*Chapter V*

# ELECTRICITY WORKFORCE OF THE 21ST CENTURY: CHANGING NEEDS AND NEW OPPORTUNITIES

This chapter provides an overview of the composition of the electricity industry workforce, as well as the challenges the sector faces in maintaining an adequate and skilled workforce for the 21st-century electricity system. This chapter further examines how qualities and characteristics of the electricity workforce are shifting in light of the ongoing transformation of the energy sector, and it provides an overview of how industry and government action can respond to challenges facing the industry.

## FINDINGS IN BRIEF:
## Electricity Workforce of the 21st Century: Changing Needs and New Opportunities

- Over 1.9 million people are employed in jobs related to electric power generation and fuels, while 2.2 million people are working in industries directly or partially related to energy efficiency.
- Job growth in renewable energy is particularly strong. Employment in the solar industry has grown over 20 percent annually from 2013 to 2015. From 2010 to 2015, the solar industry created 115,000 new jobs. In 2016, approximately 374,000 individuals worked, in whole or in part, for solar firms, with more than 260,000 of those employees spending most of their time on solar. There were an additional 102,000 workers employed at wind firms across the Nation. The solar workforce increased by 25 percent in 2016, while wind employment increased by 32 percent.
- The oil and natural gas industry experienced a large net increase in jobs over the last several years, adding 80,000 jobs from 2004 to 2014. Unlike coal production, natural gas production is projected to increase over the coming decades under a business-as-usual scenario, sustaining natural gas industry employment.
- Employment in the natural gas extraction industry is regionally and temporally volatile; 28,000 jobs were lost between January 2015 and August 2016. Shifts in locations pose challenges for employees and the economies of the areas where they live and work.
- Between 1985 and 2001, coal production increased 28 percent as industry employment fell by 59 percent due to efficiencies gained by shifting production from Appalachia to the West.
- Aside from a minor employment increase from 2000 to 2011, 141,500 domestic coal jobs were lost between 1985 and 2016, and the industry shrank by 60 percent. In 2015, annual coal production was at its lowest level since 1986, and it is forecast to continue declining over the coming decades. As of November 2016, according to data from the Bureau of Labor Statistics, the coal mining industry employs about 53,000 people.
- Despite ongoing economic challenges in the Appalachian region, the non-highway appropriated budget for the Appalachian Regional Commission (ARC), a federally funded regional economic development agency, has fallen from roughly $600 million in the early 1970s to around $100 million in the 1980s and remained roughly constant until 2016. The ARC budget recently increased from $90 million in fiscal year 2015 to nearly $150 million in fiscal year 2016.
- The Abandoned Mine Lands Reclamation Fund's (AML Fund's) inability to fully support the reclamation of lands disrupted by the coal mining industry has the potential to leave communities in regions with declining local revenues with polluted and unsafe lands and few means to repair the damage. The AML Fund's increased ability to support coal mine reclamation would provide local employment opportunities and help coal communities transition to new industries.
- The continued fiscal difficulties of coal miner pensions threaten the solvency of the Pension Benefit Guaranty Corporation, a Federal agency that insures private-sector pension funds and is funded out of insurance premiums paid by member funds.

**FINDINGS IN BRIEF:**
**Electricity Workforce of the 21st Century: Changing Needs and New Opportunities** (continued)

- Proliferation of information and communications technologies and new technologies like distributed generation, smart home devices, and electric battery storage have led to new businesses and employment opportunities, which will require a wide array of new skills.
- The electricity industry will need a cross-disciplinary power grid workforce that can comprehend, design, and mange cyber-physical systems; the industry will increasingly require a workforce adept in risk assessment, behavioral science, and familiarity with cyber hygiene.
- A dip in the number of electricity industry workforce training programs in the 1980s contributed to a currently low number of workers in the electric utilities able to move into middle and upper management positions—creating a workforce gap as the large number of baby boomers retire.
- Workforce retirements are a pressing challenge. Industry hiring managers often report that lack of candidate training, experience, or technical skills are major reasons why replacement personnel can be challenging to find—especially in electric power generation.
- Electricity and related industries employ fewer women and minorities than the national average, but have a higher proportion of veterans. Only 5 percent of the boards of utilities in the United States in 2015 included women, and approximately 13 percent of board members among the top 10 publicly owned utilities were African American or Latino. Underrepresentation in or lack of access to science, technology, engineering, and mathematics educational opportunities and programs contribute to the underrepresentation of minorities and women within the electricity industry.
- From 1995 to 2013, the number of injuries per 100 employee-years in the electricity utility industry decreased from 4.7 to 1.3. However, line workers continue to experience hazardous working conditions. In 2014, electrical power line installers and repairers suffered 25 fatal work injuries—a rate of 19 per 100,000 full-time equivalent workers, which is more than five times the national fatal work injury rate.
- While data on energy sector workforce are improving, there are still major shortcomings in the data availability, precision, and categorization of energy sector jobs.

## A Modern Workforce for the 21st-Century Electricity Industry

The evolving demands on the electricity industry are causing a number of workforce challenges for the electricity industry, which include large shifts in skills needed and in geographic location of jobs, a skills gap for deploying and operating newer technologies, changes occurring during a period when the industry is facing high levels of retirements, and challenges recruiting and retaining a workforce that reflects the gender and racial diversity of the Nation. At the same time, the evolution of the industry is also creating a number of new workforce opportunities, including jobs in renewable energy, natural gas, and information and communications technology (ICT).

The electricity sector's full potential will only be realized if its workforce is able to appropriately adapt and evolve to meet the needs of the 21st-century electricity system. A skilled workforce that can build, operate, and manage this modernized grid infrastructure is an essential component for the sector's development. Addressing the workforce challenges identified here will create well-paying jobs that contribute to the economic health of local communities, support the increased use of efficiency technologies, reduce injuries and improve worker safety, enable employees in the electricity industry to support a modernized 21st-century energy system, and ensure a resilient electricity system.

## Overview of the Electricity Industry Workforce

The electricity system depends on a workforce that fills a diverse set of jobs—from the coal miner extracting fuel from the ground for electricity generation, to the utility worker repairing a distribution line, and everything in between. The following section provides an overview of the number and types of jobs related to the electricity industry.

### Workforce Size

The Bureau of Labor Statistics (BLS) reports that nearly half a million people are employed in electric power generation, transmission, and distribution (Table 5-1).[1] Of the 290,000 employees in the electric power transmission and distribution subsector, over a quarter million are employed with distribution companies. There are an additional 600,000 jobs in extraction and mining industries, though only a portion of those jobs are directly attributable to the electricity industry.[2]

**Table 5-1. Direct Employment and Income in Industries Related to Electric Power Supply as Tracked by BLS, 2015[3]**

| Industry Sector/Subsector | Jobs | % Related to Electricity Industry | Average Annual Income |
|---|---|---|---|
| Electric power generation | 192,000 | 100% | $116,000 |
| Electric power transmission and distribution | 290,000 | 100% | $99,000 |
| **Total – Electric Power** | **482,000** | **100%** | **$106,000** |
| Coal mining[a] | 71,000 | ~ 80% | $83,000 |
| Oil and gas extraction[b] | 540,000 | ~35% of gas, ~1% of oil | $113,000 |
| **Total – Mining and Extraction** | **611,000** | **Unknown** | **$110,000** |

The Bureau of Labor Statistics reports 482,000 people in the electric power generation, transmission, and distribution. A portion of the over 611,000 jobs in mining and extraction jobs are also in support of the electricity sector.

**Note:** More than 80 percent of the coal mined in the United States goes to power production.[4] The oil and gas extraction sector is not subdivided and includes many non-power uses. About 35 percent of the natural gas and roughly 1 percent of petroleum usage in the United States is for power production.[5]

In addition to the 482,000 jobs in the electric power generation, transmission, and distribution subsectors, BLS reports that 169,000 people are employed in the Power and Communication Line and Related Structures Construction industry. Some of these employees work constructing transmission lines, substations, and power plants.[6]

The electricity industry is a dynamic industry with changing sources of employment and job categories. As a result, the direct employment figures captured by the BLS job categories provided in Table 5-1 do not include all employment related to the electricity industry, particularly those related to construction, solar, wind, and energy efficiency workers.[7] In 2015, the Department of Energy published the first edition of the "U.S. Energy and Employment Report" (USEER), which provided a broader depiction of electricity industry employment than the BLS data based on supplemental employment surveys. A second edition of the USEER, published

[a] Includes supporting North American Industry Classification System (NAICS) industry categories.

[b] Includes supporting NAICS industry categories.

in January 2017, finds that about 862,000 people are employed in jobs related to electric power generation. Another 1,082,746 are also employed in jobs related to fuels extraction and mining, although not all are directly attributable to the electric power sector (Table 5-2).

**Table 5-2. Electric Power Generation and Fuels Extraction and Mining Employment Estimates by Technology, Q1 2016**[8]

| Technology | Electric Power Generation (Employment Estimates) | Fuels Extraction and Mining (Employment Estimates) |
|---|---|---|
| Hydroelectric | 65,554 | - |
| Coal | 86,035 | 74,084 |
| Natural Gas | 88,242 | 309,993 |
| Nuclear | 68,176 | 8,592 |
| Solar | 373,807 | - |
| Wind | 101,738 | - |
| Geothermal | 5,768 | - |
| Bioenergy | 7,980 | 104,663 |
| Oil | 12,840 | 502,678 |
| Combined Heat and Power | 18,034 | - |
| Other | 32,695 | 82,736 |
| **Total** | **860,869** | **1,082,746** |

The "U.S. Energy and Employment Report" provides a broader accounting than the Bureau of Labor Statistics data presented above, and it finds that as of the first quarter of 2016, over 860,000 people were employed in the electric power generation industry, most of which are related to the construction and buildout of new solar and wind generation capacity. Another 1,082,746 are also employed in jobs related to fuels extraction and mining, although not all of these are directly attributable to the electric power sector. As noted above, over 80 percent of coal, 35 percent of the natural gas, and 1 percent of petroleum usage in the United States are for power production.[9]

USEER finds that the BLS estimates are particularly low for jobs associated with solar, wind, geothermal, and biomass electric power generation.[10] These low estimates result from classifying many jobs in these industries as construction or business and professional services employment. For instance, most solar company installers are classified as electrical contractors.[11]

Though BLS does not estimate employment in energy efficiency jobs, USEER found that 2.2 million people are working in industries directly or partially related to energy efficiency—more than 2.5 times the number employed by electric power generation. Of those 2.2 million, 1.4 million are in the construction industry.[12] Energy efficiency employment includes both the production of energy-saving products and the provision of services that reduce end-use energy consumption. However, USEER estimates only include work with efficient technologies or building design and retrofits. They do not capture employment related to energy-efficient manufacturing processes. If process efficiencies were included, estimates for the energy efficiency workforce would be even larger.

### 5.2.2 Electricity Industry Skills and Training

The electricity industry offers diverse jobs, which require a variety of skills. Table 5-3 includes job descriptions and educational requirements for selected job categories across the utility portion of the electricity industry. Traditional jobs, such as lineman, will continue to be needed, but the increase of renewable energy, as well as an increased ICT component to the electricity industry, will change the skillset required for many jobs in the electricity system of the 21st century.

**Table 5-3. Typical Electricity Workforce Roles and Required Education or Training[13]**

| | | Required Education | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Job Category** | **Job Description** | **High School** | **Vocational** | **Apprenticeship** | **Associates** | **Bachelors** | **Masters** | **Doctorate** |
| **Lineman** | Responsible for the installation and repair of overhead and underground distribution and transmission lines, poles, transformers, and other equipment. | [green] | [green] | | [green] | [gray] | | |
| **Power Plant Operator** | Responsible for the maintenance and operation of all primary and auxiliary equipment required to generate electricity or meet natural gas customers' demands. | [green] | [green] | | [green] | [gray] | | |
| **Technicians (Transmission and Distribution)** | Responsible for the repair of both electrical and mechanical equipment. This includes inspecting and testing electrical equipment in generating stations and substations. | [green] | [green] | | [green] | [gray] | | |
| **Technicians (Generation)** | Responsible for the construction, assembly, maintenance, and repair of steam boilers and boiler house auxiliary equipment. | [green] | [green] | | [green] | [gray] | | |
| **Pipefitters and Pipelayers (Generation)** | Responsible for the installation and maintenance of pipe systems and related equipment for steam, hot water, heating, sprinkling, and industrial production and processing systems. | [green] | [green] | | [gray] | | | |
| **Power Engineers** | Focus on electrical systems, equipment, and facilities rather than on mechanical systems and other non-electrical systems involved in electric and natural gas energy services. It includes people involved in planning, research, design, development, construction, installation, and operation of equipment, facilities, and systems for the safe, reliable, and economic generation, transmission, distribution, consumption, and control of electricity. | | | | | [green] | [green] | [gray] |
| **All Other Engineers** | Focus on non-electrical systems, processes, equipment, and facilities involved in electric energy services. It includes people involved in the planning, research, design, development, construction, installation, and operation of equipment, facilities, and systems for the safe, reliable, and economic generation/supply, transmission, distribution, consumption, and control of electricity. | | | | | [green] | [green] | [gray] |

The electricity workforce includes several job categories, each with specific educational requirements (shown in green). The gray boxes show where a specific level of education is sometimes required or infrequently required.

One ongoing challenge for maintaining the electric industry workforce is the amount of time required to train new workers. For example, training to become a journeyman line worker can take up to 7 years.[14] If enrollment in apprenticeships and training programs increases during a period of worker shortage, the new employees would not be prepared for the full range of line worker duties for several years.[15] The electricity industry appears to have made progress on maintaining a pipeline of skilled labor; the number of pre-apprenticeship training programs has more than tripled since the 1990s.[16, 17] Furthermore, skilled workers coming from related industries—such as construction electricians—may not require as much training and would be ready for duty in a shorter timeframe.

In addition to the electricity workforce job categories shown in Table 5-3, the electricity industry also employs thousands of corporate services employees engaged in jobs such as customer service, finance, management, and human relations. Skills required in these jobs are often more transferable between industries and require less specialized electricity industry training.

### Training Programs in the Electricity Industry between the 1980s and Today

The economic outlook of an industry often determines the availability of training programs. During the 1980s and 1990s, the electricity industry experienced much lower demand growth than the decade before. A conservative outlook on demand growth coupled with an increased focus on productivity in anticipation of impending industry deregulation led utilities to scale back hiring and internal training programs.[c]

The 1980s and 1990s also coincided with a shift away from technical education as the primary tool to train the next generation, toward a larger emphasis on 4-year college programs. This shift further decreased the interest in technical and vocational training, previously a main pillar of education for the electricity industry workforce, which led to the closure of many technical high schools, shrinking the pool of available applicants for the electricity industry even further.[d] The future workforce is now educated through a variety of means, including community colleges, apprenticeship programs, and certificate programs. This has led to a lack of uniformity of standards and curricula, which is a challenge for electric companies, as they often have to retest skills to ensure that applicants have the necessary education. While the 2000s have seen a rebuilding of some of the training and apprenticeship programs, the dip in training programs in the 1980s contributed to fewer workers in middle management in the electric utilities—creating a gap as the large number of baby boomers retire.[e]

[c] Marika Tatsutani, *National Commission on Energy Policy's Task Force on America's Future Energy Jobs* (Washington, DC: Bipartisan Policy Center, 2009), 14, http://bipartisanpolicy.org/wp-content/uploads/sites/default/files/NCEP%20Task%20Force%20on%20America's%20Future%20Energy%20Jobs%20-%20Final%20Report.pdf.

[d] Marika Tatsutani, *National Commission on Energy Policy's Task Force on America's Future Energy Jobs* (Washington, DC: Bipartisan Policy Center, 2009), 45, http://bipartisanpolicy.org/wp-content/uploads/sites/default/files/NCEP%20Task%20Force%20on%20America's%20Future%20Energy%20Jobs%20-%20Final%20Report.pdf.

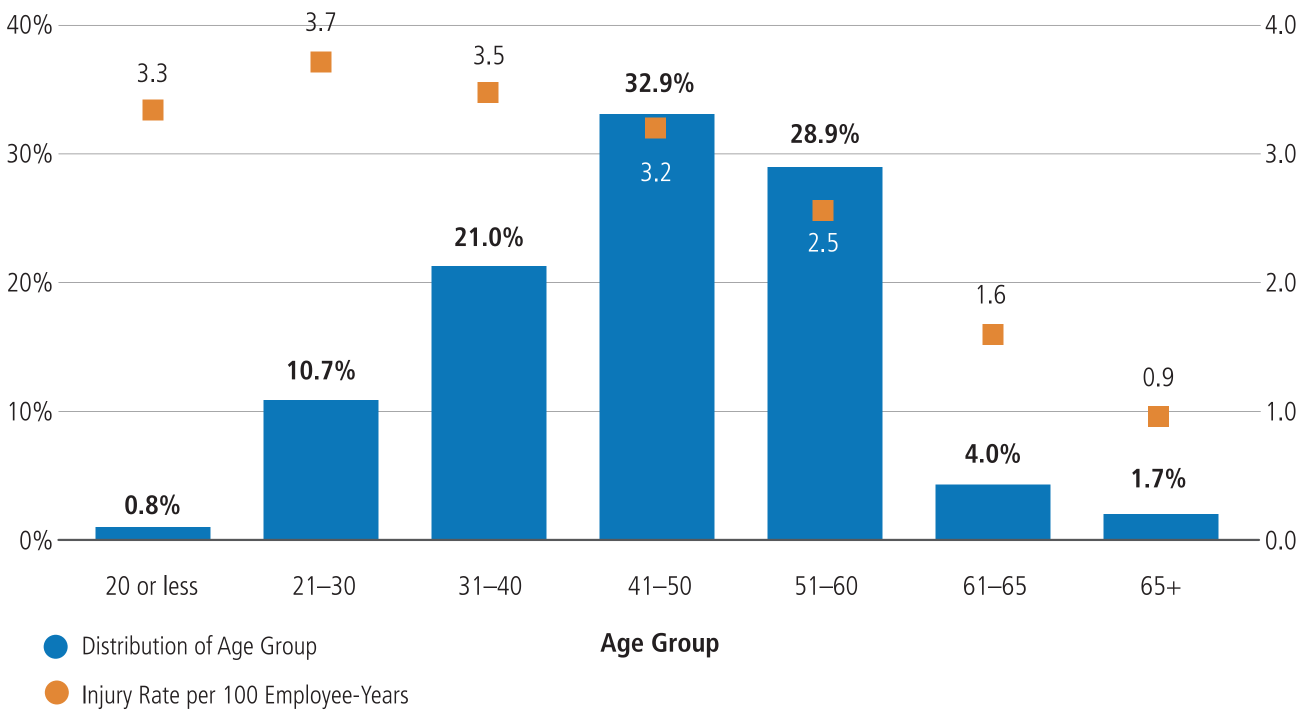
[e] Marika Tatsutani, *National Commission on Energy Policy's Task Force on America's Future Energy Jobs* (Washington, DC: Bipartisan Policy Center, 2009), http://bipartisanpolicy.org/wp-content/uploads/sites/default/files/NCEP%20Task%20Force%20on%20America's%20Future%20Energy%20Jobs%20-%20Final%20Report.pdf.

## Electric Utility Worker Health and Safety

The electricity industry has made progress in improving workplace safety. From 1995 to 2013, the number of injuries[f] per 100 employee-years in electricity utilities decreased from 4.7 to 1.3.[18] In 2015, the workplace injury rate across electricity generation, transmission, and distribution companies was slightly more than half the national rate.[19] However line workers continue to experience hazardous working conditions. In 2014, electrical power line installers and repairers suffered 25 fatal work injuries—a rate of 19 per 100,000 full-time equivalent workers, which is over five times the national fatal work injury rate.[20]

For electricity utility workers, the injury rate is highest among the 21–30-year-old age group at 3.7 percent (Figure 5-1). This segment only makes up 10.7 percent of the sector workforce, but has higher rates of injury due to "fewer years of experience and a higher proportion of young workers employed in higher risk occupations, performing physically demanding or higher risk tasks."[21]

**Figure 5-1. Injury Rates and Employee Age Group Distribution for Electricity Utilities, 1995–2013[22]**




Overall injury rates are highest among the 21–30-year-old group, although employees between 41 and 50 years of age comprise the largest group of employees, with 32.9 percent.

Injury rates for electricity utilities are not only unevenly distributed by age group, they also differ regarding the nature of the job. Welders, line workers, and meter readers accounted for the highest proportion of injuries among all electricity power sector occupations.[23] The specific causes of worker injuries and fatalities can be generally grouped into four categories: a misunderstanding or noncompliance with safety concepts, poor communication, absence of leadership, and/or lack of experience and qualified employees.[24]

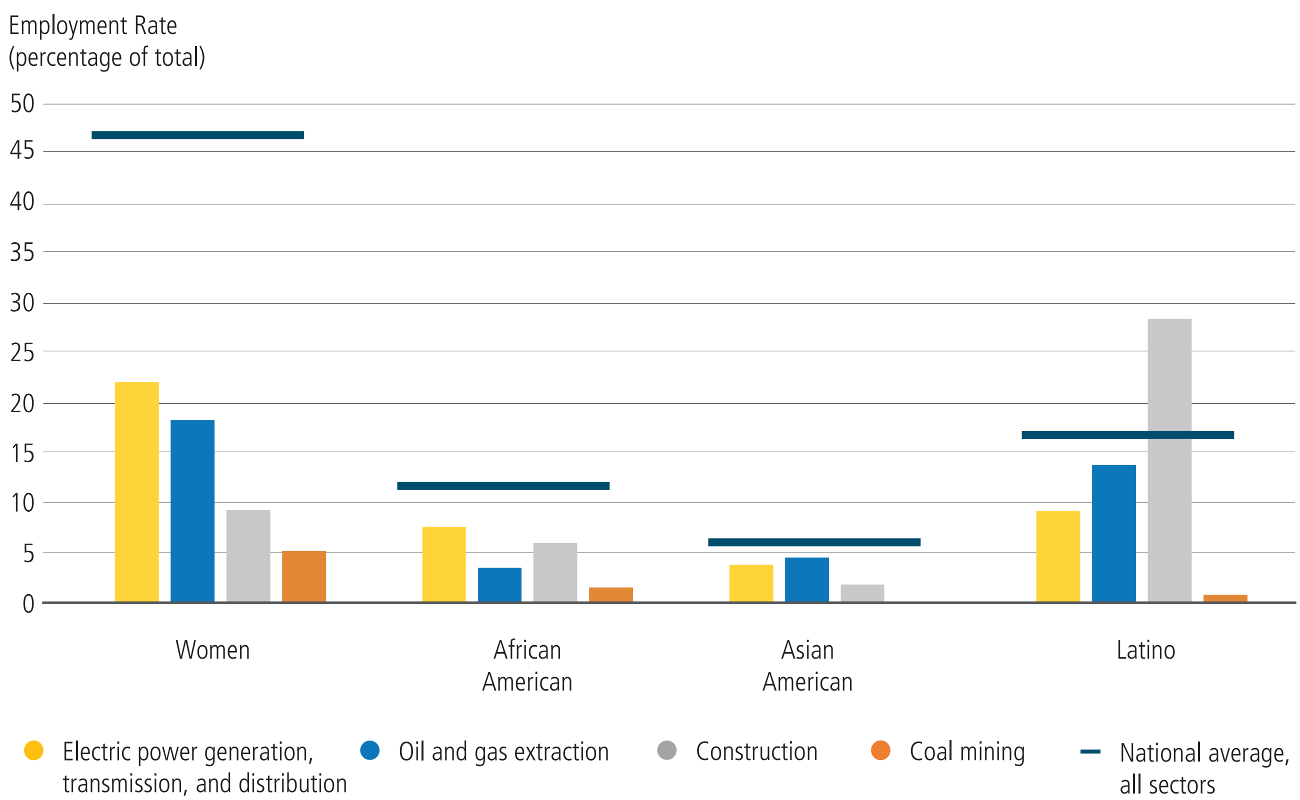
[f] Injury rates reported here are for injuries resulting in a worker missing at least one full day of work after the injury date.

As the electricity sector modernizes, there may be opportunities to leverage technological advances to improve worker safety and reduce rates of injury. New equipment, processes, and infrastructure design can complement innovations in training practices to improve workplace safety in the electricity industry by reducing electrical exposures, instances where utilities deploy crews and trucks, and instances where crews work at elevated heights.

## Electricity Industry Workforce Inclusion

The electricity and related resource extraction industries employ fewer women and minorities than the national average (Figure 5-2). Women constitute 22 percent of the electric power generation, transmission, and distribution industry workforce, compared to 47 percent of the entire workforce. African Americans constitute just 8 percent of the electricity workforce, but are 12 percent of the workforce as a whole. Oil and gas extraction, construction, and coal mining industries employ even fewer women and African Americans. Asian Americans are not statistically represented in the coal mining industry and, again, lag the national average for the other industries surveyed here. Latino employment in the construction industry is the only minority demographic that is higher than the national average for the population groups and industries included here.[25]

**Figure 5-2. Electricity and Related Industry Employment Demographic Indicators, 2015**[26]




The electricity industry ranks far below the national average in employment of women, African Americans, Asian Americans, and Latinos. The oil and gas extraction and coal mining industries have similar demographic characteristics. The construction industry, where energy efficiency jobs are mostly located, has a higher percentage of employment of Latino Americans.

The lack of diversity in the electricity industry extends to the executive level as well—only 5 percent of the boards of utilities in the United States in 2015 included any women, and approximately 13 percent of board members among the top 10 publicly owned utilities were African American or Latino.[27, 28]

Veterans make up a slightly higher proportion of electricity industry jobs than their representation in the national workforce. A recent study found that veterans make up 8 percent of the current workforce and 10 percent of new hires across the electricity utility, natural gas utility, and nuclear energy industries.[29] The solar industry employed an estimated 16,835 U.S. veterans in 2015, and the percentages of veterans working as solar manufacturers, solar installers, and solar project developers each exceeded the total percentage of veterans in the broader national workforce.[30]

Underrepresentation in or lack of access to science, technology, engineering, and mathematics (STEM) educational opportunities and programs contribute to the underrepresentation of minorities and women within the electricity industry. For instance, African American and Latino students are critically underrepresented in STEM programs in high schools and colleges, and STEM education is often necessary for entry into many positions in the electricity sector. Two-thirds of public high schools with a majority of African American students do not offer calculus, and more than half do not offer physics.[31] These curricula deficits result in lower STEM college graduation rates among underrepresented communities. In the 2013–2014 school year, African Americans and Latinos received only 7.2 percent and 9.5 percent of all STEM bachelor's degrees, respectively.[32]

While the renewable portion of the electricity industry is seeing dynamic job growth, workforce inclusion in renewable energy also tends to lag behind the national average. Women represented 24 percent of the solar workforce, which is well below the national average workforce participation levels. However, the number of women in the solar industry has been steadily trending upward from 19 percent in 2013. This trend is reversed for African Americans and Latinos, who are trending downward, with African Americans comprising 5.2 percent of the solar workforce in 2015 (down from 5.9 percent in 2013), and Latinos accounting for 11 percent of the workforce in 2015 (down from 16 percent in 2013). The number of veterans in the solar workforce is also trending downward—9.2 percent in 2013 and 8.1 percent in 2015, but it is still above the national average.[33]

## Electricity Industry Workforce Challenges

The electricity industry is facing several changes that present challenges for maintaining a skilled workforce. New technologies require new and evolving skillsets for industry employees as high levels of retirees take with them industry experience, and regional mismatches are emerging between the needed and available workforce. These changes could create skills gaps for the industry and workforce, as well as recruitment challenges in attracting appropriately trained and qualified employees. The time required to train new, qualified workers in the sector serves to limit the industry's ability to respond to rapid shifts in the workforce and limit the employment appeal to prospective employees faced with alternative career options. Workforce challenges facing the industry are exacerbated by the lack of robust, reliable data and by forecasts on industry needs and workforce supply—especially as business models evolve. Meanwhile, new technologies like distributed generation, smart home devices, and electric battery storage have led to the proliferation of many new business, job types, and employment opportunities. These new business models are expanding the definition of electricity industry jobs, and they present new workforce development challenges related to skills transferability and uniform safety and security practices and services.

The electricity system of the 21st century will require an adaptable and flexible workforce with additional areas of expertise and capabilities than the current workforce. The integration of variable renewable sources, storage systems, smart grid, and demand management will require new training and skillsets. Sector engineers need to have well-developed expertise in traditional topics such as electrical engineering, while also possessing knowledge of information technology, communications, and other relevant topics. Maintaining existing training programs for the legacy systems while also focusing on the skillsets of tomorrow's workers will be a unique challenge. As an example of these new workforce needs, the increased ICT component in the smart grid of the 21st century requires a wide array of new and different skills.[34]

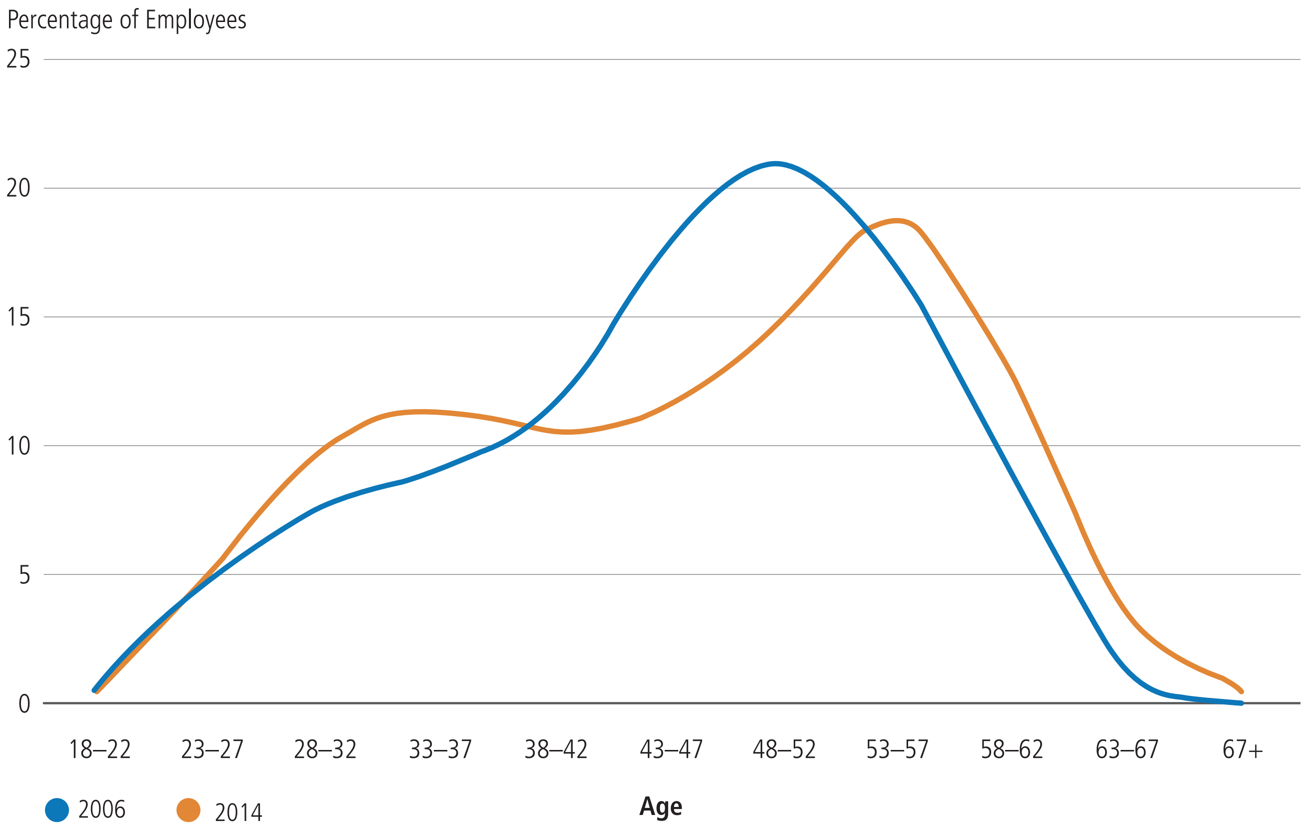
With the issue of cybersecurity increasingly at the forefront of electricity industry concern, the industry will require a workforce adept in risk assessment and behavioral science, as well as familiar with cybersecurity risk factors.[35] A 2010 report from the President's Council of Advisors on Science and Technology, "Designing a Digital Future," highlighted challenges stemming from the lack of a dedicated and trained cross-disciplinary power grid workforce that can comprehend, design, and manage cyber-physical systems (CPS).[36] In the future, the electricity industry faces dual challenges of growing a workforce with new requirements and qualifications, while also competing with other industries that are demanding CPS-trained workers. Training, curricula, and education in CPS remains nascent. The shortage of CPS-trained workers could place constraints on the evolution of the 21st-century electricity system. Addressing those ICT and sectoral skills challenges requires a strategic approach to talent management, focused on upgrading skills for existing employees and recruiting new employees with needed skills.

## Electricity Industry Capacity Gaps

Much of the utility and electricity sector workforce is nearing retirement. The aging workforce of the electricity sector is not unique in the U.S. economy, yet its specific skills requirements and the importance of the industry to national security and economic prosperity elevate the importance of its workforce management. Electricity utility, natural gas utility, and nuclear generation industry surveys indicate that roughly 25 percent of employees will be ready to retire in the next 5 years.[37] Noting demographic trends within the industry, in 2006, the North American Electric Reliability Council (NERC) raised concerns about worker and skills gaps among electricity industry employees, stating that "industry action is urgently needed to meet the expected 25 percent increase in demand for engineering professionals by 2015."[38] Spurred by this and other reports, the industry has pursued multiple initiatives and programs to address the looming increase in demand for skilled workforce.

Although the industry has made some progress on recruiting and developing the next-generation workforce through hiring (Figure 5-3), the capacity gap remains stubbornly persistent due to a workforce that continues to age, recruitment difficulties, a rapidly changing industry, and specific training and certification needs.[39] A recent industry study forecasts the need for 105,000 new workers in the smart grid and electric utility industry by 2030, but expects that only 25,000 existing industry personnel are interested in filling those positions.[40] The remaining 80,000 employees in this supply-demand mismatch will need to be filled through recruiting and training. However, the industry is not expected to meet the forecasted need with its current recruitment and training rates.[41] In one recent survey, 43 percent of utilities surveyed stated that they see the aging workforce and the increased rate of retirements as one of their top three most pressing challenges.[42]

**Figure 5-3. Age Distribution in Electric and Natural Gas Utilities, 2006–2014[43]**



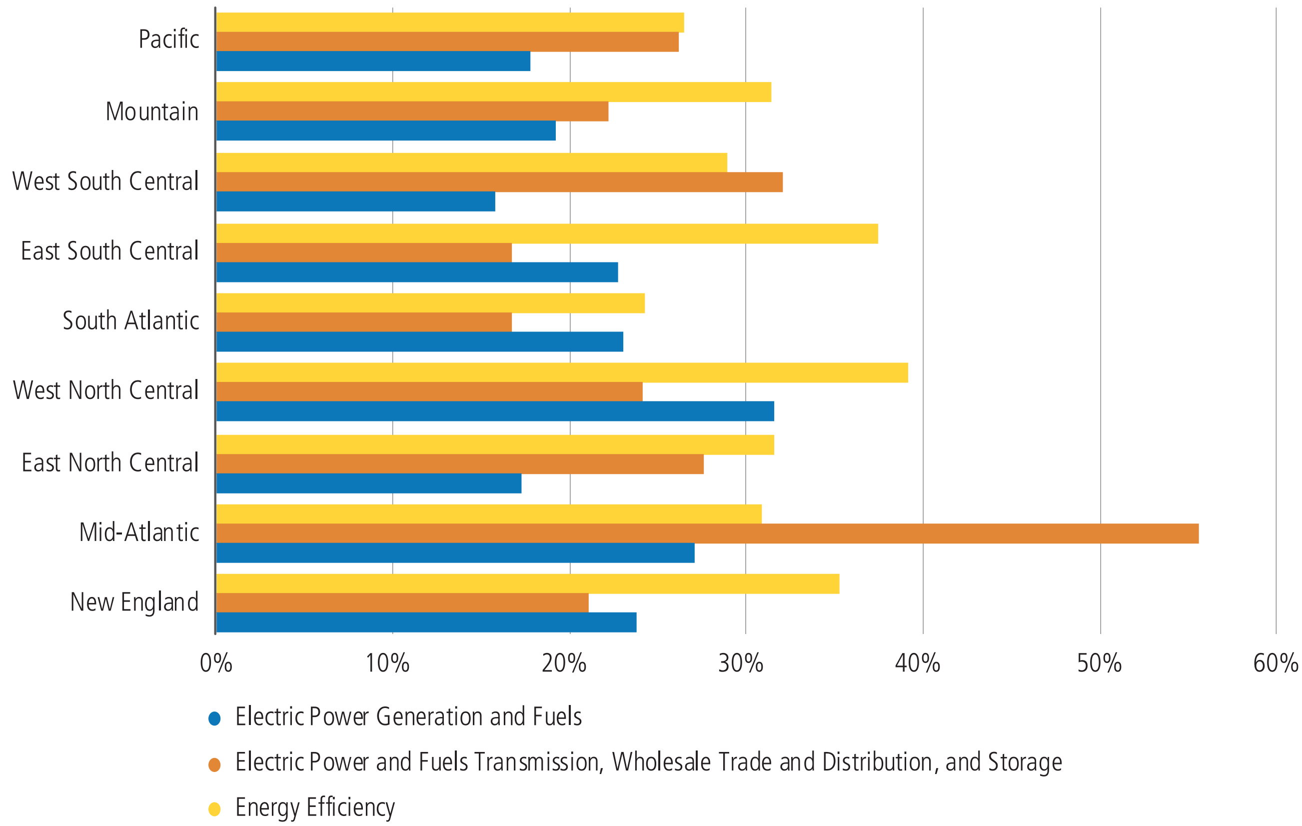

The age distribution in electric and natural gas utilities has shifted between 2006 and 2014, reflecting both the higher proportion of the workforce that is nearing retirement and industry efforts to address the aging workforce by hiring younger employees.

## Electricity Industry Employee Recruitment Challenges

As workers retire, the electricity sector is experiencing challenges in hiring replacement personnel. Industry hiring managers often report that lack of candidate training, experience, or technical skills are major reasons why replacement personnel can be challenging to find—especially in electric power generation.[44] This lack of experience can, in part, be attributed to hiring slow-downs in the 1990s and 2000s that have resulted in a current shortage of mid-career professionals with the experience to take on supervisory roles (see "Training Programs in the Electricity Industry between 1980 and Today" textbox).[45]

According to survey responses, over half of employers in the Mid-Atlantic region report very high difficulty with hiring in the electric power and fuels transmission, wholesale trade and distribution, and storage subsector, while no more than 32 percent of employers in other regions reported hiring difficulty in this field (Figure 5-4). The Mid-Atlantic region, home to more than 40 million people and Washington, D.C., also reports among the highest rates of difficulty hiring in the energy efficiency and electric power generation and fuels industries.[46, 47]

**Figure 5-4. Percentage of Employers Reporting Very High Hiring Difficulty by Census Region and Subsector, Q4 2015[48]**




Over half of employers in the Mid-Atlantic region report very high difficulty hiring in the electric power and fuels transmission, wholesale trade and distribution, and storage subsector, while no more than 32 percent of employers in other regions reported hiring difficulty in this field. The Mid-Atlantic also reports among the highest rates of difficulty hiring in the energy efficiency and electric power generation and fuels industries.

The employment supply and demand imbalance is already evident in the electric power transmission industry. One analysis finds that 10 states were experiencing a shortage of workers for electric power transmission in 2014. The same analysis projects that the number of states that will experience a shortage of worker supply will grow to at least 12 by 2018.[49]

## Training Capacity and Timeline

One of the challenges for maintaining the electric sector workforce is the amount of time required to train new workers in response to changing industry needs. Even if enrollment in apprenticeships and training programs increased today, sector employees would not be ready to enter the job market until several years from now. For example, initial training to become a fully educated line worker is between 4.5 and 7 years.[50] And, due to the closure of many training programs in the 1980s because of lower need (see "Training Programs in the Electricity Industry between 1980 and Today" textbox), there is also a dearth of mid-career employees within the electricity sector that might otherwise fill these roles (Figure 5-3).[51]

# Electricity Industry Sectoral and Regional Variations, Training Opportunities

The electricity industry is the dominant consumer of coal, natural gas, and renewable energy technologies, so changes in electricity industry demand for these resources can cause separate regional and sectoral dislocations in these industries. Each industry has distinctive workforce characteristics, skills requirements, and geographic concentrations, which means that employment gains in one industry do not always translate to opportunities to workers affected by employment loss in other industries that may be geographically distant and require different skills.

In many cases, changes in the electricity industry result in new businesses and sources of employment, especially with the growth of natural gas production and the renewable energy industry. In other parts of the country where employment is heavily dependent on a single industry, like coal, the economic consequences of the shifts in the electricity industry can be significant; employment in the coal mining industry has fallen by nearly 70 percent over the last three decades, largely in rural America.[52] Even in sectors experiencing long-term growth, employment can be volatile; the oil and natural gas extraction industry has lost about 14 percent of its workforce since the beginning of 2015 (through August 2016).[53] These changes in employment not only impact the labor force, but also the communities in which they live, work, and contribute to funding public infrastructure and services like roads and schools. While the shift from jobs in coal to natural gas and renewables is a recent example of job dislocation, this issue is not limited to coal or to the energy industry as a whole. Job dislocation has been, and will continue to be, a critical issue across many industries as the Nation's economy grows and changes.

## Falling Demand for Coal Has Reduced Coal-Related Employment

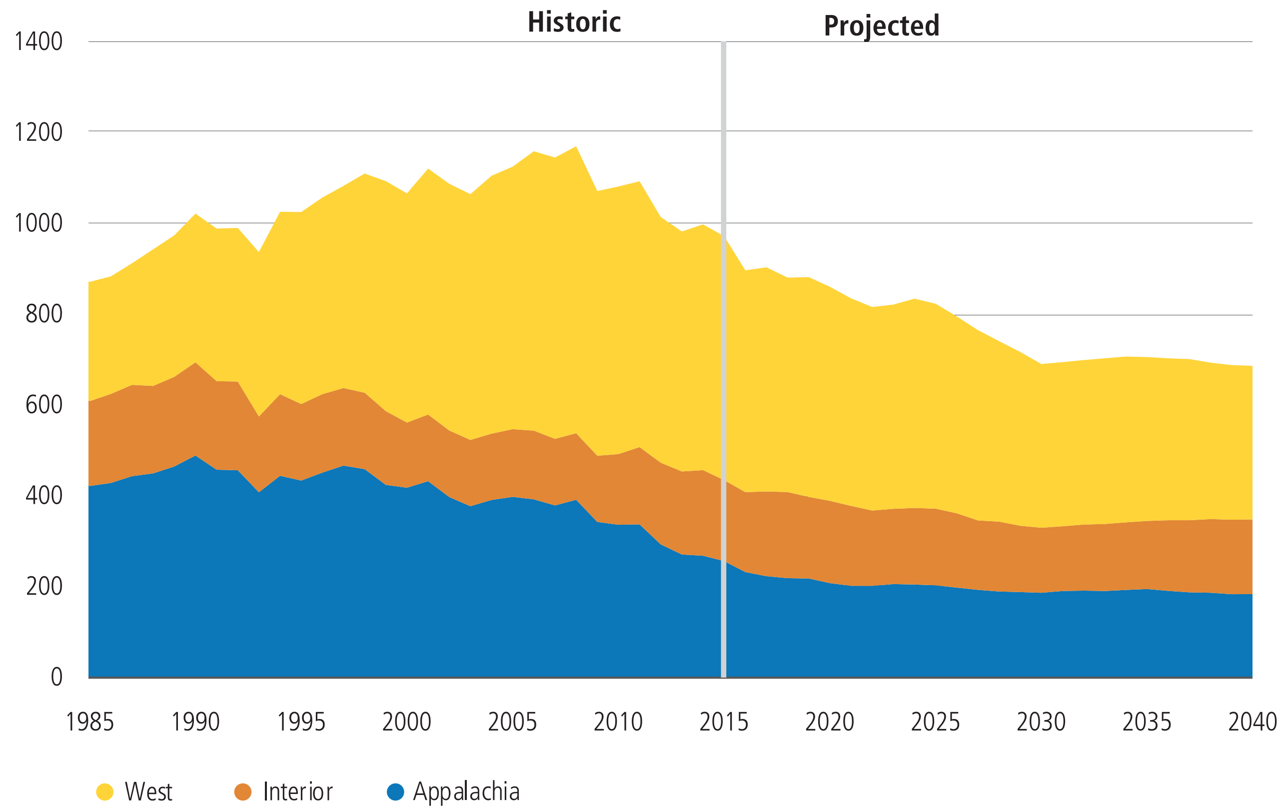
In 2015, the electricity industry consumed more than 80 percent of domestically produced coal.[54] Recent shifts away from coal for electricity generation and toward natural gas and renewable energy technologies—largely driven by recent reductions in natural gas prices and renewable generation costs—have sharply reduced overall coal demand over the past several years. Annual coal production in 2015 was at its lowest level since 1986.[55] Because of the reduction in electricity industry demand and other shifts in the economy, coal production is forecast to continue declining over the coming decades (Figure 5-5).

Coal production in the Appalachian region began falling in 1990, even as total U.S. coal production increased through 2007. The primary reason for coal's reduced market share in Appalachia is its higher relative price compared to coal in the western United States; in 2015, the price of coal from West Virginia was four times as much per ton as coal from Wyoming.[56]

Differences in mining efficiency and ownership cause the higher cost for Appalachian coal. Mines in the West tend to be larger and use surface mining techniques, which result in lower production expenses compared to the mix of underground and surface mining used in Appalachia.[57] While most mining in Appalachia occurs on private lands, 80 percent of coal production in the western United States occurs on Federal lands, where companies pay lower royalties and fees.[58] Appalachian coal's relative economic disadvantage is forecast to continue for the coming decades (Figure 5-5).[59]

**Figure 5-5. Historic and Projected Coal Production, 1985–2040[60, 61]**

(Million Short Tons)



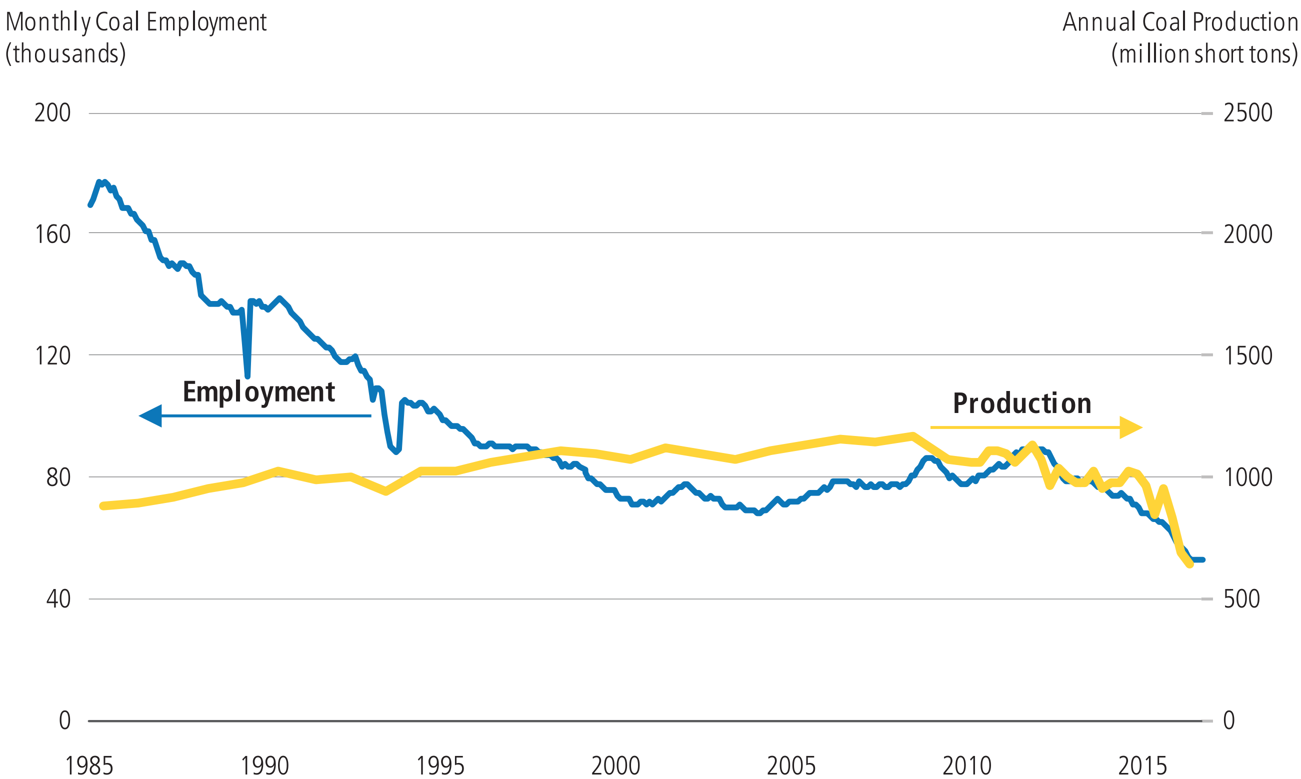

Coal production in the United States peaked in 2008 after a period of decreasing production in Appalachia and increasing production in the West. Production is forecast to continue to fall in the business-as-usual scenario shown here.

Coal mining jobs in the United States have declined over the last several decades. Between 1985 and 2000, employment in the coal industry shrank nearly 60 percent. During this period, 105,500 domestic coal jobs were lost. While national coal mining employment experienced a minor increase from 2000–2011, 36,000 coal mining jobs were lost between 2011 and September 2016, a 40 percent reduction.[g] Of these losses, nearly 90 percent were in the Appalachian region. As of November 2016, the BLS reported employment of about 53,000[h] people in the coal mining industry (Figure 5-6).[62]

[g] The base year used for this comparison is 2011 because it was the peak year for domestic coal production this century. Since then, coal mining jobs have been declining, while natural gas and oil extraction jobs have been on the rise overall.

[h] The 2017 "U.S. Energy and Employment Report" records higher coal fuels employment numbers in comparison to BLS due to differences in terms, categorizations, and survey methods; it reports 74,084 coal fuels jobs in March 2016, as shown in Table 5-2. The BLS data is relied upon here to illustrate both the recent trends and the historical record over many decades.

**Figure 5-6. Coal Industry Employment and Production, January 1985–September 2016**[63, 64]

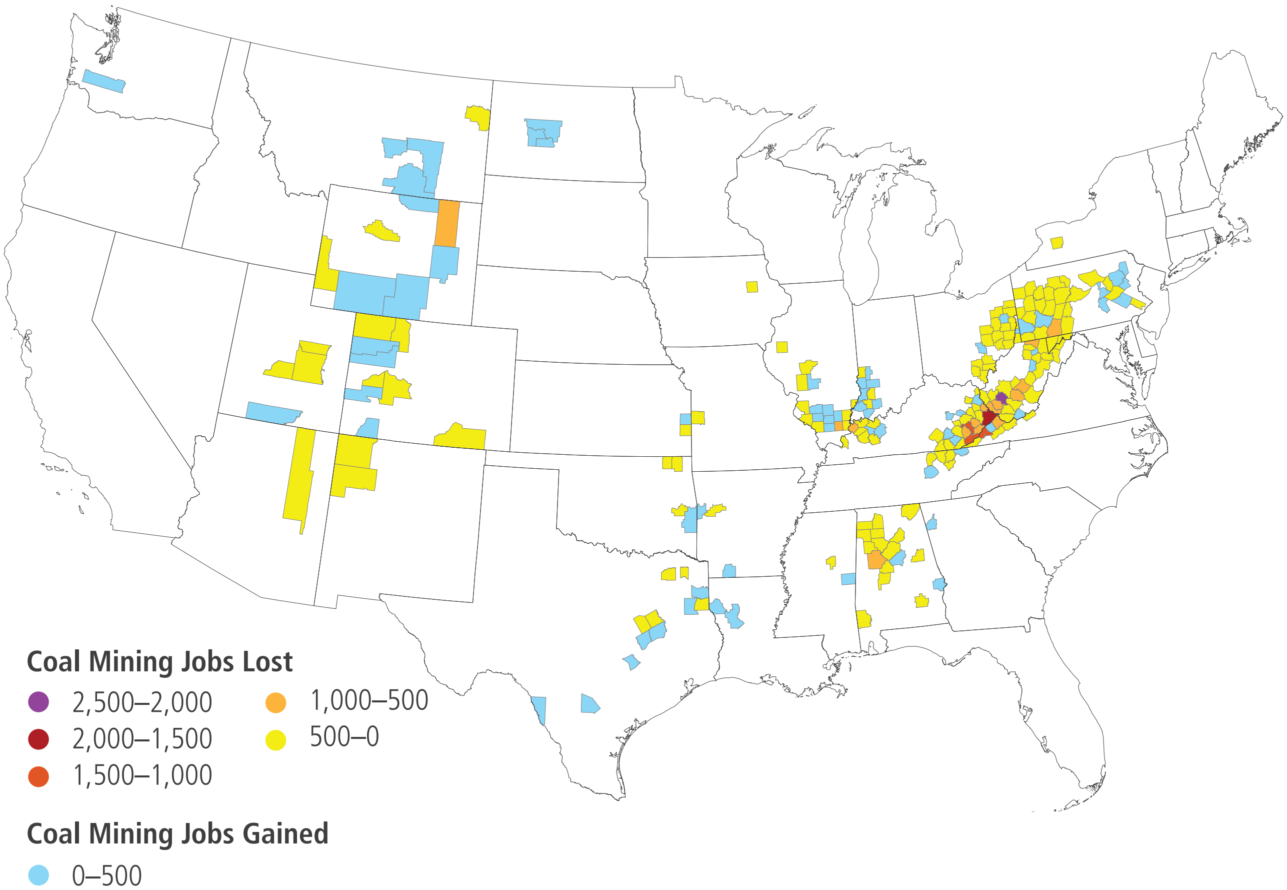



Employment in the coal industry fell from 1985 through 2003 even while coal production increased during this period. This employment reduction was due to mechanization and a shift to western coal that has much higher labor productivity than Appalachian mines. Over 23,000 jobs were lost between 2011 and 2015 while coal production decreased; nearly 90 percent of those losses were in the Appalachian region. Note: Data from 2010 to 2016 are quarterly, extrapolated to annual estimates.

This loss of coal jobs can be attributed to increased efficiencies in mining and, later, a reduction in coal demand over the last several decades. Between 1985 and 2001, coal production increased 28 percent, as industry employment fell by 59 percent, due to the increased efficiencies in the industry and by the shifting of production and lower sulfur coal produced by shifting production from Appalachia to the Western United States, especially within the Powder River Basin.[65, 66] From 2001 to 2015, annual mining productivity in Appalachia ranged from 5,100 tons per employee to 8,100 tons per employee; in the West, it ranged from 35,000 tons per employee to 45,000 tons per employee.[67]

Coal miners provide crucial economic support for the communities in which they live, which tend to be concentrated in rural areas. In 2011, at the peak of coal mining employment in this century, coal mining jobs accounted for more than 5 percent of employment in 64 U.S. counties and over 20 percent in 12 counties, not including indirect employment supporting the coal sector. Fifty of the counties with over 5 percent coal mining employment experienced job losses between 2011 and 2015.[68, 69] The total net job loss in the 64 counties was over 20,000 jobs, with 12 counties losing more than 10 percent of their entire workforce.[70, 71] These counties that have been hit particularly hard by recent employment declines are located primarily in central and northern Appalachia (Figure 5-7).

**Figure 5-7. Change in Coal Mining Employment by County, 2011–2015**[72]



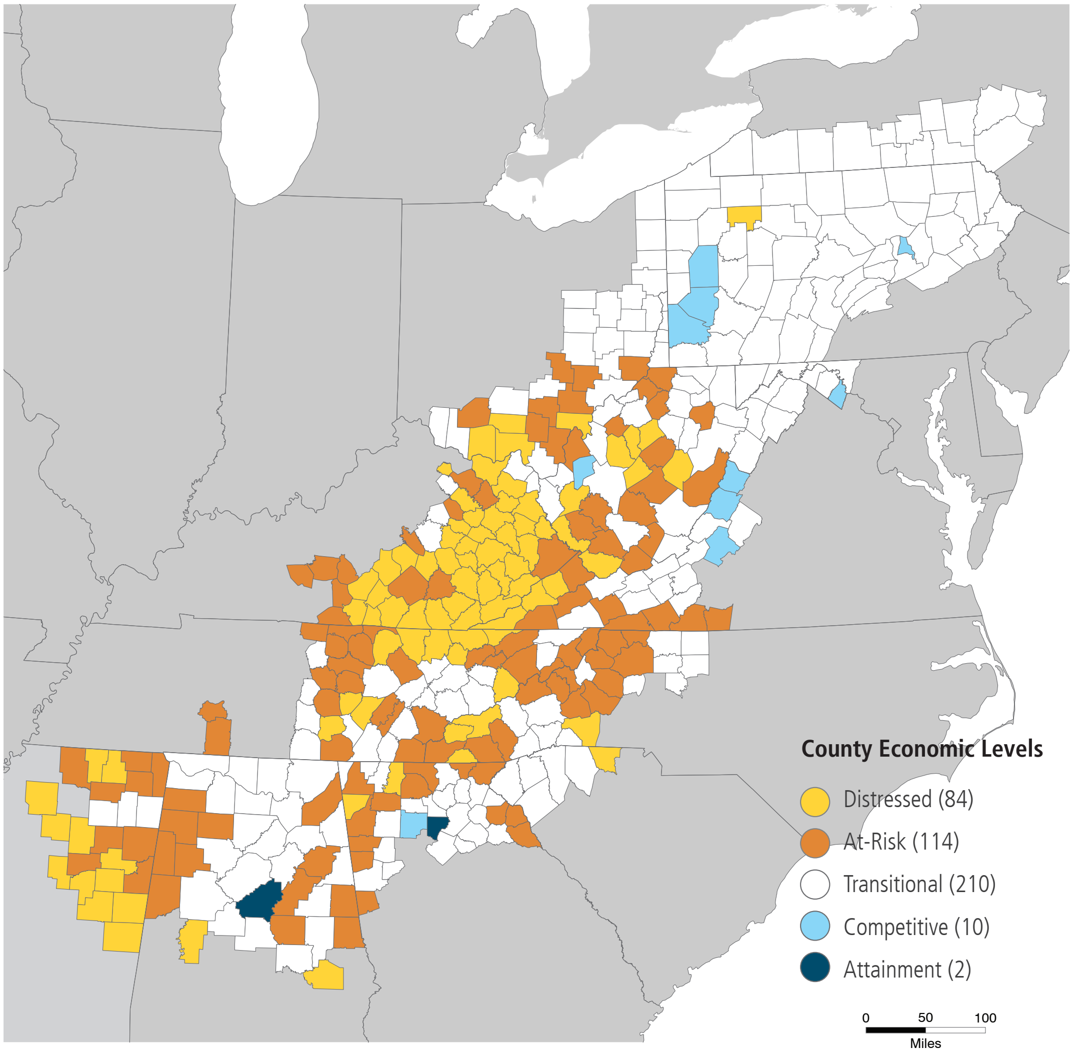

Nationally, 161 counties experienced coal industry job losses between 2011 and 2015, when over 20,000 jobs were lost in total. The most severe job losses are concentrated in central and northern Appalachia, where some regions have a high proportion of their workforce in the coal industry.

Coal mining is a major economic driver within many rural communities. Coal mining jobs pay well relative to other available occupations in those areas; miners earn roughly 40 percent more than the average wage for all U.S. workers.[73] The combination of relatively high income and employment concentration means that many local economies are very sensitive to changes in the industry.[74] A reduction in jobs lowers municipal tax revenues, severely impacting support for public schools, local infrastructure, and public services. Less spending at local businesses depresses the local economy, causing more unemployment and further reducing public revenue.

There are 1.8 million people living in Appalachian counties with ongoing coal-mining activity and classified as "economically distressed" or "economically at risk" by the Appalachian Regional Commission (ARC) based on a combined index of unemployment, poverty, and income levels.[i, 75, 76] These counties are heavily concentrated in West Virginia, eastern Kentucky, and southern Ohio, largely overlapping with regions facing coal industry employment losses (Figure 5-8).

[i] The Appalachian Regional Commission ranks all U.S. counties according to a combined index of unemployment, poverty, and income, and it considers counties in the bottom decile for the country to be "distressed" and the bottom quartile to be "at risk."

**Figure 5-8. Economic Wellbeing of Appalachian Counties, 2016[77, 78]**

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More than 45 percent of the mining workforce is over 45 years old.[79] For these employees, finding alternative employment—especially at a similar income level—can be more challenging than for younger workers with more time ahead of them in the labor force.[80] Underfunded pension and retiree healthcare obligations put these older workers, retired miners, and their communities in a particularly vulnerable position. Federal efforts to support economically vulnerable communities and workers are discussed in later sections of this chapter.

Coal miner pension funds are in financial distress, putting retirees and surviving dependents in jeopardy of losing their planned retirement and healthcare benefits. As coal employment has declined, mine worker pensions have some of the highest ratios of retirees to current workers of any pension programs in the United States, which can drain the principal balance of the fund faster than it can be replenished. The largest coal miner pension fund, United Mine Workers of America's 1974 Pension Plan, has 90,000 beneficiaries, with only 8,000 working members still contributing to the fund—a 9 percent ratio of contributing workers to active beneficiaries.[81] On average, 37 percent of pension participants in federally guaranteed, multi-employer pensions are still working and contributing to their pension funds.[82]

The financial crisis and the bankruptcy of three of the largest coal mining companies in the United States between 2014 and 2016 have further imperiled these pension and healthcare programs. These bankruptcies have allowed several large coal companies, including Patriot Coal and Alpha Natural Resource, to default on some or all of their obligations to these pension and healthcare funds.[83, 84] The miners' pension funds are insured by the Pension Benefit Guaranty Corporation (PBGC), a Federal corporation analogous to the Federal Deposit Insurance Corporation and funded out of insurance premiums paid by member pension funds. The 1974 Pension Plan is so large that its default could lead to the insolvency of the PBGC, imperiling retirements across the economy.[85] Retiree health insurance programs have no similar Federal guarantee.[86] Typically, a single employer providing retiree health insurance is not required to pre-fund such obligations, and, in bankruptcy, may be relieved of the obligation to fulfill its commitments.[87] Historically, the Federal Government has intervened to support coal miner retiree benefits in times of crisis through legislative and administrative actions.[88] President Obama's fiscal year (FY) 2016 and FY 2017 budgets included the transfer of Federal funds to protect the health and pension benefits of retired coal miners and their families, as did bipartisan legislation in the Senate and House. However, the 114th Congress adjourned at the end of 2016 without passing this legislation and instead only extended healthcare coverage to retired miners and their dependents through the term of the Continuing Resolution (April 28, 2017).

Continued reductions in coal production in Appalachia are also frustrating efforts to protect community health and the environment against land and water degradation from pre-1977 mining activities. Since 1977, the coal industry has taken responsibility for the remediation of the lands and waters affected by mining, as required by the Surface Mining Control and Reclamation Act of 1977 (SMCRA). However, prior mining activity has left an estimated $4 billion of high-priority, health-related and safety-related issues with abandoned mine lands in the United States[89] and up to $9 billion of abandoned coal mine sites needing restoration.[90] SMCRA created the Abandoned Mine Lands Reclamation Fund (AML Fund) to reclaim land damaged before 1977 using funds collected through a small per-ton fee—currently less than 1 percent of retail value—on all coal mined in the United States.[91]

Declining coal production has reduced funding for abandoned mine reclamation. AML Fund receipts have declined from a peak in 2007 of $305 million to $197 million in 2016.[92] At this revenue level, it would take 20 years to fully fund the high-priority, health-related and safety-related coal mine reclamation in the United States—the majority located in Appalachia.

The current formula for distributing AML Fund resources poorly matches regional needs. Until 2023, SMCRA requires that 50 percent of the fees collected for AML Fund restoration are spent in the state in which they are collected. Most U.S. coal is produced in the western United States, where little need for pre-1977 mine reclamation remains. Meanwhile, disbursements to Appalachia—the historic heart of coal production, where mine reclamation needs are most severe—have fallen due to declining coal production in that region. The President's FY 2016 and FY 2017 budgets proposed to invest $1 billion over 5 years from the remaining unappropriated balance in the AML Fund. The proposal would allow states and Native American tribes across the country to accelerate efforts to clean up abandoned mine lands and polluted waters, then link those projects with economic development strategies to revitalize coal communities impacted by the downturn of the coal industry. In February 2016, the Revitalizing the Economy of Coal Communities by Leveraging Local Activities and Investing More (commonly known as RECLAIM) Act (H.R. 4456), a bill consistent with the President's proposal sponsored by Congressman Hal Rogers, was introduced in the House and gained a bipartisan group of 27 co-sponsors by the end of the 114th Congress.

### Coal Power Plant Closures

From 2011 to 2015, 345 coal-fired generators were shut down and 20 were added, resulting in a loss of 33 gigawatts, or 10 percent, of the 2011 coal-fired generating capacity.[j, k] The number of power plants reporting coal as their primary fuel source dropped from 589 to 427.[l] Not all of these numbers represent closures of entire plants; many plants have multiple generating units, and some units have been switched to natural gas rather than shut down, retaining much of their workforce. Nevertheless, fossil fuel electric power generation employment fell 5 percent from 2011–2015.[m] The loss of power plant jobs in rural communities can have effects similar to those described above for coal mining job losses.

Several factors help mitigate, though not eliminate, the effects of coal-fired power plant job losses.[n, o] For example, in 2012, American Electric Power began planning for plant closures affecting 570 jobs that would occur by 2016. As closures occurred, almost half of the employees moved to positions at other plants. Some retraining occurred, but many employees received similar jobs. Other positions remained vacant after normal retirements, and many employees were retirement eligible at the time of closure due to the advanced age of the workforce.[p] These closures still affected workers and communities, but the utility's planning efforts lessened the effect.

[j] Energy Information Administration (EIA), *Electric Power Annual* 2015 (Washington, DC: EIA, November 2016), Table 4.6, http://www.eia.gov/electricity/annual/.

[k] Energy Information Administration (EIA), *Electric Power Annual* 2015 (Washington, DC: EIA, November 2016), Table 4.3, http://www.eia.gov/electricity/annual/.

[l] Energy Information Administration (EIA), *Electric Power Annual* 2015 (Washington, DC: EIA, November 2016), Table 4.1, http://www.eia.gov/electricity/annual/.

[m] Department of Labor, "Quarterly Census of Employment and Wages," Bureau of Labor Statistics, NAICS 221112, accessed November 21, 2016, http://www.bls.gov/data.

[n] Edward Louie and Joshua Pearce, *Retraining Investment for U.S. Transition from Coal to Solar Photovoltaic Employment* (Michigan: Michigan Technological University, 2016).

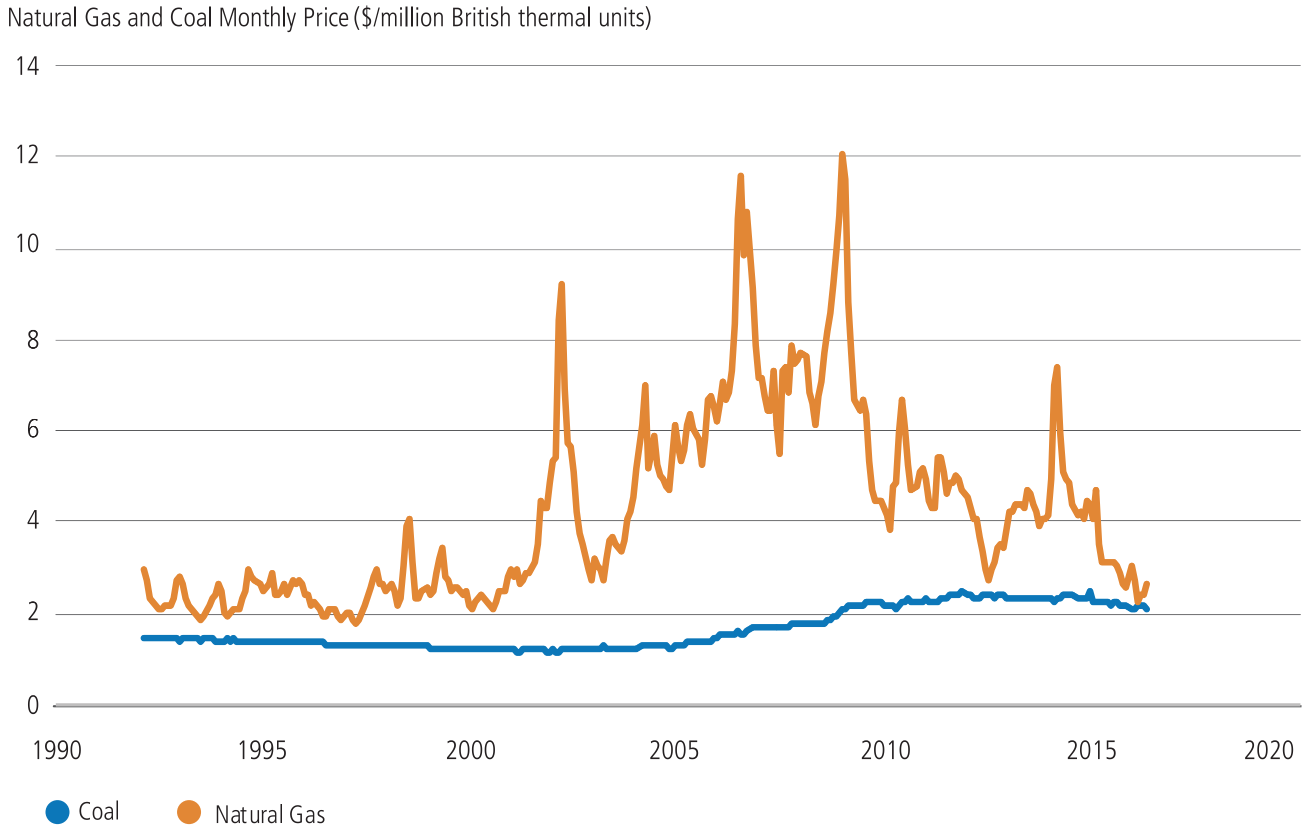
[o] Lee Buchsbaum, "Supporting Coal Power Plant Workers through Plant Closures," *Power*, June 1, 2016, http://www.powermag.com/supporting-coal-power-plant-workers-plant-closures/?pagenum=1.

[p] Lee Buchsbaum, "Supporting Coal Power Plant Workers through Plant Closures," *Power*, June 1, 2016, http://www.powermag.com/supporting-coal-power-plant-workers-plant-closures/?pagenum=1.

## Natural Gas Employment Trends Reflect Shale Boom

Beginning around 2009, the influx of new supply from unconventional sources reduced natural gas prices to pre-2000 low price levels (Figure 5-9).[93] Low prices relative to coal increased demand for natural gas from the electric power system—now the largest consumer of natural gas in the United States. From 2008 to 2015, electricity generation from natural gas rose 51 percent.[94]

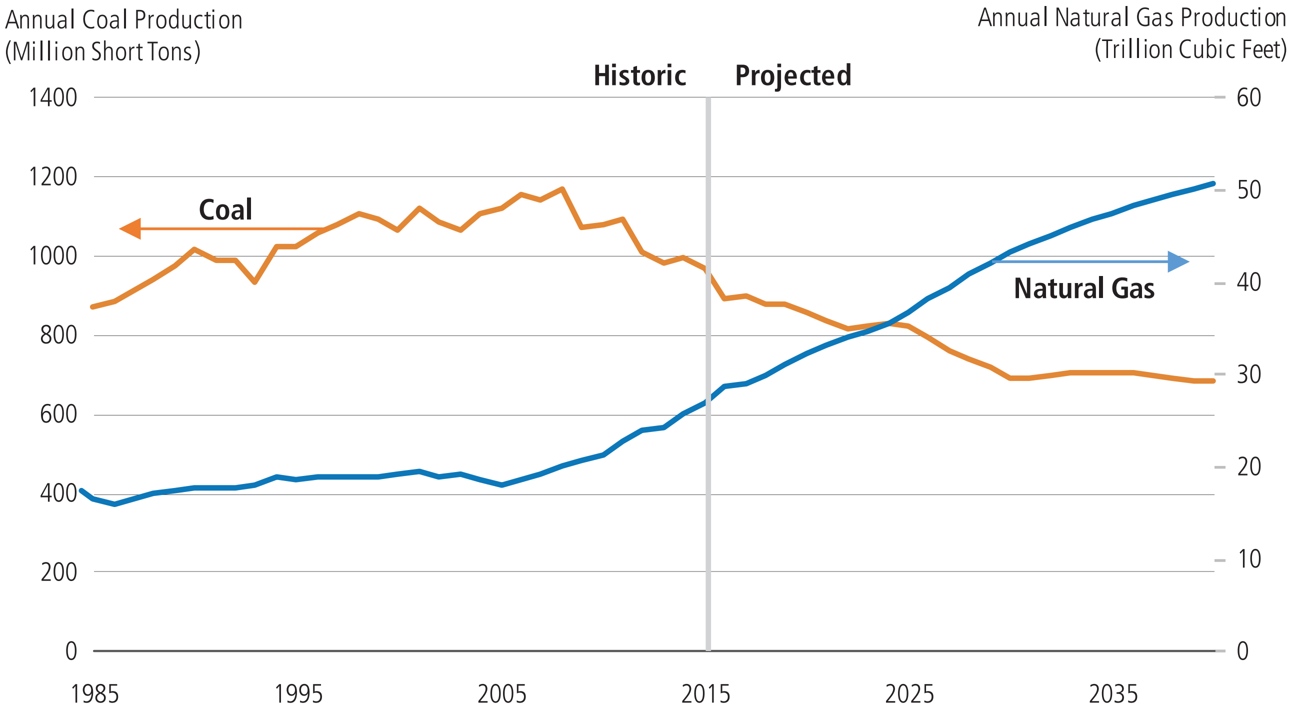
**Figure 5-9. Average Monthly Cost of Delivered Fossil Fuels in the U.S. Electricity Industry, 1993–2015[95]**




Natural gas prices fell back to pre-2000 prices around 2008. This price drop and increase in the price of coal has made natural gas more competitive than coal in many regions of the country.

The changing relative prices of natural gas and coal and the subsequent change in generation mix led to a large net increase in jobs over the last decade. The natural gas and oil extraction industry added about 80,000 jobs from 2004 to 2014.[96] When support activities, pipeline construction, and associated machinery construction are included, this number increases to about 400,000.[97] Recently, natural gas and oil extraction employment has declined by around 25,000 jobs between early 2015 through November 2016.[98] However, unlike coal production, natural gas production is projected to increase over the coming decades, sustaining natural gas industry employment (Figure 5-10).[99, 100]

**Figure 5-10. Historic and Projected Annual Coal and Natural Gas Production, 1985–2040[101, 102, 103]**




Coal production is projected to decline in the coming years in the business-as-usual scenario shown here, while natural gas production is forecast to increase substantially. These changes imply the employment prospects within these two industries. Though the oil and gas industry has lost a substantial number of jobs in 2015 and 2016, the industry is forecast to increase production in the long term.

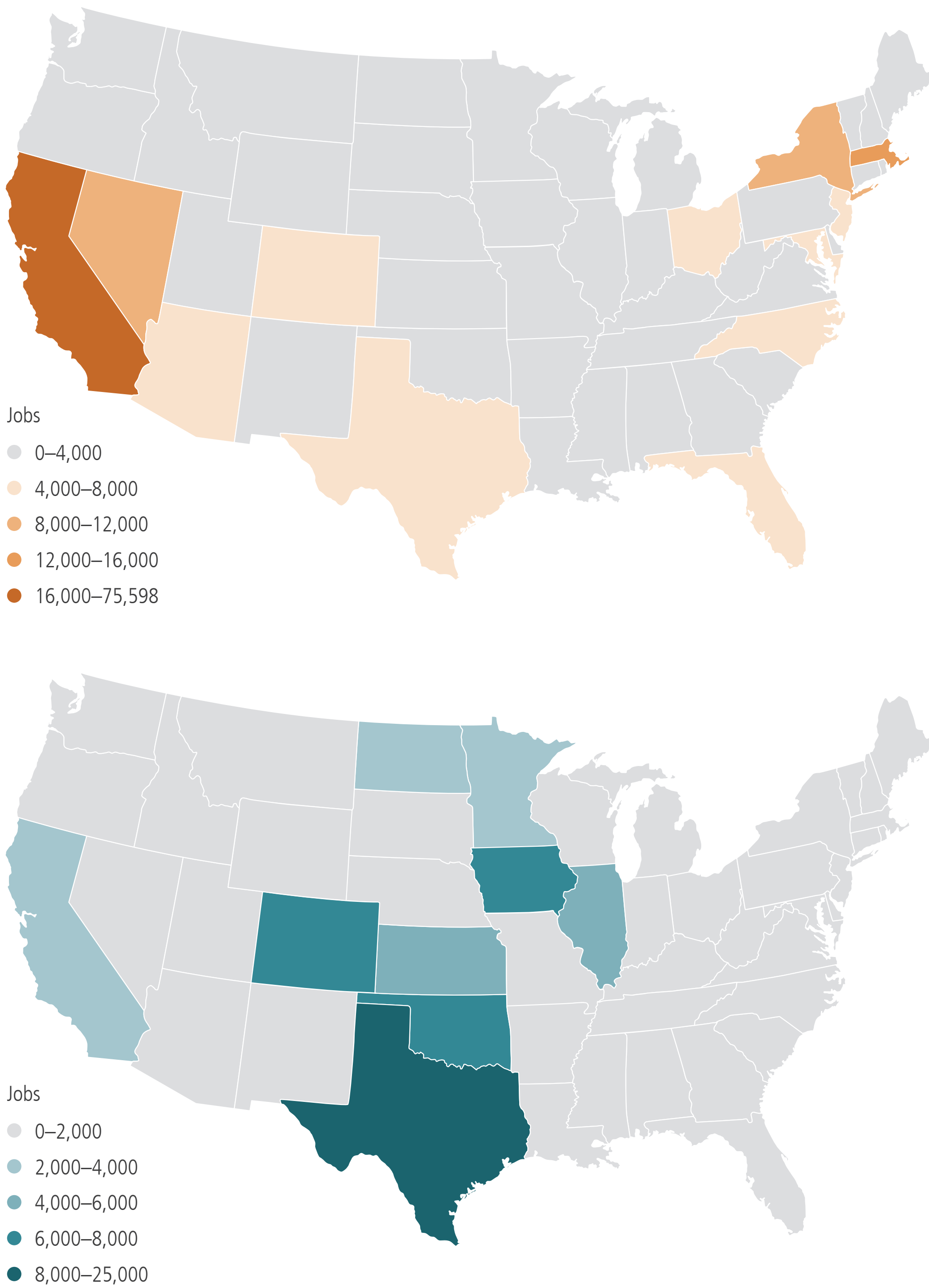
Despite potential employment growth from the expected increase in natural gas production in the coming years, jobs in the natural gas industry pose several workforce challenges. As revealed by the recent shale boom, jobs in the oil and natural gas production industry shift location regularly—posing challenges for employees and the economies of the areas where they live and work.[104] Rapid influx of workers can strain local housing availability, and subsequent outflows of workers can leave partially constructed housing in its wake.[105] While average incomes in oil and gas extraction are high (Table 5-1), job security is low, as the industry fluctuates in response to global markets and as extraction regions experience boom and bust cycles.[106] These rapid transitions are characteristic of the oil and natural gas industry, while changes in the coal industry have played out over longer periods.

## Sector Employment in Renewable Energy Continues to Grow

In 2016, the traditional energy sector employed approximately 4.1 million workers. Of these, electric power generation and fuels technologies directly employed more than 1.9 million workers. And, job growth in the renewable energy industry remains strong. Wind power constituted the largest portion of generation capacity additions in 2015.[107] Employment in the solar industry has grown over 20 percent annually from 2013 to 2015. From 2010 to 2015, the solar industry created 115,000 new jobs. In 2016, just under 375,000 individuals worked, in whole or in part, for solar firms, with more than 260,000 of those employees spending most of their time on solar. There were an additional 108,000 workers employed at wind firms across the Nation. The solar workforce increased by 25 percent in 2016, while wind employment increased by 32 percent.[108] Of the 375,000 individuals working in solar, nearly half of these are in the solar installation industry, requiring distinct skillsets compared to traditional generation technologies. Solar industry jobs are relatively high paying compared to all jobs nationally, with a significant range of earnings across occupations within the industry.

Currently, renewable energy jobs are geographically concentrated according to high-value wind and solar resources and state-specific renewable portfolio standards; over half of all the solar jobs in the United States are found in only four states (Figure 5-11).[109]

### Figure 5-11. Distribution of Solar Industry Jobs (top) and Wind Industry Jobs (bottom) by State, 2015[110, 111]




Solar industry jobs are primarily located on the coasts, while wind industry jobs are prevalent in the central United States. Together, wind and solar employment cover much of the United States. Job locations are driven by resource availability and by state policies.

## Coal, Natural Gas, and Renewable Energy Shifts Create a Mismatch in Electricity System Job Opportunities

While there is potential for long-term job growth in renewable energy and natural gas extraction and further declines in coal mining, these jobs are not substitutable. Several factors prevent employment opportunities in the renewables and natural gas industries from reaching those communities most affected by erosion of job opportunities:

- **The geographic locations of electricity sector job losses and gains are currently not well correlated.**

  *Job losses from the coal mining industry are largely concentrated in southern Appalachia, while growth in natural gas extraction and the renewable energy industry is located elsewhere.*

- **Income discrepancies between industries is a challenge for reemployment.**

  *The median wage for solar installers is higher than the median wage across all occupations. It remains more than 20 percent less than the median wage for coal mining jobs,[112] and U.S. solar manufacturing jobs generally pay 10 percent less than U.S. manufacturing jobs.[113] While there is an income discrepancy between coal and solar jobs, solar jobs are rapidly increasing. Retraining and creating more localized solar jobs is important.*

- **The skills required for employment vary between industries experiencing growth and those experiencing decline.**

  *Natural gas and coal jobs are largely extraction focused; whereas, wind and solar energy jobs are significantly manufacturing based (almost 50 percent for wind and 40 percent for solar) and construction based (20 percent for wind and almost 30 percent for solar).[114] Significant retraining would be required to transition between these jobs.*

## Employment in the Nuclear Industry

The "U.S. Energy and Employment Report" finds that 68,000 people are employed in the nuclear generation industry.[q] Employment in the industry may fall as nuclear power plants retire. Since 2013, six nuclear reactors have shut down prior to the end of their existing licenses. Another 10 reactors have made closure announcements to cease operation over the next 10 years; 8 will close before the end of their current operating licenses. Recent state actions, pending any legal challenges, may enable four of those to continue operating. However, the net employment impact of plant closures may be mitigated through employee retirements and transfers to other power generation facilities.[r]

Construction of nuclear power plants requires thousands of skilled construction workers.[s] To ensure an adequate supply of highly trained workers for the construction of nuclear reactor units at Plant Vogtle in Georgia, North America's Building Trades Unions and Georgia Power created an apprenticeship-readiness training program under the Helmets to Hardhats initiative. The program focuses on increasing workforce inclusiveness and providing job opportunities to veterans.[t]

Employment in uranium production (mining, milling, and processing) has trended with production levels. Though employment numbers are unknown prior to 1993, uranium production over the last two decades was a fraction of average annual production from 1960 to the early 1980s.[u] The uranium production industry employed 625 people in 2015, down from a 21st-century peak of 1,563 in 2008.[v]

Employment trends in the uranium industry closely mirror resource prices; these have fallen from a peak of over $100 per pound of triuranium octoxide (U3O8) in 2007 to below $30 in 2015. Prices are anticipated to remain low due to growing inventories owned by nuclear power owners and operators. Total inventories in 2015 were enough to fuel 2 years of nuclear power production at use-rate averages over the last decade.[w]

[q] BW Research, *U.S. Energy and Employment Report* (Washington, DC: Department of Energy, January 2017).

[r] Elizabeth McAndrew-Benavides, "NEI's 2015 Nuclear Workforce Survey" (presented on behalf of the Nuclear Energy Institute, October 2015), https://www.nei.org/CorporateSite/media/filefolder/Backgrounders/Presentations/NEI-s-2015-Nuclear-Workforce-Survey-Presentation-to-the-NRC-October-2015.pdf?ext=.pdf.

[s] "Nuclear Job Opportunities, Plant Vogtle Units 3 & 4," Georgia Power, accessed November 21, 2016, https://www.georgiapower.com/about-energy/energy-sources/nuclear/jobs.cshtml.

[t] "Building Trades Apprenticeship-Readiness Program," Commercial Construction & Renovation, accessed November 21, 2016, http://www.ccr-mag.com/augusta-building-trades-apprenticeship-readiness-program/.

[u] Doug Bonnar, "U.S. Uranium Production Is Near Historic Low as Imports Continue to Fuel U.S. Reactors," *Today in Energy*, Energy Information Administration, June 1, 2016, http://www.eia.gov/todayinenergy/detail.php?id=26472.

[v] Energy Information Administration (EIA), *2015 Domestic Uranium Production Report* (Washington, DC: EIA, May 2016), https://www.eia.gov/uranium/production/annual/pdf/dupr.pdf.

[w] Doug Bonnar, "U.S. Uranium Production Is Near Historic Low as Imports Continue to Fuel U.S. Reactors," *Today in Energy*, Energy Information Administration, June 1, 2016, http://www.eia.gov/todayinenergy/detail.php?id=26472.

## How Government and Industry Can Respond to Recent Changes

The broader changes in the electricity industry have created both new opportunities and new challenges for the electricity industry workforce. Opportunities include new workforce potential in the renewable energy industry and ICT; challenges include the skills gap for deploying and operating new technologies, the shift in the geographic location of jobs, and the need to recruit and retain an inclusive workforce. The government working with industry could help provide skills training, workforce data, and support for communities experiencing economic dislocation.

### Skills Training and Workforce Development

Companies, industry representatives, and labor unions have pursued a variety of skills training and workforce development programs to overcome workforce skills deficiencies.

Many utilities operate their own line worker schools, joint labor management apprenticeship programs, and other training programs, while others recruit from line worker training schools that offer introductory programs.[115] Additional programs include a uniform nuclear curriculum program and a power plant technology program.[116] In FY 2014, 7,253 apprentices were enrolled in registered apprenticeship programs for line installer/repairers, line maintainers, and line erectors.[117]

In 2006, the major industry trade associations and many leading companies formed the nonprofit Center for Energy Workforce Development (CEWD): "CEWD was formed to help utilities work together to develop solutions to the coming workforce shortage in the utility industry. It is the first partnership between utilities, their associations, contractors, and unions to focus on the need to build a skilled workforce pipeline that will meet future industry needs."[118] Today, CEWD includes the five major utility trade associations, the industry's two principal unions, and more than 100 companies that employ over 90 percent of utility workers. CEWD is organized through more than 30 state consortia that are focused on working with local educational institutions, their union apprenticeship programs, and other stakeholders to create a high-quality, diversified workforce.

Construction industry training programs are particularly important for energy efficiency. Nationally, North America's Building Trades Unions operate over 1,600 Joint Apprenticeship Training Committees (JATC) with their construction employers. These JATC's train 74 percent of all construction apprentices in the United States at a cost of $1.3 billion annually.[119]

As the electricity industry relies increasingly on ICT components in creating a smart grid, the labor intensity of the electricity grid of the 21st century may decrease. Critically important industries that face similar challenges have already used redesigned work processes and innovative workforce practices to increase efficiency. The increased use of technology—for example smart meters to reduce the need for meter readers, smart grid components that isolate faults and reduce outages, or aerial inspection technology to improve damage assessments—might also increase workforce efficiency.

### Smart Grid Workforce Training and Development under the American Recovery and Reinvestment Act of 2009

In 2010, the Department of Energy awarded nearly $100 million of funding appropriated under the American Recovery and Reinvestment Act of 2009 to support 54 workforce training programs in the utility and electrical manufacturing industries. Funding for these programs was cost-shared with community colleges, universities, utilities, and manufacturers, and it is estimated to have trained approximately 30,000 people.[x]

[x] "Obama Administration Announces Nearly $100 Million for Smart Grid Workforce Training and Development," Department of Energy, April 8, 2010, http://energy.gov/articles/obama-administration-announces-nearly-100-million-smart-grid-workforce-training-and.

## Electricity System Workforce Outreach and Inclusion Programs

In addition to government programs, private partnerships with nonprofit organizations are also focused on increasing the inclusiveness of the energy sector workforce. GRID Alternatives, together with SunEdison, created the Realizing an Inclusive Solar Economy Initiative, which focuses on recruiting members of underrepresented communities for jobs in the solar industry—providing solar installation training, working with the solar industry to identify needed skills for the trainings, linking trained candidates with available employers, and ensuring the retention of a diverse workforce in the industry.[120]

Additional targeted initiatives include the Utility Industry Workforce Initiative, where CEWD joined with the Departments of Energy, Labor, Defense, and Veterans Affairs; the International Brotherhood of Electrical Workers; and the Utility Workers Union of America to increase hiring rates of veterans in the industry.[121] Helmets to Hardhats, run by the North American Building Trades Unions, also trains veterans for the construction and utility industries.[122]

### Department of Energy Workforce Inclusion Programs

Several outreach programs have been established to build a more inclusive work environment in the energy sector. The Department of Energy (DOE) launched the Minorities in Energy Initiative in 2013 to "strive to ensure that our energy workforce more fully reflects the diversity and strengths of the country."[y] DOE, through the National Nuclear Security Agency, also sponsors the Minority Serving Institutes Partnership Program and the Cybersecurity Consortium at Historically Black Colleges and Universities.[z] In 2014, DOE also created the Solar Ready Vets® program through its SunShot Initiative.[aa] The program trains exiting service members to become solar installers and, through the Department of Defense SkillBridge program, has developed a program that provides on-base training during the last six months of service. Other programs are more broadly focused on improving participation among women and minorities in science, technology, engineering, and mathematics (STEM) fields and career pathways. Specific DOE initiatives for STEM outreach include the Clean Energy Education & Empowerment initiative and the Mickey Leland Energy Fellowship Program.[ab]

[y] "Introducing the Minorities in Energy Initiative," Department of Energy, accessed December 12, 2016, http://energy.gov/articles/introducing-minorities-energy-initiative.

[z] Carenda L Martin, "Labs Team Up with Historically Black Colleges and Universities in Cybersecurity Consortium," Lawrence Livermore National Laboratory, January 23, 2015, https://www.llnl.gov/news/labs-team-historically-black-colleges-and-universities-cybersecurity-consortium.

[aa] "Solar Ready Vets," Department of Energy, accessed November 2016, http://energy.gov/eere/sunshot/solar-ready-vets.

[ab] "Clean Energy Education & Empowerment (C3E)," Clean Energy Ministerial, accessed November 2016, http://www.cleanenergyministerial.org/Our-Work/Initiatives/Women-in-Clean-Energy; "Mickey Leland Energy Fellowship (MLEFProgram," Department of Energy, accessed November 2016, http://orise.orau.gov/mlef/.

## Federal Workforce Data and Coordinated Programs

In response to the lack of high-quality and discrete energy jobs data, the Department of Energy launched the Jobs Strategy Council, which commissioned USEER, making significant strides in improving the availability of data and insights for the energy and electricity industry workforce.[123] The second edition of the report will provide more precise job categorization—particularly for natural gas industry employment estimates—and will be published in January 2017.

Title X of H.R. 6, the 2007 Energy Bill, established the Energy Efficiency and Renewable Energy Worker Training program for the Department of Labor to administer.[124] In addition to the training program, H.R. 6 required the Secretary of Labor to collect and analyze labor market data to track energy-related workforce trends, award competitive National Energy Training Partnerships Grants to implement training for economic self-sufficiency, and develop an energy efficiency and renewable energy industries workforce. Finally, the Secretary of Labor was required to award competitive grants to states to administer labor market research, information, and labor exchange research programs, as well as renewable energy and energy efficiency workforce development programs.[125] To date, this program remains unfunded by Congress.

## Support for Communities Experiencing Economic Dislocation

The United States has a long history of providing adjustment and training programs to workers in industries undergoing transition. The Trade Adjustment Assistance program for workers in trade-exposed industries with increased import competition was established in 1962, and the broader Job Training Partnership Act was passed in 1982.[126] The Clean Air Employment Transition Assistance Program, included in the Clean Air Act Amendments of 1990 and subsequently repealed, provided training, adjustment assistance, employment services, and needs-related payments to workers who lost jobs due to a business's compliance with the Clean Air Act.[127, 128] Current changes in the electricity sector are rapid and significant; targeted assistance may aid in addressing this transition. An alternative approach for older workers in regions with few economic opportunities could also provide a financial bridge to retirement in areas of rapid transition.

ARC is a regional economic development agency created in 1965 to help the Appalachian region reach socioeconomic parity with the rest of the Nation. ARC funds business development, workforce development, infrastructure investment, and community capacity building through Federal appropriations. Despite ongoing economic challenges in the region, ARC's non-highway appropriated budget has fallen from roughly $600 million in the early 1970s to below $100 million in the 1980s. Its budget has averaged below $100 million per year until 2016 when it grew to $146 million.[129, 130]

The continued fiscal difficulties of coal miner pensions threaten the solvency of PBGC. Ensuring the continued fiscal health of PBGC would support retired workers and their spouses and provide sources of economic wealth in communities with decreasing sources of local government revenues.

While local governments experience losses in tax revenue, it is essential to ensure that children have access to adequate education. The Federal Government previously assisted in similar situations through the now-expired Department of Agriculture Secure Rural Schools (SRS) program, which provided grants to schools in communities that were suffering from the precipitous decline in logging on Federal land in the 1990s.[131] In FY 2015, the SRS program paid $222 million to localities in 41 states and Puerto Rico to invest in school systems and road infrastructure.[132, 133] The amount of support required in coal communities is likely significantly less than in the SRS program, which reached 9 million children.[134] All of the central Appalachian states spend within 10 percent of the U.S. average of $10,600 per student per year, and fewer than 100,000 students live in counties where at least 1 percent of the population works in coal mining.[135, 136, 137]

The AML Fund's inability to fully support reclamation of lands disrupted by the coal mining industry has the potential to leave communities in regions with declining local revenues with polluted and unsafe lands and few means to repair the damage. Ensuring funding and appropriate design for the AML Fund will help prevent mines that were once a source of prosperity for these communities from becoming sources of sustained financial and community health challenges.

## The Partnership for Opportunity and Workforce Economic Revitalization (POWER) Initiative

The POWER Initiative is a coordinated Federal effort designed to assist communities that are negatively impacted by changes in the coal and electricity industries by funding investments in economic revitalization and workforce training in coal communities across the United States. The Appalachian Regional Commission and the Department of Commerce's Economic Development Administration administer the program.[ac] Several first and second round grantees provide workforce development and training opportunities for workers displaced by the contraction of the coal industry in addition to economic development planning assistance.[ad]

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The recommendations based on the analysis in this chapter are covered in Chapter VII (*A 21st-Century Electricity System: Conclusions and Recommendations*).

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