Tennessee Advanced Energy Economic Impact Report

Tennessee Advanced Energy Business Council

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Research conducted by The Howard Baker Jr. Center for Public Policy
at the University of Tennessee

Tennessee
Advanced Energy
Business Council

www.TNAdvancedEnergy.com

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About Us

The **Tennessee Advanced Energy Business Council (TAEBC)** champions advanced energy as a job creation and economic development strategy. No other entity in the state concentrates specifically on this robust sector.

We educate public officials and business leaders about the value and job creation potential of Tennessee's advanced energy economy, establish strategic partnerships to connect assets with opportunities, and inform policy that expands and strengthens the industry.

TAEBC seeks to understand the advanced energy sector's priorities (manufacturers, installers, researchers, entrepreneurs, professional service providers, and companies that are end users of advanced energy technologies), share information about the value of this sector with public and private-sector leaders, and develop programs that connect and leverage our state's assets with opportunities to promote Tennessee's advanced energy economy.

The **Howard Baker Jr. Center for Public Policy at the University of Tennessee** is an education and research center that serves the University of Tennessee, Knoxville, and the public. The Baker Center is a nonpartisan institute devoted to education and public policy scholarship focused on energy and the environment, global security, leadership and governance.

We'd also like to thank the University of Tennessee and the Energy Foundation for their financial support of this report.

Executive Summary

As the advanced energy economy continues to skyrocket, it is more critical than ever for Tennessee to grow its share of this $1.4 trillion global market. Advanced energy will further enhance the state's economic development, attract companies to locate and expand in-state, and most importantly, create high-quality jobs for Tennesseans. This report is a follow up to the 2015 Tennessee Advanced Energy Economic Impact Report, which provided the first comprehensive look at the advanced energy (AE) economy in Tennessee. To measure the state's advanced energy sector, this report relies upon the critical baseline established in 2015's inaugural report, especially important to demonstrate the full, positive economic impact advanced energy is having in Tennessee, as well as to weigh future progress and identify paths for improvement.

Defining the Advanced Energy Economy

Advanced energy was defined after a thorough review of multiple studies on advanced energy, clean energy, and green energy, along with consideration of Tennessee's energy assets, for the initial 2015 report. Three years later, the conceptual definition of advanced energy continues to be interpreted somewhat differently across stakeholders and research studies. However, like its predecessor, this report uses a standard, measured, state-specific definition to assess the growth and impact of Tennessee's advanced energy economy. In measuring employment, payroll, and other economic factors, the advanced energy sector in Tennessee falls into five broad, mutually exclusive categories: AE utilities and construction; AE manufacturing; AE information; AE professional, scientific, and technical services; and AE other services.

What is Advanced Energy?

Advanced energy is a relatively new term, but already represents a $1.4 trillion global market.

To put this figure in perspective, it is almost twice the size of the global airline industry and nearly equal to worldwide apparel revenue.[1]

Rather than favoring specific technologies, the term advanced energy is technology neutral. It includes energy and transportation. Any technology that makes energy cleaner, safer, more secure, and more efficient is considered advanced energy.

Examples include electric and plug-in hybrid cars, lightweight composites for the automotive industry, natural gas-fueled trucks, pollution control equipment, bio energy, high-performance buildings, more efficient industrial processes, power reliability, smart grids, combined heat and power, and the latest wind, solar, and nuclear technologies.

Examples of Tennessee's advanced energy industry are scattered throughout this report to give readers a better understanding of the breadth and depth of the advanced energy economy.

1 Advanced Energy Economy, "Advanced Energy Now: 2017 Market Report," 2017. **http://info.aee.net/hubfs/PDF/AEN-2017-Market-Report.pdf**

Trends in Advanced Energy in Tennessee

This valuable follow-up report provides an opportunity to chart significant trends in the state's advanced energy economy, which has soared since 2015.

Fast Facts: Tennessee's advanced energy economy

Employs nearly 360,000 Tennesseans

Includes more than 18,000 businesses

Contributes nearly $40 billion to the state's GDP

Showed stronger growth than the overall state economy

→ The advanced energy sector employs Tennesseans in high-quality jobs

AE employs 358,360 Tennesseans, accounting for nearly 14 percent of total employment in the state and with total payroll expenditures of $21.4 billion. The AE manufacturing sector represents the largest share of the advanced energy employment at 41.6 percent, followed by AE utilities and construction at 27.7 percent of total advanced energy employment. Workers in the advanced energy sector earn an average wage of $59,665, compared to the state's economy-wide average of $44,317.

The advanced energy economy has significantly contributed to the state's goal of becoming the #1 location in the Southeast for high-quality jobs. The advanced energy workforce and employers have benefited tremendously from initiatives such as "Drive to 55" (to equip 55 percent of Tennesseans with a college degree or certificate by the year 2025) and the complementary "Tennessee Reconnect" program (to help adults attend a community college or technical college and complete a postsecondary degree or credential, tuition-free).

→ The advanced energy sector is growing — and this means more jobs for more Tennesseans

Employment in the advanced energy sector in Tennessee grew by 10.3 percent, a rate higher than the state's overall growth rate of 8.3 percent. The number of companies in Tennessee's advanced energy sector grew 4.8 percent to 18,107 business establishments.

Most significantly, employment continues to grow in the AE professional, scientific, and technical services—the highest paying of the advanced energy sector with an average annual wage of nearly $70,000—and employment associated with each advanced energy activity has increased overall and within each industry group.

→ Advanced energy boosts our state economy

The advanced energy sector in Tennessee generates $39.7 billion in state GDP and comprises more than 10 percent of the state's total GDP. The AE manufacturing sector contributes the most and also leads in economic output. Because this output is produced in Tennessee but sold outside the state, the advanced energy sector enhances the state's competitiveness through the supply chain.

Likewise, inflation-adjusted state and local sales tax revenues due to advanced energy are increasing. Compared to the 2015 report, total state sales tax revenue for the advanced energy sector increased by 31 percent, totaling $823 million. Local sales tax revenue increased by nearly 34 percent, amounting to $289 million to our local government coffers.

→ The advanced energy sector positions Tennessee as an attractive place to do business

Thanks to the advanced energy economy, Tennessee is earning a reputation as the kind of place high-profile companies seek to locate their business. In early 2018, Amazon — committed in its core mission to sustainability and also seeking a second headquarters projected to need a workforce of about 50,000 people — elevated Nashville, the largest metropolitan advanced energy employer, to the finalist round for HQ2. Tennessee also ranks as a top state in the nation for automotive manufacturing. With the global markets increasingly trending toward fuel-efficient vehicles, Tennessee's auto sector is a crown jewel of the state's advanced energy potential.

→ Advanced energy contributes to rapid growth in metropolitan areas

The advanced energy sector thrives in most of Tennessee's major metropolitan areas, with advanced energy jobs in Nashville accounting for nearly 14 percent of employment in the region. In Memphis, the second-largest advanced energy employer in the state, total payroll spending related to advanced energy activity is nearly $3 billion. And Knoxville, the third-largest advanced energy employer in the state, presents a unique case where the largest sector is professional, scientific, and technical services, which employs more than 17,000 Tennesseans. The AE information sector is experiencing the largest growth of the five advanced energy categories in seven of 10 metropolitan areas. Growth in advanced energy employment has outpaced growth in total employment in six of 10 metropolitan areas, good news for the Tennessee workforce.

→ The advanced energy economy can enhance economic development in rural areas too

While most of the growth is being experienced in metropolitan areas, the advanced energy sector has the potential to create economic development opportunities in rural areas as well. The advanced energy sector is a cluster of diverse industries with strong growth potential not tethered to urban areas alone. Reports such as this one can help policymakers and stakeholders alike identify and develop strategies to increase high-quality employment opportunities and draw new capital investment to rural parts of the state.

→ County-level impacts of the advanced energy economy

Although the advanced energy economy extends across all 95 counties in the state, advanced energy activities are concentrated in a small number of counties. The top 20 counties employ nearly 286,000 Tennesseans in advanced energy jobs and spend $12.3 billion in payroll, representing 80 percent of the total advanced energy activity in the state. Nineteen of the top 20 counties detailed in the last report remained in the updated top 20. New to the list is Wilson County, ranked 19th, while Putnam County, ranked 20th in the last report, fell to 22nd in the update. On the flip side, Shelby County is the largest advanced energy employer in state, barely surpassing the former number one, Davidson County, which fell to second, while still experiencing growth in employment/payroll.

Conclusion

When comparing against the baseline report published in 2015, the advanced energy economy is thriving in Tennessee, setting the state up as a nation-leading example for how to create high-quality jobs and attract state-of-the-art industries. Overall, analysis of the economic data underscoring this and the initial report indicate that the advanced energy sector in Tennessee and each industry subgroup has experienced positive growth since 2013. The growth rate for the number of employees, payroll spending, and number of establishments associated with advanced energy activity is higher than the growth rates for all industries within Tennessee.

The state's advanced energy economy contributed nearly $40 billion to state GDP in 2016, and output generated by the sector indicates vibrant growth of the advanced energy sector. The advanced energy sector enhances Tennessee's competitive advantage and sets the state up as an attractive place to do business. Just as the advanced energy economy has grown since the initial Advanced Energy report, it can be expected that this growth will continue into the future as more producers and consumers demand energy efficient products, seek energy efficient manufacturing processes, and strive to reduce energy use.

Therefore, the advanced energy industry represents a sound candidate for inclusion as a statewide targeted industry cluster. Tennessee and its local communities commonly target specific industries and industry clusters as part of their broad-based economic development strategies. These targets then become the focus of business recruitment, expansion, and retention strategies through a variety of policies including marketing, workforce development, infrastructure development, and incentives. The targeted approach to economic development is intended to maximize the returns to business development efforts and better coordinate public policy.

As concluded in the Ceres study Power Forward 3.0, "the largest companies in the United States are steadily increasing their clean energy and energy efficiency efforts while improving their bottom lines. " This can only be good news for Tennessee's advanced energy economy, which has a critical role to play in the manufacturing and research development of the components that will allow those advancements to be met.

Introduction

An increasing number of businesses are investing in advanced energy to power their operations, offset their consumption of conventional energy, or gain a competitive edge in the marketplace. For example, Denso announced a $1 billion plant expansion in Maryville, Tennessee, which allows the company to move production of advanced components for electric and connected vehicles from Japan to the U.S.[2] Twenty-one corporations last year publicly announced renewable energy contracts with energy providers, compared to just four companies in 2013.[3]

These are just three examples out of many of the ongoing development of advanced energy (AE), which is now a $1.4 trillion global market that generated $200 billion in revenue nationally in 2016.[4] Other examples are included throughout this report.

Given the emergence, growth, and potential of the advanced energy economy, many states have commissioned reports to document the presence and size of this diverse sector of their state economy. This includes Arkansas, California, Iowa, Illinois, Pennsylvania, Florida, Massachusetts, North Carolina, South Carolina, Vermont, Washington, and more recently Indiana and Texas. Some of these state-specific studies have relied on relatively small surveys while others have used more expansive methods. These state studies show that advanced energy employment is roughly one to four percent of overall statewide employment. To put this figure in perspective, Tennessee's transportation equipment sector will employ about 74,000 workers in 2018, or 2.4 percent of statewide nonfarm employment.

This report updates the baseline study, Tennessee Advanced Energy Economic Impact Report, which was published in 2015 and identified trends in the advanced energy economy in Tennessee. The first report provided a benchmark for the state's advanced energy economy based on 2013 County Business Patterns (CBP) data acquired from the U.S. Census Bureau. This update relies on the same source of information. The data include information on the number of business establishments, number of employees, and payroll expenditures, based on the North American Industrial Classification System (NAICS). Once again, data are analyzed at the county, metropolitan statistical area (MSA), and state levels.

Consistent with the baseline report, 62 four-digit industry groups were identified as part of Tennessee's advanced energy sector. These industries represent both current advanced energy activity and the foundation for future growth opportunities in the advanced energy sector. The 2015 baseline analysis identified 17,334 business establishments as part of the Tennessee's advanced energy sector, employing 324,920 individuals in the state and generating $33.4 billion in state gross domestic product (GDP).

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2 Automotive News, "Why Denso is pending big in East Tennessee," 6/11/2018. **http://www.autonews.com/article/20180611/OEM10/180619972/denso-east-tennessee-investment**
3 Rocky Mountain Institute Business Renewables Center, 2018. **http://www.businessrenewables.org/corporate-transactions/**
4 Navigant Research for Advanced Energy Economy, "Advanced Energy Now: 2017 Market Report," 2017. **https://www.info.aee.net/hubfs/PDF/AEN-2017-Market-Report.pdf**

This updated analysis using 2016 CBP data reveals that Tennessee's advanced energy economy has grown significantly. The number of businesses engaged in the advanced energy sector has grown by 4.8 percent, totaling 18,170 establishments in 2016. The advanced energy sector now supports 358,360 jobs, which is a 10.3 percent increase from 2013. Lastly, the advanced energy sector's contribution to state GDP has increased to $39.7 billion. The Nashville MSA continues to be the largest contributor to the advanced energy sector and accounts for 32.1 percent of the state's advance energy employment.

At the state level, growth in employment, payroll expenditures, and the number of establishments in the advanced energy sector outpaced total growth for the overall Tennessee economy by a significant margin. The lesson from these figures is that the advanced energy economy is creating significantly more new opportunities for the business community and state residents than the state economy as a whole. If you are looking for opportunity, look to Tennessee's advanced energy sector.

TENNESSEE ADVANCED ENERGY CASE STUDIES

Schneider Electric Franklin, TN

Schneider Electric is a French-based global corporation specializing in energy management and automation with a focus on efficiency and sustainability. In 2018 Schneider Electric opened its southeast regional hub in Franklin, Tennessee, in a newly constructed 150,000 square-foot space, making the hub the largest Schneider Electric office in the country. The move consolidated its existing Middle Tennessee operations and relocated 900 current employees. More than 250 new jobs were created.

Wacker Polysilicon Bradley County, TN

Munich-based global chemical company Wacker is expanding its $2.5 billion polysilicon production plant in Charleston, Tennessee. The Tennessee plant where polysilicon is made for use in solar power panels marked the biggest single private manufacturing investment in state history, as well as the biggest single investment in Wacker's history. Now the chemical giant is investing an additional $150 million into expanding its facilities and workforce. At least 50 new jobs will be created to join the existing 650 people who work at the plant.

Defining the Advanced Energy Economy

Defining and assessing the economic impacts of the advanced energy sector within a state is an essential and valuable undertaking. States have long supported monitoring and nurturing key industries that have been pivotal to economic development. More recently, the focus has shifted to business and industry clusters that cross traditional NAICS boundaries. The advanced energy sector is an example of a cluster of diverse industries and business groupings that encompass multiple NAICS sectors. Tracking such a cluster, particularly an emerging one with strong growth potential, is informative for policymakers and stakeholders alike. This can aid in the development of strategies intended to increase high-quality employment opportunities and new capital investment in the state.

The first Tennessee Advanced Energy Economic Impact Report, which was published in 2015, provided a baseline for measuring the advanced energy sector in Tennessee. As part of that report, the advanced energy sector was defined after a thorough review of multiple studies on advanced energy, clean energy, and green energy, along with Tennessee's advanced energy assets. After extending this review to include additional recent studies, the conceptual definition of the advanced energy sector continues to be the following:

> **An advanced energy firm is defined as being directly involved with researching, developing, producing, manufacturing, distributing, selling, or implementing components, goods, or services related to advanced energy; energy efficiency; renewable, nuclear, and natural gas electricity generation; distributed generation; advanced manufacturing; lightweight composites for the automotive industry; electric and hybrid vehicles; pollution control technologies; smart grid; and other related technologies. This can include supporting services such as consulting, finance, tax, and legal services related to advanced energy. It includes farm workers involved in growing feedstock (corn, soy, etc.) for advanced fuels.**

Research, including the aforementioned studies from other states, recognizes that defining advanced energy and measuring its size is challenging. Advanced energy is interpreted somewhat differently across stakeholders and research studies. Moreover, measuring the size and impacts of the advanced energy sector is complicated since it crosses traditional industrial (and occupational) categories, as noted above. Similar challenges arise in defining related "green" or "clean" industries which do not fall into a neat industry classification. Unfortunately, there is no publicly available national or regional database on the advanced energy economy and its sub-industries.

Studies undertaken for Arkansas, California, Iowa, Massachusetts, North Carolina, South Carolina, and Vermont have taken a conceptual approach similar to that followed here where advanced energy activity is classified as being directly involved with researching, developing, producing, manufacturing, distributing, selling, or implementing components, goods, or services related to alternative fuels and vehicles, energy efficiency, renewable, nuclear, and natural gas electricity generation; smart grid; and other related technologies. This classification system can include supporting activities such as consulting, finance, tax, and legal services related to advanced energy. This definition characterizes the activities of a firm in the advanced energy industry on being on either the demand or supply side of the market.[5] Tennessee has several advanced energy assets that are unique to the state. A review of Tennessee's Advanced Energy Asset Inventory[6] reveals that Tennessee's advanced energy sector is extensive and encompasses a variety of organizations including research institutions, economic development organizations, companies, and advanced energy entrepreneurs as well as training programs in advanced energy technology. Therefore it is important to be mindful of these assets — which have likely seen significant expansion — as we define advanced energy for Tennessee.

For example, initiatives at the Tennessee Valley Authority, Oak Ridge National Lab, and the University of Tennessee have been responsive to efforts by Tennessee's automotive manufacturers to promote clean and advanced technologies, both in their products and in the operation of their manufacturing facilities. Tennessee has ranked as the number one state for automotive manufacturing strength in five of the last eight years.[7] Given the global shift toward fuel efficient vehicles, the automotive sector represents a major end-user and manufacturer of advanced energy technologies.

In this report, the familiar NAICS industry accounting scheme is used to identify industries that are part of the advanced energy economy. NAICS codes are a common classification system across Canada, Mexico, and the U.S. and cover all economic activity.[8] NAICS codes identify sectors by grouping firms together that have similar production processes for goods and services. The system, which uses two- through six-digit codes, is hierarchical, where the first two digits identify sectors while more digits provide progressively more narrowly defined industry groups.

In the first Tennessee Advanced Energy Economic Impact Report, NAICS codes were identified that depict the advanced energy economy by examining previous studies on advanced energy, clean energy, and green energy by other states and national organizations. Each of the selected NAICS codes were identified by either the Center for Community Innovation at the University of California, Berkeley; the Puget Sound Regional Council and the Workforce Development Council of Seattle-King County; Iowa Workforce Development; the Brookings Institution; or the Washington State Employment Security Department. This resulted in a total of 62 four-digit NAICS codes, all of which capture some element of the definition of advanced energy presented above. These selected industries not only capture firms that are currently engaged in advanced energy activity but also firms that are poised to take advantage of future growth opportunities in the advanced energy sector. In this study, we provide an updated

5 An alternative means of conceptualizing the advanced energy economy is to consider the characteristics of production and service processes instead of the nature of products and services themselves. This is the approach taken by the Brookings Institution, which examines trends in advanced industries in a recent report (Muro et al., 2016). Industries are classified as advanced if the R&D spending per worker ranks among the top 20 percent of industries and the share of workers with a high level of STEM knowledge exceeds the national average, which is 21 percent. This results in 50 advanced industries in which output and employment levels are summarized at the national level, state level, and for the largest 100 metropolitan areas. Most definitions of advanced industry, including those discussed in the text, focus on products or services, whereas Brookings seeks to focus on innovation and skills that underlay production processes. This approach is not practical for states since detailed R&D and other data are simply not available.

6 Tennessee Advanced Energy Business Council, "Tennessee Advanced Energy Asset Inventory," Sept. 2013. **https://www.tnadvancedenergy.com/advanced-energy-asset-inventory/**

7 Tennessee Department of Economic and Community Development. **http://www.tnecd.com/industries/automotive/**

8 North American Industry Classification System, 2017. **http://www.census.gov/eos/www/naics/**

impact assessment of the advanced energy sector using the same 62 NAICS codes, which naturally describe five different industry groups:

- Advanced energy utilities and construction;
- Advanced energy manufacturing;
- Advanced energy information;
- Advanced energy professional, scientific, and technical services; and
- Advanced energy other services (includes administrative and support, waste management and remediation services, and health care and social assistance).

AE manufacturing is the largest group and is composed of 36 four-digit NAICS industries. AE utilities and construction is the second-largest group with nine NAICS industries. AE information includes seven four-digit NAICS industries, while AE professional, scientific, and technical services has six NAICS industries. Finally, AE other services includes four NAICS industries. The selected NAICS codes that characterize the AE economy are listed in Table 1.

Table 1: Advanced Energy NAICS Industry Groups

Industry Group	NAICS	Descriptor
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution
	2212	Natural Gas Distribution
	2361	Residential Building Construction
	2362	Nonresidential Building Construction
	2371	Utility System Construction
	2379	Other Heavy and Civil Engineering Construction
	2381	Foundation, Structure, and Building Exterior Contractors
	2382	Building Equipment Contractors
	2383	Building Finishing Contractors
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation
	3221	Pulp, Paper, and Paperboard Mills
	3241	Petroleum and Coal Products Manufacturing
	3251	Basic Chemical Manufacturing
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing
	3253	Pesticide, Fertilitzer, and Other Agricultural Chemical Manufacturing
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing
	3259	Other Chemical Product and Preparation Manufacturing
	3272	Glass and Glass Product Manufacturing
	3279	Other Nonmetallic Mineral Product Manufacturing
	3311	Iron and Steel Mills and Ferroalloy Manufacturing
	3313	Alumina and Aluminum Production and Processing
	3315	Foundries
	3331	Agriculture, Construction, and Mining Machinery Manufacturing
	3332	Industrial Machinery Manufacturing
	3333	Commercial and Service Industry Machinery Manufacturing
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing
	3339	Other General Purpose Machinery Manufacturing

Table 1: Advanced Energy NAICS Industry Groups (cont'd)

Industry Group	NAICS	Descriptor
Advanced Energy Manufacturing	3341	Computer and Peripheral Equipment Manufacturing
	3342	Communication Equipment Manufacturing
	3343	Audio and Video Equipment Manufacturing
	3344	Semiconductor and Other Electronic Component Manufacturing
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing
	3346	Manufacturing and Reproducing Magnetic and Optical Media
	3351	Electric Lighting Equipment Manufacturing
	3352	Household Appliance Manufacturing
	3353	Electrical Equipment Manufacturing
	3359	Other Electrical Equipment and Component Manufacturing
	3361	Motor Vehicle Manufacturing
	3362	Motor Vehicle Body and Trailer Manufacturing
	3363	Motor Vehicle Parts Manufacturing
	3364	Aerospace Product and Parts Manufacturing
	3366	Ship and Boat Building
	3369	Other Transportation Equipment Manufacturing
	3391	Medical Equipment and Supplies Manufacturing
	3399	Other Miscellaneous Manufacturing
Advanced Energy Information	5112	Software Publishers
	5152	Cable and Other Subscription Programming
	5172	Wireless Telecommunications Carriers (except Satellite)
	5174	Satellite Telecommunications
	5179	Other Telecommunications
	5182	Data Processing, Hosting, and Related Services
	5191	Other Information Services
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services
	5414	Specialized Design Services
	5415	Computer System Design and Related Services
	5416	Management, Scientific, and Technical Consulting Services
	5417	Scientific Research and Development Services
	5419	Other Professional, Scientific, and Technical Services
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal
	6215	Medical and Diagnostic Laboratories
	8112	Electronic and Precision Equipment Repair and Maintenance
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance

The U.S. Census Bureau's CBP data are used to characterize the economic impacts of the advanced energy sector. The database is for all firms in the state and provides information on the number of establishments, payroll expenditures, and the number of employees by NAICS code. The latest available data describes economic activity for 2016, and thus provides an update from the previous report, which used data for 2013. The data are available at the county, metropolitan statistical area (MSA), and state level. To prevent data from being released on individual companies, payroll data are withheld for NAICS codes for which there are disclosure concerns. In addition, employment levels for these NAICS codes are reported

in ranges. In these cases, the midpoint of the range in employment is used, which is consistent with the previous report. In practice, disclosure issues increase as the geographical area becomes smaller (i.e., going from state-level data to county-level data). The number of NAICS codes and which NAICS codes are affected by disclosure issues also differ between the annually released databases. For the NAICS codes that are included in the advanced energy sector, fewer NAICS codes had data withheld in the 2016 CBP compared to the 2013 CBP data. Less data needing to be withheld is indicative of the growth in the advanced energy sector between 2013 and 2016.

TENNESSEE ADVANCED ENERGY CASE STUDIES

FedEx Memphis, TN

Headquartered in Memphis, Tennessee, FedEx is a leading multinational courier delivery services company. In 2018 the corporation announced a $1 billion investment to upgrade and expand its Memphis hub, a transformative undertaking projected to take more than seven years, increase its existing 11,000 workforce, and modernize its Tennessee campus into the world's most sophisticated cargo hub.

FedEx is a global leader in sustainable corporate practices. Through its EarthSmart program, the corporation integrates innovative sustainable practices into its everyday operations: FedEx has explicitly committed to 100 percent renewable packaging, carbon-neutral envelope shipping, and is actively engaged in the development of smarter, sustainable jet fuel alternatives.

Oak Ridge National Laboratory & Centrus Energy Oak Ridge, TN

Centrus Energy is a global supplier of nuclear fuel and leader in the development and handling of the world's most advanced uranium enrichment centrifuges. From its facility in Oak Ridge, Tennessee, Centrus is partnered with Oak Ridge National Laboratory to to develop and advance a highly efficient uranium enrichment gas centrifuge technology, the AC100, to meet evolving national security and energy security needs. The partners announced a new contract in 2017 to continue this effort valued at $16 million.

RAE Johnson City, TN

Renewable Algal Energy is an algal biotechnology firm headquartered in Johnson City, Tennessee. It developed groundbreaking technology to produce sustainable, economically viable products from microalgae. At its plant in Arizona, RAE grows, harvests, and processes algae for simultaneous production of high-quality carotenoids, protein, and oil, using patented technology that keeps prices competitive in the commodity market. These algal products are used to manufacture biodiesel fuel and as natural alternatives to whey and soy products.

Tennessee's Advanced Energy Economy: Statewide Impacts

Advanced Energy Outcomes

In 2016, there were 358,360 advanced energy jobs in Tennessee, which represents 13.8 percent of total employment in the state. Manufacturing has the largest share of employment at 149,112 and represents 41.6 percent of total advanced energy employment. Following manufacturing, utilities and construction is the next largest contributor to employment at 99,110, or 27.7 percent of total advanced energy employment. AE professional, scientific, and technical services provides 75,615 jobs (21.1 percent of advanced energy employment), while AE information provides 20,077 jobs (5.6 percent of advanced energy employment). Lastly, AE other services employs 14,446 individuals, which represents 4.0 percent of total advanced energy employees in the state.

Given that manufacturing is the largest employer in the advanced energy sector, it follows that it accounts for the most payroll spent in 2016 at almost $8.9 billion. The other advanced energy industry groups follow a similar pattern. Both AE utilities and construction and AE professional, scientific, and technical services spend almost $5.3 billion in payroll. Firms in the AE information group incur about $1.2 billion in payroll expenditures, while firms in the AE other services group spend $775 million. This yields a total of $21.4 billion in payroll expenditures in Tennessee for firms affiliated with advanced energy activity.

These payroll expenditures and employment levels for advanced energy activity in Tennessee result in an overall average annual wage of $59,665, which is substantially higher than the state average for all jobs ($44,317). Employees in the AE professional, scientific, and technical services group earn the highest average wage at $69,813 annually. AE information earns the second-highest average wage at $60,350, followed closely by AE manufacturing at $59,448. Lastly, AE other services and AE utilities and construction earn an average wage of $53,659 and $52,987, respectively.

Table 2 summarizes the CBP data for the advanced energy sector in Tennessee by industry groups as well as the growth in advanced energy activity since 2013.

Table 2: Advanced Energy in Tennessee by Industry Group, 2016

Industry Group	Employment		Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	99,110	9.5%	$5,251,538	20.9%	8,509	3.4%
AE Manufacturing	149,112	6.5%	$8,864,401	48.8%	1,811	0.7%
AE Information	20,077	5.1%	$1,211,619	16.7%	900	29.3%
AE Professional, Scientific, & Technical Services	75,615	21.6%	$5,278,895	24.5%	6,060	5.2%
AE Other Services	14,446	9.6%	$775,154	4.2%	890	4.7%
Total Advanced Energy Industry	**358,360**	**10.3%**	**$21,381,607**	**31.0%**	**18,170**	**4.8%**

The number of advanced energy establishments in the state follows a different trend compared to rankings for employment and annual payroll. While manufacturing holds the largest number of jobs, AE utilities and construction have the largest number of establishments in the state at 8,509, which represents 46.8 percent of advanced energy establishments in Tennessee. AE professional, scientific, and technical services has the second-highest number of establishments at 6,060, which is 35.3 percent of all advanced energy establishments. While AE manufacturing employed the most people in the advanced energy sector, it only consists of 1,811 establishments. AE information and AE other services are similar in that they both have almost 900 establishments each. Together, this amounts to a total of 18,170 advanced energy establishments, which is 13.4 percent of total establishments (135,352) in Tennessee.

Similar to considering the number of establishments per industry group, recognizing the number of advanced energy NAICS codes within each industry group is also informative. There are a total of 62 four-digit NAICS codes that make up the advanced energy sector. AE manufacturing is comprised of 36 of these NAICS codes, while AE utilities and construction is made up of nine NAICS codes. Therefore, AE utilities and construction has a higher number of employees and establishments per NAICS code compared to AE manufacturing. For example, AE manufacturing has an average of 50 establishments and 4,142 employees per NAICS code, while AE utilities and construction has over 18 times as many establishments per NAICS code and more than twice as many employees per NAICS code. A similar pattern holds for AE professional, scientific, and technical services compared to AE manufacturing, which demonstrates the varying density of NAICS codes associated with advanced energy activity within industry groups.

Trends in Advanced Energy Outcomes

Comparing 2016 to 2013 CBP data allows the analysis of trends in advanced energy outcomes. In Table 2, the percent change from 2013 to 2016 is shown for employment, annual payroll, and the number of establishments for each industry group and for the total advanced energy sector in Tennessee. Between 2013 and 2016, employment in the advanced energy sector in Tennessee increased by 10.3 percent, which is greater than overall total 8.3 percent job growth in Tennessee. Employment grew the most in AE professional, scientific, and technical services (21.6 percent). AE utilities and construction and AE other services both experienced gains in employment of almost 10 percent. AE manufacturing and AE information's employment

increased by 6.5 and 5.1 percent, respectively. Importantly, employment associated with advanced energy activity increased overall in the state and within each industry group.

Consistently, annual payroll expenditures for advanced energy activity also increased for the advanced energy sector and each subindustry group. To account for the effects of inflation, 2013 payroll (and all other dollar amounts, including state GDP) have been adjusted to 2016 dollars using the Consumer Price Index (CPI) from the Bureau of Labor Statistics. Total inflation-adjusted payroll for all advanced energy industries increased by 31.0 percent, which is greater than the growth in payroll spending for all industries in the state (12.6 percent). Manufacturing experienced the largest increase in payroll at 48.8 percent, followed by AE professional, scientific, and technical services where inflation-adjusted payroll spending increased by 24.5 percent. AE utilities and construction and AE information experienced 20.9 percent and 16.7 percent growth. Lastly, annual payroll for AE other services increased by 4.2 percent.

It is noteworthy that some NAICS codes experienced enough growth between 2013 and 2016 that data no longer needed to be withheld in 2016 because of the growth in the number of business firms. For example, in 2016 there was only one instance of state-level data being withheld for disclosure reasons, while in 2013, state-level data was withheld for seven NAICS codes.[9] These additional NAICS sectors in which data is no longer suppressed represent 9.5 percent of the total payroll in 2016. Five out of six of these are within manufacturing and account for 22.5 percent of the total payroll for manufacturing. Payroll data no longer having to be withheld for disclosure reasons explains why the growth rates are larger for payroll spending compared to employment and demonstrate how the advanced energy sector has seen robust growth in Tennessee.

The number of advanced energy establishments in Tennessee and establishments within each subcategory likewise experienced positive growth since 2013. Overall, establishments associated with advanced energy activity increased by 4.8 percent, which is greater than the 3.5 percent growth in total establishments for all industries in Tennessee. AE information incurred the largest increase in establishments, 29.3 percent. AE professional, scientific, and technical services had the second-largest growth in establishments at 5.2 percent. The percent change in establishments for AE other services and AE utilities and construction is 4.7 percent and 3.4 percent, respectively. Lastly, the number of establishments in AE manufacturing increased by 0.7 percent.

Analyzing growth within the industry groups reveals that the trends in establishments differ from the trends in employment. For example, AE information grew the most in terms of establishments while AE professional, scientific, and technical services grew the most in terms of employment. This demonstrates how growth can be in the number of employees, establishments, or a combination of these. Overall, analysis of this economic data reveal that the advanced energy sector in Tennessee and each industry subgroup has experienced positive growth since 2013. Moreover, the rate of growth for the number of employees, inflation-adjusted payroll spending, and the number of establishments associated with advanced energy activity is higher than the growth rates for all industries within Tennessee.

9 Payroll data at the state level for NAICS 5152, cable and other subscription programming, was withheld in both 2013 and 2016. In 2013, data for the following additional NAICS codes were also withheld: Natural Gas Distribution 2212; Basic Chemical Manufacturing 3251; Audio and Video Equipment Manufacturing 3343; Semiconductor and Other Electronic Component Manufacturing 3344; Motor Vehicle Manufacturing 3361; Motor; Vehicle Body and Trailer Manufacturing 3362; Cable and Other Subscription Programming 5152. Detailed data for each specific NAICS code at both the state and MSA level are presented in the Appendix.

Output and Impact on Tax Revenues

To estimate the output or GDP that is generated by the advanced energy sector in Tennessee, data from the U.S. Bureau of Economic Analysis (BEA) is used to measure output per worker for each of the five industry groups.[10] The ratio of output per worker was then multiplied by the number of employees in the advanced energy sector as reported in the CBP data to estimate GDP for each advanced energy industry group. AE manufacturing contributes the most to state GDP and provides $22.5 billion in output. (See Table 3.) AE utilities and construction and AE professional, scientific, and technical services are the next largest contributors by supplying $7.1 billion and $6 billion of output. AE information generates $3.4 billion in state GDP while AE other services supplies $786 million.[11] Together, the advanced energy sector in Tennessee generated a total of $39.7 billion in state GDP in 2016, which is 12 percent of total GDP for the state. Output provided by the advanced energy sector increased by 16.4 percent since 2013, which illustrates the growth in the advanced energy economy. (The growth rates for GDP and sales tax revenues in Table 3 have been adjusted for inflation similar to dollar amounts for payroll expenditures.)

State and local sales tax revenue impacts are estimated using the value of payroll disbursements by advanced energy firms. AE manufacturing generates the most in state and local sales tax revenues at $341.3 million and $119.9 million. AE professional, scientific, and technical services provides a slightly larger amount of revenue at the state ($203.2 million) and local ($71.4 million) level than AE utilities and construction ($202.2 million for the state and $71.1 million locally). AE information generated $46.6 million in state sales tax revenue and $16.4 million in local sales tax revenue. Lastly, AE other services produced $29.8 million and $10.5 million in state and local sales tax revenue, respectively. Given the growth in inflation-adjusted payroll expenditures since 2013 for all AE industry groups, it follows that inflation-adjusted state and local sales tax revenues also increased for all five industry groups. Total state sales tax revenue for the AE sector increased by 31 percent and totaled $823.2 million in 2016. Total local sales tax revenue amounted to $289.3 million for the advanced energy sector, which is a 33.7 percent increase since 2013.

Table 3: Advanced Energy State GDP and Sales Tax Revenues in Tennessee by Industry Group, 2016

Industry Group	GDP		State Sales Tax Revenue		Local Sales Tax Revenue	
	Level ($1,000)	% Change 2013-2016	Level ($1,000)	% Change 2013-2016	Level ($1,000)	% Change 2013-2016
AE Utilities and Construction	$7,059,298	34.9%	$202,184	20.9%	$71,053	23.4%
AE Manufacturing	$22,474,680	13.7%	$341,279	48.8%	$119,935	51.9%
AE Information	$3,395,280	9.3%	$46,647	16.7%	$16,393	19.1%
AE Professional, Scientific, & Technical Services	$6,032,222	13.4%	$203,237	24.5%	$71,423	27.1%
AE Other Services	$785,537	11.0%	$29,843	4.2%	$10,488	6.4%
Total Advanced Energy Industry	**$39,747,017**	**16.4%**	**$823,192**	**31.0%**	**$289,293**	**33.7%**

10 U.S. Bureau of Economic Analysis, 2016.
11 Output per worker was incorrectly calculated for AE other services in the 2015 report. The percent change in GDP for AE other services and for the total advanced energy sector reflect correcting this error.

TENNESSEE ADVANCED ENERGY CASE STUDIES

Silicon Ranch Corporation Nashville, TN

Silicon Ranch Corporation is one of the largest independent solar power producers in the country. Headquartered in Nashville, the corporation owns, operates or is developing more than 100 solar energy facilities across in the U.S. in 14 states. In 2018 Silicon Ranch announced a joint venture partnership with Shell to provide the oil and gas giant with a U.S.-based solar energy platform and enable Silicon Ranch to expand its market reach and develop new projects and product offerings. Shell became the largest shareholder in Silicon Ranch with an investment that could top $217 million.

Denso Maryville, TN

Denso is an international automotive supplier of advanced technologies, systems, and components. It invested $1 billion in its existing plant in Maryville, Tennessee, to remake the plant into Denso's largest manufacturing facility in the United States. Today it employs more than 3,660 people, specializing in electrification and safety systems. The $1 billion investment expanded production of advanced safety, connectivity, and electrification products for hybrid and electric vehicles, crucial for fuel efficiency advancements and electric power conservation.

Memphis Bioworks Foundation Memphis, TN

Memphis Bioworks Foundation is a Memphis-based nonprofit aimed at fostering economic growth through bioscience across Tennessee and the mid-South region. The organization's initiatives focused on entrepreneurship, business and workforce development have resulted in more than $50 million invested in startups, over 800 jobs created, more than $2 billion invested in the Memphis Medical Center district and UT-Baptist Research Park, and more than 1,000 workers earning degrees or certificates. Memphis Bioworks partners with public and private entities to advance the economic potential of STEM and biosciences.

The University of Tennessee: A Pivotal Asset to Supporting the State's Advanced Energy Economy

The University of Tennessee (UT) is working across the state to support the advanced energy industry through public/private partnerships – collaborations including Volkswagen in East Tennessee, Nissan and Bridgestone in Middle Tennessee, and FedEx in West Tennessee. UT's projects with private industry have boosted Tennessee's economy and played a major role cementing the state's growing reputation as a power player in advanced energy, particularly materials and advanced manufacturing.

UT-Battelle

In partnership with the Battelle Memorial Institute, UT manages and operates the Oak Ridge National Laboratory (ORNL) for the U.S. Department of Energy. ORNL is DOE's largest science and energy lab, conducting basic and applied research to deliver transformative solutions to compelling problems in energy and security. Together UT-Battelle oversees more than 200 joint faculty members at ORNL and five joint institutes. UT is ORNL's largest research partner, conducting more than $300 million in research annually, including some $17.3 million sponsored by ORNL.

Cherokee Farm

Cherokee Farm Innovation Campus is a research and development park located adjacent to the UT-Knoxville campus. This collaborative effort by UT and ORNL offers private companies the opportunity to lease space where they can access the resources of a major research university and DOE's largest science and energy lab. Private industry tenants also have access to the Joint Institute for Advanced Materials, a $56 million research facility focused on materials science innovation that houses UT faculty and Oak Ridge scientists.

West Tennessee Solar Farm

The Tennessee Department of Economic and Community Development tapped UT to oversee the creation and operation of the West Tennessee Solar Farm. The 5-megawatt Solar Farm provides electricity to local utilities and the Tennessee Valley Authority. The renewable energy project is part of the Volunteer State Solar Initiative, a comprehensive solar energy and economic development program focused on job creation, education, renewable power production, and technology commercialization.

Governor's Chairs

The Governor's Chairs program brings world-renowned scientists and researchers to Tennessee, solidifying the state as a nerve center for advanced energy innovation and investment. The program focuses specifically on drafting experts in advanced manufacturing, advanced materials, smart-grid technology, biological sciences, energy sciences, nuclear security, and other areas DOE has identified as hotspots.

IACMI

The Institute for Advanced Composites Manufacturing Innovation, known as IACMI, is a DOE national manufacturing institute operated by UT and ORNL as part of a public-private consortium. With an operation of more than $250 million, IACMI brings together key parties in industry, academia, and government to accelerate the research, development, and adoption of cutting-edge, energy-efficient manufacturing technologies for advanced composites.

The Institute for iacmi Advanced Composites Manufacturing Innovation

THE COMPOSITES INSTITUTE

Bredesen Center

The Bredesen Center for Interdisciplinary Research and Graduate Education recruits students from the best and the brightest in the country to Tennessee for the opportunity to work with the University and ORNL's unique advanced research capabilities in energy, engineering, and computation. The Bredesen Center currently offers doctoral degrees in energy/data science and engineering, where PhD students apply coursework in bioenergy and biofuels, renewable and nuclear energy, transportation, and more to research innovative solutions to global challenges in science, energy, engineering, and national security.

The Advanced Energy Economy in Tennessee's Metropolitan Areas

County business patterns data at the MSA-level are used to identify where economic activity for the advanced energy sector is occurring. Tables 4 through 13 present employment, annual payroll spending, and the number of establishments in 2016 for the 10 metropolitan areas in Tennessee. Similar to the analysis above, the growth rates between 2013 and 2016 are presented for each outcome and industry group.

Table 4 presents the economic data for **Nashville MSA**, which is the largest MSA in Tennessee and includes advanced energy activity in Cannon, Cheatham, Davidson, Dickson, Hickman, Macon, Maury, Robertson, Rutherford, Smith, Sumner, Trousdale, Williamson, and Wilson Counties. In 2016, there were 115,078 advanced energy jobs in the Nashville MSA, which represents 13.9 percent of total employment in the MSA. Similar to 2013, AE utilities and construction is the largest advanced energy employer at 37,177 workers, and AE manufacturing is the second-highest advanced energy employer at 34,855. With the exception of AE information, all industry groups experienced growth in employment. Overall advanced energy employees in the Nashville MSA grew by 13.5 percent between 2013 and 2016. Payroll expenditures in the Nashville MSA totaled $6.6 billion, and with the exception of AE other services, all industry groups experienced growth in payroll spending. As previously discussed in the state-level analysis, for some NAICS codes, payroll spending is reported in 2016 while it was withheld for disclosure reasons in 2013. This newly-disclosed data provide evidence of growth in the advanced energy sector and is apparent in the CBP data for all 10 MSAs in Tennessee. In fact, all MSAs experienced a decline in the number of NAICS codes in which payroll spending was suppressed. Lastly, establishments associated with advanced energy activity in the Nashville MSA totaled 6,396 and grew by 9.6 percent since 2013.

Table 4: Advanced Energy in Nashville-Davidson-Murfreesboro-Franklin, TN MSA by Industry Group, 2016

Industry Group	Employment		Annual Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	37,177	9.8%	$2,128,944	24.3%	2,890	10.2%
AE Manufacturing	34,855	26.1%	$1,463,267	189.7%	472	2.6%
AE Information	9,604	-9.5%	$682,288	39.8%	399	27.9%
AE Professional, Scientific, & Technical Services	27,913	17.2%	$2,072,213	19.4%	2,357	8.5%
AE Other Services	5,529	1.0%	$278,182	-6.6%	278	2.6%
Total Advanced Energy Industry	**115,078**	**13.5%**	**$6,624,894**	**39.8%**	**6,396**	**9.6%**

Bridgestone Nashville, TN

Bridgestone Corporation is the world's largest tire and rubber company, and Bridgestone Americas is headquartered in Nashville, Tennessee. The corporation announced a Global Sustainable Procurement Policy in 2018 aimed at addressing deforestation, reducing waste and carbon emissions, water management, and identifying and rooting out labor and human rights violations in its international supply chain. Bridgestone has committed to a goal of 100 percent sustainable materials in every product by 2050.

In presenting MSAs in descending order in terms of advanced energy employees, the **Memphis MSA** is the next-largest advanced energy employer. The Memphis MSA includes Fayette, Shelby, and Tipton Counties in Tennessee; Crittenden County in Arkansas; and Benton, DeSoto, Marshall, Tate, and Tunica Counties in Mississippi. Table 5 lists the economic data for the MSA as well as the percent change in all variables since 2013. In 2016, there were 55,750 workers in the advanced energy sector, which is 10.4 percent of total employment in the Memphis MSA. AE utilities and construction and AE manufacturing are again the largest employers and employ almost 18,400 workers each. Total payroll spending related to advanced energy activity in the Memphis MSA is $2.9 billion, while there are 2,990 establishments. Employment and payroll spending increased for all industry groups between 2013 and 2016, but interestingly, the number of establishments declined slightly overall and in four out of five of the industry groups.

Table 5: Advanced Energy in Memphis, TN-MS-AR MSA by Industry Group, 2016

Industry Group	Employment		Annual Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	18,357	9.2%	$1,004,676	21.0%	1,387	-2.3%
AE Manufacturing	18,358	12.7%	$887,685	18.0%	258	-1.1%
AE Information	3,815	47.2%	$118,967	133.6%	164	13.1%
AE Professional, Scientific, & Technical Services	11,672	13.4%	$678,219	10.7%	1,019	-0.2%
AE Other Services	3,548	27.5%	$189,704	18.7%	162	-3.6%
Total Advanced Energy Industry	**55,750**	**14.3%**	**$2,879,251**	**19.7%**	**2,990**	**-0.8%**

The **Knoxville MSA** is the third-largest employer of advanced energy workers. Table 6 lists the economic data for advanced energy activity in the Knoxville MSA, which includes Anderson, Blount, Campbell, Grainger, Knox, Loudon, Morgan, Roane, and Union Counties. Employment in the advanced energy sector totaled 52,541, which is 15.6 percent of total employment in the MSA. The Knoxville MSA is unique in that AE professional, scientific, and technical services contribute the most to advanced energy employment at 17,324 workers, followed by AE manufacturing which employs 15,732 workers. Payroll spending in the advanced energy sector for the Knoxville MSA is $3.1 billion, and there are 2,720 establishments. Since 2013, the number of employees, payroll spending, and the number of establishments in the advanced energy sector have increased. This holds across all industry groups with the exception of a very small decline in establishments for AE utilities and construction.

Table 6: Advanced Energy in Knoxville, TN MSA by Industry Group, 2016

Industry Group	Employment		Annual Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	13,472	23.0%	$653,898	27.8%	1,187	-0.6%
AE Manufacturing	15,732	6.8%	$647,693	27.7%	230	0.0%
AE Information	3,323	4.1%	$104,191	28.4%	108	40.3%
AE Professional, Scientific, & Technical Services	17,324	10.2%	$1,513,119	26.6%	1,056	5.9%
AE Other Services	2,690	2.6%	$163,205	9.5%	139	9.4%
Total Advanced Energy Industry	**52,541**	**11.3%**	**$3,082,106**	**26.1%**	**2,720**	**3.6%**

TENNESSEE ADVANCED ENERGY CASE STUDIES

Innovation Crossroads Oak Ridge National Laboratory

Innovation Crossroads is a program to help entrepreneurs create the next generation of clean energy companies. The initiative matches innovators with technology leaders, experienced mentors, and business and investment networks to give startups the support and tools to accelerate the transition of their world-changing ideas to the marketplace. Innovation Crossroads partnered with LaunchTN and TAEBC to provide business mentoring through the Energy Mentor Network, which connects mentors with promising new Tennessee companies and entrepreneurs and leads them through a structured program involving panel presentations and coaching sessions.

Table 7 lists the economic data for advanced energy activity in the **Chattanooga MSA**, which includes Hamilton, Marion, and Sequatchie Counties in Tennessee and Catoosa, Dade, and Walker Counties in Georgia. Total employment for the advanced energy sector was 31,142 in 2016, which is 14.3 percent of total employment in the Chattanooga MSA. Following the general trend, AE manufacturing and AE utilities and construction are the largest contributors to advanced energy employment at 12,689 and 9,894 workers. Annual advanced energy payroll totaled $1.5 billion, which corresponds to 1,568 establishments in the MSA. Following the general trend across MSAs, AE utilities has the most establishments at 692, followed by AE professional, scientific, and technical services at 556. Lastly, there are 168 establishments in AE manufacturing. With the exception of a slight decrease in the number of establishments in AE manufacturing, employment, payroll spending, and the number of establishments have all increased in the Chattanooga MSA since 2013.

Table 7: Advanced Energy in Chattanooga, TN-GA MSA by Industry Group, 2016

Industry Group	Employment		Annual Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	9,894	14.6%	$571,301	30.6%	692	2.5%
AE Manufacturing	12,689	2.0%	$443,281	94.5%	168	-1.2%
AE Information	1,385	26.6%	$67,709	402.2%	70	45.8%
AE Professional, Scientific, & Technical Services	6,008	15.9%	$309,926	11.9%	556	8.8%
AE Other Services	1,166	47.6%	$64,407	27.4%	82	10.8%
Total Advanced Energy Industry	**31,142**	**10.6%**	**$1,456,624**	**44.7%**	**1,568**	**6.1%**

TENNESSEE ADVANCED ENERGY CASE STUDIES

White Harvest Energy Chattanooga, TN

Founded in Chattanooga, White Harvest Energy partners with utilities, electric power distributors, cooperatives, and energy customers to help these organizations adapt to and deploy energy efficiency and distributed generation technologies. White Harvest joined forces with Erlanger Health System, the largest hospital in the Chattanooga region, to secure a $6.75 million grant to assist in financing a $13 million Combined Heat and Power facility for the hospital's main campus. White Harvest developed and is managing the design, installation, and construction of the new natural gas-powered system. It will produce eight megawatts of electricity for the hospital, bringing major energy cost-savings that Erlanger can redirect toward patient care.

The next largest employer in the advanced energy sector is the **Kingsport MSA**, which includes Hawkins and Sullivan Counties in Tennessee and Scott County, Washington County, and Bristol City in Virginia. In 2016, total employment was 22,376 for the advanced energy sector, which is 21.6 percent of total employment in the area. AE manufacturing employs the most people in the advanced energy sector at 14,134. However, employment levels in advanced energy manufacturing and AE information have decreased significantly since 2013. This decline is not unique to the advanced energy sector. For example, total manufacturing jobs in the Kingsport MSA decreased by 14.6 percent between 2013 and 2016. Within the NAICS codes that are related to advanced energy manufacturing, basic chemical manufacturing (NAICS 3251) has seen a notable decline in employment levels. While this particular NAICS code does not report annual payroll figures due to disclosure reasons, ranges are given for employment levels, and the median values of these ranges have decreased from 17,500 in 2013 to 7,500 workers in 2016, a decrease of 57.1 percent. Similarly, total information jobs in the area have decreased by 32.5 percent since 2013. Within advanced energy NAICS codes, wireless telecommunications carriers (NAICS 5172) experienced a 67.1 percent decrease in employees since 2013. Payroll spending for advanced energy totaled $532 million. Note that the percent change in annual payroll cannot be reported for AE information because in 2013, all NAICS codes either had data withheld for disclosure reasons or did not have any activity in the MSA. Interestingly, while the total number of establishments in the advanced energy sector declined in the Kingsport MSA, establishments increased for AE information and AE other services.

Table 8: Advanced Energy in Kingsport-Bristol-Bristol, TN-VA MSA by Industry Group, 2016

Industry Group	Employment		Annual Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	4,574	-10.3%	$204,734	58.8%	351	-3.0%
AE Manufacturing	14,134	-44.3%	$88,812	-19.6%	87	-10.3%
AE Information	666	-62.8%	$12,643	D/NA	23	15.0%
AE Professional, Scientific, & Technical Services	2,234	38.5%	$188,479	115.6%	191	-15.9%
AE Other Services	768	20.4%	$37,907	78.2%	56	51.4%
Total Advanced Energy Industry	**22,376**	**-35.1%**	**$532,575**	**53.0%**	**708**	**-4.7%**

TENNESSEE ADVANCED ENERGY CASE STUDIES

Star LED Johnson County, TN

Star LED is an international manufacturer, distributor, and wholesaler of LED lighting products, specializing in commercial, residential, marine and automotive applications. Star LED is investing approximately $1 million in Mountain City, Tennessee, to set up manufacturing and distribution operations there. The company is renovating and expanding an existing facility in Johnson County Industrial Park to house its new operations, which will create at least 50 new jobs in the community.

Table 9 presents economic data for Montgomery County in Tennessee and Christian and Trigg Counties in Kentucky, which make up the **Clarksville MSA**. In 2016, total employment for the advanced energy sector in this area was 12,616, which is 18.1 percent of total employment. AE manufacturing is the largest employer at 8,720 jobs. Annual payroll for the advanced energy sector is $369 million, and there are 570 establishments related to advanced energy activity. While AE information experienced a decline in employment since 2013, total employment for the advanced energy sector increased by 16.3 percent. Establishments increased for all industry subcategories, and total establishments increased by 10.5 percent.

Table 9: Advanced Energy in Clarksville, TN-KY MSA by Industry Group, 2016

Industry Group	Employment		Annual Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	1,939	-1.5%	$79,533	16.8%	315	10.5%
AE Manufacturing	8,720	25.8%	$182,720	33.9%	62	10.7%
AE Information	107	-38.9%	$5,792	D/NA	14	55.6%
AE Professional, Scientific, & Technical Services	1,663	2.3%	$93,072	-36.0%	146	5.8%
AE Other Services	187	29.0%	$8,023	84.2%	33	17.9%
Total Advanced Energy Industry	**12,616**	**16.3%**	**$369,140**	**4.2%**	**570**	**10.5%**

Employment, payroll, and establishment data for the **Johnson City MSA**, which consists of Carter, Unicoi, and Washington Counties in Tennessee, are presented in Table 10. Total employment for the advanced energy sector is 7,185 workers, which is 11 percent of total employment in the area. AE manufacturing is the largest employer at 3,507 jobs, followed by AE utilities and construction and AE professional, scientific, and technical services at 1,766 and 1,055 employees. Overall, advanced energy employment decreased by 2.8 percent since 2013, and this decline was concentrated around AE information and AE other services. Annual payroll spending totaled $146 million. Note that the anomalous increase in payroll expenditures for AE information is driven by reporting changes due to disclosure issues. Within AE information, $19.4 million was spent on annual payroll in wireless telecommunications carriers (NAICS code 5172), while in 2013, data for this particular NAICS code was suppressed. There are a total of 456 advanced energy establishments. Similar to employment levels, the total number of establishments decreased by 2.6 percent since 2013. Across all industries in the area, there was some modest growth with employment and establishments increasing 1.7 and 2.9 percent.

Table 10: Advanced Energy in Johnson City, TN MSA by Industry Group, 2016

Industry Group	Employment		Annual Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	1,766	-0.4%	$61,432	4.6%	244	-2.4%
AE Manufacturing	3,507	-0.1%	$23,326	52.0%	37	-9.8%
AE Information	664	-26.6%	$19,382	1640.3%	19	-5.0%
AE Professional, Scientific, & Technical Services	1,055	12.1%	$35,865	6.3%	133	1.5%
AE Other Services	193	-26.1%	$6,142	-58.0%	23	-11.5%
Total Advanced Energy Industry	**7,185**	**-2.8%**	**$146,147**	**18.3%**	**456**	**-2.6%**

Eastman Kingsport, TN

Headquartered in Kingsport, Tennessee, Eastman Chemical Company is a global producer and provider of advanced materials, specialty chemicals, fibers, additives and functional products found in items people use every day. In 2018 Eastman helped develop and rollout an advanced 3D polymer for use in industrial 3D printing. The company has won a variety of top awards for its commitment to sustainability and safety. It has been named one of the World's Most Ethical Companies for four consecutive years, as well as ENERGY STAR Partner of the Year for six consecutive years.

One Scientific Johnson City, TN

One Scientific is a Johnson City, Tennessee-based clean tech company that develops modular hydrogen solutions for businesses to save money and enhance sustainability. The startup harnesses 40-year-old technology coupled with advanced materials and processes to generate hydrogen onsite from pure water, unlocking clean and abundant energy. One Scientific is a participant in the Energy Mentor Network, working to raise the capital and blueprint to commercialize its technology. It's currently partnering with public and private organizations to pilot systems in various commercial settings to harden its breakthrough technology and prepare it for market.

Table 11 presents the economic data for Hamblen and Jefferson Counties, which make up the **Morristown MSA**. Total advanced energy employment was 6,200 in 2016, which represents 15.4 percent of total employment in the MSA. AE manufacturing and AE utilities and construction have the highest levels of employment at 4,480 and 1,222. With the exception of AE information and AE other services, advanced energy employment has increased across the different industry groups and overall in the MSA. Annual payroll spending amounted to $223.5 million and has likewise increased since 2013. There were a total of 211 establishments in the advanced energy sector in the Morristown MSA, and establishments have increased by 9.9 percent since 2013.

Table 11: Advanced Energy in Morristown, TN MSA by Industry Group, 2016

Industry Group	Employment		Annual Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	1,222	5.5%	$40,951	82.8%	113	17.7%
AE Manufacturing	4,480	8.8%	$172,125	22.5%	37	-5.1%
AE Information	64	-8.6%	$2,455	D/NA	8	166.7%
AE Professional, Scientific, & Technical Services	304	13.0%	$7,995	32.6%	47	2.2%
AE Other Services	130	-7.1%	D/NA	D/NA	6	-25.0%
Total Advanced Energy Industry	**6,200**	**7.7%**	**$223,526**	**32.3%**	**211**	**9.9%**

The **Jackson MSA** includes Chester, Crockett, and Madison Counties in Tennessee. In 2016, total advanced energy employment for this area was 5,928, which is 10.3 percent of total employment (see Table 12). Following the trend for all MSAs, AE manufacturing and AE utilities and construction account for the majority of the advanced energy jobs in the area at 3,123 and 2,220 employees. However, advanced energy employment in the Jackson MSA has decreased since 2013, both overall and in four out of five of the industry groups. This decline was accompanied by total jobs (for all NAICS codes) in information and professional, scientific, and technical services decreasing by 17.1 and 10.6 percent since 2013. However, total jobs in the Jackson MSA increased by 4.6 percent over the same time period. Annual advanced energy payroll spending totaled $201.7 million. Less payroll data being withheld due to disclosure concerns contributes to the increases in payroll spending that coincide with decreases in employment since 2013. In fact, there were nine NAICS codes for the Jackson MSA in which payroll data no longer needed to be withheld in 2016. Among the 10 metropolitan areas in Tennessee, this was the largest increase in NAICS codes where data was reported in 2016, which was not reported in 2013. advanced energy establishments totaled 349, which was a 1.4 percent decrease since 2013. Total establishments for all sectors in the Jackson MSA also experienced a decline of 1.1 percent since 2013.

Table 12: Advanced Energy in Jackson, TN MSA by Industry Group, 2016

Industry Group	Employment		Annual Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	2,220	5.1%	$113,551	16.2%	193	-2.0%
AE Manufacturing	3,123	-23.6%	$57,010	114.5%	44	0.0%
AE Information	89	-36.4%	$4,064	D/NA	10	0.0%
AE Professional, Scientific, & Technical Services	440	-5.8%	$21,719	4.5%	85	-4.5%
AE Other Services	56	-30.0%	$5,324	-61.4%	17	21.4%
Total Advanced Energy Industry	**5,928**	**-13.9%**	**$201,668**	**26.9%**	**349**	**-1.4%**

Lastly, Table 13 summarizes employment, payroll spending, and the number of establishments pertaining to advanced energy activities for the **Cleveland MSA**, which includes Bradley and Polk Counties in Tennessee. Total advanced energy employment in the MSA is 5,535 jobs, which is 13.7 percent of total jobs. AE utilities and construction and AE manufacturing experienced growth in employment, while AE information, AE professional, scientific, and technical services, and AE other services experienced declines in employment. Together, accounting for growing and declining sectors, total advanced energy employment increased by 7.3 percent since 2013. Annual payroll expenditures amounted to $74.8 million. advanced energy establishments increased by 2.6 percent since 2013 and totaled 240 establishments in the Cleveland MSA.

Table 13: Advanced Energy in Cleveland, TN MSA by Industry Group, 2016

Industry Group	Employment		Annual Payroll ($1,000)		Number of Establishments	
	Level	% Change 2013-2016	Level	% Change 2013-2016	Level	% Change 2013-2016
AE Utilities and Construction	868	17.1%	$36,553	49.4%	117	0.9%
AE Manufacturing	4,097	7.4%	$18,130	D/NA	31	0.0%
AE Information	57	-5.0%	$2,008	D/NA	9	350.0%
AE Professional, Scientific, & Technical Services	393	-4.4%	$16,242	15.3%	73	-2.7%
AE Other Services	120	-7.7%	$1,860	9.3%	10	0.0%
Total Advanced Energy Industry	**5,535**	**7.3%**	**$74,793**	**85.8%**	**240**	**2.6%**

County-Level Economic Impacts from the Advanced Energy Economy

A small number of counties account for the majority of the statewide activity in the advanced energy sector. The top 20 advanced energy counties employ 285,823 individuals in 13,787 establishments, spending $12.3 billion on payroll expenditures. This accounts for 80 percent of all advanced energy activity in Tennessee for 2016.

Table 14 lists the economic data for each of the top 20 advanced energy counties as well as a comparison of rankings from 2013 and 2016. The county-level CBP data partially disaggregate the MSA-level data and reveal the employment, payroll spending, and number of establishments for the largest advanced energy employing counties in Tennessee. Nineteen of the top 20 counties in 2013 remained in the top 20 in 2016. New to the top 20 is Wilson County, ranked 19, while Putnam County, which was ranked 20 in 2013, just missed the top 20 and ranked 22 in 2016. Barely surpassing Davidson County, which was ranked number one in 2013, Shelby County is now the largest advanced energy employer in the state. In 2016, there were 46,621 advanced energy employees in Shelby County, at 2,299 establishments with $2.4 billion in payroll expenditures. Davidson County employed 46,317 workers in the advanced energy sector in 2016 at 2,691 establishments with $2.9 billion in payroll expenditures. Hamilton County is the third-largest advanced energy county in Tennessee at 25,888 workers, but it would need to employ more than 20,000 additional individuals to be close to the size of Davidson and Shelby County's advanced energy employment levels. Payroll spending in Hamilton County amounted to $1.3 billion for 1,279 advanced energy establishments. Following Hamilton County, Knox County is the next-largest advanced energy employer at 22,272 jobs and 1,681 establishments. Rutherford, Williamson, Sullivan, Anderson, and Blount Counties support between 10,000 and 20,000 advanced energy jobs. The rest of the top 20 advanced energy sector counties in Tennessee are Sumner, Bradley, Robertson, McMinn, Coffee, Montgomery, Maury, Washington, Madison, Wilson, and Hamblen. McMinn County and Coffee County are the only counties in the top 20 that are not represented in the MSA-level data.

TENNESSEE ADVANCED ENERGY CASE STUDIES

Signal Energy Chattanooga, TN

Signal Energy Constructors is a global general contractor providing engineering, procurement, and construction services for utility-scale renewable energy projects. Headquartered in Chattanooga, Tennessee, Signal Energy is the renewable energy arm of the EMJ Corporation, possessing more than 8,000 megawatts of utility-scale project experience in the design and construction of wind, solar, storage, infrastructure, and other power projects. The company has been ranked in the top ten solar EPC contractors in the country for the last seven years. In December 2017, Signal Energy opened an international office in Sydney, Australia, expanding its reach into the Asian-Pacific market.

Table 14: Advanced Energy Outcomes in Top 20 Tennessee Counties by Employment, 2016

County	Employment	Annual Payroll ($1,000)	Number of Establishments	2016 Ranking	2013 Ranking
Shelby	46,621	$2,397,582	2,299	1	2
Davidson	46,317	$2,947,029	2,691	2	1
Hamilton	25,888	$1,286,573	1,279	3	4
Knox	22,272	$1,112,381	1,681	4	5
Rutherford	19,810	$605,147	706	5	6
Williamson	18,039	$1,178,929	1,227	6	7
Sullivan	16,272	$243,981	395	7	3
Anderson	13,651	$524,735	285	8	8
Blount	11,340	$125,855	365	9	13
Sumner	7,685	$357,431	503	10	9
Bradley	7,057	$64,772	219	11	15
Robertson	6,297	$91,611	198	12	11
McMinn	6,197	$136,511	93	13	19
Coffee	5,936	$210,206	142	14	18
Montgomery	5,636	$140,178	358	15	12
Maury	5,548	$196,890	203	16	17
Washington	5,485	$122,049	336	17	14
Madison	5,311	$184,591	286	18	10
Wilson	5,301	$189,545	402	19	
Hamblen	5,160	$197,873	119	20	16
Total for Top 20 Counties	**285,823**	**$12,313,869**	**13,787**	**85.8%**	

Conclusion

This report updates the baseline 2015 Tennessee Advanced Energy Economic Impact Report, which provided impacts of the advanced energy sector for 2013. Using the latest county business pattern data for 2016 from the U.S. Census Bureau, the economic activity produced by the advanced energy sector as well as trends in the advanced energy economy are presented in this updated analysis. Consistent with the original report, the advanced energy sector in Tennessee is comprised of 62 four-digit NAICS industry groups, which naturally fall in five mutually exclusive categories: AE utilities and construction, AE manufacturing, AE information, AE professional, scientific, and technical services, and AE other services.

Firms in the advanced energy sector provided 358,360 jobs in Tennessee at 18,170 establishments in 2016. With total payroll expenditures of $21.4 billion, workers in the advanced energy sector earn an average wage of $59,665 in the state, compared to the economy-wide average in Tennessee of $44,317. AE manufacturing and AE utilities and construction, followed by AE professional, scientific, and technical services, support the most jobs in the advanced energy sector statewide and across metropolitan areas in the state. Statewide and in all 10 metropolitan areas, AE utilities and construction has the most establishments, followed by AE professional, scientific, and technical services and AE manufacturing.

Advanced energy employment levels, establishments, and payroll expenditures have all grown since the time of the original study. Statewide employment in the advanced energy sector has increased by 10.3 percent. Advanced energy establishments in the state have increased by 4.8 percent, annual payroll expenditures have increased by 31.0 percent, and state GDP is up 16.4 percent since 2013. While trends for the five different industry groups vary across regions, AE information experienced the largest growth in establishments statewide and in seven out of the 10 metropolitan areas. Growth in AE employment outpaced growth in total employment for Tennessee and in six out of 10 of the metropolitan areas. Likewise, business establishments in the advanced energy sector grew faster than total establishments in the state and in six out of 10 of the metropolitan areas. The Nashville MSA continues to be the largest contributor to the advanced energy sector, producing 32.1 percent of the state's advanced energy employment, while 25.9 percent of the state's advanced energy employment is attributable to the combination of Shelby County and Davidson County. Almost 80 percent of Tennessee's advanced energy employment is concentrated in 20 counties. While advanced energy activity is concentrated around the state's metropolitan areas, the advanced energy economy extends across the 95 counties in the state.

The state's advanced energy economy contributed $39.7 billion in state GDP in 2016, which is 12 percent of total state GDP. Inflation-adjusted output generated by the advanced energy sector increased by 16.4 percent since 2013, which demonstrates the vibrant growth in the advanced energy economy. While this output is produced in Tennessee, much of it is sold outside of the state, thus providing a significant net increase in statewide employment, just like the state's production of automobiles which are consumed elsewhere but support Tennessee jobs. The advanced energy sector directly enhances the state's competitiveness and attractiveness as a place to do business. By providing goods and services to other firms in the state, the advanced energy sector also indirectly boosts the state's competitive position through the supply chain.

Tennessee's advanced energy economy has grown in recent years and will undoubtedly continue to grow in the years ahead as both producers and consumers are striving to reduce energy use and seek more energy efficient products and manufacturing processes.

Targeting the Advanced Energy Cluster in Tennessee as an Engine of Economic Growth

Tennessee and its local communities commonly target specific industries and industry clusters as part of their broad-based economic development strategies. These targets then become the focus of business recruitment, expansion and retention strategies through a variety of policies including marketing, workforce development, infrastructure development, and incentives. The targeted approach to economic development is intended to maximize the returns to business development efforts and better coordinate public policy.

The advanced energy industry cluster represents a sound candidate for inclusion as a statewide targeted industry cluster. Together it represents 62 different industries that are allocated across five subclusters. Nearly 360,000 individuals were employed by 18,170 firms in the overall advanced energy cluster in 2016.

Clusters are especially attractive because of the spillovers and interconnectivity that arises from the different industries that constitute the cluster. In general, clusters may include firms that produce a similar good or service, rely on similar workforce skills and occupations, build on similar supply chains, and require a common business climate. Firms in the cluster do not need to engage in business activity with other firms in the cluster in order for the cluster to prosper. For example, disparate industries may simply rely on similarly-skilled workers or similar occupations to produce their product. The availability of a broader labor pool can help businesses in the cluster better compete in the marketplace.

Studies from 2015 and 2018 have documented the significant economic impact benefits of the advanced energy industry cluster for the state, its metropolitan areas, and individual counties across Tennessee. Between 2013 and 2016, the advanced industry cluster generally showed stronger growth than the overall state economy. In 2016, it accounted for about 12 percent of state GDP. Importantly, the average wage paid by firms in the advanced energy sector pays a 35 percent premium above the statewide average wage. The stronger rate of growth and high earnings suggest that this cluster has the potential to be a major driver of the state economy in the years ahead, expanding the job base for businesses and workers and expanding the tax base for the state and its localities.

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Appendix

Appendix Table 1: Advanced Energy by NAICS in Tennessee, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	2,414	$176,559	89
		Electric Power Generation, Transmission and Distribution	2,414	$176,559	89
	2212	Natural Gas Distribution	561	$42,601	25
	2361	Residential Building Construction	8,525	$444,725	1,966
	2362	Nonresidential Building Construction	16,008	$947,718	684
	2371	Utility System Construction	9,265	$509,635	346
	2379	Other Heavy and Civil Engineering Construction	942	$50,403	75
	2381	Foundation, Structure, and Building Exterior Contractors	14,008	$676,377	1,322
	2382	Building Equipment Contractors	37,881	$1,994,206	2,735
	2383	Building Finishing Contractors	9,506	$409,314	1,267
	Subtotal		**99,110**	**$5,251,538**	**8,509**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	2,207	$74,859	149
	3221	Pulp, Paper, and Paperboard Mills	2,896	$233,490	12
	3241	Petroleum and Coal Products Manufacturing	927	$83,913	64
	3251	Basic Chemical Manufacturing	11,501	$1,066,178	62
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	2,239	$163,258	28
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	308	$18,010	18
	3259	Other Chemical Product and Preparation Manufacturing	3,492	$183,279	57
	3272	Glass and Glass Product Manufacturing	4,022	$206,728	30
	3279	Other Nonmetallic Mineral Product Manufacturing	1,422	$67,835	78
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	1,547	$111,632	21
	3313	Alumina and Aluminum Production and Processing	2,801	$182,911	17
	3315	Foundries	3,404	$192,659	29
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	4,308	$233,429	49
	3332	Industrial Machinery Manufacturing	1,112	$62,685	51
	3333	Commercial and Service Industry Machinery Manufacturing	1,421	$81,380	22
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	7,464	$347,881	42
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	1,398	$61,410	18

Appendix Table 1, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3339	Other General Purpose Machinery Manufacturing	5,132	$289,555	96
	3341	Computer and Peripheral Equipment Manufacturing	284	$24,636	8
	3342	Communication Equipment Manufacturing	101	$5,263	8
	3343	Audio and Video Equipment Manufacturing	63	$2,904	11
	3344	Semiconductor and Other Electronic Component Manufacturing	2,922	$133,888	27
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	3,324	$215,237	58
	3346	Manufacturing and Reproducing Magnetic and Optical Media	303	$12,517	11
	3351	Electric Lighting Equipment Manufacturing	414	$22,352	17
	3352	Household Appliance Manufacturing	8,239	$371,435	21
	3353	Electrical Equipment Manufacturing	2,708	$128,692	42
	3359	Other Electrical Equipment and Component Manufacturing	2,270	$97,553	25
	3361	Motor Vehicle Manufacturing	7,943	$688,170	5
	3362	Motor Vehicle Body and Trailer Manufacturing	2,106	$100,777	43
	3363	Motor Vehicle Parts Manufacturing	41,868	$2,304,137	188
	3364	Aerospace Product and Parts Manufacturing	1,659	$132,592	20
	3366	Ship and Boat Building	2,934	$140,260	22
	3369	Other Transportation Equipment Manufacturing	211	$8,329	21
	3391	Medical Equipment and Supplies Manufacturing	8,326	$571,470	190
	3399	Other Miscellaneous Manufacturing	5,836	$243,097	251
	Subtotal		**149,112**	**$8,864,401**	**1,811**
Advanced Energy Information	5112	Software Publishers	2,383	$257,487	131
	5152	Cable and Other Subscription Programming	1,750	D	8
	5172	Wireless Telecommunications Carriers (except Satellite)	8,369	$390,228	342
	5174	Satellite Telecommunications	41	$1,951	4
	5179	Other Telecommunications	625	$31,950	99
	5182	Data Processing, Hosting, and Related Services	4,634	$376,250	191
	5191	Other Information Services	2,275	$153,753	125
	Subtotal		**20,077**	**$1,211,619**	**900**

Appendix Table 1, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	20,362	$1,401,821	1,539
	5414	Specialized Design Services	1,244	$63,657	324
	5415	Computer System Design and Related Services	15,180	$1,275,427	1,260
	5416	Management, Scientific, and Technical Consulting Services	19,958	$1,387,898	1,691
	5417	Scientific Research and Development Services	7,196	$743,190	181
	5419	Other Professional, Scientific, and Technical Services	11,675	$406,902	1,065
	Subtotal		**75,615**	**$5,278,895**	**6,060**
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	1,608	$110,920	77
	6215	Medical and Diagnostic Laboratories	6,746	$382,090	300
	8112	Electronic and Precision Equipment Repair and Maintenance	3,173	$139,864	206
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	2,919	$142,280	307
	Subtotal		**14,446**	**$775,154**	**890**
All Advanced Energy Industry	**Total**		**358,360**	**$21,381,607**	**18,170**

Appendix Table 2: Advanced Energy by NAICS in Chattanooga, TN-GA MSA, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	120	$8,586	6
	2212	Natural Gas Distribution	60	D	3
	2361	Residential Building Construction	591	$21,790	148
	2362	Nonresidential Building Construction	1,172	$90,369	58
	2371	Utility System Construction	1,194	$99,195	31
	2379	Other Heavy and Civil Engineering Construction	117	$5,896	10
	2381	Foundation, Structure, and Building Exterior Contractors	1,084	$49,871	90
	2382	Building Equipment Contractors	4,810	$267,294	257
	2383	Building Finishing Contractors	746	$28,300	89
	Subtotal		**9,894**	**$571,301**	**692**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	10	D	1
	3221	Pulp, Paper, and Paperboard Mills	375	D	2
	3241	Petroleum and Coal Products Manufacturing	26	$1,972	5
	3251	Basic Chemical Manufacturing	325	$17,321	13
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	826	$62,450	8
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	10	D	1
	3259	Other Chemical Product and Preparation Manufacturing	133	$6,493	6
	3272	Glass and Glass Product Manufacturing	60	D	3
	3279	Other Nonmetallic Mineral Product Manufacturing	179	$9,807	9
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	60	D	2
	3313	Alumina and Aluminum Production and Processing	NA	NA	NA
	3315	Foundries	527	$27,089	7
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	1,581	$127,364	6
	3332	Industrial Machinery Manufacturing	407	$27,664	8
	3333	Commercial and Service Industry Machinery Manufacturing	NA	NA	NA
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	175	D	3
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	60	D	2
	3339	Other General Purpose Machinery Manufacturing	627	$34,651	15
	3341	Computer and Peripheral Equipment Manufacturing	60	D	1
	3342	Communication Equipment Manufacturing	NA	NA	NA

Appendix Table 2, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3343	Audio and Video Equipment Manufacturing	NA	NA	NA
	3344	Semiconductor and Other Electronic Component Manufacturing	10	D	1
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	112	$5,352	5
	3346	Manufacturing and Reproducing Magnetic and Optical Media	NA	NA	NA
	3351	Electric Lighting Equipment Manufacturing	10	D	1
	3352	Household Appliance Manufacturing	1,750	D	1
	3353	Electrical Equipment Manufacturing	15	$512	3
	3359	Other Electrical Equipment and Component Manufacturing	465	$16,917	5
	3361	Motor Vehicle Manufacturing	1,750	D	2
	3362	Motor Vehicle Body and Trailer Manufacturing	750	D	3
	3363	Motor Vehicle Parts Manufacturing	1,170	$52,123	8
	3364	Aerospace Product and Parts Manufacturing	10	D	1
	3366	Ship and Boat Building	60	D	2
	3369	Other Transportation Equipment Manufacturing	106	$4,718	5
	3391	Medical Equipment and Supplies Manufacturing	449	$20,585	20
	3399	Other Miscellaneous Manufacturing	591	$28,263	19
	Subtotal	**12,689**	**$443,281**	**168**	
Advanced Energy Information	5112	Software Publishers	16	$1,227	4
	5152	Cable and Other Subscription Programming	10	D	1
	5172	Wireless Telecommunications Carriers (except Satellite)	983	$44,070	38
	5174	Satellite Telecommunications	10	D	1
	5179	Other Telecommunications	15	$542	6
	5182	Data Processing, Hosting, and Related Services	330	$21,133	12
	5191	Other Information Services	21	$737	8
	Subtotal		**1,385**	**$67,709**	**70**
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	2,416	$142,240	159
	5414	Specialized Design Services	126	$5,620	33
	5415	Computer System Design and Related Services	587	$45,374	112
	5416	Management, Scientific, and Technical Consulting Services	1,369	$71,175	143
	5417	Scientific Research and Development Services	89	$5,372	15
	5419	Other Professional, Scientific, and Technical Services	1,421	$40,145	94
	Subtotal		**6,008**	**$309,926**	**556**

Appendix Table 2, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	60	D	4
	6215	Medical and Diagnostic Laboratories	544	$33,705	27
	8112	Electronic and Precision Equipment Repair and Maintenance	77	$3,673	22
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	485	$27,029	29
	Subtotal		**1,166**	**$64,407**	**82**
All Advanced Energy Industry	**Total**		**31,142**	**$1,456,624**	**1,568**

Appendix Table 3: Advanced Energy by NAICS in Clarksville, TN-KY MSA, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	175	D	3
	2212	Natural Gas Distribution	10	D	1
	2361	Residential Building Construction	243	$15,704	61
	2362	Nonresidential Building Construction	182	$8,205	29
	2371	Utility System Construction	214	$11,197	19
	2379	Other Heavy and Civil Engineering Construction	10	D	1
	2381	Foundation, Structure, and Building Exterior Contractors	151	$5,647	36
	2382	Building Equipment Contractors	740	$31,346	110
	2383	Building Finishing Contractors	214	$7,434	55
	Subtotal		**1,939**	**$79,533**	**315**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	81	$2,567	7
	3221	Pulp, Paper, and Paperboard Mills	NA	NA	NA
	3241	Petroleum and Coal Products Manufacturing	66	$4,465	4
	3251	Basic Chemical Manufacturing	112	$6,789	4
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	NA	NA	NA
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	NA	NA	NA
	3259	Other Chemical Product and Preparation Manufacturing	60	D	2
	3272	Glass and Glass Product Manufacturing	NA	NA	NA
	3279	Other Nonmetallic Mineral Product Manufacturing	60	D	1
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	175	D	1
	3313	Alumina and Aluminum Production and Processing	175	D	1
	3315	Foundries	10	D	1
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	NA	NA	NA
	3332	Industrial Machinery Manufacturing	NA	NA	NA
	3333	Commercial and Service Industry Machinery Manufacturing	NA	NA	NA
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	1,750	D	2
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	NA	NA	NA
	3339	Other General Purpose Machinery Manufacturing	375	D	4
	3341	Computer and Peripheral Equipment Manufacturing	NA	NA	NA

Appendix Table 3, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3342	Communication Equipment Manufacturing	NA	NA	NA
	3343	Audio and Video Equipment Manufacturing	NA	NA	NA
	3344	Semiconductor and Other Electronic Component Manufacturing	60	D	2
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	NA	NA	NA
	3346	Manufacturing and Reproducing Magnetic and Optical Media	10	D	1
	3351	Electric Lighting Equipment Manufacturing	NA	NA	NA
	3352	Household Appliance Manufacturing	10	D	1
	3353	Electrical Equipment Manufacturing	NA	NA	NA
	3359	Other Electrical Equipment and Component Manufacturing	10	D	1
	3361	Motor Vehicle Manufacturing	NA	NA	NA
	3362	Motor Vehicle Body and Trailer Manufacturing	1,750	D	2
	3363	Motor Vehicle Parts Manufacturing	3,810	$167,883	12
	3364	Aerospace Product and Parts Manufacturing	NA	NA	NA
	3366	Ship and Boat Building	NA	NA	NA
	3369	Other Transportation Equipment Manufacturing	NA	NA	NA
	3391	Medical Equipment and Supplies Manufacturing	31	$1,016	8
	3399	Other Miscellaneous Manufacturing	175	D	8
	Subtotal		**8,720**	**$182,720**	**62**
Advanced Energy Information	5112	Software Publishers	NA	NA	NA
	5152	Cable and Other Subscription Programming	NA	NA	NA
	5172	Wireless Telecommunications Carriers (except Satellite)	99	$5,716	11
	5174	Satellite Telecommunications	NA	NA	NA
	5179	Other Telecommunications	8	$76	3
	5182	Data Processing, Hosting, and Related Services	NA	NA	NA
	5191	Other Information Services	NA	NA	NA
	Subtotal		**107**	**$5,792**	**14**

Appendix Table 3, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	179	$11,175	29
	5414	Specialized Design Services	24	$415	6
	5415	Computer System Design and Related Services	859	$63,740	52
	5416	Management, Scientific, and Technical Consulting Services	295	$6,946	28
	5417	Scientific Research and Development Services	5	$133	4
	5419	Other Professional, Scientific, and Technical Services	301	$10,663	27
	Subtotal		**1,663**	**$93,072**	**146**
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	NA	NA	NA
	6215	Medical and Diagnostic Laboratories	41	$2,457	9
	8112	Electronic and Precision Equipment Repair and Maintenance	104	$3,748	10
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	42	$1,818	14
	Subtotal		**187**	**$8,023**	**33**
All Advanced Energy Industry	**Total**		**12,616**	**$369,140**	**570**

Appendix Table 4: Advanced Energy by NAICS in Cleveland, TN MSA, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	60	D	2
	2212	Natural Gas Distribution	NA	NA	NA
	2361	Residential Building Construction	69	$2,002	20
	2362	Nonresidential Building Construction	58	$3,497	11
	2371	Utility System Construction	77	$4,522	6
	2379	Other Heavy and Civil Engineering Construction	NA	NA	NA
	2381	Foundation, Structure, and Building Exterior Contractors	153	$6,288	22
	2382	Building Equipment Contractors	389	$18,455	41
	2383	Building Finishing Contractors	62	$1,789	15
	Subtotal		**868**	**$36,553**	**117**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	NA	NA	NA
	3221	Pulp, Paper, and Paperboard Mills	NA	NA	NA
	3241	Petroleum and Coal Products Manufacturing	10	D	1
	3251	Basic Chemical Manufacturing	175	D	3
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	750	D	1
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	NA	NA	NA
	3259	Other Chemical Product and Preparation Manufacturing	345	$16,418	3
	3272	Glass and Glass Product Manufacturing	NA	NA	NA
	3279	Other Nonmetallic Mineral Product Manufacturing	60	D	2
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	NA	NA	NA
	3313	Alumina and Aluminum Production and Processing	NA	NA	NA
	3315	Foundries	NA	NA	NA
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	10	D	1
	3332	Industrial Machinery Manufacturing	10	D	1
	3333	Commercial and Service Industry Machinery Manufacturing	NA	NA	NA
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	175	D	1
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	NA	NA	NA
	3339	Other General Purpose Machinery Manufacturing	10	D	1
	3341	Computer and Peripheral Equipment Manufacturing	NA	NA	NA
	3342	Communication Equipment Manufacturing	NA	NA	NA

Appendix Table 4, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3343	Audio and Video Equipment Manufacturing	NA	NA	NA
	3344	Semiconductor and Other Electronic Component Manufacturing	NA	NA	NA
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	NA	NA	NA
	3346	Manufacturing and Reproducing Magnetic and Optical Media	NA	NA	NA
	3351	Electric Lighting Equipment Manufacturing	NA	NA	NA
	3352	Household Appliance Manufacturing	1,750	D	3
	3353	Electrical Equipment Manufacturing	175	D	1
	3359	Other Electrical Equipment and Component Manufacturing	175	D	1
	3361	Motor Vehicle Manufacturing	NA	NA	NA
	3362	Motor Vehicle Body and Trailer Manufacturing	NA	NA	NA
	3363	Motor Vehicle Parts Manufacturing	10	D	1
	3364	Aerospace Product and Parts Manufacturing	NA	NA	NA
	3366	Ship and Boat Building	NA	NA	NA
	3369	Other Transportation Equipment Manufacturing	NA	NA	NA
	3391	Medical Equipment and Supplies Manufacturing	67	$1,712	8
	3399	Other Miscellaneous Manufacturing	375	D	3
	Subtotal		**4,097**	**$18,130**	**31**
Advanced Energy Information	5112	Software Publishers	10	D	2
	5152	Cable and Other Subscription Programming	NA	NA	NA
	5172	Wireless Telecommunications Carriers (except Satellite)	37	$2,008	5
	5174	Satellite Telecommunications	NA	NA	NA
	5179	Other Telecommunications	10	D	2
	5182	Data Processing, Hosting, and Related Services	NA	NA	NA
	5191	Other Information Services	NA	NA	NA
	Subtotal		**57**	**$2,008**	**9**
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	80	$3,483	19
	5414	Specialized Design Services	10	D	3
	5415	Computer System Design and Related Services	21	$1,038	9
	5416	Management, Scientific, and Technical Consulting Services	76	$6,019	17
	5417	Scientific Research and Development Services	NA	NA	NA
	5419	Other Professional, Scientific, and Technical Services	206	$5,702	25
	Subtotal		**393**	**$16,242**	**73**

Appendix Table 4, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	60	D	2
	6215	Medical and Diagnostic Laboratories	10	D	1
	8112	Electronic and Precision Equipment Repair and Maintenance	10	D	1
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	40	$1,860	6
	Subtotal		**120**	**$1,860**	**10**
All Advanced Energy Industry	**Total**		**5,535**	**$74,793**	**240**

Appendix Table 5: Advanced Energy by NAICS in Jackson, TN MSA, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	60	D	3
	2212	Natural Gas Distribution	10	D	1
	2361	Residential Building Construction	323	$20,304	33
	2362	Nonresidential Building Construction	252	$15,122	20
	2371	Utility System Construction	179	$4,159	8
	2379	Other Heavy and Civil Engineering Construction	NA	NA	NA
	2381	Foundation, Structure, and Building Exterior Contractors	283	$13,955	32
	2382	Building Equipment Contractors	1,026	$57,961	65
	2383	Building Finishing Contractors	87	$2,050	31
	Subtotal		**2,220**	**$113,551**	**193**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	149	$3,788	5
	3221	Pulp, Paper, and Paperboard Mills	NA	NA	NA
	3241	Petroleum and Coal Products Manufacturing	NA	NA	NA
	3251	Basic Chemical Manufacturing	10	D	1
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	NA	NA	NA
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	NA	NA	NA
	3259	Other Chemical Product and Preparation Manufacturing	175	D	2
	3272	Glass and Glass Product Manufacturing	175	D	1
	3279	Other Nonmetallic Mineral Product Manufacturing	10	D	2
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	375	D	1
	3313	Alumina and Aluminum Production and Processing	331	$21,955	3
	3315	Foundries	375	D	2
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	NA	NA	NA
	3332	Industrial Machinery Manufacturing	NA	NA	NA
	3333	Commercial and Service Industry Machinery Manufacturing	NA	NA	NA
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	NA	NA	NA
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	NA	NA	NA
	3339	Other General Purpose Machinery Manufacturing	460	$29,320	5
	3341	Computer and Peripheral Equipment Manufacturing	NA	NA	NA
	3342	Communication Equipment Manufacturing	NA	NA	NA

Appendix Table 5, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3343	Audio and Video Equipment Manufacturing	NA	NA	NA
	3344	Semiconductor and Other Electronic Component Manufacturing	NA	NA	NA
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	60	D	1
	3346	Manufacturing and Reproducing Magnetic and Optical Media	NA	NA	NA
	3351	Electric Lighting Equipment Manufacturing	NA	NA	NA
	3352	Household Appliance Manufacturing	NA	NA	NA
	3353	Electrical Equipment Manufacturing	175	D	2
	3359	Other Electrical Equipment and Component Manufacturing	NA	NA	NA
	3361	Motor Vehicle Manufacturing	NA	NA	NA
	3362	Motor Vehicle Body and Trailer Manufacturing	23	$586	3
	3363	Motor Vehicle Parts Manufacturing	750	D	6
	3364	Aerospace Product and Parts Manufacturing	NA	NA	NA
	3366	Ship and Boat Building	NA	NA	NA
	3369	Other Transportation Equipment Manufacturing	10	D	1
	3391	Medical Equipment and Supplies Manufacturing	13	$398	4
	3399	Other Miscellaneous Manufacturing	32	$963	5
	Subtotal		**3,123**	**$57,010**	**44**
Advanced Energy Information	5112	Software Publishers	NA	NA	NA
	5152	Cable and Other Subscription Programming	NA	NA	NA
	5172	Wireless Telecommunications Carriers (except Satellite)	57	$3,160	6
	5174	Satellite Telecommunications	NA	NA	NA
	5179	Other Telecommunications	22	$904	3
	5182	Data Processing, Hosting, and Related Services	NA	NA	NA
	5191	Other Information Services	10	D	1
	Subtotal		**89**	**$4,064**	**10**
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	165	$11,250	28
	5414	Specialized Design Services	10	D	1
	5415	Computer System Design and Related Services	29	$1,225	9
	5416	Management, Scientific, and Technical Consulting Services	105	$4,604	25
	5417	Scientific Research and Development Services	6	$310	3
	5419	Other Professional, Scientific, and Technical Services	125	$4,330	19
	Subtotal		**440**	**$21,719**	**85**

Appendix Table 5, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	NA	NA	NA
	6215	Medical and Diagnostic Laboratories	34	$4,530	9
	8112	Electronic and Precision Equipment Repair and Maintenance	12	$794	5
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	10	D	3
	Subtotal		**56**	**$5,324**	**17**
All Advanced Energy Industry	**Total**		**5,928**	**$201,668**	**349**

Appendix Table 6: Advanced Energy by NAICS in Johnson City, TN MSA, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	10	D	2
	2212	Natural Gas Distribution	60	D	2
	2361	Residential Building Construction	183	$5,745	54
	2362	Nonresidential Building Construction	298	$11,672	26
	2371	Utility System Construction	61	$1,787	8
	2379	Other Heavy and Civil Engineering Construction	10	D	1
	2381	Foundation, Structure, and Building Exterior Contractors	215	$7,876	40
	2382	Building Equipment Contractors	701	$25,608	76
	2383	Building Finishing Contractors	228	$8,744	35
	Subtotal		**1,766**	**$61,432**	**244**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	60	D	7
	3221	Pulp, Paper, and Paperboard Mills	NA	NA	NA
	3241	Petroleum and Coal Products Manufacturing	NA	NA	NA
	3251	Basic Chemical Manufacturing	750	D	2
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	60	D	2
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	NA	NA	NA
	3259	Other Chemical Product and Preparation Manufacturing	NA	NA	NA
	3272	Glass and Glass Product Manufacturing	NA	NA	NA
	3279	Other Nonmetallic Mineral Product Manufacturing	10	D	2
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	NA	NA	NA
	3313	Alumina and Aluminum Production and Processing	10	D	1
	3315	Foundries	NA	NA	NA
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	175	D	1
	3332	Industrial Machinery Manufacturing	10	D	2
	3333	Commercial and Service Industry Machinery Manufacturing	NA	NA	NA
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	375	D	1
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	NA	NA	NA
	3339	Other General Purpose Machinery Manufacturing	175	D	3
	3341	Computer and Peripheral Equipment Manufacturing	NA	NA	NA
	3342	Communication Equipment Manufacturing	NA	NA	NA

Appendix Table 6, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3343	Audio and Video Equipment Manufacturing	NA	NA	NA
	3344	Semiconductor and Other Electronic Component Manufacturing	60	D	2
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	10	D	1
	3346	Manufacturing and Reproducing Magnetic and Optical Media	NA	NA	NA
	3351	Electric Lighting Equipment Manufacturing	NA	NA	NA
	3352	Household Appliance Manufacturing	750	D	2
	3353	Electrical Equipment Manufacturing	375	D	1
	3359	Other Electrical Equipment and Component Manufacturing	NA	NA	NA
	3361	Motor Vehicle Manufacturing	NA	NA	NA
	3362	Motor Vehicle Body and Trailer Manufacturing	NA	NA	NA
	3363	Motor Vehicle Parts Manufacturing	175	D	1
	3364	Aerospace Product and Parts Manufacturing	NA	NA	NA
	3366	Ship and Boat Building	NA	NA	NA
	3369	Other Transportation Equipment Manufacturing	NA	NA	NA
	3391	Medical Equipment and Supplies Manufacturing	427	$20,112	6
	3399	Other Miscellaneous Manufacturing	85	$3,214	3
	Subtotal		**3,507**	**$23,326**	**37**
Advanced Energy Information	5112	Software Publishers	60	D	1
	5152	Cable and Other Subscription Programming	NA	NA	NA
	5172	Wireless Telecommunications Carriers (except Satellite)	474	$19,382	10
	5174	Satellite Telecommunications	NA	NA	NA
	5179	Other Telecommunications	10	D	3
	5182	Data Processing, Hosting, and Related Services	60	D	4
	5191	Other Information Services	60	D	1
	Subtotal		**664**	**$19,382**	**19**
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	162	$7,707	37
	5414	Specialized Design Services	21	$598	5
	5415	Computer System Design and Related Services	124	$7,344	20
	5416	Management, Scientific, and Technical Consulting Services	270	$9,596	33
	5417	Scientific Research and Development Services	175	D	7
	5419	Other Professional, Scientific, and Technical Services	303	$10,620	31
	Subtotal		**1,055**	**$35,865**	**133**

Appendix Table 6, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	10	D	2
	6215	Medical and Diagnostic Laboratories	60	D	9
	8112	Electronic and Precision Equipment Repair and Maintenance	11	$556	3
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	112	$5,586	9
	Subtotal		**193**	**$6,142**	**23**
All Advanced Energy Industry	**Total**		**7,185**	**$146,147**	**456**

Appendix Table 7: Advanced Energy by NAICS in Kingsport-Bristol-Bristol, TN-VA MSA, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	175	D	10
	2212	Natural Gas Distribution	41	$1,622	3
	2361	Residential Building Construction	300	$10,935	100
	2362	Nonresidential Building Construction	1,063	$54,579	26
	2371	Utility System Construction	138	$6,157	14
	2379	Other Heavy and Civil Engineering Construction	39	$1,660	5
	2381	Foundation, Structure, and Building Exterior Contractors	479	$19,282	54
	2382	Building Equipment Contractors	2,154	$104,559	107
	2383	Building Finishing Contractors	185	$5,940	32
	Subtotal		**4,574**	**$204,734**	**351**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	41	$1,173	7
	3221	Pulp, Paper, and Paperboard Mills	375	D	1
	3241	Petroleum and Coal Products Manufacturing	10	D	2
	3251	Basic Chemical Manufacturing	7,500	D	5
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	750	D	1
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	10	D	2
	3259	Other Chemical Product and Preparation Manufacturing	10	D	2
	3272	Glass and Glass Product Manufacturing	650	$31,022	5
	3279	Other Nonmetallic Mineral Product Manufacturing	NA	NA	NA
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	NA	NA	NA
	3313	Alumina and Aluminum Production and Processing	175	D	1
	3315	Foundries	175	$5,927	5
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	375	D	3
	3332	Industrial Machinery Manufacturing	10	D	2
	3333	Commercial and Service Industry Machinery Manufacturing	10	D	2
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	750	D	3
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	NA	NA	NA
	3339	Other General Purpose Machinery Manufacturing	375	D	4
	3341	Computer and Peripheral Equipment Manufacturing	NA	NA	NA
	3342	Communication Equipment Manufacturing	60	D	1

Appendix Table 7, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3343	Audio and Video Equipment Manufacturing	NA	NA	NA
	3344	Semiconductor and Other Electronic Component Manufacturing	60	D	2
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	NA	NA	NA
	3346	Manufacturing and Reproducing Magnetic and Optical Media	NA	NA	NA
	3351	Electric Lighting Equipment Manufacturing	175	D	1
	3352	Household Appliance Manufacturing	NA	NA	NA
	3353	Electrical Equipment Manufacturing	375	D	4
	3359	Other Electrical Equipment and Component Manufacturing	60	D	3
	3361	Motor Vehicle Manufacturing	NA	NA	NA
	3362	Motor Vehicle Body and Trailer Manufacturing	750	D	2
	3363	Motor Vehicle Parts Manufacturing	1,048	$42,578	10
	3364	Aerospace Product and Parts Manufacturing	175	D	1
	3366	Ship and Boat Building	NA	NA	NA
	3369	Other Transportation Equipment Manufacturing	NA	NA	NA
	3391	Medical Equipment and Supplies Manufacturing	84	$3,346	11
	3399	Other Miscellaneous Manufacturing	131	$4,766	7
	Subtotal		**14,134**	**$88,812**	**87**
Advanced Energy Information	5112	Software Publishers	60	D	3
	5152	Cable and Other Subscription Programming	NA	NA	NA
	5172	Wireless Telecommunications Carriers (except Satellite)	576	$12,643	14
	5174	Satellite Telecommunications	NA	NA	NA
	5179	Other Telecommunications	10	D	2
	5182	Data Processing, Hosting, and Related Services	10	D	1
	5191	Other Information Services	10	D	3
	Subtotal		**666**	**$12,643**	**23**
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	449	$33,412	64
	5414	Specialized Design Services	19	$470	7
	5415	Computer System Design and Related Services	137	$7,145	18
	5416	Management, Scientific, and Technical Consulting Services	1,139	$128,938	46
	5417	Scientific Research and Development Services	64	$4,636	8
	5419	Other Professional, Scientific, and Technical Services	426	$13,878	48
	Subtotal		**2,234**	**$188,479**	**191**

Appendix Table 7, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	10	D	1
	6215	Medical and Diagnostic Laboratories	456	$19,830	31
	8112	Electronic and Precision Equipment Repair and Maintenance	125	$7,819	12
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	177	$10,258	12
	Subtotal		**768**	**$37,907**	**56**
All Advanced Energy Industry	**Total**		**22,376**	**$532,575**	**708**

Appendix Table 8: Advanced Energy by NAICS in Knoxville, TN MSA, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	36	$2,923	4
	2212	Natural Gas Distribution	10	D	2
	2361	Residential Building Construction	1,226	$51,451	306
	2362	Nonresidential Building Construction	1,491	$97,582	104
	2371	Utility System Construction	2,587	$117,632	33
	2379	Other Heavy and Civil Engineering Construction	180	$9,500	21
	2381	Foundation, Structure, and Building Exterior Contractors	1,365	$55,110	170
	2382	Building Equipment Contractors	4,762	$237,352	354
	2383	Building Finishing Contractors	1,815	$82,348	193
	Subtotal		**13,472**	**$653,898**	**1,187**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	161	$5,093	8
	3221	Pulp, Paper, and Paperboard Mills	375	D	3
	3241	Petroleum and Coal Products Manufacturing	50	$3,827	7
	3251	Basic Chemical Manufacturing	217	$13,297	5
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	375	D	3
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	60	D	2
	3259	Other Chemical Product and Preparation Manufacturing	375	D	4
	3272	Glass and Glass Product Manufacturing	375	D	5
	3279	Other Nonmetallic Mineral Product Manufacturing	77	$3,161	5
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	307	$22,315	4
	3313	Alumina and Aluminum Production and Processing	750	D	4
	3315	Foundries	60	D	2
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	2	$147	3
	3332	Industrial Machinery Manufacturing	220	$10,612	7
	3333	Commercial and Service Industry Machinery Manufacturing	375	D	3
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	351	$30,585	7
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	10	D	2
	3339	Other General Purpose Machinery Manufacturing	455	$26,130	15
	3341	Computer and Peripheral Equipment Manufacturing	60	D	1
	3342	Communication Equipment Manufacturing	10	D	1

Appendix Table 8, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3343	Audio and Video Equipment Manufacturing	NA	NA	NA
	3344	Semiconductor and Other Electronic Component Manufacturing	36	$3,187	4
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	1,053	$82,966	26
	3346	Manufacturing and Reproducing Magnetic and Optical Media	60	D	1
	3351	Electric Lighting Equipment Manufacturing	10	D	1
	3352	Household Appliance Manufacturing	375	D	3
	3353	Electrical Equipment Manufacturing	85	$5,484	4
	3359	Other Electrical Equipment and Component Manufacturing	102	$7,088	4
	3361	Motor Vehicle Manufacturing	60	D	1
	3362	Motor Vehicle Body and Trailer Manufacturing	91	$2,977	5
	3363	Motor Vehicle Parts Manufacturing	7,166	$387,104	19
	3364	Aerospace Product and Parts Manufacturing	10	D	2
	3366	Ship and Boat Building	750	D	4
	3369	Other Transportation Equipment Manufacturing	33	$869	4
	3391	Medical Equipment and Supplies Manufacturing	759	$22,027	23
	3399	Other Miscellaneous Manufacturing	477	$20,824	38
	Subtotal		**15,732**	**$647,693**	**230**
Advanced Energy Information	5112	Software Publishers	196	$12,562	13
	5152	Cable and Other Subscription Programming	1,750	D	2
	5172	Wireless Telecommunications Carriers (except Satellite)	908	$57,300	48
	5174	Satellite Telecommunications	NA	NA	NA
	5179	Other Telecommunications	180	$13,821	11
	5182	Data Processing, Hosting, and Related Services	174	$12,990	20
	5191	Other Information Services	115	$7,518	14
	Subtotal		**3,323**	**$104,191**	**108**
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	4,445	$358,777	328
	5414	Specialized Design Services	194	$8,992	44
	5415	Computer System Design and Related Services	1,515	$105,899	196
	5416	Management, Scientific, and Technical Consulting Services	4,761	$474,617	293
	5417	Scientific Research and Development Services	4,875	$514,991	36
	5419	Other Professional, Scientific, and Technical Services	1,534	$49,843	159
	Subtotal		**17,324**	**$1,513,119**	**1,056**

Appendix Table 8, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	854	$72,278	25
	6215	Medical and Diagnostic Laboratories	1,255	$62,730	45
	8112	Electronic and Precision Equipment Repair and Maintenance	116	$5,411	30
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	465	$22,786	39
	Subtotal		**2,690**	**$163,205**	**139**
All Advanced Energy Industry	**Total**		**52,541**	**$3,082,106**	**2,720**

Appendix Table 9: Advanced Energy by NAICS in Memphis, TN-MS-AR MSA, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	300	$20,822	15
	2212	Natural Gas Distribution	60	D	2
	2361	Residential Building Construction	1,023	$60,556	244
	2362	Nonresidential Building Construction	1,845	$129,518	122
	2371	Utility System Construction	705	$35,767	41
	2379	Other Heavy and Civil Engineering Construction	667	$37,392	11
	2381	Foundation, Structure, and Building Exterior Contractors	3,001	$161,253	189
	2382	Building Equipment Contractors	8,599	$460,832	548
	2383	Building Finishing Contractors	2,157	$98,536	215
	Subtotal		**18,357**	**$1,004,676**	**1,387**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	37	$1,143	5
	3221	Pulp, Paper, and Paperboard Mills	750	D	2
	3241	Petroleum and Coal Products Manufacturing	676	$61,093	14
	3251	Basic Chemical Manufacturing	1,353	$126,261	14
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	60	D	2
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	255	$7,448	9
	3259	Other Chemical Product and Preparation Manufacturing	286	$17,581	10
	3272	Glass and Glass Product Manufacturing	10	D	3
	3279	Other Nonmetallic Mineral Product Manufacturing	339	$17,223	14
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	375	D	4
	3313	Alumina and Aluminum Production and Processing	175	D	2
	3315	Foundries	10	D	1
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	60	D	2
	3332	Industrial Machinery Manufacturing	146	$8,049	10
	3333	Commercial and Service Industry Machinery Manufacturing	270	$11,644	4
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	1,696	$76,643	9
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	375	D	3
	3339	Other General Purpose Machinery Manufacturing	564	$29,927	12
	3341	Computer and Peripheral Equipment Manufacturing	175	D	1
	3342	Communication Equipment Manufacturing	10	D	1

Appendix Table 9, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3343	Audio and Video Equipment Manufacturing	10	D	1
	3344	Semiconductor and Other Electronic Component Manufacturing	1,750	D	3
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	151	$11,160	9
	3346	Manufacturing and Reproducing Magnetic and Optical Media	NA	NA	NA
	3351	Electric Lighting Equipment Manufacturing	360	$14,871	4
	3352	Household Appliance Manufacturing	750	D	2
	3353	Electrical Equipment Manufacturing	271	$10,186	9
	3359	Other Electrical Equipment and Component Manufacturing	175	D	2
	3361	Motor Vehicle Manufacturing	60	D	1
	3362	Motor Vehicle Body and Trailer Manufacturing	175	D	3
	3363	Motor Vehicle Parts Manufacturing	917	$35,485	14
	3364	Aerospace Product and Parts Manufacturing	180	$8,953	7
	3366	Ship and Boat Building	NA	NA	NA
	3369	Other Transportation Equipment Manufacturing	60	D	2
	3391	Medical Equipment and Supplies Manufacturing	5,406	$430,032	50
	3399	Other Miscellaneous Manufacturing	471	$19,986	29
	Subtotal		**18,358**	**$887,685**	**258**
Advanced Energy Information	5112	Software Publishers	383	$30,630	17
	5152	Cable and Other Subscription Programming	10	D	1
	5172	Wireless Telecommunications Carriers (except Satellite)	1,281	$65,193	76
	5174	Satellite Telecommunications	NA	NA	NA
	5179	Other Telecommunications	47	$3,795	17
	5182	Data Processing, Hosting, and Related Services	344	$19,349	37
	5191	Other Information Services	1,750	D	16
	Subtotal		**3,815**	**$118,967**	**164**
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	3,333	$185,359	225
	5414	Specialized Design Services	242	$9,979	58
	5415	Computer System Design and Related Services	2,738	$188,475	227
	5416	Management, Scientific, and Technical Consulting Services	2,568	$144,488	294
	5417	Scientific Research and Development Services	723	$68,281	46
	5419	Other Professional, Scientific, and Technical Services	2,068	$81,637	169
	Subtotal		**11,672**	**$678,219**	**1,019**

Appendix Table 9, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	279	$15,316	12
	6215	Medical and Diagnostic Laboratories	1,790	$105,236	48
	8112	Electronic and Precision Equipment Repair and Maintenance	835	$37,716	43
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	644	$31,436	59
	Subtotal		**3,548**	**$189,704**	**162**
All Advanced Energy Industry	**Total**		**55,750**	**$2,879,251**	**2,990**

Appendix Table 10: Advanced Energy by NAICS in Morristown, TN MSA, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	175	D	2
	2212	Natural Gas Distribution	10	D	1
	2361	Residential Building Construction	83	$3,197	28
	2362	Nonresidential Building Construction	134	$6,126	12
	2371	Utility System Construction	128	$6,425	6
	2379	Other Heavy and Civil Engineering Construction	NA	NA	NA
	2381	Foundation, Structure, and Building Exterior Contractors	372	$13,250	19
	2382	Building Equipment Contractors	185	$6,329	30
	2383	Building Finishing Contractors	135	$5,624	15
	Subtotal		**1,222**	**$40,951**	**113**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	10	D	2
	3221	Pulp, Paper, and Paperboard Mills	NA	NA	NA
	3241	Petroleum and Coal Products Manufacturing	NA	NA	NA
	3251	Basic Chemical Manufacturing	NA	NA	NA
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	60	D	3
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	NA	NA	NA
	3259	Other Chemical Product and Preparation Manufacturing	375	D	2
	3272	Glass and Glass Product Manufacturing	NA	NA	NA
	3279	Other Nonmetallic Mineral Product Manufacturing	60	D	1
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	NA	NA	NA
	3313	Alumina and Aluminum Production and Processing	NA	NA	NA
	3315	Foundries	NA	NA	NA
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	175	D	3
	3332	Industrial Machinery Manufacturing	10	D	1
	3333	Commercial and Service Industry Machinery Manufacturing	60	D	1
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	60	D	1
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	175	D	1
	3339	Other General Purpose Machinery Manufacturing	36	$1,369	4
	3341	Computer and Peripheral Equipment Manufacturing	NA	NA	NA
	3342	Communication Equipment Manufacturing	NA	NA	NA

Appendix Table 10, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3343	Audio and Video Equipment Manufacturing	NA	NA	NA
	3344	Semiconductor and Other Electronic Component Manufacturing	NA	NA	NA
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	NA	NA	NA
	3346	Manufacturing and Reproducing Magnetic and Optical Media	NA	NA	NA
	3351	Electric Lighting Equipment Manufacturing	10	D	1
	3352	Household Appliance Manufacturing	NA	NA	NA
	3353	Electrical Equipment Manufacturing	175	D	1
	3359	Other Electrical Equipment and Component Manufacturing	NA	NA	NA
	3361	Motor Vehicle Manufacturing	NA	NA	NA
	3362	Motor Vehicle Body and Trailer Manufacturing	NA	NA	NA
	3363	Motor Vehicle Parts Manufacturing	2,875	$169,722	8
	3364	Aerospace Product and Parts Manufacturing	NA	NA	NA
	3366	Ship and Boat Building	NA	NA	NA
	3369	Other Transportation Equipment Manufacturing	NA	NA	NA
	3391	Medical Equipment and Supplies Manufacturing	24	$1,034	4
	3399	Other Miscellaneous Manufacturing	375	D	4
	Subtotal		**4,480**	**$172,125**	**37**
Advanced Energy Information	5112	Software Publishers	10	D	1
	5152	Cable and Other Subscription Programming	NA	NA	NA
	5172	Wireless Telecommunications Carriers (except Satellite)	44	$2,455	6
	5174	Satellite Telecommunications	NA	NA	NA
	5179	Other Telecommunications	10	D	1
	5182	Data Processing, Hosting, and Related Services	NA	NA	NA
	5191	Other Information Services	NA	NA	NA
	Subtotal		**64**	**$2,455**	**8**
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	16	$1,198	12
	5414	Specialized Design Services	NA	NA	NA
	5415	Computer System Design and Related Services	17	$983	9
	5416	Management, Scientific, and Technical Consulting Services	57	$1,588	7
	5417	Scientific Research and Development Services	60	D	2
	5419	Other Professional, Scientific, and Technical Services	154	$4,226	17
	Subtotal		**304**	**$7,995**	**47**

Appendix Table 10, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	NA	NA	NA
	6215	Medical and Diagnostic Laboratories	10	D	1
	8112	Electronic and Precision Equipment Repair and Maintenance	60	D	2
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	60	D	3
	Subtotal		**130**	**D/NA**	**6**
All Advanced Energy Industry	**Total**		**6,200**	**$223,526**	**211**

Appendix Table 11: Advanced Energy by NAICS in Nashville-Davidson--Murfreesboro--Franklin, TN MSA, 2016

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Utilities and Construction	2211	Electric Power Generation, Transmission and Distribution	719	$58,252	23
	2212	Natural Gas Distribution	370	$29,785	10
	2361	Residential Building Construction	3,496	$225,578	722
	2362	Nonresidential Building Construction	7,342	$426,329	205
	2371	Utility System Construction	2,723	$163,899	104
	2379	Other Heavy and Civil Engineering Construction	47	$1,671	14
	2381	Foundation, Structure, and Building Exterior Contractors	5,659	$299,681	466
	2382	Building Equipment Contractors	13,313	$763,838	891
	2383	Building Finishing Contractors	3,508	$159,911	455
	Subtotal		**37,177**	**$2,128,944**	**2,890**
Advanced Energy Manufacturing	3211	Sawmills and Wood Preservation	365	$14,054	20
	3221	Pulp, Paper, and Paperboard Mills	NA	NA	NA
	3241	Petroleum and Coal Products Manufacturing	93	$14,032	17
	3251	Basic Chemical Manufacturing	241	$16,972	7
	3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing	139	$9,224	6
	3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing	60	D	2
	3259	Other Chemical Product and Preparation Manufacturing	625	$41,238	24
	3272	Glass and Glass Product Manufacturing	750	D	6
	3279	Other Nonmetallic Mineral Product Manufacturing	327	$17,338	26
	3311	Iron and Steel Mills and Ferroalloy Manufacturing	352	$19,596	6
	3313	Alumina and Aluminum Production and Processing	756	$51,555	4
	3315	Foundries	749	$40,064	4
	3331	Agriculture, Construction, and Mining Machinery Manufacturing	132	$7,325	11
	3332	Industrial Machinery Manufacturing	127	$5,807	9
	3333	Commercial and Service Industry Machinery Manufacturing	251	$29,720	6
	3334	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	307	$17,431	8
	3336	Engine, Turbine, and Power Transmission Equipment Manufacturing	60	D	2
	3339	Other General Purpose Machinery Manufacturing	1,221	$71,834	23
	3341	Computer and Peripheral Equipment Manufacturing	19	$683	3
	3342	Communication Equipment Manufacturing	60	D	3

Appendix Table 11, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Manufacturing	3343	Audio and Video Equipment Manufacturing	49	$2,613	8
	3344	Semiconductor and Other Electronic Component Manufacturing	88	$2,864	4
	3345	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	366	$19,475	9
	3346	Manufacturing and Reproducing Magnetic and Optical Media	245	$9,505	8
	3351	Electric Lighting Equipment Manufacturing	311	$16,230	8
	3352	Household Appliance Manufacturing	3,796	$190,078	4
	3353	Electrical Equipment Manufacturing	644	$30,837	9
	3359	Other Electrical Equipment and Component Manufacturing	839	$28,474	9
	3361	Motor Vehicle Manufacturing	7,500	D	2
	3362	Motor Vehicle Body and Trailer Manufacturing	347	$14,621	12
	3363	Motor Vehicle Parts Manufacturing	10,456	$667,570	62
	3364	Aerospace Product and Parts Manufacturing	750	D	4
	3366	Ship and Boat Building	375	D	5
	3369	Other Transportation Equipment Manufacturing	23	$1,000	4
	3391	Medical Equipment and Supplies Manufacturing	791	$46,242	43
	3399	Other Miscellaneous Manufacturing	1,641	$76,885	94
	Subtotal		**34,855**	**$1,463,267**	**472**
Advanced Energy Information	5112	Software Publishers	1,240	$146,736	77
	5152	Cable and Other Subscription Programming	8	$289	3
	5172	Wireless Telecommunications Carriers (except Satellite)	3,761	$166,999	100
	5174	Satellite Telecommunications	60	D	2
	5179	Other Telecommunications	311	$10,385	43
	5182	Data Processing, Hosting, and Related Services	3,552	$308,433	101
	5191	Other Information Services	672	$49,446	73
	Subtotal		**9,604**	**$682,288**	**399**
Advanced Energy Professional, Scientific, and Technical Services	5413	Architectural, Engineering, and Related Services	6,770	$522,350	527
	5414	Specialized Design Services	611	$37,726	168
	5415	Computer System Design and Related Services	8,146	$764,117	555
	5416	Management, Scientific, and Technical Consulting Services	7,217	$460,849	718
	5417	Scientific Research and Development Services	1,059	$120,534	52
	5419	Other Professional, Scientific, and Technical Services	4,110	$166,637	337
	Subtotal		**27,913**	**$2,072,213**	**2,357**

Appendix Table 11, continued

Industry Group	NAICS	Descriptor	Employment	Payroll ($1,000)	Number of Establishments
Advanced Energy Other Services (Includes Administrative and Support, Waste Management and Remediation Services, and Health Care and Social Assistance)	5622	Waste Treatment and Disposal	222	$11,312	19
	6215	Medical and Diagnostic Laboratories	2,614	$145,326	102
	8112	Electronic and Precision Equipment Repair and Maintenance	1,962	$87,832	66
	8113	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	731	$33,712	91
	Subtotal		**5,529**	**$278,182**	**278**
All Advanced Energy Industry	**Total**		**115,078**	**$6,624,894**	**6,396**