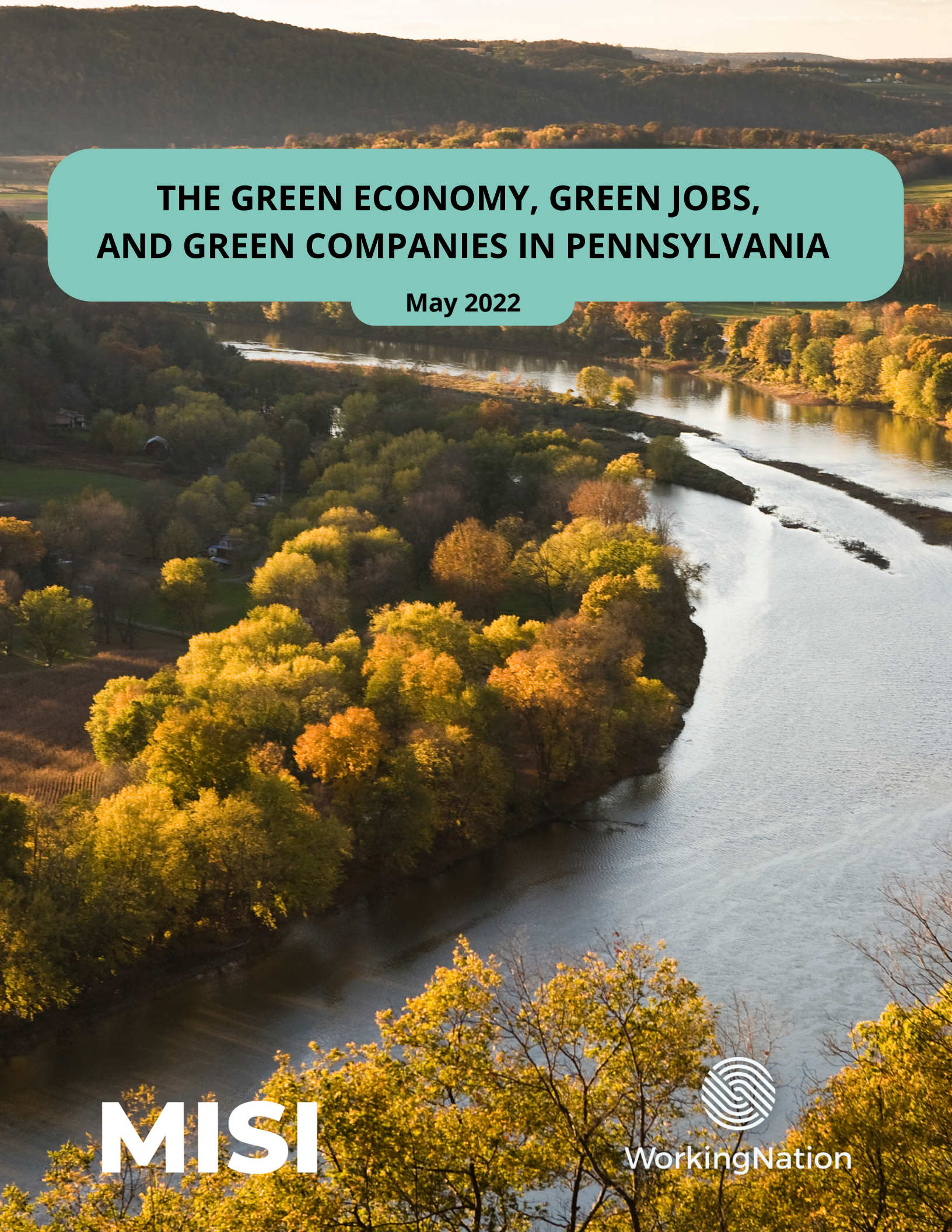

THE GREEN ECONOMY, GREEN JOBS, AND GREEN COMPANIES IN PENNSYLVANIA

May 2022

MISI

WorkingNation

THE GREEN ECONOMY, GREEN JOBS, AND GREEN COMPANIES IN PENNSYLVANIA

Prepared by Management Information Services, Inc.
For WorkingNation

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BOTTOM LINE UP FRONT

The COVID-19 pandemic has exacerbated worrying trends in the U.S. economy related to the jobs skills gap that is threatening to disrupt the labor market. There is a growing mismatch between the skills that employers want and the skills that employees have and, as the economy struggles to fully reopen, that warning is more relevant than ever – especially for green industries and jobs.

A major purpose of this report is to provide compelling empirical information that will facilitate initiatives to develop stories and narratives about solutions to the jobs skills gap – especially as it relates to the emerging and rapidly growing green industries in Pennsylvania. This research and the resultant database and IT capabilities also has relevance to other states and regions. MISI first provides a broad overview of the green jobs picture in the U.S. Second, MISI conducted statewide research for Pennsylvania on green jobs and industries, with a further drill down on rehiring potential, identifying a sample of specific locales and employers.

The report contains a wealth of valuable information and makes seminal contributions to the issues of evolving jobs skills and requirements and the education and training requirements that will be required for jobs post COVID-19. The major conclusions derived, and their implications, are summarized below.

Conclusion Number 1: The COVID-19 pandemic has accelerated and exacerbated worrying trends in the U.S. economy related to the jobs skills gap that is threatening to disrupt the labor market. There is a growing mismatch between the skills that employers want and the skills that employees have and, as the economy struggles to fully reopen, that warning is more relevant than ever.

Implication Number 1: This report can be used to identify for specific occupations in Pennsylvania the mismatch between desired skills and available skills and communicate this to state officials.

Conclusion Number 2: Many companies, whether they realize it or not, owe their profits – and in some cases their existence – to "green" expenditures. Many workers, whether they realize it or not, would be unemployed were it not for these expenditures.

Implication Number 2: This report can be used to inform companies, workers, and Pennsylvania policymakers of the importance of green expenditures and the green economy in generating company revenues, jobs, and economic growth. Many workers in Pennsylvania are dependent on the green economy for their employment, although they have no way of recognizing this unless it is brought to their attention.

Conclusion Number 3: There exists relatively little rigorous and comprehensive research addressing the practical relationship between green industries and existing jobs or future job creation. Even some research in this area sponsored by environmental organizations is off the mark, in that it has tended to emphasize jobs creation in classically green activities, such as environmental lawyers, solar engineers, or workers in recycling plants. However, while these jobs count as green jobs, the classic green job constitutes only a small portion of the jobs created by the green economy. Rather, the vast majority of the jobs created are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. Green firms employ a wide range of workers at all educational and skills levels and at widely differing earnings levels, and in green companies most of the employees are not classified as "environmental specialists" or "green energy specialists."

Implication Number 3: The information in this report can be used to correct this dangerously misleading information on green jobs and to document and emphasize that classic green jobs (e.g., ecologist, solar engineer, etc.) comprise only a small fraction of the total number of jobs created by the green economy. Pennsylvania workers and their representatives must be educated on the importance of the green economy to their jobs and livelihoods.

Conclusion Number 4: The concentration of green jobs in Pennsylvania within certain economic sectors is significant. Green investments will provide a greater than proportionate assist to Pennsylvania's high-tech and manufacturing sectors, and green investments generate, proportionately, three times as many jobs in professional, scientific, and technical services as the state average.

Implication Number 4: Pennsylvania is seeking to modernize and expand its high-tech industrial and professional, scientific, and technical services industries, and the green economy can aid in this objective. State policymakers can be educated and assisted in devising appropriate post-COVID green jobs and skills training programs. It must be emphasized that jobs in this sector are the high-skilled, high-wage, technical and professional jobs that Pennsylvania seeks to attract and retain.

Conclusion Number 5: In many occupations not traditionally identified as green, a greater than proportionate share of the jobs are generated by the green economy. These findings are significant for they indicate that state investments in green initiatives will create jobs in greater than proportionate shares in two categories Pennsylvania is eager to attract – college-educated professional workers, many with advanced degrees, and highly-skilled, technical workers, with advanced training and technical expertise. Green industries thus generate jobs that are disproportionately for highly skilled, well paid, technical and professional workers, who in turn underpin and provide a middle-class foundation for entrepreneurship and economic growth.

Implication Number 5: These findings can be communicated to Pennsylvania policymakers. It is critical that policymakers realize that green initiatives can facilitate a middle-class foundation for entrepreneurship and economic growth in the state and that state economic and job programs incorporate this.

Conclusion Number 6: Most of the green companies MISI surveyed were adversely affected by COVID during 2020. However, they were affected relatively less than many other types of companies in the state and by April 2021 they were all recovering.

Implication Number 6: It can be emphasized to Pennsylvania policymakers and industry leaders that green companies proved to be relatively resilient during 2020 and are currently recovering better than the state economy as a whole.

Conclusion Number 7: It is possible to develop meaningful green industry narratives for Pennsylvania illustrating the potential of green jobs and green jobs initiatives in the state, and MISI developed three of these.

Implication Number 7: An aggressive media and PR campaign based on these narratives can be initiated to begin to frame a national discussion to reach people and entities that can effect change, to connect the dots for companies and communities seeking solutions to their own workforce issues, and to identify for workers and job seekers where the jobs of the future will be. These narratives will facilitate cooperative initiatives with showcase corporations, thought leaders, NGOs, foundations, and local governments that are working on scalable solutions.

Conclusion Number 8: Clean energy jobs in the Pennsylvania will not return to their pre-COVID level for years – and first, clean energy jobs losses will have to be halted and reversed; EE jobs in the state will not return to their pre-COVID level until mid-2024. However, MISI estimates that the current number of green jobs in Pennsylvania totals approximately 400,000, and is growing at a CAGR of 5%, which represents a total annual increase in green jobs in the state of about 20,000 – nearly 30 times the number of annual estimated job losses in clean energy and EE jobs in the state. Thus: i) total green job growth in the state could replace all of the clean energy and EE jobs lost in Pennsylvania during 2020 by 1Q 2021; ii) all of the clean energy and EE jobs lost in Pennsylvania pre-COVID could be replaced by green job growth by 1Q 2022.

Implication Number 8: Pennsylvania policymakers must be made to realize that green jobs in the state are being seriously under-estimated, and that the potential implications of this for state jobs and training programs are serious. Second, it must be emphasized to Pennsylvania policymakers that green jobs in the state are much more resilient and have recovered much more rapidly than most other jobs or total employment, and that the potential implications of this for state jobs and training programs are important.

Conclusion Number 9: MISI forecasts that in 2028 Pennsylvania green jobs will total 8.8% of all jobs in the state, and this implies that by 2028 green jobs in Pennsylvania will increase as a total of all jobs in the state by about 45%. Between 2027 and 2028 green jobs in Pennsylvania increase about 5% – or a total of about 30,000. PDLI forecasts that total employment in the state over that period will increase by 32,000 jobs. Thus, green job growth in the state that year will nearly be equivalent to total job growth in Pennsylvania. With appropriate federal and state government policies in place, the number of green jobs in Pennsylvania could increase even more substantially.

Implication Number 9: It should be emphasized to state policymakers that over the next decade the number of annual new green jobs in Pennsylvania will be increasing at nearly the same number as total net jobs in the state – increasing at a rate that is 8 to 12 times greater than total Pennsylvania employment. The annual increase in Pennsylvania green jobs post-COVID could nearly equal the total number of jobs forecast by the state to be created annually over the next several years. This has profound implications for state economic, jobs, and education and training programs.

Conclusion Number 10: Green jobs are increasing rapidly in Pennsylvania and offer important opportunities for encouraging green industries in the state. However, they will continue for the foreseeable future to comprise only a small portion of total jobs and of new jobs in the state. Any ambitious employment and job creation programs must take such discrepancies into account.

Implication Number 10: It must be emphasized to Pennsylvania policymakers that jobs and job training programs must realistically target occupations and skills that have large numbers of workers and are growing rapidly. They should be warned against fixation on "sexy" green jobs such as wind turbine technicians or solar photovoltaic installers, where annual new job openings in the entire state will total only about 15 a year. This fixation represents misguided and self-defeating jobs and jobs training programs. Many occupations contain many more workers, are growing rapidly, will continue to employ many more workers and, crucially, will provide many more annual job openings than will most green jobs in the state.

Conclusion Number 11: There is synergy between green companies/green jobs and other rapidly growing sectors in Pennsylvania. For example, many of the green companies profiled here are active in and obtain substantial revenues from the health care industry. These include, especially, Envinity, but also Barry Isett & Associates, Clean Harbors, Elk Environmental Services, and Green Mountain Energy. Since the health care industry is one of the largest and most rapidly-growing industries in the state, this implies that associated green jobs will also be growing substantially and rapidly.

Implication Number 11: The information presented here can be used to communicate to and facilitate Pennsylvania policymakers and health care industry officials on the close relationship between the growing health care industry in the state and green jobs in the state. This provides the basis for an interesting narrative. This will also tend to increase the forecasts of future green jobs in the state.

Conclusion Number 12: Green jobs are not self-evident. For example, occupations such as drywall installers and HVAC technicians and workers in the nuclear industry and CCS are not generally defined as "green." This is a serious error which substantially distorts green jobs estimates.

Implication Number 12: This report can help specify and reclassify the definition of green jobs in Pennsylvania. This will be critical in estimating the numbers of green jobs in the state and forecasting their growth and to identifying for workers and job seekers where the green jobs of the future will be.

Conclusion Number 13: Median hourly wages for clean energy jobs are about 25% higher than the national median wage. However, green jobs paying better than burger flippers or baristas is a low bar. Many green jobs pay substantially less than the jobs they are displacing, energy workers earn more than the typical U.S. worker, and the highest-paying positions are skewed heavily toward nuclear, utility, natural gas, and coal industry workers. Many wind, solar, and "green" jobs pay well below them.

Implication Number 13: This information can provide a critically needed service by communicating the realty of relative green job wages and devising solutions to the serious problem that many green jobs pay less than those they are displacing. Solutions involve policy initiatives and greatly increasing the rate of unionization of green jobs.

Conclusion Number 14: Organized labor abhors the term "just transition," but green energy advocates continue to use it and are shooting themselves in the foot. Labor leaders contend: "There's never been such a thing as a just transition," and "We believe that the Second Coming of the Lord is gonna get here before a just transition makes it our way."

Implication Number 14: Union support for green initiatives is critical, and green advocates should not inadvertently alienate organized labor by using terminology that raises red flags. This report can assist in: 1) Informing green advocates and policymakers in Pennsylvania that use of terms such as "just transition" is counterproductive; 2) working with green advocates and organized labor in the state to develop terminology that unions are comfortable with; 3) utilizing this new terminology in an aggressive green media and marketing campaign in the state targeted at labor leaders and union members.

Conclusion Number 15: Green jobs will be created across a new continuum of employment, skills, responsibilities, and earnings. Training for new skills will be needed across a wide spectrum of industries. Some changes in skills are relatively well defined, but many likely changes remain difficult to forecast since the technologies are still evolving. Many job tasks currently remain unknown, and thus identification of training needs requires interactive research combined with job definition. Many of these jobs do not currently exist and do not have occupational titles defined in federal or Pennsylvania state government occupational handbooks and employment guides. Further, many of these new jobs require different skills and education than current jobs, and training needs must be determined to enable this rapidly-growing green sector to have a sufficient supply of trained and qualified employees.

Implication Number 15: There is a growing mismatch between the skills that employers want and the skills that employees have and this warning is relevant for the green economy. Post-pandemic, the U.S. will require a clear understanding of the skills required for new jobs – especially green jobs. This report can provide critically-needed information relating to emerging new green jobs, the experience, skills, and education and training required for these jobs, and the salaries that can be expected, and help identify for workers and job seekers where the green jobs of the future will be.

I. GREEN INDUSTRIES AND GREEN JOBS IN PENNSYLVANIA

I.A. Summary of the Green Industry and Jobs in Pennsylvania

MISI estimates that in 2019:

- Sales generated by green industries in Pennsylvania totaled $42.9 billion.
- The number of green jobs totaled over 376,000.
- The green industry in Pennsylvania comprised 5.3% percent of gross state product.
- Pennsylvania green industries accounted for 6.6% of the sales of the U.S. environmental industry.
- Green jobs comprised 6.1 percent of Pennsylvania employment.
- Green jobs in Pennsylvania comprised 4.7 percent of the total number of green jobs in the U.S.

MISI forecasts that, post COVID-19, green jobs will increase three to four times more rapidly than total employment in the state.

Table I-1 shows the industrial distribution of green jobs in Pennsylvania in 2019.

Comparison of the industrial sector distribution of green jobs in Pennsylvania with that of total employment in the state is instructive. A significant portion of the green jobs is in the public administration sector which, given the public nature of green programs, is to be expected. However, most of the green jobs in Pennsylvania are in the private sector, and focusing on these reveals that they are heavily concentrated in several sectors. Of particular note is that the private sector green industry in Pennsylvania is more manufacturing intensive than other average private sector activity in the state:

- Over 16 percent of private sector jobs in the green industry are in manufacturing, compared to nine percent in manufacturing among all private sector industrial activities in Pennsylvania.
- Over 17 percent of private sector green jobs are in professional, scientific, and technical services, compared to less than six percent of all private sector jobs in the state.
- Nearly 10 percent of private sector green jobs are in administrative, support, and waste management services, compared to less than six percent of all private sector jobs in the state.
- Less than three percent of private sector green jobs are in educational services, compared to over four percent of all private sector jobs in the state.

Conversely, there are relatively few private sector green jobs in other parts of the Pennsylvania economy:

- Less than five percent of private sector green jobs are in the retail trade sector, compared to over 10 percent in retail trade among all private sector jobs in the state.

- Less than one percent of green jobs are in the finance and insurance sector, compared to nearly five percent among all private sector jobs in the state.
- A little over one percent of green jobs are in the health care and social service sector, compared to over 17 percent among all private sector jobs in the state.
- Less than three percent of green jobs are in the transportation and warehousing sector, compared to four percent among all private sector jobs in the state.

Table I-1
Green Jobs in Pennsylvania in 2019, by Industry

Industry	2017 NAICS code	Green Jobs
Agriculture, Forestry, Fishing and Hunting	11	3,041
Mining	21	4,189
Utilities	22	9,233
Construction	23	48,990
Manufacturing	31-33	61,505
Wholesale Trade	42	11,836
Retail Trade	44-45	17,393
Transportation and Warehousing	48-49	10,032
Information	51	3,715
Finance and Insurance	52	3,347
Real Estate and Rental and Leasing	53	3,257
Professional, Scientific, and Technical Services	54	65,361
Management of Companies and Enterprises	55	5,659
Administrative/Support/ Waste Management/ Remediation Services	56	37,212
Educational Services	61	10,802
Health Care and Social Assistance	62	4,844
Arts, Entertainment, and Recreation	71	1,848
Accommodation and Food Services	72	3,438
Other Services	81	8,478
Public Administration	92	62,474
State Total		376,655

Source: U.S. Bureau of Labor Statistics, Pennsylvania Department of Labor and Industry, and Management Information Services, Inc.

Assessing the portion of total state employment in each industrial sector accounted for by green jobs indicates that the 376,700 green jobs accounted for about a little over six percent of the total 6.2 million jobs in Pennsylvania in 2019. However, this distribution is uneven among industry sectors:

- Over one-third of employment in the utilities sector consists of green jobs, primarily water, waste treatment, sanitation, and related facilities.
- Nearly ten percent of public administration employment (federal, state, and local) in the state consists of green jobs.
- Nearly 20 percent of Pennsylvania jobs in the professional, scientific, and technical services are green jobs.
- 11 percent of the state's manufacturing employment is green-related
- Only very small portions of total state employment in sectors such as food services, entertainment, real estate, transportation, and retail trade are comprised of green jobs.

The concentration of green jobs within certain industrial sectors is instructive and interesting. While accounting for a little over six percent of total state employment, the industrial sector composition of green employment is highly skewed in favor of certain sectors. For example, more than 16 percent of private sector green jobs are in manufacturing, compared to nine percent of all private sector employment, and more than 17 percent of private sector green jobs are in professional, scientific, and technical services, compared to less than six percent of all private sector jobs in the state.

This indicates that green investments will provide a greater than proportionate assist to Pennsylvania's high-tech and manufacturing sectors. As noted in Chapter IV, Pennsylvania is seeking to modernize and expand its high-tech industrial and manufacturing base. Table V-1 indicates that the green industry can aid in this objective.

Similarly, green investments generate, proportionately, three times as many jobs in professional, scientific, and technical services as the state average. Jobs in this sector are the high-skilled, high-wage, technical and professional jobs that Pennsylvania – and other states – seeks to attract and retain. Table V-1 indicates that investments in green protection can be of considerable assistance here.

I.B. Green Jobs in Pennsylvania by Occupation and Skill

Green jobs in Pennsylvania can be disaggregated by specific occupations and skills, and this information for 2019 for selected occupations is given in Table I-2. This table illustrates that green jobs in Pennsylvania are widely distributed among all occupations and skill levels and, while the number of jobs created in different occupations differs substantially, employment in virtually all occupations is generated by green industries.

As noted in Chapter III, the vast majority of the green jobs created are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. and most of the persons employed in these jobs may not even realize that they owe their livelihood to the green economy. This is borne out in Table I-2 and Figure I-1, which list the jobs created by environmental protection in Pennsylvania

in 2019 within selected occupations. These show that in 2019 green industries in Pennsylvania generated:

- More jobs for welders (1,281) than for biochemists (481)
- More jobs for office clerks (4,686) than for environmental engineers (322)
- More jobs for executive secretaries and administrative assistants (1,933) than for hazardous materials removal workers (1,314)
- More jobs for bookkeeping and accounting clerks (4,622) than for environmental scientists and specialists (1,816)
- More jobs for machinists (1,186) than for health and safety engineers (341)
- More jobs for janitors (3,177) than for wind turbine technicians (224)
- More jobs for cost estimators (1,002) than for landscape architects (591)
- More jobs for management analysts (1,844) than for environmental engineering technicians (508)
- More jobs for inspectors and testers (1,502) than for chemists (566)
- More jobs for human resources specialists (1,882) than for solar photovoltaic installers (255)

Thus, many workers in Pennsylvania are dependent on the green economy for their employment, although they often would have no way of recognizing that connection unless it is brought to their attention.

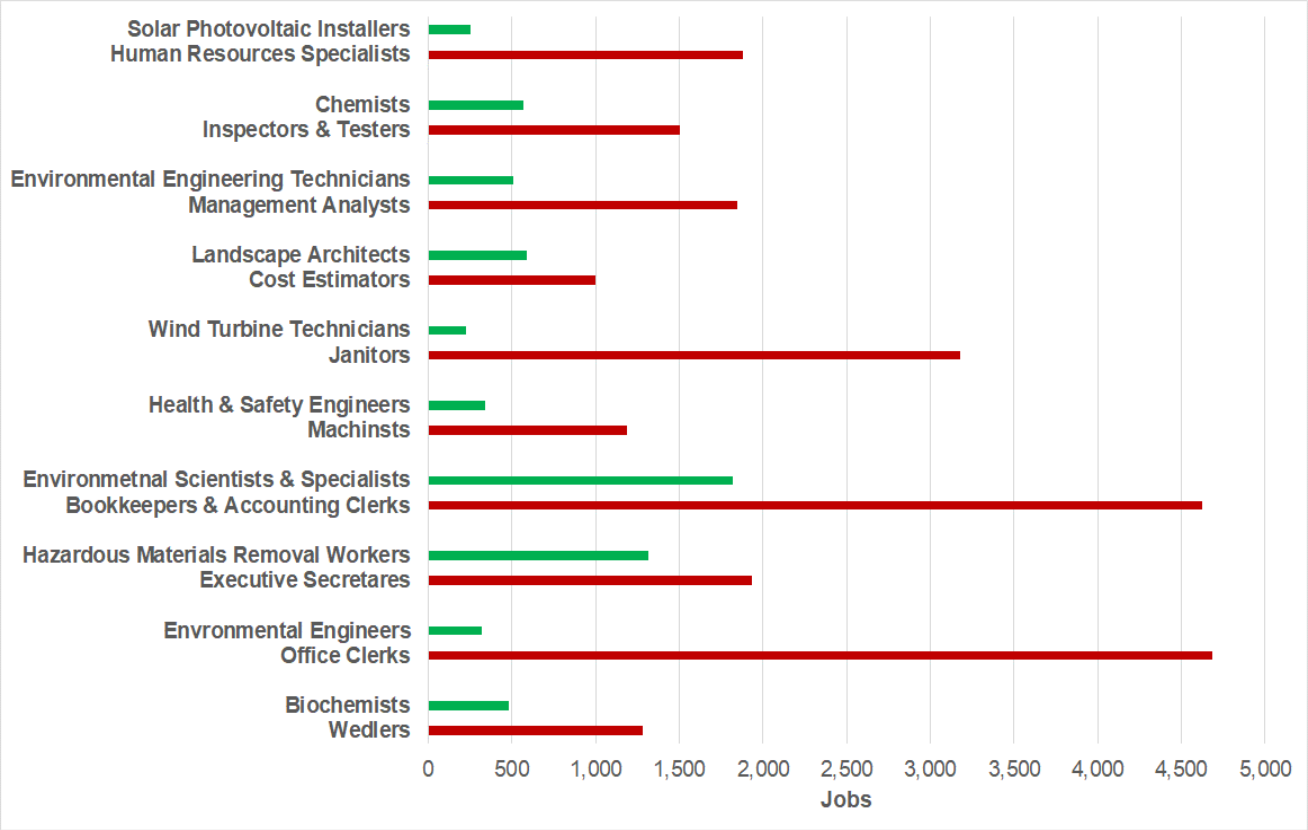
The importance of green industries for jobs in some occupations is much greater than in others. For some occupations, such as environmental scientists and specialists, environmental engineers, hazardous materials workers, water and liquid waste treatment plant operators, environmental science protection technicians, wind turbine technicians, refuse and recyclable material collectors, and environmental engineering technicians, much of the demand in Pennsylvania is created by green activities. This is hardly surprising, for most of these jobs are clearly identifiable as “green” jobs.

Table I-2
Green Jobs Generated in Pennsylvania in 2019, by Selected Occupations

Occupation	Jobs
Accountants and Auditors	3,462
Biochemists and Biophysicists	481
Biological Technicians	693
Bookkeeping, Accounting, and Auditing Clerks	4,622
Budget Analysts	207
Chemists	556
Computer Programmers	1,113
Computer Systems Analysts	1,948
Cost Estimators	1,002
Electrical and Electronic Engineering Technicians	508
Database Administrators	986
Electricians	2,001
Environmental Engineering Technicians	322
Environmental Engineers	2,212
Environmental Scientists and Specialists, Including Health	1,816
Executive Secretaries and Administrative Assistants	1,933
Financial Managers	1,898
Geoscientists, Except Hydrologists and Geographers	447
Hazardous Materials Removal Workers	1,314
Health and Safety Engineers	341
Human Resources Specialists	1,882
Industrial Machinery Mechanics	1,640
Inspectors, Testers, Sorters, Samplers, and Weighers	1,502
Janitors and Cleaners, Except Maids and Housekeeping Cleaners	3,177
Landscape Architects	591
Machinists	1,186
Management Analysts	1,844
Mechanical Engineers	1,662
Office Clerks	4,686
Plumber, Pipefitters, and Steamfitters	1,435
Refuse and Recyclable Material Collectors	3,122
Security Guards	1,872
Septic Tank Services and Sewer Pipe Cleaners	1,140
Solar Photovoltaic Installers	255
Truck Drivers, Heavy and Tractor Trailer	2,989
Water and Liquid Waste Treatment Operators	3,041
Welders, Cutters, Solders, and Brazers	1,211
Wind Turbine Technicians	224

Source: Management Information Services, Inc.

Figure I-1
Green Jobs Generated in Pennsylvania in 2019, by Selected Occupations



Source: Management Information Services, Inc.

However, in many occupations not traditionally identified as green, a greater than proportionate share of the jobs are also generated by the green economy. Recalling that, on average, environment-related employment in Pennsylvania comprises only about six percent of total employment, in 2019 green expenditures generated jobs for a greater than proportionate share of many professional occupations in the state, including:

- Computer software applications engineers
- Electrical and electronics engineers
- Computer programmers
- Landscape architects
- Operations research analysts
- Biochemists and biophysicists
- Computer systems software engineers
- Network systems and data communications analysts
- Medical scientists (except epidemiologists)
- Chemical engineers
- Management analysts

- Civil engineers
- Chemical technicians
- Architecture and civil drafters
- Electrical and electronics engineering technicians
- Chemical plant and system operators
- Chemical technicians
- Mechanical engineering technicians
- Technical writers
- Electrical and electronics drafters
- Electrical and electronics repairers (powerhouse, substation and relay)
- Chemical plant and system operators
- Surveying and mapping technicians
- Operating engineers

The above findings are significant for they indicate that state investments in green initiatives and environmental protection will create jobs in greater than proportionate shares in two categories Pennsylvania -- and other states -- are eager to attract:

- College-educated professional workers, many with advanced degrees
- Highly skilled, technical workers, with advanced training and technical expertise, many of them in the manufacturing sector.

Green industries thus generate jobs that are disproportionately for highly skilled, well paid, technical and professional workers, who in turn underpin and provide foundation for entrepreneurship and economic growth.

II. SUMMARY PROFILES OF SELECTED PENNSYLVANIA GREEN COMPANIES

MISI conducted a survey of a representative sample existing green companies in Pennsylvania, examining a functional, technological and geographic mix of companies. Our research revealed many firms, and they:

- Are located throughout the state, in major urban centers, suburbs, small towns, and rural areas.
- Range in size from small firms of 20 employees or less to large firms employing hundreds or thousands.
- Are engaged in a wide variety of activities, including remediation, construction, manufacturing, testing, monitoring, analysis, etc.
- Include some of the most sophisticated, high-tech firms in the state.

Summary descriptions of a representative sample of these firms are given in Table II-1 and are discussed below. The information presented is current as of April 2021.

Table II-1
Summary of the Select Pennsylvania Environmental Companies Profiled

Company	Location	Products/Services	Jobs
American Hydro	York, Pennsylvania	American Hydro is a leading supplier and installer of large equipment for the hydroelectric industry, specializing in design, engineering, precision CNC manufacture, upgrades, and servicing of high performance hydro turbines and pumps.	166
Barry Isett & Assoc.	Allentown, Pennsylvania	Barry Isett & Associates is an environmental and energy engineering and consulting services firm that provides single-source engineering and start-to-finish project involvement in the design, construction, operation, maintenance, renovation, and replacement of facilities.	137
Bright Eye Solar	Lancaster County, Pennsylvania	Bright Eye Solar is a solar electric design and installation company that provides options for people who want affordable, clean solar energy.	12
Clean Harbors	Philadelphia, Pennsylvania	Clean Harbors is a leading provider of environmental and industrial services and the largest hazardous waste disposal company in North America. It provides a broad range of services such as end-to-end hazardous waste management, emergency spill response, industrial cleaning and maintenance, and recycling services.	6,000
Elk Environmental	Reading, Pennsylvania	Elk Environmental Services is a full-service environmental remediation and waste management services firm that provides	39

		environmental solutions to industrial and commercial businesses.	
Envinity, Inc.	State College, Pennsylvania	Envinity is an energy conservation, efficiency, and generation company that that utilizes the building science approach to green design, construction, and energy management for residential and commercial clients.	29
EvolveVA	Pittsburgh, Pennsylvania	Evolve Environment is a multidisciplinary practice situated at the intersection of sustainability and the built environment whose mission is to advance sustainable systems and solutions.	14
Exus Partners	Pittsburgh, Pennsylvania	Exus Partners is an independent investment and asset management firm focused on the renewable energy sector: Wind, photovoltaics and small hydro.	17
Green Mountain Energy	Pittsburgh and Philadelphia, Pennsylvania	Green Mountain Energy is the nation's longest-serving renewable energy retailer: It assists customers in making a positive environmental impact, support a cleaner grid, and green their carbon footprints with sustainable living solutions, renewable energy plans, and the purchase of carbon offsets.	34
J&J Environmental Services	East Norriton, Pennsylvania	J&J Environmental Services is an emergency spill response and environmental contracting company.	6
Practical Energy Solutions	West Chester, Pennsylvania	Practical Energy Solutions is an independent energy management advisory firm providing energy management services and education/awareness programs.	8
Siemens Gamesa	Trevose, Pennsylvania	Siemens Gamesa provides wind power onshore and offshore and related services.	1,112

Source: Management Information Services, Inc.

II.A. American Hydro

American Hydro is a leading supplier and installer of large equipment for the hydroelectric industry, specializing in design, engineering, precision CNC manufacture, upgrades and servicing of high performance hydro turbines and pumps. At present, the company has over 166 employees out of its headquarters in York, Pennsylvania. Its employees include engineers, machine operators, mechanics, field reps, estimators, project managers, and management. Clients include independently-owned power producers, investor-owned utilities, public utilities, industrial enterprises, and governmental organizations.

American Hydro was founded in York in 1986 by four engineers who recognized that the hydropower industry lacked a manufacturer who specialized in the upgrade and rehabilitation of turbines and turbine components. The firm currently offers whole solutions for hydropower needs and provides expertise in everything from the conceptual design of a project to operational support and maintenance of power

stations. American Hydro was acquired from Weir Group plc by Wärtsilä, based in Helsinki, Finland, in June 2016.

American Hydro's offerings include the following.

Manufacturing

- Production of high quality hydro mechanical components cost effectively and in less time than by conventional means, leveraging expertise in computer and manufacturing integration. Engineered designs created with specialized software are input directly into work centers equipped with CNC milling or plasma cutting machines for complete accuracy.

Engineering

- Creation of designs that maximize turbine capacity and efficiency while eliminating cavitation to meet customers' needs. Complete machines are analyzed for each design to ensure the full operating range is optimized while balancing the structural integrity of the unit with the hydraulic performance.

Turbines

- Upgrading and refurbishing of Francis, Kaplan, propeller, large pumps, pump-turbines, and Kaplan conversions. Each design is customized to meet specific project requirements, including life extension, increased capacity and peak efficiency, elimination of cavitation, and environmentally-friendly technology.

Field Services

- Site surveys of existing plants
- Complete disassembly and reassembly of hydro turbines, generators, and ancillary equipment
- In-place machining of all embedded components
- Turning, milling, grinding on-site with an extensive fleet of portable precision machine tools
- High Precision 3-D Laser Measurement Laser Tracker surveys and complete unit alignment of stationary parts
- Refurbishment or replacement of discharge rings
- Stay ring and guide vane modifications or replacements
- Stator realignments
- Installation of oil lube and cooling systems
- Governor replacements
- Cavitation repairs
- Performance testing

II.B. Barry Isett & Associates, Inc.

Barry Isett & Associates is an environmental and energy engineering and consulting services firm that provides single-source engineering and start-to-finish

project involvement in the design, construction, operation, maintenance, renovation, and replacement of facilities. Isett employs 137 people across the U.S. with 132 based in Pennsylvania, half at headquarters in Allentown and the rest spread among multiple offices across the state. Employees include engineers, environmental scientists, architects, project managers, and operations specialists. Typical clientele spans developers, municipalities, educational institutions, residential clients, governmental agencies, and healthcare providers.

Founded by Barry E. Isett, PE, PLS, F.NSPE, in 1977, Isett is now owned by a consortium of associate shareholders. The company is organized into three divisions to provide greater client focus:

1. The Design Division encompasses Civil, Structural, Mechanical/ Electrical/ Plumbing (MEP), and Project Management groups.
2. The Public Division incorporates Code Inspection & Plan Review Services, Municipal Engineering, and Grants Services under a comprehensive umbrella.
3. The Field Division includes Construction Materials Testing, Environmental Consulting, Survey, Geotechnical Engineering, and Forensic Engineering.

Disciplines include civil/land development; structural; mechanical/electrical/ plumbing; forensics; water & wastewater; municipal; and traffic. Associated professional services include survey, environmental, code services, landscape architecture, geotechnical and inspection/materials testing, grant writing, and construction services/ project management. Isett professionals are licensed in AK, AZ, CO, DC, DE, FL, GA, IA, IL, KY, MD, MI, MO, NC, NH, NM, OH, PA, TX, VA and WV.

II.C. Bright Eye Solar LLC

Bright Eye Solar (BES) is a solar electric design and installation company based out of Lancaster County, Pennsylvania. It provides options for clients who want affordable, clean solar energy. BES has 12 employees, with eight based in Pennsylvania across two locations including headquarters in Lancaster. Employees include sales reps, project managers, journeyman, master electricians, and panel installers. BES serves both residential and commercial clients, with a focus on farming and agriculture.

BES was founded in 2011 in Lancaster by Jim Noden. It helps municipalities, organizations, and homeowners in the decision making process to determine if investing in solar photovoltaics (PV) is feasible and an advantageous investment for them. BES strives to help educate customers regarding benefits, pricing, and ROI. It assists customers secure financing and delivers a complete turn-key solar PV analysis, design and, installation. Following project completion, BES monitors and manages each system through its entire life cycle.

BES is accredited by the IREC (Interstate Renewable Energy Council). Its technicians have successfully completed NABCEP certified training for photovoltaic systems.

II.D. Clean Harbors

Clean Harbors is a leading provider of environmental and industrial services and the largest hazardous waste disposal company in North America – see the discussion in Section VII.B. It delivers a broad range of services such as end-to-end hazardous waste management, emergency spill response, industrial cleaning and maintenance, and recycling services. It has 6,000 employees, including 175 in Pennsylvania, across multiple offices with the largest concentration at the Philadelphia office. Employees include Environmental Technicians, Drivers, Environmental Field Laborers, Project Managers, Account Managers, Sales, Customer Service, and Operations. It is currently hiring for 14 positions in Pennsylvania.[1]

Founded by Alan S. McKim, Clean Harbors began as a four-person tank cleaning business. At present, Clean Harbors is a publicly traded company (NYSE: CLH) that maintains a vast network of service centers and waste management, treatment, and disposal facilities and provides a broad range of services. The Company serves a diverse customer base, including a majority of Fortune 500 companies. Its customer base spans a number of industries, including chemical, energy, and manufacturing, as well as numerous government agencies.

Clean Harbors Services include the following.

Technical Services

- Waste Disposal – comprehensive disposal of hazardous and non-hazardous waste at Company-owned facilities
- Recycling Services – extensive recycling, reuse, and reclamation options for materials such as solvents, chemicals, oil, and electrical equipment
- Chemical Packing – safe, efficient handling and disposal of the widest range of chemicals, including reactives and compressed gases
- Household Hazardous Waste (HHW) Services – HHW collection programs of all types and sizes, facilitated by Clean Harbors expert personnel

Industrial and Field Services

- Emergency Response Services – OSHA-certified personnel to safely contain and clean up any type of emergency spill
- Field Services – expert personnel, dispatched on a planned or emergency basis, utilize specialty equipment and resources to perform services at any location
- Industrial and Specialty Services – specialized industrial services provided at refineries, mines, chemical plants, manufacturing and generation facilities, and other industrial facilities

[1]A more detailed discussion of Clean Harbors is given in Section VI.B.

- Daylighting and Hydro Excavation – safer, cleaner, more precise hydro excavation for clients' daylighting and other excavation needs
- Production Services – expansive array of services to meet clients' needs

Oil and Gas Industry Services

- Lodging Services – exceptional housing and work accommodations in remote locations
- Seismic Services -- project management expertise during surveying, land clearing, and other key seismic projects
- Surface Rentals -- high-quality, durable equipment rentals clients can rely on during critical projects
- Fracking water treatment and disposal
- Drilling fluids and solids disposal
- Rolloff and frac tanks

Safety-Kleen, a subsidiary of Clean Harbors, provides used oil recycling and re-refining, parts washers, and environmental solutions for small quantity waste generators supported by the world's largest re-refining capabilities to convert used oil into base and blended lube oils.

II.E. Elk Environmental Services

Elk Environmental Services is a full-service environmental remediation and waste management services firm that provides environmental solutions to industrial and commercial businesses. Elk serves clients throughout the Mid-Atlantic states. At present, it has 39 employees across Pennsylvania, with 21 based at the headquarters in Reading. During the COVID pandemic, Elk did not add any net new head count, although it did backfill 3 - 4 roles based on employees that departed on their own accord. Types of employees on staff include operations, transportation, safety, marketing, account managers, and project managers and trainers. Elk is currently seeking to hire 1 - 2 technical employees.

Elk Environmental Services was founded in 1988 by the Empire Group as an environmental waste transportation company to complement their demolition and excavation business -- Empire Services. The owners encountered environmental concerns during demolition and excavation jobs, such as the discovery of asbestos and leaking storage tanks. Addressing these issues would have meant putting a stop to a job, costing the customer additional time and money. Also, new local, state, and federal regulations dictated how these issues were to be handled with as minimal damage to the environment as possible. The owners saw this as an opportunity to create a business that would provide turnkey solutions for these issues and more.

Elk's offerings include the following.

Field Services: All-inclusive line of environmental remediation, field and industrial cleaning services.

- Industrial Cleaning & Maintenance
- Confined Space Entry & Rescue
- Tank Cleaning & Removal (UMR/AMR PADEP Removal Certified)
- High Vac, Vacuum & Vactor Services
- Liquid Pump-out/ Soil Excavation/Remediation
- Hydro & Dry Ice Blasting
- Line Jetting & Video Inspection
- Decontamination & Disinfecting
- PCB Transformer & Equipment Management
- Dredging
- Hazardous Waste handling
- Soft-digging/Potholing
- Mold Remediation

Waste Management: Full line of hazardous and non-hazardous waste management services.

- Hazardous & Non-Hazardous Waste Transportation & Disposal
- Roll-off, Vacuum & Sludge Box Rental
- E-waste & Universal Waste
- Drum, Tote, Cubic Yard Box & Pail Services
- Waste Consolidation & Minimization
- Medical Waste Disposal
- Waste Process Review
- Beneficial Reuse & Recycling
- Waste to Energy Services
- Fuel Blending

Lab Packing: Comprehensive lab packing and consolidation.

- On-site Material Inventory
- Sampling
- Identification
- Classification
- Segregation & Compatibility Packaging
- On-site Unknown Material Qualitative Testing
- Reactive Chemical Handling & Stabilization
- Chemical Transfer
- Laboratory Transfer & Moving
- Pack & Ship
- Disposal/Recycling Approval Submittals
- Technical & Professional Document Preparation
- Transportation & Disposal/Recycling to Appropriate Facilities

Oil & Gas Energy: The Elk Wysox location provides producers in the Marcellus and Utica Shale industry with comprehensive environmental assistance.

- 24/7 Emergency Spill Response
- Frac Tank Cleaning/Rousabout
- Drill Rig, Cellar & Mat Decon Services with CSE & Rescue Trained Crews
- Frac Tank Cleaning / Roustabout
- Remedial Cleanup, Restoration
- Roll-Off Truck Services / Plant Trash
- Solidification Agent & Solidification
- Container Rental
- Vacuum, Sludge, Clam Shell & Roll-Off Container Rental
- Health & Safety Training Courses
- Aerial Lift
- Bloodborne Pathogen
- Confined Space Entry
- Electrical Safety
- Ergonomics
- Fall Protection
- Forklift Safety
- Globally Harmonized System/Hazard Communication (GHS/HAZCOM)
- Hearing Conservation
- Heartsaver First Aid/ CPR/ AED
- Industrial Fire Extinguishing
- Lead Worker
- Lock-out / Tag-out
- Machine Guarding
- OSHA 10-hour - Construction / General Industry
- Resource Recovery Conservation Act
- OSHA 30-hour - Construction / General Industry
- Personal Protective Equipment (PPE)
- Radiation Awareness
- Respiratory Protection
- Safety Systems
- Scaffolding Safety
- Trenching / Excavation

Emergency Response

- Hazardous Waste Spill Clean Up
- Non-hazardous Waste Spill Clean Up
- Chemical Spill Clean Up
- Oil Spill Clean Up
- Emergency Building Stabilization Service
- Emergency Demolition
- Emergency Lab Packing

- Emergency Pump-outs
- Emergency Waste Disposal
- Standby Emergency Response Coverage

II.F. Envinity Inc.

Envinity is an energy conservation, efficiency, and generation company that is rooted in the building science approach to green design, construction, and energy management for residential and commercial clients. Headquartered in State College, Pennsylvania, it has 29 employees in the state.

Established in 2005, Envinity currently serves residential customers in Pennsylvania and runs their commercial division from Gainesville, Florida. Commercial operations serve customers in Pennsylvania, New Jersey, Maryland, New York, and Florida. Much of their commercial division services the healthcare industry, including helping hospitals make their buildings run more efficiently and preventing problems before they occur. That includes designing or modifying air systems to contain infectious diseases like COVID-19.

When the COVID pandemic hit in 2020, Envinity laid off 16 people, which predominantly made up their entire field operations staff. However, construction in Pennsylvania was allowed to begin again on May 1, 2021. Between restarting construction and assistance from the federal Paycheck Protection Program loan, Envinity has hired everyone back. The company doubled its solar work force this past year, and it currently has four to six months of work lined up, with projects like solar panel installation. Envinity feels while residential work may slow down, commercial and agricultural business is expected to keep coming in.

When COVID-19 began appearing in the U.S., Envinity realized it was going to have to shift focus. In the industry, it is called the COVID response, and refers to how firms such as Envinity are adapting their facilities to the changing needs now of having a more infectious population. Key to that is creating more negative pressure rooms for hospital patients. Those areas are used for patients with infectious diseases like COVID-19. The low air pressure prevents the air from leaving the room, while fresh air is allowed to come in. Envinity believes that what is currently happening could change the way hospitals are designed in the long run, with a need to be able to adapt to a pandemic, and that “A better building is about a lot of things other than just energy performance.”

Before COVID-19 hit, Envinity was on track to add another five or six employees to the field team. It anticipates slowing that down somewhat into the summer. However, if things pick back up where they left off, Envinity envisions adding three to five more employees, creating those jobs by the end of 2021. Employees are given the option of staying home -- but so far none has. All employees received special training and are taking extra precautions, including setting up hand-washing stations at job sites.

The firm's employees span business development, construction, energy analysts, design engineers, commissioning engineers, project managers, operations, carpenters, HVAC technicians, and renewable energy installers.

Residential services offered include custom green design and construction, alternative energy installation, energy auditing, mechanical installation and service, air sealing and insulation, and professional engineering services throughout Pennsylvania. Commercial services include energy master planning, commissioning, retro-commissioning, mechanical, electrical and plumbing (MEP) design services.

II.G. EvolveEA

Evolve environment: architecture (evolveEA) is a multidisciplinary practice situated at the intersection of sustainability and the built environment. Its mission is to advance sustainable systems and solutions with design and thought leadership. The firm employees 14 people out of its headquarters in Pittsburgh, Pennsylvania. The team consists of designers, architects, environmental scientists, and sustainable business experts. During the COVID pandemic in 2020, Evolve had intended to hire one additional FTE and one intern. Those two positions were put on hold and now in 2021, Evolve intends to hire for these two positions.

EvolveEA is well versed in the new WELL Health-Safety Rating for Facility Operations and Management from the International WELL Building Institute (IWBI). EvolveEA's team of WELL Accredited Professionals helped one of the first medical offices in the country to achieve WELL certification. As the WELL Administrator to the Cleveland Clinic Center for Functional Medicine, it successfully led the design and construction team in setting and achieving goals for the successful WELL certification of the space, along with protocols for ongoing monitoring and design of a suite of communications graphics.

Services provided include the following.

Placemaking

- *Architecture*: Create compelling and thought provoking landscapes, buildings, experiences and objects.
- *Urban Design*: Create more liveable places, systems and economies by addressing ecological, social, and economic issues.

Sustainability Services

- *Buildings*: Help teams add value to their building projects by identifying and implementing smart environmental strategies.
- *Operations*: Help building owners and operators optimize performance with attention to users' needs and experiences.

Strategy & Engagement

- *Strategic Planning*: Build capacity for organizations to analyze, plan, and execute short and long-term sustainability efforts.

II.H. Exus Partners

Exus Management Partners is an independent investment and asset management firm focused on the renewable energy sector (wind, photovoltaics, and small hydro). The firm works on behalf of an increasing variety of investors to source investment opportunities, acquire assets, and undertake full technical and commercial management of renewable energy portfolios worldwide. While headquartered in Madrid, Spain, Exus has a large office in Pittsburgh, Pennsylvania that employs 17 people. Their employees consist of asset managers, controllers, operations engineers, project accountants and contract administrators. Exus has two active positions they are currently working to fill.

The Exus U.S. branch opened in 2019 through a partnership with the previous EverPower senior management team. One of their first deals in the U.S. was a Cambria County wind farm that had fallen into bankruptcy when FirstEnergy Solutions, an Akron, Ohio-based company that itself filed for bankruptcy in 2018, used the courts to break its long-term contract with the wind farm. Exus came in and helped a large Spanish conglomerate buy the 63-megawatt farm for 20 cents on the dollar compared with what it cost to build.

Exus has a presence in the U.S., Europe, and Latin America. It has transacted and manages more than 5 gigawatts of wind and solar projects globally, representing over $3 billion of total enterprise value. Exus currently manages 280 megawatts of wind and solar portfolio in the U.S. and will continue to acquire additional renewable projects.

Services provided include the following.

Origination, Product, Structuring & Investment

- Initial steps include originate, assess, and present opportunities, structure transactions, assist in negotiations with sellers and other third parties, and coordinate the DD process and advisors. Beyond the initial steps, work to make asset acquisitions smooth and secure.

Business Development

- Provide full Greenfield and brownfield project development, regulatory, and legal framework reviews, site conditions and grid connection assessment, and support every aspect of development from licensing to budgeting, to construction, and more.

Full Asset Management

- Manage projects in the form of a range of analysis to guarantee success, commercial activity, and the many relations needed to make investments succeed.

Exus Management Systems: Bluesky

- A range of systems to manage a client's assets to the highest possible standard. These include address controlling, project finance, reporting, optimization planning, maintenance supervision, and many more.

Operation & Maintenance

- Services cover the full range of needs of the industry, including facility operation, warranty packages, real-time monitoring & trouble-shooting through the Exus Control Centre and the further nuances of different sectors and stages in operations.

Technical Consultancy

- Address the technical details that work together to make an investment a success: Energy yield assessment, inspections and technical audits, thermographies of main equipment, and the full depth of assessments to provide confidence in the efficiency of an asset.

II.J. Green Mountain Energy

Green Mountain Energy is the nation's longest-serving renewable energy retailer. It assists customers to make a positive environmental impact, support a cleaner grid, and green their carbon footprints with sustainable living solutions, renewable energy plans, and the purchase of carbon offsets. Headquartered in Houston, Texas, Green Mountain has 34 employees in Pennsylvania -- primarily in Pittsburgh and Philadelphia. Pennsylvania employees are primarily composed of sales representatives.

Since its inception in Vermont in 1997, Green Mountain has been on a mission to change the way power is made. By choosing their 100% clean, renewable wind and solar energy plans for their homes and businesses, Green Mountain customers have avoided more than 81 billion pounds of CO_2 emissions to date, which is the equivalent taking 8.6 million cars off the road for an entire year. Green Mountain also has a 501(c)(3) nonprofit organization, Green Mountain Energy Sun Club®, which has donated more than $10 million in grants to nonprofits for sustainability projects focused on renewable energy, energy efficiency, resource conservation, and environmental stewardship.

Green Mountain services both residential and commercial customers in Pennsylvania. It offers households 100% renewable pollution free electricity made from domestic wind. In addition, Green Mountain offers the highest solar energy content of any electricity supply product in Pennsylvania with its Pollution Free Gold™ product. On the commercial side, Green Mountain offers a host of renewable energy plans for small, medium, and large businesses with comprehensive solutions for apartment

communities, hospitality, education, healthcare, retail and wholesale trade, and manufacturing.

II.K. J&J Environmental

J&J Environmental, Inc. is an emergency spill response and environmental contracting company based in East Norriton, Pennsylvania and servicing Eastern Pennsylvania, Southern New Jersey, and Delaware. J&J Environmental's goal is to provide prompt, dependable, cost competitive, and ethical environmental services. J&J services residential customers and municipalities. Its employees include project managers, field technicians, and spill technicians. J&J currently has six full-time employees in Pennsylvania.

J&J was one of the region's first environmental response companies beginning operations in 1975 as J&J Spill Services & Supplies. In 2010, a group of senior managers who had been with the company for more than 20 years took ownership of the organization. New services were added and the name was changed to J&J Environmental.

Environmental services provided include:

- 24 Hr. emergency spill response
- Fuel oil spill cleanup
- Tank removal
- Tank cleaning
- Fuel oil remediation
- Environmental hauling
- Oil excavation
- Soil Testing

II.L. Practical Energy Solutions

Practical Energy Solutions is a privately-owned energy consulting group that strives to find energy saving results and is committed to creating actionable steps to ensure that their clients achieve their energy and cost-reduction goals. Headquartered in West Chester, Pennsylvania with a satellite office in Philadelphia, PES employs eight people in Pennsylvania. Employees include project engineers, project managers and sales reps.

Established in 2006, Practical Energy Solutions functions as independent energy management advisors providing energy management services and education/awareness programs. By determining how and when the waste occurs, PES is able to provide strategies for reducing energy consumption and costs with no capital investment. The system uses advanced diagnostics and software to database the

performance of energy systems in a building. Working with existing energy equipment, building automation systems, and building personnel, PES staff deliver information that substantially increases the operational efficiency of buildings. PES also provides education to the building occupants, to show them how they can contribute to energy conservation and sustainability initiatives.

PES serves municipal, educational, commercial, and industrial clients. Its expertise helps solve energy management issues, including fixing equipment, replacing heating, ventilation and air-conditioning (HVAC) systems, and lighting systems. PES will assist anyone who is interested in energy efficiency. PES also takes the lead on renewable energy, green building certification, and campus energy planning. As one of the top sustainable companies in Pennsylvania, PES combines creativity and technical expertise to transform buildings into comfortable, efficient, healthy spaces to live and work.

Services provided include the following.

Evaluations

- Energy Benchmarking
- Energy Audits (ASHRAE I, II, III) and Operational/System Assessments
- Building Energy Simulation Modeling

Strategic & Technical Advising

- Municipal Specification/Bidding Packages and Contractor Selection
- HVAC and Lighting Design
- ROI/Feasibility Studies for Capital and Renewable Energy Projects
- Energy Project Grant Writing

Education

- K-12 Energy + Sustainability Education Programs

Certifications

- Scopes 1, 2 + 3 Carbon Footprinting/Reporting
- ENERGY STAR Building Certifications
- LEED Project Management + Building Certifications

II.M. Siemens Gamesa

Siemens Gamesa is a global technology leader in the renewable energy industry -- specifically in the development, manufacturing, installation, and maintenance of wind turbines. While headquartered in Zamudio, Vizcaya (Spain), it has a large office in Trevose, Pennsylvania that employs over 266 of the firm's 1,112 US based employees.

Siemens Gamesa employs a wide spectrum of employees including purchasing, procurement, engineers, production, project planners, project managers, sourcing, sales, account managers, data scientists and more. While COVID did cause furloughs at some manufacturing facilities due to supply chain constraints, as of April 2021 Pennsylvania employees were not impacted.

First incorporated in 1976, Gamesa worked on the management of industrial projects and technology for emerging businesses. In 1982, Bonus Energy (later to be acquired by Siemens AG), delivered its first turbines to the American market. In April 2017, Siemens Wind Power and Gamesa concluded the merger of their wind power businesses. The two companies boast a unique product portfolio for wind power onshore, offshore, and services, with a presence in more than 90 countries. As of January 2021, Siemens Gamesa has over 99 GW of installed capacity worldwide and has serviced over 29,000 wind turbines. Siemens Gamesa Renewable Energy serves industrial facility management, the automotive industry, and new technology development worldwide.

Siemens Gamesa offers one of the industry's broadest product portfolios, with both offshore and onshore technology as well as industry-leading service solutions. Accordingly, the company has three core business units: Onshore Wind Power, Offshore Wind Power, and Servicing. Across the three business units it provides:

- Wind Turbine Generators
- Offshore Wind Power
- Onshore Wind Power
- Renewable Energy
- Energy Storage Solutions
- Hybrid Energy Solutions
- Wind Turbine Operation and Maintenance
- Wind Power Service
- Wind Energy
- Wind Power
- Wind Power Digitalization
- Wind Digital Solutions
- Wind Power Diagnostics
- Heath Storage
- Wind Turbine Engineering.

III. ILLUSTRATIVE GREEN INDUSTRY NARRATIVES FOR PENNSYLVANIA

MISI developed three green industry narratives for Pennsylvania illustrating the potential of green jobs and green jobs initiatives in the state. These are summarized below.

III.A. The Energy Coordinating Agency: Training Philadelphia's Diverse Future Energy Workforce

Why this is of interest:

- The Energy Coordinating Agency (ECA) is a commendable example of a Philadelphia program that both trains minorities, poor, and disadvantaged in useful, marketable energy efficiency/renewable energy skills and assists low-income persons in increasing the energy efficiency of their residences and reducing their HVAC bills.
- ECA strives to create lasting solutions to the energy problems of low-income Philadelphians by coordinating low-income energy services, and administering high quality energy conservation, education, heating, and home repair services to reduce households' energy costs and stabilize families in their communities.
- It is well established and has been in business for four decades – it is here to stay.
- ECA established a resilient network of 15 Neighborhood Energy Centers, each of which serves as a one-stop-shop for low-income energy services, including weatherization, heating system repair and replacement, home repair, bill payment assistance, budget counseling, and home energy education.
- Each of ECA's programs is an industry-driven curriculum of training that includes classroom theory, hands-on training, and field experience. Students receive portable, stackable credentials to help them gain full-time jobs and build careers.
- ECA has thus far helped over 5,000 participants graduate across a broad array of programs, with students attaining national credentials in building science, weatherization, residential and commercial heating, solar installation, environmental remediation, and lead safety, and most of them proceeded to good jobs and careers.

Description of the ECA

The mission of the Energy Coordinating Agency (ECA) in Philadelphia is to help people conserve energy and to promote a sustainable and socially equitable energy future. Founded in 1984, the ECA strives to create lasting solutions to the energy problems of low-income Philadelphians by coordinating low-income energy services and administering high quality energy conservation, education, heating, and home repair services to reduce households' energy costs and stabilize families in their communities. To build capacity at the grassroots level, ECA established a resilient network of what is currently 15 Neighborhood Energy Centers (NECs), each of which serves as a one-

stop-shop for low-income energy services, including weatherization, heating system repair and replacement, home repair, bill payment assistance, budget counseling, and home energy education.

ECA's Knight Green Jobs Training Center was founded in 2009 to develop and facilitate a diverse clean energy workforce. Since then, the Center has helped over 5,000 participants graduate across a broad array of programs, with students attaining national credentials in building science, weatherization, residential and commercial heating, solar installation, environmental remediation, and lead safety. Training Center programs are certified by the Building Performance Institute, the Interstate Renewable Energy Council, and the EPA. In addition, the Training Center hosts federally recognized apprenticeship programs for clean energy jobs, which ECA's weatherization staff participate in.

Current core programs include training students to install solar photovoltaic panels, training students for tiered levels of commercial HVAC mastery, and training a broad green renovation and retrofit curriculum that prepares students for remediation of hazardous building material and equips them with the fundamental skills to grow across building trades.

Each of ECA's programs is an industry-driven curriculum of training that includes classroom theory, hands-on training, and field experience. Students receive portable, stackable credentials to help them gain full-time jobs and build a career. The Center is located in ECA's LEED Gold facility, which gained a new state-of-the-art commercial heating lab in 2019 -- thanks to Johnson Controls Inc. The Center also features a residential heating lab, life-size house mock-ups, a modern computer lab which doubles as a Scranton test site, and a house of pressures lab.

One successful example of ECA's graduates, Andy Depestre, graduated from the ECA's Phase 1 class of the JCI HVAC training. He was an excellent student who was hired by a plumbing/heating firm in Montgomery County because of this training. He is currently considering Phase 2 of the training, which would provide opportunities to increase his skills and income.

III.B. Clean Harbors: Green Jobs by the Thousands

Why this is of interest:

- Clean Harbors is the leading environmental remediation services provider and largest hazardous waste disposal company in North America.
- It has been in business for over 35 years and currently employees 6,000 in the U.S. – including nearly 200 in Pennsylvania.
- These are current, existing, real, well-paying, good jobs ("jobs that have materialized") with benefits: They are not pie-in-the-sky jobs dependent on future mandates, subsidies, or multi-billion dollar spending programs.

- The jobs involved range from relatively low-skilled to technical, supervisory, and highly skilled. Many of the jobs are blue collar, potential entry level positions, suitable for high school dropouts, GED holders, minorities, persons with troubled job histories, etc.
- Most important, these are not the kind sexy, glamorous jobs green advocates mistakenly and dangerously associate with clean energy, green spending, etc.: They are not predominantly Ph.Ds, ecologists, photovoltaic engineers, environmental lawyers, etc. This is a critical message MISI has been advocating for three decades.
- For example, current Clean Harbor available job openings include: Human Resources & Payroll Clerk, Sales Route Driver, Class A Roll-off Driver, Vice President of Environmental Compliance, Diesel Mechanic, Class A Regional Tanker Driver, Industrial Service Supervisor, Environmental Technician CBPP, Class B Delivery Driver, Class A OTR Dry Van Driver, Dispatcher, Industrial Services Sales Specialist, Route Box Truck Driver, Oil Sales and Service Rep III, Branch Manager, Environmental Field Technician, Environmental Compliance Manager, Facility General Manager II, Route Driver, Equipment Operator II, Warehouse Material Handler, Retail Technician, Receiving Coordinator, Sales Route Driver, Heavy Duty Truck/Equipment Mechanic, Inside Sales Coordinator, Facility Engineer, Vehicle Maintenance Administrator, Inside Sales Representative, Regional Health & Safety Manager, Class B Hazmat Driver, Corporate Account Manager, etc.

Description of the Company

Clean Harbors (CH), founded in 1980, is the leading environmental services provider and largest hazardous waste disposal company in North America, and is a recognized leader in environmental emergency response services. Clean Harbors is a publicly traded company that maintains a vast network of service centers and hazardous waste management, treatment, and disposal facilities, and provides a broad range of environmental remediation services. The company's branch locations are strategically located across North America in order to provide emergency response services and perform planned work at customer locations. CH provides waste transportation and disposal, laboratory chemical packing, 24-hour emergency response, parts cleaning, and field and industrial services to over 300,000 customers. It owns and operates waste management facilities offering a wide range of disposal options including incineration, wastewater treatment, landfill, recycling, and specialty disposal. It generates over $3 billion in revenue annually and operates more than 480 service locations. It has 6,000 employees in the U.S and nearly 200 in Pennsylvania.

Clean Harbors Technical Services Business involves the packaging, collection, transportation, treatment and disposal of hazardous and non-hazardous waste at company-owned facilities. It operates the largest number of hazardous waste incinerators, landfills, wastewater, and other treatment facilities in North America, along

with the largest number of treatment, storage and disposal facilities. In 2019, CH facilities incinerated 430,928 metric tons of waste, 86% of which was hazardous waste.

Clean Harbors is:

- The leading North American provider of services that protect the ozone layer from the destructive effects of CFCs, which are 5,000 to 10,000 times more destructive to the ozone layer than other greenhouse gases (GHGs). It has the most EPA approved CFC disposal capacity regulated under the Montreal Protocol, and in 2019 destroyed over 2 million pounds of CFCs. The destruction of this volume of CFCs is equal to approximately 1.7 million metric tons of CO_2e emissions.
- North America's largest re-refiner of used motor oil. It offers closed-loop solutions for recycling, reclaiming and reusing both used oil and cleaning solvent. In 2019, it collected more than 235 million gallons of used oil and recycled it into more than 190 million gallons of high quality recycled oil products.
- Facilitates thousands of Household Hazardous Waste (HHW) and pesticide collection programs throughout North America -- collecting paints, solvents, batteries, fluorescent lamps, pesticides, cleaners, and other hazardous materials. In 2019, Clean Harbors HHW services collected 27,000 tons of hazardous waste.
- Provides a spectrum of services, from scheduled site decontamination projects to emergency response. It annually responds to an average of more than 6,000 emergencies.
- Is the industry's leading provider of high-tech, high temperature incinerators that destroy hazardous and industrial waste. Its incineration facilities specialize in high-temperature incineration of regulated waste materials -- such as industrial and laboratory chemicals, manufacturing byproducts, medical waste, fertilizers and other solid and liquid materials -- that would otherwise be hazardous if not properly managed. Destruction in high-temperature incinerators has been determined by the EPA to be the Best Demonstrated Available Technology for safely destroying many hazardous waste compounds, including organic compounds high in ammonia, chlorine, fluorine and halogens.

Clean Harbors has a respectable employee and labor relations record. CH:

- Has employee compensation that is competitive and reflects geographical differences, complexity and scope of position, and business unit or division, while remaining consistent with all applicable laws.
- Provides employees a 401(k) match contribution, affordable health care, and a wellness program that encourages a healthy active lifestyle through employee challenges and rewards.
- Has adopted policies and training that address the protection and support of the rights of women and minorities in the workplace.
- Operates its facilities and equipment in a safe and efficient manner and in compliance with all applicable federal, state and local safety and health laws, regulations and standards.

- Has established employee wellness programs to promote a culture of health for the benefit of its workforce.
- Respects the right of employees to form, join or assist labor organizations and to bargain collectively through representatives of their own choosing without fear of retaliation, intimidation or harassment.
- Offers a tuition reimbursement program that provides financial assistance to employees who want to complete an undergraduate or advanced degree, participate in non-degree refresher courses, prepare for a professional certification or participate in other non-degree certificate programs.
- Invests millions annually to provide internal training and leadership development. These programs range from keeping employees current on OSHA training to classes to further develop their knowledge and skills, and CH provides access to a virtual platform to assist in developing and fine-tuning leadership skills. CH offers a Branch Manager training program that takes 13 to 15 weeks to complete depending on scheduling and culminates with a certification.
- Offers an Employee Assistance Program designed to ensure the emotional and social well-being of all employees.

III.C. Union Members Build a Bridge From the Past to the Future

Why this is of interest:

- It is an example of renewable energy helping to repurpose an abandoned industrial rustbelt sight in Pittsburgh.
- It constitutes the largest sloped roof solar project in the U.S. at Pittsburgh's Mill 19 – an abandoned, decrepit steel mill. It installed 2.5 MW of solar – which is a lot of solar.
- It is an example of creating good jobs using union labor in a landmark green project.
- It is an example of a green initiative repurposing an abandoned industrial facility into a high-tech research facility housing labs and organizations such as the Carnegie Mellon University (CMU) Advanced Robotics for Manufacturing Institute, CMU's Manufacturing Futures Initiative, and others.
- The project is envisioned as "a model for the transformative redevelopment of an urban brownfield into a center of innovation that powers Pittsburgh's new economy while remaining grounded in the principles of sustainability, equity, and inclusive economic opportunity."

Description of the Project

In June 2020, workers from various trades and unions, including the United Brotherhood of Carpenters and Joiners of America (UBC) Local 441, finished installing the largest sloped roof solar project in the U.S. at Pittsburgh's Mill 19. Mill 19, currently under the ownership Regional Investment Development Corporation (RIDC), is a major project on the 178-acre Hazelwood Green site, once owned by J&L Steel Hazelwood

Works and LTV Steel along the Monongahela River in the Hazelwood neighborhood of Pittsburgh.

The rolling mill produced 10” bar steel for several decades. When the steel industry collapsed, the building was abandoned and all that remained was the steel exoskeleton and the roof, which was removed and replaced with a 2 megawatt (MW) solar project consisting of 4,784 solar panels. An additional 0.5 MW of solar is being mounted on parking lot canopies.

Scalo Solar Solutions was the solar developer and engineering, procurement and construction manager for Mill 19, and it hired the installation crew as their own employees from the UBC for the project. Scalo also contracted with Bruce & Merrilees, a National Electrical Contractor Association electrical contractor, to install conduit, wire, and switchgear for the alternating current (AC) side of the solar array and connect it to the electric utility grid.

Mill 19 will generate most of the annual net electricity demand for the 90,000-square-foot, three stories of buildings that are being built beneath the steel exoskeleton. The solar panels serve as the new roof over the entire site. Light flows through the bifacial panels for which solar cells are mounted in both the front and back of the glass of the panels to maximize energy production.

The buildings will include offices, ground floor prototyping, lab, and workshop space as well as the Carnegie Mellon University (CMU) Advanced Robotics for Manufacturing Institute (ARM) and CMU’s Manufacturing Futures Initiative. All the buildings under the solar panels will be LEED v4 Gold certified and they will capture rooftop rainwater that will be reused in the cooling tower and for flushing in the restrooms.

Mill 19 occupies Hazelwood Green property adjacent to Mill 19 that is owned by Almono LP, a collaboration of three major Pittsburgh foundations. Hazelwood Green is envisioned as “a model for the transformative redevelopment of an urban brownfield into a center of innovation that powers Pittsburgh’s new economy while remaining grounded in the principles of sustainability, equity, and inclusive economic opportunity.”

UBC managed construction of the project over an 18 month period. Tim Sippey, the foreman of the solar installation crew stated “Most people don’t think of bridge builders (which is what this crew typically constructs) as solar installers, but we are a natural fit for this job as we are used to working 100 feet in the air under steel trusses. The most difficult thing about this job was planning the logistics, but our crew was able to devise a technique to pre-wire and construct an array of solar panels and then lift them up by crane to the roofing frame where our guys then mounted them to the existing steel frame.”

Tim also has a personal connection to the project, since his father, Meade J. Sippey, who passed away in 2012, worked in the LTV steel mill for 34 years on this site.

Tim worked on the same ground installing solar panels, and both he and his father worked in contemporary industries. Tim stated that he thought that his father would have enjoyed seeing him work on this project.

APPENDIX A: THE PENNSYLVANIA ECONOMY

A.A. The Pennsylvania Economy in 2019

The Pennsylvania economy performed well in 2019, growing at real rate of 3.9%, compared to the national growth rate of 2.3% rate, and estimated state personal income grew 7.0 percent in 2019, compared to national rate of 6.1 percent. Total Pennsylvania GDP reached $809 billion and per capita income increased in 2019 to $63,173, as compared to U.S. per capita GDP of $65,240. It ranks 20th in state per capita GDP and is 3.3% below the U.S, average.[2] Pennsylvania State GDP accounts for 3.8% of the 2019 U.S. total of $21.43 trillion. If Pennsylvania was an independent nation, in terms of GDP it would rank 23rd: Just above Saudi Arabia, Turkey, and Switzerland.[3]

Pennsylvania's 2019 population totaled 12.9 million, 3.9% of the U.S. total and was the nation's fifth most populous. The state's population increased an estimated 0.8 percent since the 2010 decennial census, a rate only about one-eighth of that the nation's 6.3-percent growth rate over the same period.[4]

Table A-1 shows the earnings by industry of employment in Pennsylvania and how these compare to the U.S. averages:

- Column 1 shows Pennsylvania State earnings by industry.
- Column 2 shows Pennsylvania State earnings by industry as a percent of the U.S. total for that industry.
- Column 3 shows Pennsylvania State earnings by industry as a percent of the state total.
- Column 4 shows U.S. earnings by industry as a percent of the U.S. total.
- Column 5 gives the derived Pennsylvania State Index: The weight of the state industry payroll vis-à-vis the national weight. 100 is the same proportion as the U.S. Thus, for example: 25 means that state industry lags the national importance; 150 means it is of 50% greater importance to the state than in the U.S. average; and so forth.[5]

This table shows that Pennsylvania ranks relatively low with respect to sectors such as agriculture, mining, and computer and electronic manufacturing, motor vehicle and parts manufacturing, and motion pictures. However, this table illustrates that the state ranks high with respect to several sectors: Specifically, with 3.9 percent of the nation's population:

- Employment earnings in the Pennsylvania Pipeline Transportation sector account for 17.6 percent of total earnings nationally in that sector.
- Employment earnings in the Pennsylvania Broadcasting (except Internet) sector account for 16.3 percent of total earnings nationally in that sector.

[2]https://www.deptofnumbers.com/gdp/pennsylvania/.
[3]https://fee.org/articles/us-state-gdps-compared-to-entire-countries/.
[4]https://www.deptofnumbers.com/gdp/pennsylvania/.
[5]Note that the Index is the product of column 3 and column 4.

- Employment earnings in the Pennsylvania Primary Metal Manufacturing Sector account for 9.4 percent of total earnings nationally in that sector.
- Employment earnings in the Pennsylvania Educational Services Sector account for 7.5 percent of total earnings nationally in that sector.
- Employment earnings in the Pennsylvania Warehouse and Storage Sector account for 7.5 percent of total earnings nationally in that sector.

Column 5 indicates that, in addition to the sectors mentioned above, Pennsylvania also ranks high relative to the U.S. with respect to Chemical Manufacturing, Nursing and Health Care Facilities, Electrical Equipment and Components Manufacturing, and Wood Product Manufacturing. However, Column 5 also indicates that Pennsylvania also ranks relatively low relative to the U.S. with respect to Water Transportation, Leather and Allied Product manufacturing, Securities, Commodities, and Other Financials, Farming, and Miscellaneous Information Services.

Table A-1.
Earnings by Industry of Employment in Pennsylvania and the U.S. in 2019

	State (millions)	State Share of U.S.	State Share of Earnings	U.S. Share of Earnings	State Index
Personal income (adjusted for residence)	$751,839	4.0%	-	-	-
Farm	$1,495	1.7%	0.3%	0.7%	43
Forestry, fishing, and related activities	912	2.4%	0.2%	0.3%	61
Forestry and logging	425	6.0%	0.1%	0.1%	153
Fishing, hunting and trapping	1	0.0%	0.0%	0.0%	1
Support activities for agriculture and forestry	486	1.7%	0.1%	0.2%	43
Mining, quarrying, and oil and gas extraction	3,301	1.9%	0.6%	1.3%	48
Oil and gas extraction	839	0.8%	0.2%	0.8%	20
Mining (except oil and gas)	950	4.1%	0.2%	0.2%	103
Support activities for mining	1,512	3.5%	0.3%	0.3%	89
Utilities	3,859	3.4%	0.7%	0.9%	87
Construction	31,267	3.8%	6.0%	6.1%	98
Construction of buildings	7,641	3.5%	1.5%	1.6%	90
Heavy and civil engineering construction	4,688	4.3%	0.9%	0.8%	109
Specialty trade contractors	18,939	3.9%	3.6%	3.7%	99
Manufacturing	52,076	4.3%	10.0%	9.1%	110
Durable goods manufacturing	29,793	3.8%	5.7%	5.9%	98
Wood product manufacturing	1,541	5.7%	0.3%	0.2%	144
Nonmetallic mineral product manufacturing	1,620	4.8%	0.3%	0.3%	123
Primary metal manufacturing	3,321	9.4%	0.6%	0.3%	239
Fabricated metal product manufacturing	6,068	5.4%	1.2%	0.8%	137
Machinery manufacturing	4,183	4.0%	0.8%	0.8%	102
Computer and electronic product manufacturing	2,949	1.8%	0.6%	1.2%	46
Electrical equipment, appliance, and components	2,659	6.6%	0.5%	0.3%	169
Motor vehicles, bodies and trailers, and parts	1,269	1.5%	0.2%	0.6%	39
Other transportation equipment manufacturing	2,535	2.8%	0.5%	0.7%	72
Furniture and related product manufacturing	1,064	4.4%	0.2%	0.2%	113
Miscellaneous manufacturing	2,584	4.1%	0.5%	0.5%	104
Nondurable goods manufacturing	22,283	5.2%	4.3%	3.2%	133
Food manufacturing	4,791	4.4%	0.9%	0.8%	113
Beverage and tobacco product manufacturing	686	3.2%	0.1%	0.2%	83
Textile mills	214	3.3%	0.0%	0.0%	84
Textile product mills	168	2.7%	0.0%	0.0%	68
Apparel manufacturing	226	3.3%	0.0%	0.1%	85
Leather and allied product manufacturing	37	2.2%	0.0%	0.0%	57
Paper manufacturing	1,808	5.2%	0.3%	0.3%	133
Printing and related support activities	1,435	5.1%	0.3%	0.2%	130
Petroleum and coal products manufacturing	899	3.0%	0.2%	0.2%	76
Chemical manufacturing	9,092	7.0%	1.7%	1.0%	177
Plastics and rubber products manufacturing	2,928	5.6%	0.6%	0.4%	142

Table A-1 (continued)
Earnings by Industry of Employment in Pennsylvania and the U.S. in 2019

	State (millions)	State Share of U.S.	State Share of Earnings	U.S. Share of Earnings	State Index
Wholesale trade	$22,592	3.7%	4.3%	4.6%	94
Retail trade	26,992	3.6%	5.2%	5.6%	93
Motor vehicle and parts dealers	5,199	3.7%	1.0%	1.1%	93
Furniture and home furnishings stores	763	3.0%	0.1%	0.2%	76
Electronics and appliance stores	870	2.9%	0.2%	0.2%	73
Building material and garden equipment and dealers	2,154	3.5%	0.4%	0.5%	89
Food and beverage stores	4,891	4.2%	0.9%	0.9%	106
Health and personal care stores	2,254	4.0%	0.4%	0.4%	101
Gasoline stations	1,222	2.9%	0.2%	0.3%	75
Clothing and clothing accessories stores	1,411	3.1%	0.3%	0.3%	79
Sporting goods, hobby, musical instrument, books	643	3.4%	0.1%	0.1%	86
General merchandise stores	3,151	3.2%	0.6%	0.7%	81
Miscellaneous store retailers	1,469	3.5%	0.3%	0.3%	89
Nonstore retailers	2,965	4.8%	0.6%	0.5%	122
Transportation and warehousing	28,055	5.2%	5.4%	4.0%	133
Air transportation	1,719	2.5%	0.3%	0.5%	64
Rail transportation	1,086	4.7%	0.2%	0.2%	118
Water transportation	69	0.8%	0.0%	0.1%	21
Truck transportation	7,378	4.6%	1.4%	1.2%	117
Transit and ground passenger transportation	1,912	3.8%	0.4%	0.4%	98
Pipeline transportation	7,662	17.6%	1.5%	0.3%	447
Scenic and sightseeing transportation	43	2.0%	0.0%	0.0%	52
Support activities for transportation	1,523	2.2%	0.3%	0.5%	56
Couriers and messengers	1,788	3.9%	0.3%	0.3%	98
Warehousing and storage	4,874	7.5%	0.9%	0.5%	190
Information	24,675	5.1%	4.7%	3.6%	131
Publishing industries (except Internet)	3,098	2.5%	0.6%	0.9%	63
Motion picture and sound recording industries	531	1.2%	0.1%	0.3%	32
Broadcasting (except Internet)	14,886	16.3%	2.9%	0.7%	415
Telecommunications	3,967	4.5%	0.8%	0.7%	115
Data processing, hosting, and related services	1,194	2.1%	0.2%	0.4%	54
Other information services	997	1.3%	0.2%	0.6%	33
Finance and insurance	29,867	3.3%	5.7%	6.9%	83
Monetary Authorities-central bank	(D)	-	-	0.0%	-
Credit intermediation and related activities	8,840	2.9%	1.7%	2.3%	74
Securities, commodities and other financials	5,420	1.9%	1.0%	2.1%	49
Insurance carriers and related activities	15,406	4.9%	3.0%	2.4%	126
Funds, trusts, and other financial vehicles	(D)	-	-	0.1%	-

Table A-1 (continued)
Earnings by Industry of Employment in Pennsylvania and the U.S. in 2019

	State (millions)	State Share of U.S.	State Share of Earnings	U.S. Share of Earnings	State Index
Real estate and rental and leasing	$9,790	2.9%	1.9%	2.5%	74
Real estate	7,384	2.8%	1.4%	2.0%	72
Rental and leasing services	2,421	3.4%	0.5%	0.5%	86
Lessors of nonfinancial intangibles (except copyright)	-15	-0.5%	0.0%	0.0%	-12
Professional, scientific, and technical services	52,620	3.8%	10.1%	10.6%	96
Management of companies and enterprises	21,268	5.9%	4.1%	2.7%	149
Administrative, support and waste/remediation services	17,824	3.2%	3.4%	4.2%	81
Administrative and support services	16,314	3.1%	3.1%	4.0%	79
Waste management and remediation services	1,511	4.2%	0.3%	0.3%	107
Educational services	16,790	7.5%	3.2%	1.7%	192
Health care and social assistance	73,182	5.0%	14.1%	11.0%	128
Ambulatory health care services	32,443	4.6%	6.2%	5.4%	116
Hospitals	22,981	5.2%	4.4%	3.4%	131
Nursing and residential care facilities	9,133	6.1%	1.8%	1.1%	155
Social assistance	8,625	5.7%	1.7%	1.1%	146
Arts, entertainment, and recreation	6,415	3.7%	1.2%	1.3%	95
Performing arts, spectator sports, and related	3,614	3.7%	0.7%	0.7%	93
Museums, historical sites, and similar institutions	351	4.4%	0.1%	0.1%	111
Amusement, gambling, and recreation industries	2,449	3.8%	0.5%	0.5%	96
Accommodation and food services	13,723	3.0%	2.6%	3.5%	76
Accommodation	2,435	2.3%	0.5%	0.8%	59
Food services and drinking places	11,288	3.2%	2.2%	2.7%	80
Other services (ex. government and govt. enterprises)	18,681	3.9%	3.6%	3.6%	100
Repair and maintenance	6,183	4.6%	1.2%	1.0%	118
Personal and laundry services	5,302	3.8%	1.0%	1.1%	96
Religious, grantmaking, civic, professional organizations	6,691	3.8%	1.3%	1.3%	96
Private households	504	2.2%	0.1%	0.2%	55
Government and government enterprises	65,147	3.1%	12.5%	15.7%	80
Federal civilian	11,234	3.1%	2.2%	2.7%	80
Military	1,612	1.1%	0.3%	1.1%	28
State and local	52,300	3.3%	10.0%	11.9%	84
State government	14,844	3.3%	2.9%	3.4%	85
Local government	37,456	3.3%	7.2%	8.5%	84

Notes: - (D) Not shown to avoid disclosure of confidential information; estimates are included in higher-level totals.
- All data are based in constant 2020 dollars.

Source: *Personal Income*, U.S. Bureau of Economic Analysis: and Management Information Services, Inc., 2021

A.B. Pennsylvania Economy Strengths and Weaknesses

Pennsylvania has both relative economic strengths and weaknesses. In terms of strengths, it ranks:[6]

- 11th in terms of opportunity
- 19th in terms of innovation potential
- 19th in terms of health care

Pennsylvania's economy is the most diverse in U.S. According to the latest Bloomberg Economic Diversity Index, Pennsylvania surpassed both Colorado and Texas to claim the top spot. The benefit of a diverse economy is that the state is less vulnerable to market fluctuations in a particular industry.[7]

Pennsylvania is the 10th largest exporter of all 50 states. The state has been competing well with regard to its high tech share of overall exports, and its top ten exports include electrical machinery, pharmaceuticals, precision instruments, organic chemicals, and aircraft goods, all of which include advanced technology products.[8]

The state's unemployment rate declined to 3.8 percent in 2019 -- the lowest level since 1976, and total employment reached an all-time high of more than 6.2 million.[9]

With top-caliber schools like Swarthmore, Haverford, and the University of Pennsylvania based in the state, companies aim to take advantage of the local graduate pool.[10]

The state has nearly 41% of its population college educated.

In terms of business dynamism as measured by turnover, the state ranks relatively high.

Broadband access has become increasingly important as all economies continue to become centered around technology and the Internet. Pennsylvania ranks 8th in this ranking with a 95% coverage rate and has an average broadband speed of 41.4 Mbps.[11]

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[6]https://teampa.com/wp-content/uploads/2020/01/PA_Econ_Competitiveness_Dashboard_011620-FINAL. pdf.
[7]https://www.commonwealthfoundation.org/policyblog/detail/pennsylvanias-economy-is-not-indicative-of-its-business-climate#:~:text=Pennsylvania's%20Economy%20Is%20Not%20Indicative%20of%20Its%20Business%20Climate,-Aug%2023%2C%202019&text=The%20variety%20of%20businesses%20in,good%2Dpaying%20jobs%20and%20opportunity.
[8]https://www.worldstopexports.com/pennsylvanias-top-10-exports/.
[9]https://www.deptofnumbers.com/gdp/pennsylvania/.
[10]https://www.forbes.com/places/pa/?sh=34b901f34fc1.
[11]https://broadbandnow.com/report/us-states-internet-coverage-speed-2018/.

A *U.S. News & World Report* ranking on affordability of the states ranks Pennsylvania as the10th most affordable among all 50 states.[12] The ranking measures housing affordability as well as cost of living. Pennsylvania's relative affordability for low to middle income households signifies that families in the state have more disposable income as a result of lower housing costs, compared to other nearby states such as New Jersey, New York, Maryland, and Delaware. In terms of housing affordability measures, including mortgage/rent, property taxes and fees, and cost of utilities Pennsylvania ranks 6th.

Pennsylvania has historically been an innovation leader, and Pennsylvania retains a stable of effective, scalable innovation assets. This includes a robust university system that generates significant R&D, as well as a set of capable technology-based economic development programs that operate across the state.

In terms of weaknesses, Pennsylvania is ranked:[13]

- 47th in terms of fiscal stability
- 44th in terms of infrastructure
- 42th in terms of overall economy
- 38th in terms of natural environment

Pennsylvania has among the nation's slowest population growth, has a contracting labor force, and declining birth rates.[14]

Pennsylvania is currently the eighth oldest state in the nation by median age and its elderly population 65+ is rapidly increasing. Its population age 80+ is growing even more rapidly, and this has economic implications as healthcare costs accelerate.

The Pennsylvania manufacturing sector has long been central to the commonwealth's economy. The sector is a large contributor to Gross State Product and a substantial source of jobs. However, the sector has seen significant losses over the last several decades. From 2004 to 2016, the manufacturing industry lost 23,300 jobs –a 20% decline -- over the 12-year period. Primarily due to this loss of jobs in the manufacturing industry, Pennsylvania experienced an 18.8% employment decline in the high-middle income wage group over the same time period.[15]

Manufacturing industry reports indicate fiscal policy as a common determining factor in industrial location, and to taxes as a deterrent to manufacturing investment. A Pennsylvania manufacturing industry study surveyed manufacturers and found that respondents considered the tax climate in the commonwealth to be "overly

[12]https://www.usnews.com/news/best-states/rankings/opportunity/affordability.
[13]https://teampa.com/wp-content/uploads/2020/01/PA_Econ_Competitiveness_Dashboard_011620-FINAL.pdf.
[14]https://www.deptofnumbers.com/gdp/pennsylvania/.
[15]https://www.pamade.org/wp-content/uploads/2013/01/Pennsylvanias-True-Commonwealth-State-of-Manufacturing-Challenges-and-Opportunities-2011.pdf.

burdensome" and that reform to the tax structure would be necessary to help Pennsylvania compete, especially against states like North Carolina and Texas that have more business-friendly tax environments. Respondents focused on the high corporate income tax rate as well as the complexity of the state's tax code. Particularly troubling is the vast difference in the growth -- or lack of -- in the commonwealth's manufacturing employment: "In both 2016 and 2017, the goods sector performed well below the national (level), and even worse, the much stronger national manufacturing gains in 2017 have not been able to increase Pennsylvania's factory jobs."[16]

Pennsylvania has a total tax burden that is about 3% higher than the U.S. average.[17]

Pennsylvania ranks an unimpressive 34th for Business Tax Climate according to the Tax Foundation, and ranks 45th on WalletHub's best states to start a business index.[18]

During 2019, the state experienced below-average personal income growth.[19]

Brain drain -- the out-migration of highly educated residents -- has been a trend in Pennsylvania since 1950, but has worsened significantly over the past decade. In 2017, the share of leavers who were highly educated was 10 percentage points higher than the share of highly educated entrants. In terms of its competitor states, Pennsylvania is faring very poorly in terms of net brain drain.[20]

State funding for higher education is a useful measure of a state's investment in the educational attainment of its population. Higher amounts of funding per student indicate a well-funded state university system, which benefits not only students but also industries that rely on universities as centers of research, development, and innovation. There is also evidence that state funding keeps tuition lower, since public university systems rely on tax dollars instead of tuition alone to fund the operations of their schools. Pennsylvania has consistently ranked as one of the lowest states on this indicator; compared to competitor states, Pennsylvania falls second to last in funding per college student. Nationally, tuition for public colleges has increased by an average of 10% over the last 5 years. Pennsylvania's tuition has been one of the highest for at least a decade, and is currently the 3rd most expensive public tuition in the nation.

Over the decade prior to 2019, Pennsylvania experienced an 11% decline in college enrollment, the fourth worst decline of the competitor states. In 2019, Pennsylvania experienced a 2.6% decline in college enrollment, about a percentage point higher than the national decline of 1.7%. Pennsylvania's colleges experienced a

[16]https://www.alleghenyinstitute.org/wp-content/uploads/2018/01/2018-01.pdf.
[17]https://wallethub.com/edu/states-with-highest-lowest-tax-burden/20494.
[18]https://www.commonwealthfoundation.org/policyblog/detail/pennsylvanias-economy-is-not-indicative-of-its-business-climate.
[19]https://www.deptofnumbers.com/gdp/pennsylvania/.
[20]https://teampa.com/wp-content/uploads/2020/01/PA_Econ_Competitiveness_Dashboard_011620-FINAL.pdf.

decrease of more than 16,800 students, the fifth largest decline in total numbers in the country.[21]

Pennsylvania has seen consistent declines in labor force participation for college-aged residents over the past 10 years.

A state's regulatory environment can significantly impact the economic activity of the businesses and people located there. Pennsylvania ranks 37th in terms of regulatory environment.[22]

Restrictive limitations and restrictions on licensing and occupational requirements such as LLC fees negatively affect job opportunities and employment growth. Pennsylvania ranks 29th in terms of these barriers.[23]

Over the decade prior to 2019, the annual average increase in the Pennsylvania median wage has been less than half a percent.[24]

As noted, Pennsylvania has historically been an innovation leader. However, in recent years, Pennsylvania's innovation economy has atrophied, and the state has scaled back public investment in its most significant innovation resources. As a result, Pennsylvania's innovation economy currently faces a set of discrete challenges, including:[25]

- The absence of a comprehensive state innovation strategy grounded in an evidence-based understanding of the state's industries and innovation status.
- Below-average industry R&D that has stagnated in recent years.
- Reduced investment in state resources for early stage companies, combined with declining venture capital in the state.
- Significant spatial divergence between the largest innovation centers (Philadelphia and Pittsburgh) and the rest of the state.

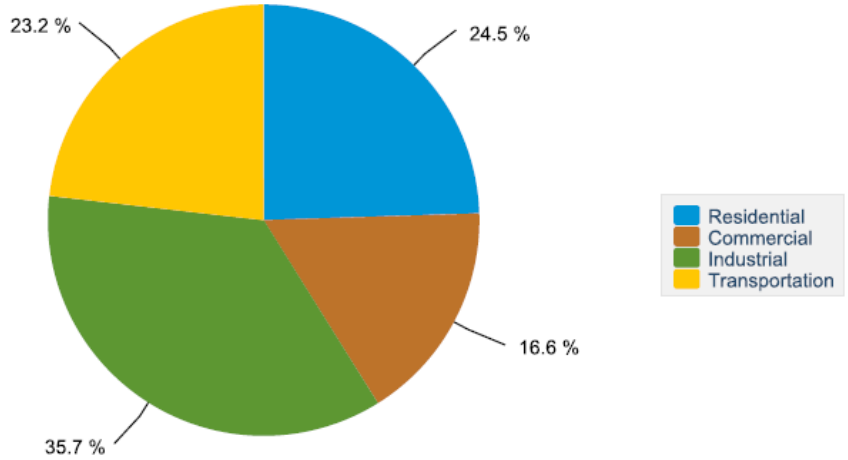
A.C. The Pennsylvania State Energy Economy

Pennsylvania, endowed with extensive fossil energy resources, is a leading East Coast supplier of coal, natural gas, electricity, and refined petroleum products to the U.S. and the world. Although the state is among the top 10 consumers of coal, natural gas, petroleum products, and electricity, Pennsylvania is the third-largest net supplier of energy to other states, after Wyoming and Texas. Its total energy consumption per

[21]https://www.inquirer.com/education/college-enrollment-decline-pennsylvania-20190530.html.
[22]https://patch.com/pennsylvania/across-pa/pa-among-lowest-ranked-states-america-u-s-news.
[23]https://teampa.com/wp-content/uploads/2020/01/PA_Econ_Competitiveness_Dashboard_011620-FINAL.pdf.
[24]https://www.deptofnumbers.com/gdp/pennsylvania/.
[25]https://www.brookings.edu/wp-content/uploads/2019/08/2019.08.13_BrookingsMetro_Pennsylvania-Innovation-Economy_Maxim-Muro.pdf.

capita is at the U.S. average.[26] As shown in figure A-1, the industrial sector leads energy consumption in Pennsylvania, accounting for just over one-third of the state's total energy use, followed by the residential sector at one-fourth, the transportation sector at just under one-fourth, and the commercial sector at about one-sixth. Major energy-consuming industries that are large contributors to the state's GDP include natural gas and oil extraction and mining; metals and machinery manufacturing; chemical products; and agriculture and food processing. As shown in Figure A-2, natural gas is the largest supplier of the state's energy, followed by coal and nuclear power.

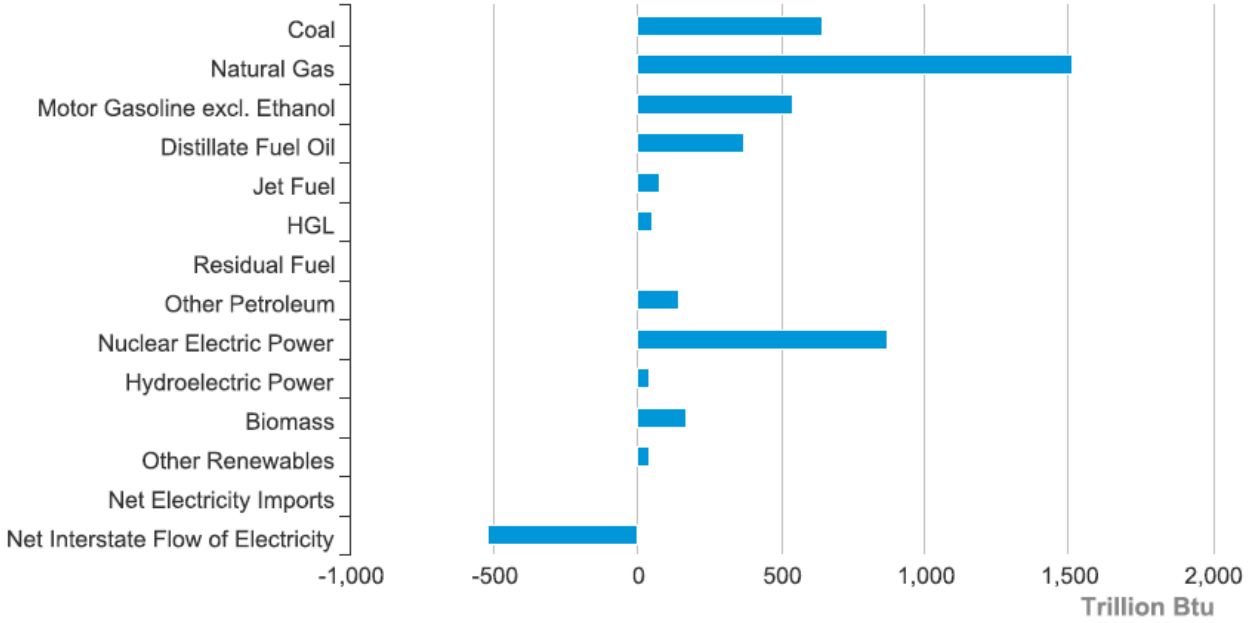
Figure A-1
Pennsylvania Energy Consumption by End-use Sector, 2018



Source: U.S. Energy Information Administration.

[26]https://www.eia.gov/state/analysis.php?sid=PA.

Figure A-2
Pennsylvania Energy Consumption Estimates, 2018



Source: U.S. Energy Information Administration.

A.C.1. Natural Gas

Pennsylvania is the second-largest natural gas-producing state, and is second only to Texas in estimated proved natural gas reserves, which nearly tripled from 2012 to 2018 because of natural gas development in the Marcellus Shale. The Marcellus Shale has the largest estimated proved reserves of any U.S. natural gas field, and during 2018 alone, Pennsylvania added 14.2 trillion cubic feet (tcf) of proved natural gas reserves, the second-largest net increase of all the states that year after Texas. Pennsylvania's marketed natural gas production was nearly 7 tcf in 2019, more than 11 times larger than in 2010. The state's annual marketed natural gas was equal to about one-fifth of total U.S. gas production.

Several pipeline projects in recent years have enabled Marcellus natural gas producers to transport their supplies to additional markets, and more pipeline projects are under construction or planned.[27] Most of the natural gas shipped by pipeline from Pennsylvania goes to New York, New Jersey, Maryland, Ohio, and West Virginia. Pennsylvania has 49 underground natural gas storage facilities, the most of any state,

[27]These projects include the Rockies Express Zone 3 expansion, which entered into service in October 2016 and moves natural gas westward from southwest Pennsylvania. The Algonquin Incremental Market pipeline, which began operating in December 2016, primarily moves natural gas from northeastern Pennsylvania into New England.

which help meet regional heating demand in the winter.[28] The state's total natural gas storage capacity is the fourth-largest in the nation.

Pennsylvania is also experiencing growth in the production of natural gas plant liquids (NGPLs), including ethane and propane, which typically sell at higher prices than natural gas. The state's natural gas plant processing was nearly 10 times larger in 2018 compared to 2010. Natural gas producers are building processing plants to extract higher-priced NGPLs from natural gas and pipelines to transport the products to domestic and Canadian markets and to ports on the East Coast and the Gulf Coast for export.

The electric power sector used about half of the natural gas delivered to consumers in the state. The industrial and residential sectors each accounted for about one-fifth of the state's total natural gas use, and the commercial sector consumed most of the rest. About half of Pennsylvania households use natural gas as their primary heating fuel.

A.C.2. Coal

Pennsylvania is the third-largest coal-producing state after Wyoming and West Virginia, is home to the 10th largest U.S. coal mine, and is the second-largest coal exporter to foreign markets. The state has substantial reserves of bituminous coal, which is used to generate electricity and to produce coke for steelmaking. Northeastern Pennsylvania has almost all the nation's reserves of anthracite coal and anthracite production, but anthracite accounts for only about 4% of the state's total coal production. Anthracite, which has a higher heat content than other types of coal and burns with little soot, is used primarily in space heating in residential and commercial buildings. The number of coal mines and amount of coal production in Pennsylvania has declined as less electricity has been generated from coal, coal-fired power plants have shut down, and foreign demand for coal has declined.

Pennsylvania is also a major coal consumer, ranking sixth among the states in total coal use. About 80% of the coal consumed in the state is burned for electricity generation, and the rest is used for steelmaking and other industrial applications. In 2018, almost 90% of Pennsylvania-mined coal was used for electricity generation. One-third of that coal was used at Pennsylvania power plants and the rest was transported to generating facilities in 15 other states, which, except for one, were located east of the Mississippi River. Pennsylvania was the second-largest coal-exporting state in 2018, after West Virginia, with about 30% of the state's mined coal exported to other nations.

A.C.3. Petroleum

[28]All but one of those storage sites are in depleted natural gas fields.

Pennsylvania, site of the first U.S. commercial oil well in 1859, has few economically recoverable crude oil reserves but continues to produce modest amounts of crude oil -- mainly paraffin-based crude oil used for making lubricants. With four petroleum refineries that can process about 600,000 barrels of crude oil per day, Pennsylvania is home to nearly half the East Coast's refining capacity.

About 18% Pennsylvania households rely on fuel oil for home heating and makes Pennsylvania, like much of the U.S. Northeast, vulnerable to heating oil shortages and price spikes. In 2000, the federal government created the 1-million-barrel Northeast Home Heating Oil Reserve to avert shortages in Pennsylvania and other Northeast states.

The transportation sector is the largest petroleum consumer in Pennsylvania, accounting for nearly 75% of the state total, and most of that petroleum is motor gasoline. To reduce emissions of smog-forming pollutants, motorists in the heavily populated areas of southeastern Pennsylvania, including Philadelphia, are required to use reformulated motor gasoline blended with ethanol. In the summer, drivers in the Pittsburgh area must use motor gasoline that has lower evaporative emissions.

A.C.4. Electricity

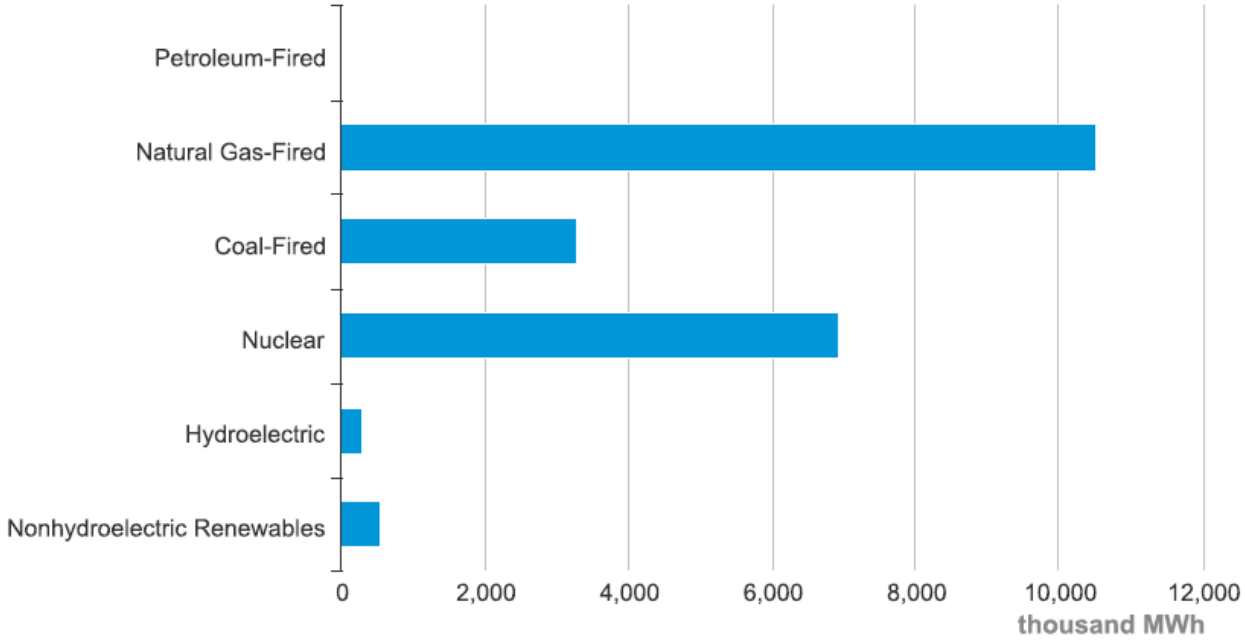
Pennsylvania is the third-largest producer of electricity in the nation, behind only Texas and Florida. Electricity generation regularly exceeds Pennsylvania's power consumption, and the state exports more electricity than any other state. Pennsylvania is part of the PJM Interconnection regional transmission organization, which manages the region' electric grid. As shown in Figure IV-3, in 2019, natural gas-fired power plants were the largest provider of in-state electricity for the first time, taking over the top spot from nuclear power. Coal-fired power plants were the third-largest providers of in-state electricity, followed by non-hydroelectric renewables.

The residential sector is the largest consumer of electricity in Pennsylvania, accounting for nearly two-fifths of the state total. About one in four Pennsylvania households use electricity as their primary heating source.

Many of Pennsylvania's coal-fired power plants have been retired with the increased availability of competitively priced natural gas, and nearly 3,000 megawatts (MW) of the state's coal-fired summer generating capacity shut down between 2015 and mid-2020. In the same period, almost 9,500 MW of natural gas-fired capacity came online, and almost all the generating capacity added in the state from the beginning of 2019 through the first half of 2020 was fueled by natural gas. In 2010, coal provided 48% of the state's electricity net generation and natural gas accounted for 15%. By 2019, coal had declined to 17% of the state's net generation and the share of natural gas generation nearly tripled to 43%.

Pennsylvania ranks second in the nation, after Illinois, in nuclear power generating capacity. Pennsylvania's five nuclear power plants provided 36% of the state's electricity net generation in 2019. Pennsylvania is the site of the first commercial U.S. nuclear power plant, which came online in 1957 in Shippingport and operated for nearly 30 years. Some of the state's nuclear power plants face economic challenges. The Unit 1 reactor at the Three Mile Island plant was shut down permanently in September 2019 because it was unprofitable. The state also had the nation's most serious nuclear power accident, a partial core meltdown at the Three Mile Island Unit 2 reactor in 1979. That accident led to sweeping changes in U.S. nuclear regulation and operating standards.

Figure A-3
Pennsylvania Net Electricity Generation by Source, 2020



Source: U.S. Energy Information Administration.

A.C.5. Renewables

Renewables, mainly hydropower, wind energy, and biomass, provide most of state's remaining net generation. Hydropower is Pennsylvania's largest renewable source for electricity generation. In 2019, about 4% of Pennsylvania's electricity was generated from renewable energy sources. Conventional hydropower was the state's largest renewable source for electricity generation and provided about 40% of the state's renewable electricity. The state's conventional hydroelectric facilities are, on average, about 60 years old, but some of them have been modernized and upgraded to operate more efficiently. Pennsylvania has two pumped storage hydropower plants,

one with 482 megawatts of generating capacity and another with 1,070 megawatts of capacity.[29]

Wind energy accounted for more than one-third of Pennsylvania's renewable electricity in 2019. Wind resources for commercial power production are found on the state's Appalachian Mountain crests mainly in Pennsylvania's southwest but also in the northeastern area's and along the state's Lake Erie shoreline. The state has 26 operating wind farms with nearly 1,500 MW of generating capacity.

Pennsylvania ranks among the top dozen states in the amount of electricity generated by biomass resources, and biomass-fueled facilities accounted for about 20% of the state's renewable generation in 2019. Biomass generation comes mainly from using municipal solid waste and landfill gas as fuel. Pennsylvania's biomass resources from wood and forest byproducts also provide feedstock for the state's eight wood pellet manufacturing plants, which have a combined production capacity of about 368,000 tons per year.

Pennsylvania's one ethanol production plant is the largest on the East Coast and has a capacity of about 128 million gallons per year (gpy), and the state ranks sixth in annual fuel ethanol consumption of 488 million gallons. The state also has two biodiesel manufacturing plants that can produce 90 million gallons gpy, and it is the 11th largest biodiesel-consuming state at nearly 40 million gallons a year.

Solar energy produced about 6% of the state's total renewable electricity in 2019, and the number of solar photovoltaic (PV) installations in Pennsylvania is increasing. In 2019, more than four-fifths of the state's net solar generation came from small-scale generating systems, such as rooftop solar panels with generating capacities of 1 megawatt or less, and the rest was from solar generating facilities larger than 1 megawatt.[30]

Pennsylvania's alternative energy portfolio standard (AEPS) was enacted in 2004 and requires that 18% of the retail electricity sold in the state be generated from renewable sources by 2021, with at least 0.5% generated by solar energy. In 2018, nearly 15% of the electricity sold to the state's retail customers was generated by qualifying alternative energy sources, and 0.34% was solar power.[31] The state also requires investor-owned utilities doing business in the state to undertake energy

[29]Pumped storage is used during periods of low power demand, usually at night, when less costly electricity is used to pump water from a lower reservoir to an upper reservoir. Then, during periods when power demand and electricity prices are higher, the water is released from the upper reservoir and flows down through generating turbines on its way back to the lower reservoir, producing electricity.

[30]Several large businesses in Pennsylvania have installed solar panels for their electricity supplies, including at the home stadium of the Philadelphia Eagles professional football team. The state's largest solar PV facility, the Whitetail Solar project, has 13.5 megawatts of summer generating capacity and came online in late 2019 to provide renewable electricity to Penn State University. The project is scheduled to be expanded in 2020 to a total of 54 megawatts with over 150,000 solar panels.

[31]Among the renewable energy sources Pennsylvania recognizes as meeting part of its AEPS requirements are byproducts of pulping and wood manufacturing, geothermal energy, and waste coal.

efficiency measures to reduce peak power demand and electricity consumption, which may include helping customers install solar and geothermal technologies, insulate buildings, and upgrade appliances.

APPENDIX B: PENNSYLVANIA CLEAN ENERGY JOBS STUDIES

There have a number of studies and estimates of green jobs, clean energy jobs, environmental jobs, etc. in Pennsylvania. However, these have not been comprehensive, consistent, comparable, or definitive.

B.A. Pennsylvania Green Jobs Studies

A Pennsylvania Department of Labor & Industry report The Pennsylvania Green Jobs Survey Report" summarized the results of a 2010 green jobs survey of employers in Pennsylvania.[32] The primary goals of the survey were to identify the number and type of green jobs that exist within the state's economy and to forecast changes in green jobs based on employers' two-year projections. While dated, the report does provide a useful benchmark and has some useful green jobs definitions.

It defined green jobs as those that employ workers in producing or offering products or services that:

- Promote energy efficiency
- Contribute to the sustainable use of resources or renewable energy
- Prevent pollution
- Clean up the environment
- Promote the reduction of harmful emissions
- Provide green education/training, awareness, or compliance

The results show an estimated 183,029 green jobs in Pennsylvania in 2010, which account for 3.4 percent of the total employment in the state. Green jobs are found in each of the six core areas represented in the state's definition, and these jobs are found in varying concentrations in all industries in the state. One out of every five responding companies employs workers in green jobs, and small companies with less than 50 employees report that they have green jobs more often than large firms.

Green jobs exist in all industry sectors of Pennsylvania; however, the bulk of this employment occurs in relatively few sectors. The top six industries account for three-quarters of all green jobs; the three largest industries – construction, manufacturing, and professional, scientific & technical services – account for more than half of all green jobs. As a percent of total employment, the proportion of green jobs varies greatly by industry sector, from a high of nearly 19 percent for construction, to a low of just one tenth of one percent in the health care & social assistance industry sector.

Green jobs also tend to be concentrated within relatively few occupations. The top 25 occupations include more than half of all green jobs in the state. The top five occupations combined constitute about one-fifth of all green jobs: production workers;

[32]Pennsylvania Department of Labor & Industry, "The Pennsylvania Green Jobs Survey Report," 2010.

heating, air conditioning & refrigeration mechanics & installers; carpenters; electricians; and retail salespersons.

Overall, employers estimated green job growth at 6.2 percent annually over the next two years, resulting in 23,232 positions. Growth was forecast across most green occupations, with increases expected in 20 of the 25 most common green jobs. This growth forecast may be due to an increase in new green jobs, a shift in the work of existing employees into jobs considered green, or both. These forecasts probably reflect a conservative estimate, since the survey does not take into account openings due to attrition and retirements. Also, no attempt was made to estimate additional jobs through indirect or induced employment that may be associated with current or future employment in green jobs.

The report found:

- The energy efficiency core area accounts for more than one-third of all green jobs (65,137).
- The construction industry sector was the largest employer in this core area, with almost 42 percent of these green jobs.
- Heating, air conditioning, & refrigeration mechanics & installers are the occupation with the largest number of jobs in this core area.
- Resource sustainability/renewable energy is the second-largest core area, with 41,141 green jobs, or 22.5 percent of the total.
- Manufacturing was by far the largest employer in this core area, with more than 40 percent all green jobs.
- Production worker was the most common occupation, accounting for nearly 15 percent of sustainability renewable energy jobs.
- Pollution prevention accounts for 16.7 percent of green employment in the state, with an estimated 30,566 jobs.
- Green jobs are most numerous in the manufacturing, construction, and professional, scientific, & technical services industry sectors.
- Production workers and refuse & recyclable material collectors constitute the largest green occupations.
- Green education/training or compliance constitutes 13 percent of all green jobs (23,991). One third of these jobs are in public administration, and 18 percent are in professional, scientific & technical services.
- The most common occupation in this core area is elementary school teachers (except special education), with nearly 16 percent of these jobs. These teachers often instruct students in green-related subject areas such as general science, biology, or environmental studies, for example.
- Environmental cleanup accounts for 6.4 percent of green jobs (11,672). One-quarter of the environmental cleanup jobs are in the professional, scientific & technical services industry sector. Refuse & recyclable material collectors account for nearly 11 percent of the jobs in this core area.
- Harmful emissions reduction has the smallest number of green jobs among the six core areas (10,522), accounting for 5.7 percent of the state's green employment.

- Transportation & warehousing, and retail trade each cover roughly one-quarter of all jobs in this core area.
- Automotive service technicians & mechanics account for 28 percent of all jobs in this core area.

Clean Jobs Pennsylvania 2020 details the size, scope, and diversity of this employment sector, the challenges it is currently facing, and how focusing recovery policies on clean energy can get struggling Pennsylvania workers and businesses back on track and the state's economy up and running again for the long run.[33] It found that in 2019, clean energy jobs in Pennsylvania increased for the seventh straight year, growing to nearly 94,000 workers statewide before the effects of the coronavirus outbreak impacted the nation's economy. A regional and national leader in clean energy jobs, Pennsylvania ranked just outside the top ten (11th) for total clean energy jobs among all 50 states and the District of Columbia for the third year in a row. Since 2017, the state has added more new jobs (8,253) than six of the current top ten states and now trails No. 10 Virginia by fewer than 3,500 workers.

Despite its large workforce size, recent years of strong growth and consistent high performance across clean technologies, the report found that Pennsylvania's clean economy is underperforming its potential, as the state's clean energy workforce still comprises a lower share of total statewide jobs than the national average. Growth in recent years has been driven primarily by energy efficiency, solar energy, and grid modernization -- high growth areas for the future that will be important as the state's economy faces its toughest test as the nation reels and rebuilds after the impact of COVID-19 economic shutdowns.

The report derived the following jobs estimates:

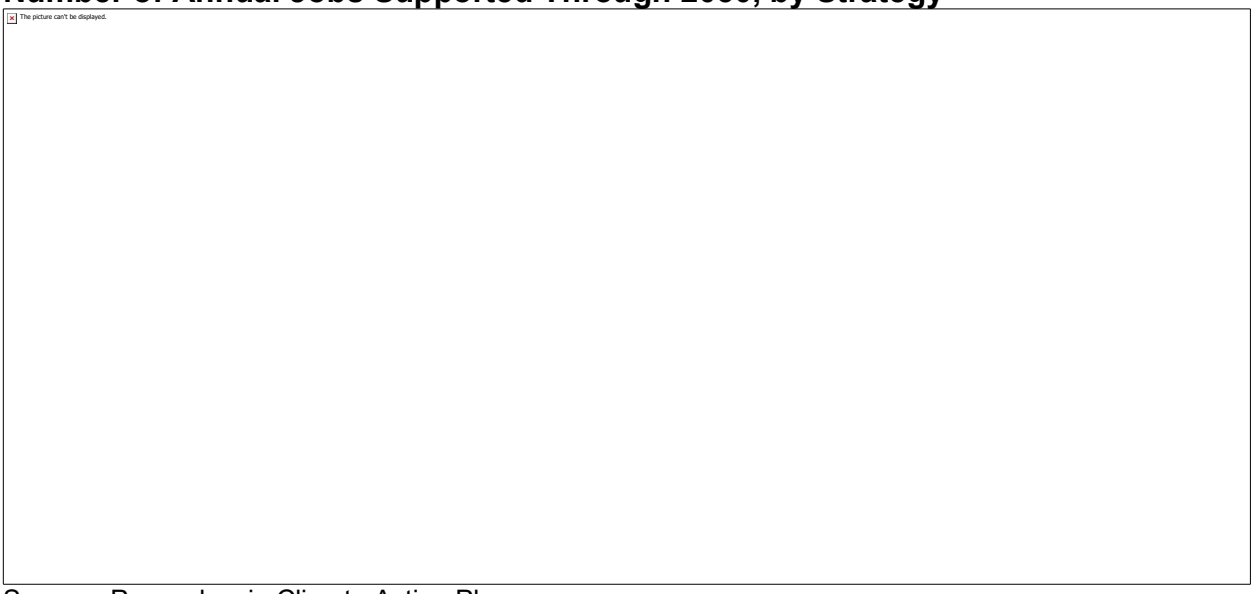
- Energy Efficiency – 71,443 jobs
- Renewable Energy – 9,744 jobs
  -- Solar Energy – 5,173 jobs
  -- Wind Energy – 2,937 jobs
- Clean Vehicles – 7,541 jobs
- Clean Storage – 1,770 jobs
- Grid Modernization – 1,929 jobs
- Clean Fuels – 1,436 jobs
- All Clean Energy Sectors – 93,861 jobs

The Pennsylvania Climate Action Plan contends that it is a common misconception that reducing energy consumption and production leads to a decreased number of jobs. Rather, if finds that developing new technologies and retrofitting

[33]E2, the Keystone Energy Efficiency Alliance (KEEA), the Green Building Alliance (GBA), Green Building United, the Sustainable Business Network of Greater Philadelphia, and Sustainable Pittsburgh, *Clean Jobs Pennsylvania 2020*, 2020. The analysis expands on data from the 2020 U.S. Energy and Employment Report (USEER) produced by the Energy Futures Initiative (EFI) in partnership with the National Association of State Energy Officials (NASEO), using data collected and analyzed by the BW Research Partnership.

existing systems for energy efficiency creates market opportunities and bolsters the economy.[34] Figure B-1 from the Action Plan demonstrates a projected net increase in jobs from 2018 across the eight sectors.

Figure B-1
Number of Annual Jobs Supported Through 2050, by Strategy



Source: Pennsylvania Climate Action Plan

The Nature Conservancy report "Pennsylvania Climate Solutions" finds that Pennsylvania's energy efficiency industry is responsible for nearly 62,000 jobs, a number that will only grow as the state transitions to cleaner and more efficient energy solutions. The report concludes that it is time to catch up to neighboring states that are surpassing Pennsylvania in pursuit of clean energy goals, jobs and greener economy. Renewable energy and energy efficiency are good for Pennsylvania. Both generate jobs and promote economic growth while benefiting nature and the health and well-being of all Pennsylvanians.[35]

The Food & Water Watch report "Cracked: The Case For Green Jobs Over Petrochemicals In Pennsylvania," finds that fracking and petrochemicals create fewer Pennsylvania jobs than clean energy.[36] The report focuses on the massive Shell petrochemical "cracker" plant outside Pittsburgh.

[34]Nicole Catino, "Key Takeaways From the New Pennsylvania Climate Action Plan," https://evolveea.com/key-takeaways-from-the-new-pennsylvania-climate-action-plan/.
[35]The Nature Conservancy, "Pennsylvania Climate Solutions," December 2020.
[36]Food & Water Watch, "Cracked: The Case For Green Jobs Over Petrochemicals In Pennsylvania," September 21, 2020.

While early backers of the $6 billion project predicted it would create between 10,000 and 20,000 jobs, the report estimates that the facility will only employ 600 workers. Factoring in the massive $1.6 billion tax break granted to the company -- the largest in Pennsylvania history -- means the state is essentially paying $2.75 million to create each job at the plant. The Food & Water Watch research estimates that a similar level of investment in wind and solar manufacturing would create over 16,000 jobs.

A report by the University of Massachusetts estimates that the public and private investments needed in Pennsylvania to achieve emission reduction targets consistent with the IPCC's goals are capable of producing, between 2021 – 2030, an average of about 162,000 per year in Pennsylvania -- about 152,000 jobs in 2021, with these 152,000 jobs carrying over into 2022, 2023, 2024, etc., along with further job increases resulting each year as clean energy investments grow along with overall economic activity in Pennsylvania.[37] These investments will entail both: 1) greatly enhancing the state's level of energy efficiency, including through deep energy retrofits to public buildings; and 2) massively expanding the state's supply of clean renewable energy sources, starting with wind power and solar power. New job opportunities will open for, among other occupations, carpenters, machinists, environmental scientists, secretaries, accountants, truck drivers, roofers, and agricultural laborers.

New job opportunities will be created in a wide range of areas, including construction, sales, management, production, engineering, and office support. Current average total compensation in these occupations mostly ranges between $70,000 – $80,000 per year. Employment growth in these areas should create increased opportunities for women and people of color to be employed and to raise unionization rates. Higher unionization rates should promote gains in compensation and better working conditions in the affected industries. Good-quality worker training programs will be needed to ensure that a wide range of workers will have access to the jobs created by clean energy investments and that the newly employed workers can perform their jobs at high productivity levels.

The report estimates overall net job creation through clean energy, manufacturing, public infrastructure, land restoration and agriculture investments. Its annual average job estimates for 2021 – 2030 include:

- 162,000 jobs per year through $22.6 billion in spending on energy efficiency and clean renewable energy.
- 33,000 jobs per year through investing $4.1 billion in manufacturing and public infrastructure.
- 48,000 jobs per year through investing $4.1 billion in land restoration and agriculture.

[37]Robert Pollin, Jeannette Wicks-Lim, Shouvik Chakraborty, and Gregor Semieniuk, "Impacts of the Reimagine Appalachia & Clean Energy Transition Programs For Pennsylvania Job Creation, Economic Recovery, and Long-Term Sustainability," Department of Economics and Political Economy Research Institute (PERI), University of Massachusetts-Amherst, January 2021.

- The total employment creation through clean energy, manufacturing/infrastructure and land restoration/agriculture will total to about 243,000 jobs.
- Net job creation will average about 3.9 percent of Pennsylvania's workforce as of 2019.

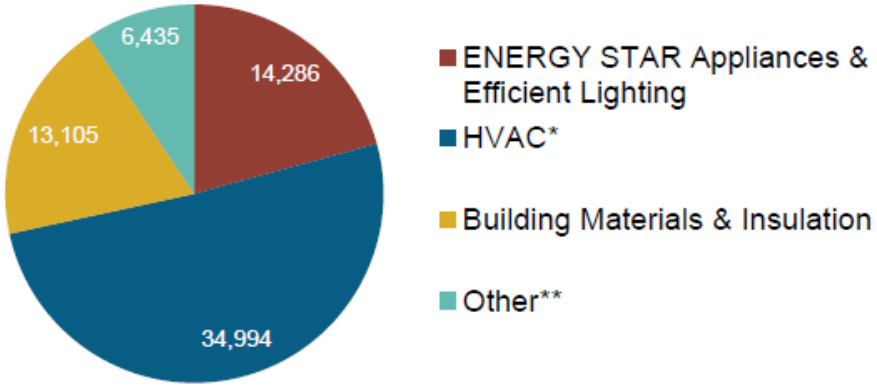
E2 estimated that in 2019, clean energy jobs in Pennsylvania increased for the seventh straight year, growing to nearly 94,000 workers statewide before the effects of the coronavirus outbreak impacted the state and national economies.[38] A regional and national leader in clean energy jobs, Pennsylvania ranked just outside the top ten (11th) for total clean energy jobs among all 50 states and the District of Columbia for the third year in a row. Since 2017, the state has added more new jobs (8,253) than six of the current top ten states and now trails No. 10 Virginia by fewer than 3,500 workers.

Despite its large workforce size, recent years of strong growth and consistent high performance across clean technologies, E2 finds that Pennsylvania's clean economy is underperforming its potential, as the state's clean energy workforce still makes up a lower share of total statewide jobs than the national average. Growth in recent years has been driven primarily by energy efficiency, solar energy, and grid modernization -- high growth areas for the future that will be important as the state's economy faces its toughest test as the nation reels and rebuilds after the impact of COVID-19 economic shutdowns.

In another study, E2, E4, and BW Research Partnership estimated that in 2019 there were 68,820 total energy efficiency jobs in Pennsylvania and that there were 9,902 energy efficiency businesses in the state.[39] The study estimated energy efficiency jobs by sector – Figure B-2, and energy efficiency firms by supply chain – Figure B-3.

Figure B-2
Jobs by Sector

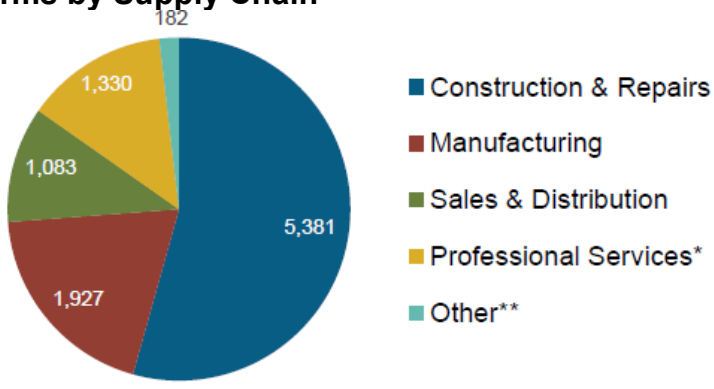
[38]E2, "Clean Energy Jobs: Key to Pennsylvania's Economic Recovery, 2019.
[39]E2, E4, and BW Research Partnership, "Pennsylvania: Energy Efficiency Jobs in America," 2019.



*Heating, Ventilation, Air Conditioning of higher than standard efficiency/renewable heating & cooling
**Other such as energy audits, building certifications, and software services

Source: E2, E4, and BW Research Partnership

Figure B-3
Firms by Supply Chain



*Professional services includes finance/accounting, architecture, engineering, R&D, etc.
**Other such as maintenance, and business and nonprofit organizations

Source: E2, E4, and BW Research Partnership

The study also estimated energy efficiency jobs by Congressional District, by metropolitan area, by State Senate District, and by State House of Representatives District.

The "U.S. Energy Employment Report for Pennsylvania" found that in 2019 the state had a low concentration of energy employment, with 113,168 Traditional Energy workers statewide (representing 3.4 percent of all U.S. Traditional Energy jobs).[40] Of these Traditional Energy workers, 19,333 are in Electric Power Generation, 54,180 are in Fuels, and 39,655 are in Transmission, Distribution, and Storage – Figure B-4. The

[40]U.S. Energy Employment Report: Pennsylvania Energy and Employment – 2019; https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/5c7f41f50d92970488a7bc42/1551843829835/Pennsylvania.pdf.

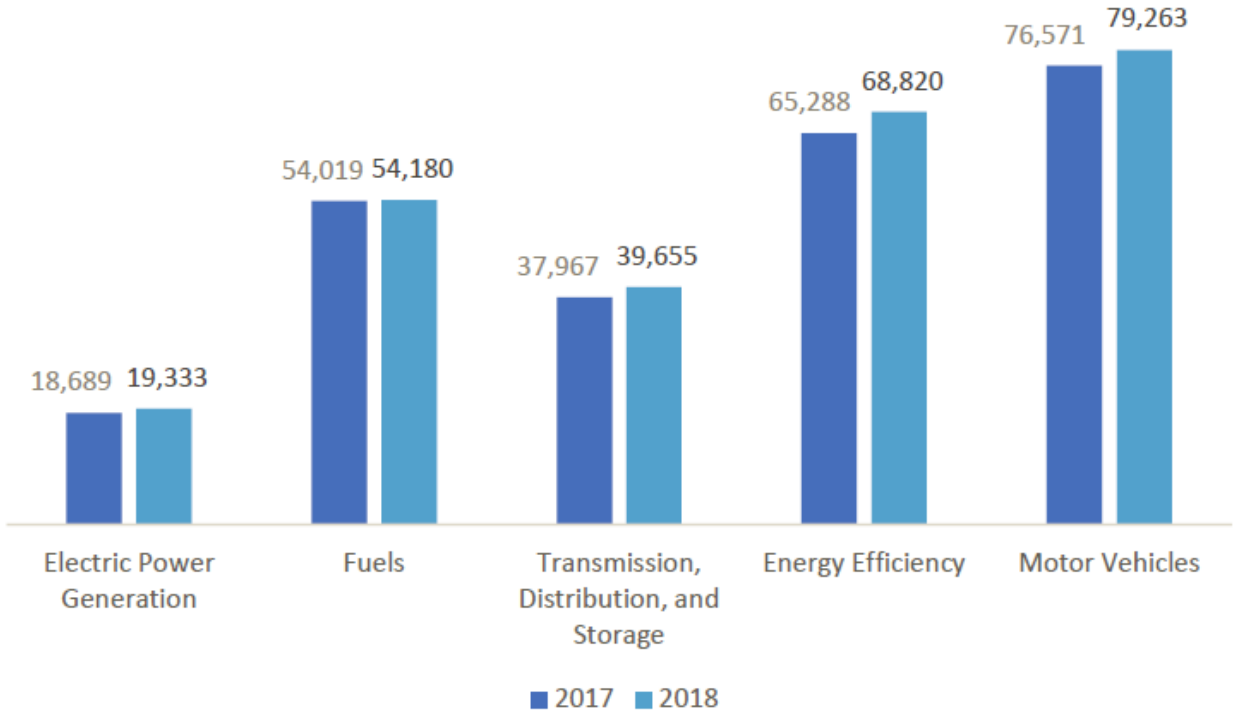
Traditional Energy sector in Pennsylvania is 1.9 percent of total state employment (compared to 2.3 percent of national employment).

The USEER estimated that Pennsylvania has an additional 68,820 jobs in Energy Efficiency (3.0 percent of all U.S. Energy Efficiency jobs) and 79,263 jobs in Motor Vehicles (3.1 percent of all U.S. Motor Vehicle jobs).

Overall, Traditional Energy jobs grew by 2.3 percent since 2018, increasing by 2,493 jobs over the period. Energy Efficiency jobs added 3,532 jobs (5.4 percent) and motor vehicles added 2,692 jobs (3.5 percent).

The 68,820 Energy Efficiency jobs in Pennsylvania represent 3.0 percent of all U.S. Energy Efficiency jobs, adding 3,532 jobs (5.4 percent) since last year. The largest number of these employees work in traditional HVAC firms, followed by high efficiency HVAC and renewable heating and cooling – Figure B-5.

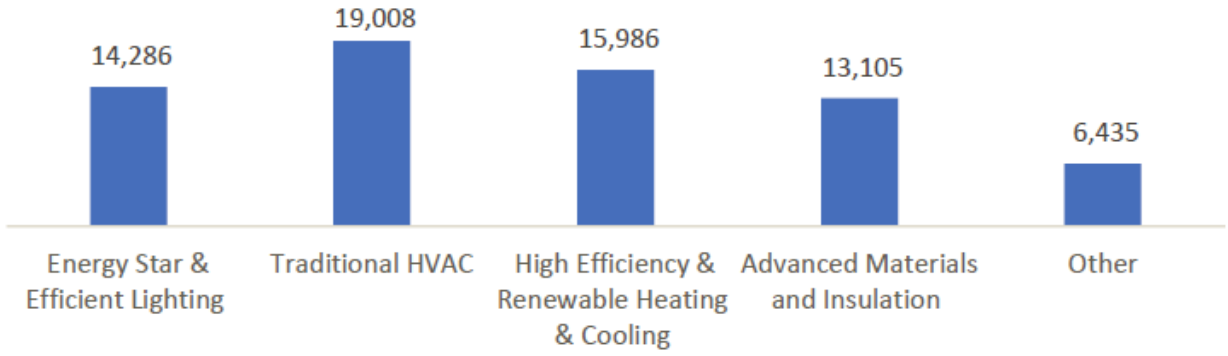
Figure B-4
Employment by Major Energy Technology Application



Source: USEER

Figure B-5

Energy Efficiency Employment by Detailed Technology Application



Source: USEER

The "2020 Pennsylvania Clean Energy Employment Report," found that Pennsylvania was home to about 97,000 clean energy workers statewide in 2019, and job creation was increasing.[41] Clean energy jobs represented 1.6 percent of the overall statewide labor market in 2019. Between 2017 and 2019, clean energy businesses created almost 7,800 new jobs -- a growth rate of 8.7 percent in two years.

Between 2017 and 2019, clean energy jobs grew faster than the overall statewide labor market. Jobs at clean energy firms grew by 8.7 percent, compared to a statewide average job growth of 1.9 percent over the same time frame. Seven percent of all new jobs in Pennsylvania were attributable to clean energy employment growth from 2018 to 2019.

Clean energy employment was concentrated largely in energy efficiency and energy generation. The energy efficiency industry accounted for roughly three-quarters of clean energy jobs across the state, followed by clean energy generation, which accounted for 15 percent.

Solar jobs in Pennsylvania continued to grow, despite nationwide declines. Between 2017 and 2019, Pennsylvania's solar workforce grew by 8.3 percent, or an additional 396 jobs. During the same time, the nationwide solar workforce declined 1.2 percent, shedding approximately 4,300 solar jobs from the clean energy workforce. The continued growth in solar jobs for Pennsylvania was likely the result of an increase in annual installations between 2018 and 2019. In 2018, the state installed just under 60 MW of residential, non-residential, and utility-scale solar capacity. In 2019, annual installed capacity reached about 70 MW.

Jobs declined in the nuclear electric power generation sector. Although nuclear accounts for a large share of Pennsylvania's electricity generation mix, the closure of Three Mile Island at the end of 2019 and the overall national and statewide shift from fossil fuels to natural gas and clean energy reduced the nuclear generation workforce.

[41]Pennsylvania Department of Environmental Protection Energy Programs Office, "2020 Pennsylvania Clean Energy Employment Report," prepared by BW Research, 2020.

Between 2017 and 2019, Pennsylvania's nuclear electric power generation labor force declined by 5.4 percent, or 256 jobs, mirroring the nationwide decline of 5.9 percent over the same time period.

Wind energy was a significant source of both jobs and renewable energy capacity in Pennsylvania. Since 2013, wind energy has become the largest source of Pennsylvania's renewable electricity generation, accounting for 36 percent of renewable electricity in 2018. Across the state, 751 wind turbines generate over 1,400 MW of wind power. In fact, Pennsylvania ranks 19th in the nation for installed wind capacity. In addition to generation capacity, the state is home to 29 manufacturing facilities that produce components for the wind industry.

Along with the increase in wind electricity generation, the statewide wind energy workforce increased from 2017 to 2019. Wind energy jobs grew by 9.7 percent, or 259 workers, amounting to a total of 2,937 wind energy jobs. In 2019, the wind energy sector in Pennsylvania accounted for 2.6 percent of all wind energy jobs in the United States.

Construction firms were a major employer of clean energy workers in Pennsylvania. The construction industry accounted for 47 percent of clean energy jobs in the state. The high prevalence of construction activity was mostly attributable to the energy efficiency sector. Out of all clean energy construction jobs across the state, 85 percent of workers were energy efficiency workers, indicating that much of energy efficiency activity was concentrated in the deployment of energy efficient systems and technologies.

Clean grid and storage construction were also an area of significant activity in Pennsylvania, as 76 percent of clean grid and storage workers were in the construction industry. This means that about three-quarters of clean grid and storage workers were engaged in the installation, maintenance, or repair of clean storage, smart grid, microgrid, or other grid modernization technologies across the state.

Pennsylvania is also a hub for clean energy manufacturing, with potential to export these services to the rest of the nation. The state is home to significant manufacturing of clean fuels, ENERGY STAR® products, and wind turbine components. Six in ten (68.7 percent) clean fuels employees in Pennsylvania worked in the manufacturing industry, likely the result of the high annual volumes of biodiesel and wood pellet production in the state.

However, Pennsylvania's clean energy manufacturing strength lies in the energy efficiency sector. In fact, of all clean energy manufacturing workers in the state, 66.9 percent were in the energy efficiency sector. Pennsylvania is well-poised to export the state's clean energy manufacturing services to the rest of the nation. As the demand for clean energy goods and services continues to increase in the U.S., Pennsylvania can likely expect to see further growth in clean energy manufacturing jobs.

B.B. The USEERs and State Reports

Most of the Pennsylvania green jobs studies discussed above relied, directly or indirectly, on the annual U.S. Energy Employment Reports (USEERs) and their state derivatives. It is thus important to understand the strengths and weaknesses of the USEERs.

The 2020 USEER is an annual $1 million+ good-faith attempt by nonprofit agencies to estimate employment-related activities in the various energy sectors of the U.S. economy. The results, published in a number of graphics-laden documents, total 621 pages in length. Unfortunately, the database and data tables required for deeper economic and employment research are not to be found among the 621 pages, making the USEER appear more of a coffee-table type book than a comprehensive, rigorous analysis.

However, the analysis in the USEER is benchmarked to the basic data available at the Bureau of Labor Statistics (BLS) and the BLS Quarterly Census Employment and Wages (QCEW) from a single quarter in 2019. It is not clear why a longer period was not chosen, but the BLS data themselves are of the highest quality for that singular 90-day period.

The wheels begin to fall off the cart as the data are stratified and tens of thousands of surveys are distributed to companies around the county by a contractor. While the survey may have been approved by OMB, it is not a government survey and is therefore not necessarily responded to by all companies completely, seriously, or accurately. This problem is especially acute for the 2018, 2019, and 2020 USEERs, which were conducted by private sector nonprofit organizations rather than DOE – as were the 2016 and 2017 USEERs.

One major weakness of the 2020 USEER is that it only covers what the USEER deems “direct” sales, so that much economic activity that is classified as “indirect” is not included. These major, important sectors of the economy -- for example, polysilicon production (a backwards linkage to solar panels) and gasoline station management and sales (a forward linkage to fuels) and their economic activity and employment – are not included. This is unfortunate since the backward and forward input-output linkages for energy technologies is very specific and not easily modeled.

The importance of this for the 2020 USEER and for estimating the jobs impacts of the energy industries cannot be over-emphasized. Some energy-related industries generate 10, 15, or 20 total (direct, indirect, and induced) jobs for every direct job. Thus, focusing only on direct jobs can underestimate the actual impact of some energy jobs and industries by a factor of 10, 15, or more. This is especially worrisome because the direct, indirect, and induced jobs concept is widely used and publicized by

numerous energy related organizations and interest groups. By ignoring these concepts, the 2020 USEER is potentially distorting its policy interpretations and implications.

Other salient issues with the 2020 USEER include:

- When former DOE Secretary Ernest Moniz launched the nonprofit Energy Futures Initiative (EFI) during the summer of 2017, he stated that EFI would produce the USEER reports on "deep decarbonization pathways." This indicates that there may be some implicit biases against fossil fuels in the 2018, 2019, and 2020 USEERs.
- The use (or misuse) of “mixed” North American Industry Classification System (NAICS) categories containing a mix of energy and non-energy jobs and combinations of them.
- Different methodologies and data concepts are used in some of the annual USEERs, which makes it difficult to estimate some multi-year employment trends.
- The use of both company-specific and contractor jobs, with a failure often to adequately differentiate between the two.

- Confusion over which “job” concepts are being used in the USEER. There are repeated references to “employment,” “workforce,” “jobs,” and “net jobs.” Further, these concepts are sometimes used interchangeably in an inconsistent and confusing manner.
- Failure to use the concept of a full time equivalent (FTE) job in the U.S. As discussed in Section II.A.2, an FTE job is defined as 2,080 hours worked in a year’s time, and adjusts for part time and seasonal employment and for labor turnover. The FTE concept normalizes job creation among full time, part time, and seasonal employment and an FTE job is the standard job concept used in these types of analyses and allows meaningful comparisons over time and across jurisdictions because it consistently measures the input of labor in the production process. This is a nontrivial issue: FTE v non-FTE jobs estimates differ substantial among industries – especially at the more detailed level. The estimates for detailed industries can differ by 25%, and the variance among industries is very high and the ratios can change year over year.
- The USEER publishes separate supplementary reports *Energy Employment by State*, which contains for each state and D.C. a 7-page summary chapter of the energy employment data. All 51 state reports are generically similar and are produced according to the same template. While perhaps of some use – and these state reports are widely quoted and referenced, their actual value is uncertain, at best. Basically, the 2020 USEER state reports are of very limited value and usefulness and, perhaps even more important, seriously misleading for the purposes of such reports, which include energy industry and job forecasting and planning, education and training programs, workforce and educational planning, etc.

Nevertheless, the 2020 USEER offers the best analysis possible given the millions of dollars it cost and may be of value and use to the Federal government, numerous industry groups and NGOs, and to the state and local government community as a strategic planning tool for economic development and education and employment training purposes. However, it is clear that this activity and data need to be fully integrated into the accounts at the BLS (and the Commerce Department's Census Bureau and the Bureau of Economic Analysis) and should probably be conducted by the Federal Government through the BLS. The 2021 USEER is presumably being conducted by DOE – as were the 2016 and 2017 USEERs, and this is, hopefully, a favorable development.

Some Basic USEER Methodology Issues

There are some basic methodology and data issues involved with the USEER, several of which are discussed below.

B.B.1. Use of QCEW and NAICS Data

As noted, data are derived primarily from the BLS Quarterly Census Employment and Wages (QCEW). USEER attempted to identify NAICS industries with all (energy NAICS) or some (mixed NAICS) energy jobs, categorized by NAICS, ownership (government, private), business size, geography (state, county):

- 100% Energy NAICS – such as NAICS 2121 "Coal Mining" are 100% energy jobs – are job estimates derived directly from BLS.
- "Mixed" NAICS categories contain a mix of energy and non-energy jobs and need to be surveyed (e.g. Construction). Establishments are identified in industries known to have
- Energy and non-energy jobs: known, unknown establishments, and random samples are conducted and surveys are conducted to determine energy employment. The percentage of energy employment identified in the sample is then applied to (energy plus non-energy jobs) by business size, public/private, county in federal data sources.
- "Full" survey results are then combined to produce job estimate totals.

In 2016, DOE attempted to reach approximately 65,000 known establishments and 411,000 unknown establishments, and made approximately 215,000 contacts. Approximately 30,000 businesses participated in the survey with 10,000 full survey completions. "Mixed" NAICS include "known" energy businesses from previous surveys, trade groups, as well as "unknown" businesses (e.g. unknown whether "construction"-classified business contain energy jobs); both known and unknown businesses are surveyed. USEER surveys both known and unknown businesses to estimate energy job percentages by category. Percent of energy jobs for each category

based on survey multiplied by total jobs (BLS) in that category. “Mixed” NAICS include “known” energy businesses from previous surveys, trade groups, as well as “unknown” businesses (e.g. unknown whether “construction”-classified business contain energy jobs); both known and unknown businesses are surveyed. USEER surveys both known and unknown businesses to estimate energy job percentages by category. Percent of energy jobs for each category based on survey multiplied by total jobs (BLS) in that category.

USEER uses jobs numbers directly in 100% NAICS codes (e.g. coal mining) and jobs from other Mixed NAICS through the survey (e.g. coal jobs in professional services, manufacturing) to obtain more complete jobs numbers than BLS can identify. USEER contains both company-specific and contractor jobs, but does not differentiate between the two.

B.B.2. Inclusion (or Not) of Contractor Jobs

- USEER is a comprehensive methodology to quantify the number of direct jobs within each energy category, similar to work done by other federal data agencies (i.e., BLS, BEA, Census) but at a more comprehensive and granular level of energy identification and categorization.
- Contractors can be included across NAICS codes. The USEER includes these contractors based on how they identify where they should be categorized, but does not explicitly differentiate between energy company employees and contractors. For example, if a contractor in the Professional Services industry says that they are involved in coal mining, they are included in the USEER coal fuel sector.
- Jobs within 100% NAICS industries such as 2121 “Coal Mining” are workers who are directly employed by companies that are identified by the BLS as operating within that respective industry (coal in this example). Jobs outside of these that are identified within the USEER could be contractors, but USEER does not break this out explicitly.
- USEER uses jobs numbers directly in 100% NAICS codes (e.g. coal mining) and jobs from other Mixed NAICS through the survey (e.g. coal jobs in professional services, manufacturing) to obtain more complete jobs numbers than BLS can identify
- USEER contains both company-specific and contractor jobs, but does not differentiate between the two

B.B.3. Different Year Methodologies

The methodologies used in the 2016 USEER, (which estimated 2015 employment) and the 2017 USEER (which estimated 2016 employment) and some of the other USEERs are different. Thus, as noted in the 2017 USEER, "As a result, not all data points are directly comparable between 2016 and 2017."[42] In other words, it is difficult to estimate employment trends between these two years and, possibly, for other years as well. Nevertheless, this has not stopped numerous such multi-year comparisons and analyses from being conducted – without the appropriate caveats or qualifications.

B.B.4. The "Jobs" Concept

The jobs issue is the key focus of the USEERs. The "jobs" concept can be subject to misinterpretation and misuse, and it is thus important that it be carefully defined. Specifically, the employment concept MISI uses in its research is a full time equivalent (FTE) job in the U.S. An FTE job is defined as 2,080 hours worked in a year's time, and adjusts for part time and seasonal employment and for labor turnover. The FTE concept normalizes job creation among full time, part time, and seasonal employment. Thus, for example, two workers each working six months of the year would be counted as one FTE job. An FTE job is the standard job concept used in these types of analyses and allows meaningful comparisons over time and across jurisdictions because it consistently measures the input of labor in the production process.

Thus, a "job" created is defined as a job created for one person for one year, and 50,000 jobs created will refer to 50,000 persons employed for one year. It is correct to state that "over a ten year period 500,000 cumulative jobs are created" as long as it is specified that this refers to 50,000 persons, each employed annually for 10 years. These distinctions may sound technical, but they are critical to a proper interpretation of the results.

Thus, in jobs studies, MISI uses the employment concept of an FTE job in the U.S.[43] The FTE concept is the standard used in economic analyses and normalizes job creation among full time, part time, and seasonal employment. The USEER does not mention the FTE job concept.

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[42]See *U.S. Energy and Employment Report,* https://www.energy.gov/downloads/2017-us-energy-and-employment-report.

[43]See, for recent examples, Management Information Services, Inc., "Use of the San Juan Generating Station to Develop Metrics to Compare Coal Fueled Power Plant Jobs Impacts to Those of Renewables," prepared for the U.S. Department of Energy, September 2020; Management Information Services, Inc., "Assessment of the Jobs Impacts of CCUS Retrofit of Four Coal Power Plants in Wyoming," prepared for the U.S. Department of Energy, July 2020.

Actually, it is not clear what "job" concept USEER utilizes. There are repeated references to "employment," "workforce," "jobs," and "net jobs." Further, these concepts are sometimes used interchangeably in an inconsistent and confusing manner.

This is a nontrivial issue: FTE v non-FTE jobs estimates differ substantial among industries – especially at the more detailed level. The estimates for detailed industries can differ by 25%, and the variance among industries is very high and the ratios can change year over year.[44]

B.B.5. Direct, Indirect, and Total Jobs

The USEER uses different definitions of direct and indirect jobs than does the supplemental surveys that are conducted by BLS to acquire more complete information on new industries – surveys upon which, supposedly, the USEER is based.

The employment figures reported in the USEER are supposed to refer only to direct employment and not to indirect employment or induced employment. However, the report's employment figures do include some indirect jobs, although it is not clear how many.

Historically, supplemental surveys have been conducted by BLS to acquire more complete information on new industries, specific demographic profiles within the workforce, or new labor force trends such as the role of contingent workers. Thus, significant modification to the current BLS structure of industry and occupational classifications is avoided by capturing the required energy employment data using a supplemental survey tool based on existing BLS data and classifications. The 2017 USEER relies on such a comprehensive survey of 30,000 business representatives across the United States, conducted by BW Research Partnership on behalf of DOE.

In the USEER, by comparison, the direct job category of interest is defined as the solar industry generally, including utility-scale solar, residential and commercial installations, as well as the manufacturing, professional services, and wholesale trade that make up the sector. However, the indirect jobs that support this industry are <u>not</u> included, such as polysilicon production (the raw material used in solar panels), aluminum production and extrusion activities for frame manufacturing, or other aspects of the solar value stream. Induced jobs those created throughout the economy as a result of the spending of wages by the employees whose income derives, in whole or part, from this industry are also not included.

Thus, the 2020 provides data for direct employment only and does not attempt to estimate indirect employment or induced employment related to the analyzed sectors --

[44]U.S. Bureau of Economic Analysis, "Full and Part Time Employees by Industry, July 31, 2020;" U.S. Bureau of Economic Analysis, "Full Time Equivalent Employees by Industry," July 31, 2020.

as do many other energy employment studies. These studies typically define an activity based on reported expenditures or expenditures and associated levels of employment reported by a defined industry or activity, such as U.S. solar PV installation. In this example, solar PV installation firm employment would be the "direct" jobs. Most studies go at least one step further, identifying "indirect" employment, which includes the supply chain or other support services to the industry. In the solar example, these would include U.S. manufacturing jobs related to producing PV equipment used in domestic installations (and their suppliers and vendors) as well as consulting, tax, legal, and other professional services to support domestic PV installation companies. Another typical calculation is "induced" jobs, which includes jobs created or supported by wages paid and other benefits provided by employers of direct and indirect employees. A direct job is created by the firm specific to the industry, while indirect jobs support these firms via supply or contracting services. Induced jobs are a result of the economic impact of direct and indirect employees spending their earnings.

In the USEER, by comparison, the direct job category of interest is defined as the solar industry generally, including utility-scale solar, residential, and commercial installations, as well as the manufacturing, professional services, and wholesale trade that make up the sector. However, the indirect jobs that support this industry are not included, such as polysilicon production (the raw material used in solar panels), aluminum production and extrusion activities for frame manufacturing, or other aspects of the solar energy value chain. Induced jobs—those created throughout the economy as a result of the spending of wages by the employees whose income derives, in whole or part, from this industry -- are also not included."[45]

However, in estimating the actual impacts on the entire labor market, it is critically important to recognize that one lost or gained dollar of economic output or one lost or gained job is not the same as another. Each industry has backward linkages to economic sectors that provide the materials needed for the industry's output, and each industry also has forward linkages to the economic sectors where the industry's employees spend their income. Therefore, in addition to the jobs directly supported by an industry, a large number of indirect jobs may also be supported by that industry. The inclusion (or exclusion) of jobs and output in industries with strong backward and forward linkages to other economic sectors can cause indirect and induced impacts. Employment multipliers measure how the creation or destruction of output or employment in a particular industry translates into wider employment changes throughout the economy.[46]

Accordingly, in its employment and jobs studies MISI estimates direct, indirect, and induced jobs:[47]

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[45]2020 USEER, p. 204.

[46]See, for example, "Understanding Multipliers," https://implanhelp.zendesk.com/hc/en-us/articles/115009505707-Understanding-Multipliers.

[47]The basic MISI methodology and model are documented in Management Information Services, Inc., *Development of Economic and Job Impacts Analysis Tool and Technology Deployment Scenario Analysis*, report prepared for the U.S. Department of Energy, National Energy Technology Laboratory, DOE/NETL-402/092509, September 2009. For applications, see Management Information Services, Inc. and Leonardo Technologies Inc., "Economic Impact Assessment of CCUS Retrofit of the Comanche Generating Station,"

- Direct jobs are those created directly in the specific activity or process.
- Indirect jobs are those created throughout the required interindustry supply chain.
- Induced jobs are those created in supporting or peripheral activities.
- Total jobs are the sum or all of the jobs created.
- For simplicity, MISI included induced jobs in the indirect category.

The total (direct, indirect, and induced) jobs concept is the accepted methodology widely used in studies of this nature and in the peer-reviewed literature.

Thus, at least three important caveats for the 2020 USEER must be noted.

First, the ratio of direct to indirect jobs differs substantially among the energy industries. The energy industries create many jobs throughout the economy: For every direct energy industry job, between 2 and 7 (or more) jobs are created indirectly in other industries. MISI estimated that, in January 2020, 1.42 million direct energy jobs created a total of 7.69 million direct plus indirect jobs.[48] Each energy industry created numerous direct jobs and direct plus indirect jobs. Relatively, natural gas, coal, and nuclear energy generated larger numbers of direct plus indirect jobs than did oil or renewables. The differences were most pronounced in the natural gas industry and the renewables industry.[49]

Second, the importance of this for the 2020 USEER and for estimating the jobs impacts of the energy industries cannot be over-emphasized. Some energy-related industries generate 10, 15, or 20 total (direct, indirect, and induced) jobs for every direct job.[50] Thus, focusing only on direct jobs can underestimate the actual impact of some energy jobs and industries by a factor of 10, 15, or more.

For example, the ratio of total jobs to direct jobs in the Motor Vehicles Manufacturing industry is greater than 14-to-1.[51] That is, for every direct job in this industry, more than 14 total jobs are created throughout the economy. Thus, in terms of the 2020 USEER, focusing exclusively on direct jobs producing electric vehicles misses 85% of the total jobs created by manufacturing EVs and gives a serious underestimate of the jobs importance to EVs.

Third, this is especially worrisome because the direct, indirect, and induced jobs concept is widely used and publicized by numerous energy related organizations and interest groups. By ignoring these concepts, the 2020 USEER is potentially distorting

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prepared for the U.S. Department of Energy and the National Energy Technology Laboratory, June 2019; Roger Bezdek and Robert Wendling, "Economic, Environmental, and Job Impacts of Increased Efficiency in Existing Coal-Fired Power Plants," *Journal of Fusion Energy*, Volume 32, Number 2 (April 2013), pp. 215-220; Roger H. Bezdek and Robert M. Wendling, "The Return on Investment of the Clean Coal Technology Program in the USA," *Energy Policy*, March 2013, Vol. 54, pp. 104-112.

[48]Management Information Services, Inc., "U.S. Energy Industry Job Changes During 2020," op. cit.

[49]Ibid.

[50]Josh Bivens, "Updated Employment Multipliers For the U.S. Economy," Economic Policy Institute, Washington, D.C., 2019.

[51]Ibid.

its policy interpretations and implications. That is, the 2020 USEER is harming its own intentions.

B.B.6. The 2020 USEER State Reports

As noted, the USEER published a separate supplementary report *Energy Employment by State – 2020*.[52] This report contains for each state and D.C. a 7-page summary chapter of the energy employment data. Each chapter contains three sections: i) An "Overview," ii) "A Breakdown by Technology Applications -- Electric Power Generation, Fuels, Transmission, Distribution and Storage, Energy Efficiency, and Motor Vehicles," and iii) A description of "Workforce Characteristics." Specifically, it states: "Data Source: Unless otherwise stated, all data are from the 2019 U.S. Energy and Employment Report, March 2019, by NASEO and EFI."[53]

All 51 state reports are generically similar and are produced according to the same template. While perhaps of some use – and these state reports are widely quoted and referenced in Pennsylvania and elsewhere, their actual value is uncertain, at best. For example:

- There is very little useful industry detail, and it is too aggregate to be of much use.
- There is no job occupation, skill, education, training, salary, etc. estimates or data.
- The "energy industry" information can be questionable. For example, each state report contains a short (three sentences and one chart) on the Motor Vehicles industry. Thus, "Motor Vehicle employment accounts for XXX jobs in State XXX, down XXX jobs over the past year (- XXX percent). The industry sector that accounts for the largest fraction of Motor Vehicle jobs is manufacturing" – or is "repair and maintenance," or is another sub-industry. The Motor Vehicle Industry is a part of the "energy industry?" The corner fender bender repair shop is part of the energy industry? If so defined, the jobs in the energy industry just increased exponentially!
- Given the above, and the fact that the 2020 USEER supposedly includes only direct jobs, from where do all of these Motor Vehicle Industry jobs originate?
- There is no occupational detail, and the industry detail provided – e.g. Manufacturing, Trade, Professional Services, Commodity Flows, etc., is so aggregate as to be useless.
- The energy jobs estimates given are inconsistent with others currently available. For example, the 2020 USEER state report estimates that in 2019 California had about 412,000 energy jobs, including energy efficiency jobs. However one wishes to parse this, it is a vast underestimate of the actual number of such jobs in the world's fifth largest economy. MISI estimates that the number of energy/ environmental/clean energy jobs in the state is likely closer to 2 million. Even if

[52] *Energy Employment by State -- 2020*, op. cit.
[53] Ibid.

MISI is off by a factor of 2, the 2020 USEER state report for California is seriously deficient and misleading.

The bottom line is that the USEER state reports are of very limited usefulness in Pennsylvania and other states and, perhaps even more troubling, are seriously misleading for the purposes of such reports, which include energy industry and job forecasting and planning, education and training programs, workforce and educational planning, etc.

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