The 1.3 million workers from Figure 37 above represent the overall repair and maintenance industry, while the subset of 912,000 employees are solely dedicated to automotive repair and maintenance.

Figure 39. Manufacturing Employment by Energy Technology (Q2 2015)



Seven in ten energy-related manufacturing firms reported hiring difficulty over the past 12 months; 20% note it was very difficult to find qualified applicants. Lack of experience, training, or technical skills was cited by four in ten employers (41%); also cited include insufficient qualifications, certifications, or education (33%) and difficulty finding industry-specific knowledge (19%). Most difficult occupations to fill include engineers (28%), management positions (25%), and sales, marketing, or customer service representatives (24%).

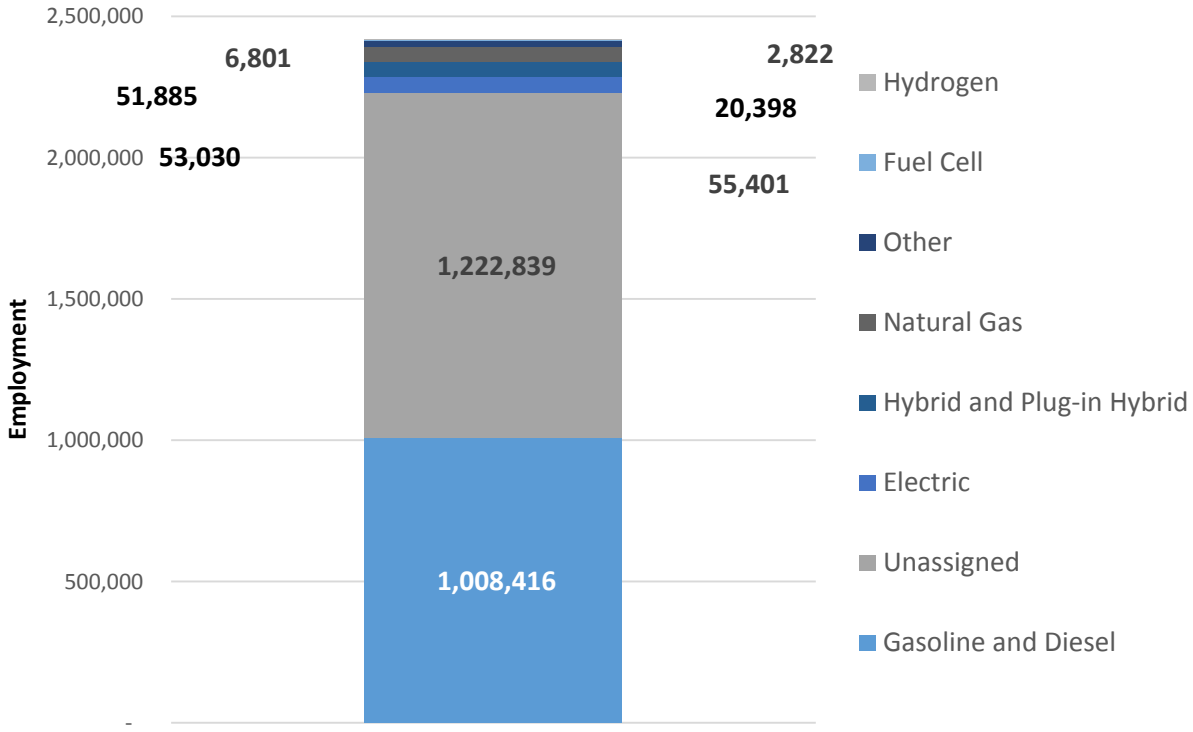
About four in ten (37%) energy-related manufacturers report primarily in-state customers, though almost half (48%) reported customers outside of a bordering state; 9% of firms primarily serve international clients. Thirteen percent of firms report that their suppliers and vendors are mostly outside of the United States.

Motor Vehicles by Sub Technology

Including all business activities, motor vehicle establishments employ about 2.4 million workers across the nation, exclusive of retail sales by auto dealers. According to BLS QCEW data, motor vehicle and parts retail dealers employ an additional 1.9 million individuals. About 42% of industry employment is primarily focused on gas and diesel motor vehicle technologies. Hybrid, electric, and natural gas vehicles employ between 50,000 to 55,000 workers each. However, a large portion of Motor Vehicle sector employment, particularly in Repair and Maintenance, remains unassigned to a particular fuel technology. The sector is projected to grow by just under one percent throughout 2016, creating an additional 11,000 jobs.

A large proportion of motor vehicle industry employment, including jobs associated with general repair and maintenance and component part manufacturing (such as windshields, brake pads, etc.), are not specific to fuel type or technology, and therefore participating employers were unable to apportion employment by vehicle sub technology (e.g., gasoline, electric, natural gas, etc.). In addition, some of these segments, notably oil change service stations and auto body repair, were not included in the business survey. Employment that could not be determined to be specific to a fuel or technology are referred to in this chapter as "unassigned."

Figure 40. Motor Vehicle Employment by Sub Technology[50] (Q2 2015)



Motor Vehicles – Workforce Characteristics

The Motor Vehicle sector reported the lowest proportion of female employees compared to the other sectors. Ethnic and racial minorities (23%) as well as workers 55 years of age or older (24%) represent about a quarter of the workforce.

[50] The BW Energy Index did not sample several automotive manufacturing and maintenance NAICS codes. Employment represented in the chart is "unassigned" given lack of survey data to allocate into respective sub technologies.

Table 12. Demographics (Q4 2015)

	Women	Ethnic or Racial Minorities	Veterans	55 and older
National Average[51]	**46.8%**	**34.0%**	**6.9%**	**22.5%**
Motor Vehicles	17.8%	23.3%	11.3%	23.8%

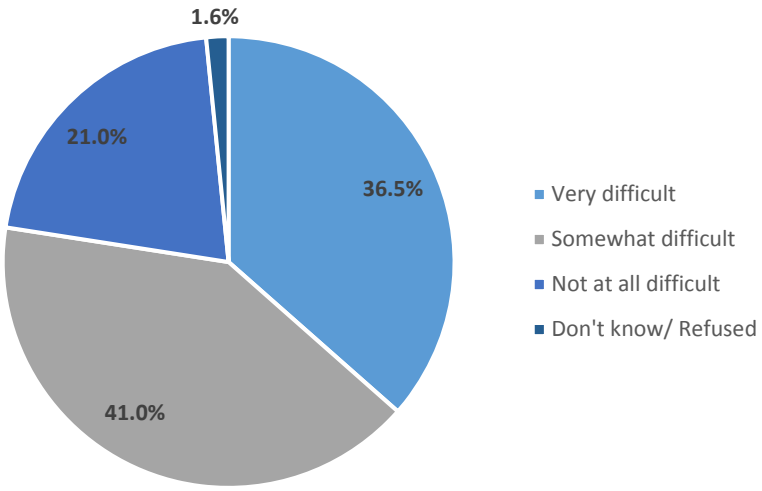
Motor Vehicle firms had the highest reported difficulty finding qualified workers (78%). Just over a third of employers mentioned lack of soft skills (35%), followed by lack of experience, training, or technical skills (34%), and insufficient qualifications, certifications, or education (30%); two in ten firms also mentioned difficulty finding industry-specific knowledge and skills (18%). Top three difficult occupations to fill include technician or technical support (43%), sales, marketing or customer service representatives (24%), and managers, directors, or supervisors (14%).

Table 13. Reported Occupations and Reasons for Hiring Difficulty (Q4 2014)

Reported Occupations with Hiring Difficulty	Reported Reasons for Hiring Difficulty
Technician or technical support (43%)	Lack of non-technical skills – work ethic, critical thinking, etc. (35%)
Sales, marketing, or customer service representatives (24%)	Lack of experience, training, or technical skills (34%)
Managers, directors, or supervisors (14%)	Insufficient qualifications, certifications, or education (30%)

[51] Current Population Survey, Bureau of Labor Statistics, 2015

Figure 41. Hiring Difficulty (Q4 2015)



Motor Vehicle Employment by Census Region

East North Central United States is home to a high concentration of Motor Vehicle employment; these states include Indiana, Illinois, Michigan, Ohio, and Wisconsin. The Motor Vehicle sector projects low employment growth across all census divisions, under one percent for nearly all regions.

Figure 42. Motor Vehicle Employment by Census Region (Q2 2015)

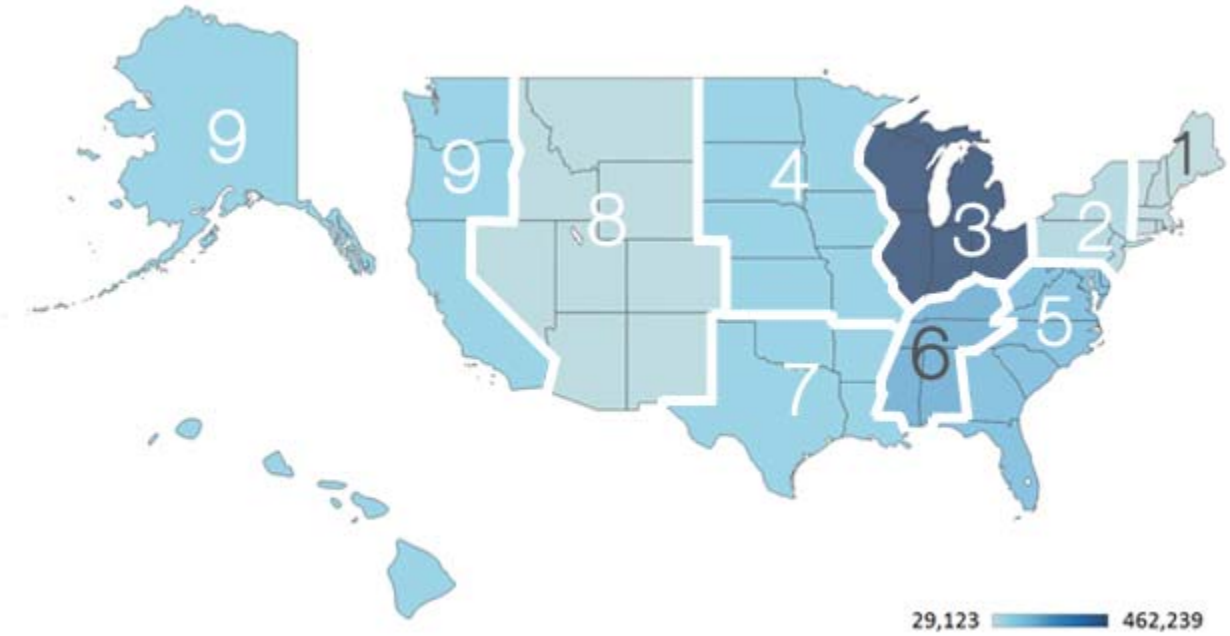
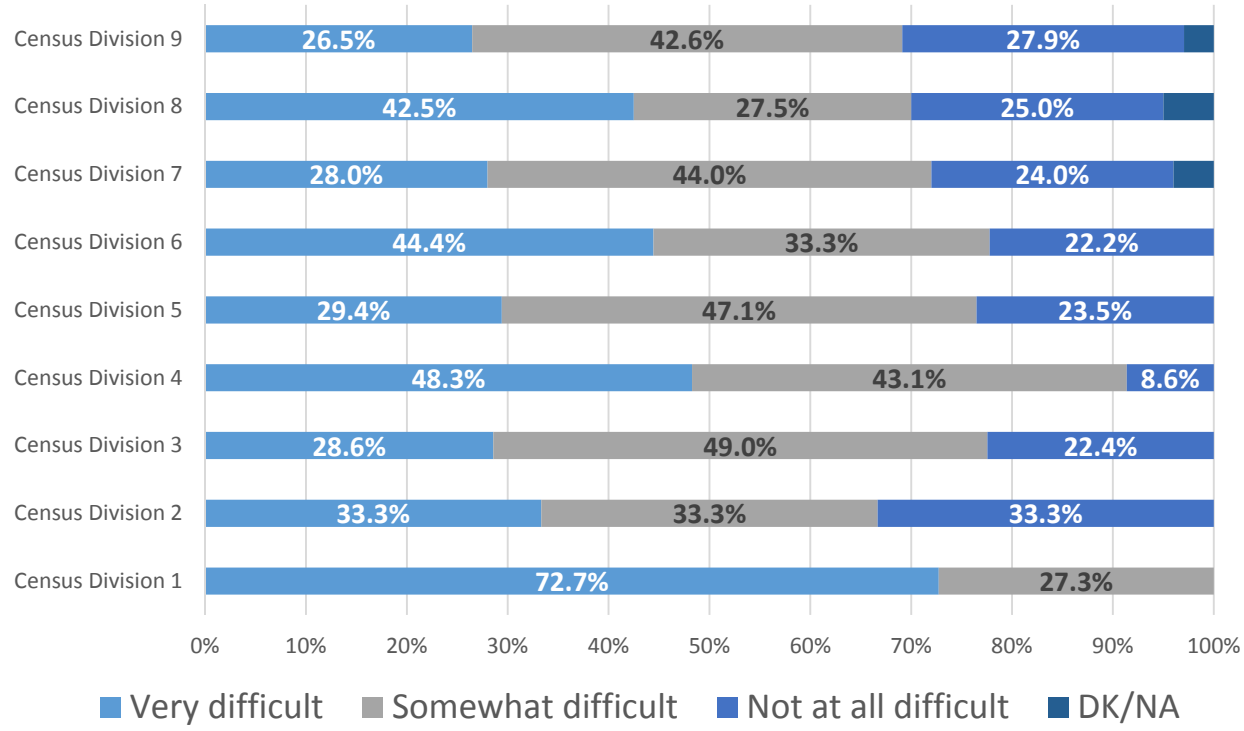


Table 14. Motor Vehicle Projected Employment Growth by Census Region (Q4 2015)

	Motor Vehicle Projected Growth
Census Region 1	0.4%
Census Region 2	0.5%
Census Region 3	-0.1%
Census Region 4	0.6%
Census Region 5	0.9%
Census Region 6	0.4%
Census Region 7	1.6%
Census Region 8	1.2%
Census Region 9	0.9%

Figure 43. Motor Vehicle Hiring Difficulty by Census Region (Q4 2015)



Survey and Analysis Methods

The BW Research Energy Employment Index (EEI) methodology relies on the most recently available data from the Bureau of Labor Statistics Quarterly Census of Employment and Wages (QCEW, Quarter 2), together with a detailed supplemental survey of business establishments across the United States designed and conducted independently by BW Research Partnership. Although DOE did not participate in the development of the Index nor the collection of survey data, DOE conducted a comprehensive review of the methodology underlying the Energy Employment Index. During a time of rapid change in energy technology and business employment structure, supplemental surveys are an important tool to capture developing trends. Taken together, the BLS and EEI data provide the most comprehensive calculation of energy-related employment available. The methodology has been used for local, state, and federal energy related data collection and analysis for nearly a decade, including The Solar Foundation's *National Solar Jobs Census* series, clean energy reports for state agencies in the Commonwealth of Massachusetts, State of Vermont, and State of Rhode Island, and numerous nonprofit agencies across the U.S.

The EEI survey uses a stratified sampling plan that is representative by industry code (NAICS or ANAICS), establishment size, and geography to determine the proportion of establishments that work with specific energy-related technologies, as well as the proportion of workers in such establishments that work with the same. These data are then analyzed and applied to existing public data published by the Bureau of Labor Statistics, effectively constraining the potential universe of energy establishments and employment. BW Research Partnership believes that the methodology used for the EEI could be adopted as a supplemental series to the QCEW with only minor revision.

The EEI survey was administered by telephone (more than 300,000 outbound calls) and by web, with more than 50,000 emails sent to participants throughout the U.S. The phone survey was conducted by I/H/R Research Group and Castleton Polling Institute. The web instrument was programmed internally and each respondent was required to use a unique ID in order to prevent duplication.

The sample was split into two categories, referred to as the known and unknown universes. The known universe includes establishments that have previously identified as energy-related, either in prior research or some other manner, such as membership in an industry association or participation in government programs. These establishments were surveyed census style, and their associated establishment and employment totals were removed from the unknown universe for both sampling and for resulting employment calculations and estimates.

The unknown universe includes hundreds of thousands of businesses in potentially energy-related NAICS codes, across agriculture, mining, utilities, construction, manufacturing, wholesale trade, professional services, and repair and maintenance. Each of these segments and their total reported establishments (within the Bureau of Labor Statistics QCEW) were carefully analyzed by state to develop representative clusters for sampling. In total, approximately 20,000 business establishments participated in the survey effort, with more than 8,500 providing full responses to the survey. These responses were used to develop incidence rates among industries (by state) as well as to apportion employment across various industry categories in ways currently not provided by state and federal labor market information agencies. The margin of error for incidence in the index is +/-0.85% at a 95% confidence interval.

For several industries, particularly transportation of goods, the Index utilized the methodology developed by the Department of Energy and the National Renewable Energy Laboratory for the Quadrennial Energy Review (QER). Proportion of employment was calculated by dividing commodity shipments by value (millions of $) for coal, fuel oil, gas, motor vehicles, petroleum, and other coal and petroleum products out of total commodity value at the state level by truck, rail, air, and water transport. This proportion was applied to NAICS employment for truck transportation (484), water transportation (483), air transportation (481), and Railroad Retirement Board employment for rail transportation at the state level. With this analysis, truck transportation represents the majority of energy-related transportation employment (65%), followed by rail (25%), water (9%), and air (1%).

Of important note, the EEI expressly excludes any employment in retail trade NAICS codes. This excludes gasoline stations, fuel dealers, motor vehicle dealerships, appliance and hardware stores and other retail establishments. Where relevant, separate reference is made to retail employment.

All data in the index rely on the Bureau of Labor Statistics Quarterly Census of Employment and Wages data for the second quarter of 2015. The EEI survey was administered between September 15, 2015 and November 24, 2015 and averaged 14 minutes in length.

Appendix A: Employment by Technology and Sub Technology

EEI Employment by Technology and Sub Technology (Q2 2015)	
Electric Power Generation and Fuels	1,606,066
Electric Power Generation	666,280
Solar	299,953
Wind	77,088
Geothermal	7,645
Bioenergy/ Biomass	18,804
Low-Impact Hydroelectric	8,608
Other Renewable Energy Generation	1,826
Traditional Hydropower	26,811
Advance/ Low Emission Natural Gas	35,980
Nuclear	36,097
Fossil Fuel	135,898
Other	17,570
Fuels	938,786
Fossil Fuels	747,877
Corn Ethanol	47,250
Other Ethanol/ Non-Woody Biomass	14,761
Woody Biomass	18,031
Nuclear	6,812
Other	104,055

Electric Power and Fuels Transmission, Wholesale Trade and Distribution, and Storage	1,045,916
Traditional Transmission and Distribution	832,290
Truck, Rail, and Other Transport of Fuel	163,869
Storage	27,140
Smart Grid	12,880
Other	9,736
Energy Efficiency	1,880,149
Energy Star Appliances	162,083
LED, CFL, and Other Efficient Lighting	328,288
Traditional HVAC	630,587
Energy Star/ High AFUE HVAC	185,545
Renewable Heating and Cooling	135,102
Advanced Building Materials/ Insulation	292,667
Other	145,876
Motor Vehicles	1,198,752
Gasoline and Diesel	1,008,416
Hybrid and Plug-In Hybrid	53,030
Electric	55,401
Natural Gas	51,885
Hydrogen	2,822
Fuel Cell	6,801
Other	20,398

Appendix B: Employment by BLS QCEW NAICS 2015 Q2

Employment by BLS QCEW NAICS 2015 Q2		
	Electric Power Generation and Fuels	935,664
211	Oil and Gas Extraction	195,604
2121	Coal Mining	65,180
213112	Support Activities for Oil and Gas Operations	275,430
213113	Support Activities for Coal Mining	7,509
	Total Mining and Extraction:	543,723
221111	Hydroelectric Power Generation	17,129
221112	Fossil Fuel Electric Power Generation	114,351
221113	Nuclear Electric Power Generation	51,537
221114	Solar Electric Power Generation	2,023
221115	Wind Electric Power Generation	4,316
221116	Geothermal Electric Power Generation	1,089
221117	Biomass Electric Power Generation	1,544
221118	Other Electric Power Generation	1,155
	Total Utilities:	193,144
324	Petroleum and Coal Products Manufacturing	112,562
33313	Mining and Oil and Gas Field Machinery Manufacturing	86,235
	Total Manufacturing:	198,797
	Electric Power Transmission, Wholesale Trade and Distribution, and Storage	767,471
22112	Electric Power Transmission, Control, and Distribution	293,786
2212	Natural Gas Distribution	119,592
221330	Steam and Air-Conditioning Supply	1,828
	Total Utilities:	415,206
23712	Oil and Gas Pipeline and Related Structures Construction	135,294

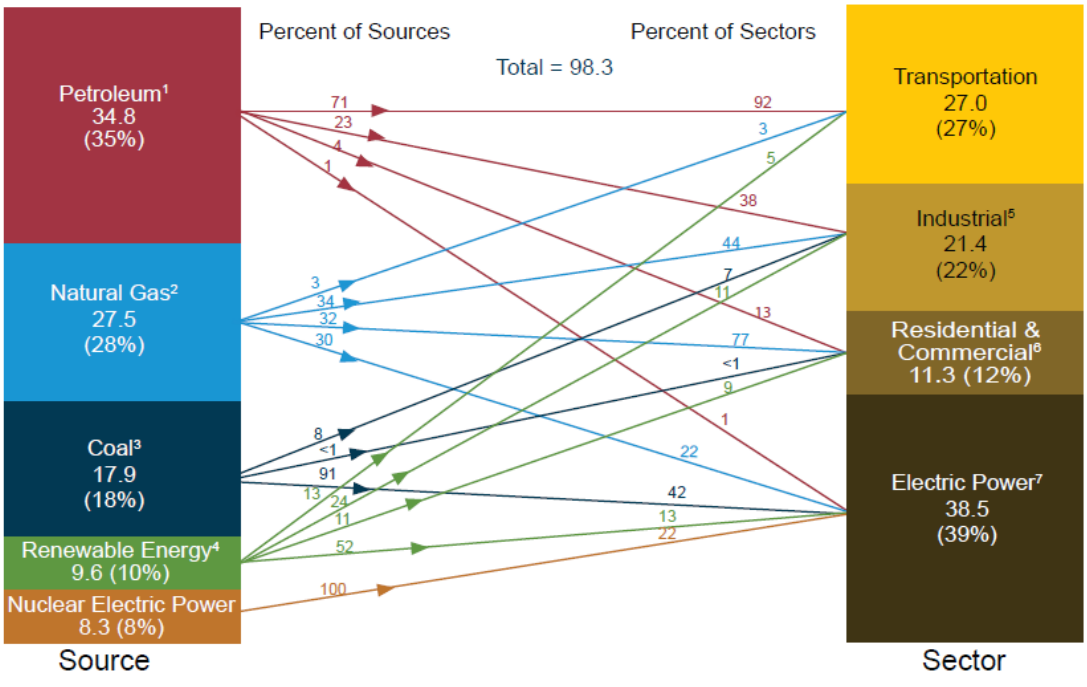
23713	Power and Communication Line and Related Structures Construction	169,226
	Total Construction:	304,520
4861	Pipeline Transportation of Crude Oil	10,730
4862	Pipeline Transportation of Natural Gas	30,658
4869	Other Pipeline Transportation	8,357
	Total Wholesale Trade, Distribution, and Transport:	49,745
	Motor Vehicles	2,163,852
3361	Motor Vehicle Manufacturing	204,253
3362	Motor Vehicle Body and Trailer Manufacturing	150,138
3363	Motor Vehicle Parts Manufacturing	567,013
	Total Manufacturing:	921,404
4231	Motor Vehicle and Parts and Supplies Merchant Wholesalers	330,221
	Total Wholesale Trade, Distribution, and Transport:	330,221
8111	Automotive Repair and Maintenance	912,227
	Total Repair and Maintenance:	912,227

Appendix C: Employment by Census Region

Census Division	Electric Power Generation and Fuels	Electric Power and Fuels Transmission, Wholesale Trade and Distribution, and Storage	Energy Efficiency	Motor Vehicles
Division 1	67,971	32,146	129,977	29,123
Division 2	141,221	88,266	163,319	50,388
Division 3	154,843	104,153	270,122	462,239
Division 4	108,511	73,758	153,426	95,357
Division 5	201,430	125,281	385,290	150,554
Division 6	81,368	59,708	82,320	186,662

Division 7	517,000	176,803	144,281	93,478
Division 8	225,620	78,406	148,070	39,306
Division 9	270,972	143,524	403,345	91,647

Appendix C: Primary Energy Consumption by Source and Sector, 2014 (Quadrillion Btu)



[1] Does not include biofuels that have been blended with petroleum—biofuels are included in "Renewable Energy."
[2] Excludes supplemental gaseous fuels.
[3] Includes less than -0.1 quadrillion Btu of coal coke net imports.
[4] Conventional hydroelectric power, geothermal, solar/photovoltaic, wind, and biomass.
[5] Includes industrial combined-heat-and-power (CHP) and industrial electricity-only plants.
[6] Includes commercial combined-heat-and-power (CHP) and commercial electricity-only plants.
[7] Electricity-only and combined-heat-and-power (CHP) plants whose primary business is to sell electricity, or electricity and heat, to the public. Includes 0.2 quadrillion Btu of electricity net imports not shown under "Source."

Notes: Primary energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy (for example, coal is used to generate electricity). • Sum of components may not equal total due to independent rounding.

Sources: U.S. Energy Information Administration, Monthly Energy Review (March 2015), Tables 1.3, 2.1-2.6.