Energy Workforce Trends and Training Needs in Appalachia

Prepared for:

The Appalachian Regional Commission
Contract CO – 16502-09

December 2011

Regional Technology Strategies, Inc. with
Penn State University

www.rtsinc.org

REGIONAL
TECHNOLOGY
STRATEGIES, INC.

Acknowledgements

This report is the product of a team that includes, or has included, Chris Beacham, Jenna Bryant, Corinne Cain, Trent Williams, Dan Broun, Dana Archer-Rosenthal, Stuart Rosenfeld, and Jim Lott from RTS, Cynthia Liston from CD Liston Consulting and Rose Baker and David Passmore from Penn State University. Beth Williams at RTS helped with editing and proof reading in addition to the contractual and financial issues.

An advisory panel (shown in Appendix D) influenced the original design and reviewed the final draft: John Carrese, Director, Bay Region Center of Excellence, City College of San Francisco; Dr. Amy Glasmeier, Head of Department of Urban Studies and Planning, MIT; Dr. Michael Karmis, Director, Virginia Center for Coal and Energy Research (VCCER), Virginia Tech; Dr. Calvin Kent, Vice President, Center for Business and Economic Research, Marshall University; and James F. McKenney, Vice President for Economic Development, American Association of Community Colleges.

We also want to express our appreciation to the many people at colleges and universities who spoke so candidly with interviewers conducting case studies and the many more who completed the online survey.

Finally, at the Appalachian Regional Commission we wish to thank our program officer David Carrier for his insights and advice on methodological issues and for ensuring rigor and Ray Daffner and Jeff Schwartz for their helpful critiques of the draft report.

Dr. Stuart Rosenfeld
May 25, 2011

Table of Contents

APPENDICES

This page left intentionally blank

EXECUTIVE SUMMARY

Introduction

Appalachia and energy have been closely linked throughout their history, from the first discovery and production of oil, to the mining of coal to fuel the nation's industrial growth, to the development of hydropower to bring prosperity and progress to remote rural communities. By using its full range of energy resources and staying at the forefront of emerging energy technologies and practices, Appalachia has the potential to increase the supply of locally produced clean energy. All of this has significant ramifications for both expanding and changing the region's labor market. Many of the jobs will require different proficiencies. Many others, such as construction and maintaining transmission lines to connect rural wind energy farms to cities, will require primarily conventional skills but with new adaptations.

This study uses the best available national data to project future supply and demand for occupations associated with the energy industry for each ARC state and the number of people enrolled in and graduating from programs in the region's institutions of higher education that will be available to meet or exceed the demand. In addition, information from a survey of educational institutions complements the national database with more detailed information about skill sets and non-credit programs. Finally, brief case studies of 13 educational institutions, one in each ARC state, is used to provide more contextual analysis.

The energy sector is defined by non-renewable sources (coal, oil, natural gas, and nuclear), renewable sources (solar, wind, hydroelectric power, geothermal, biomass, and fuel cells), and industries that promote energy efficiency.

The report includes analyses of employment by energy sector by state that include projected job replacement needs; current and future energy training programs; gaps in trained workers in each state by occupation; case studies of educational institutions in the region; state and Federal policies that impact the energy sectors; and key findings and recommendations.

Employment by energy sector

Energy employment in Appalachia totaled close to one million jobs in 2009 with the energy efficiency sector having the largest employment (Table A).[i] Employment in non-renewable sectors shows slow growth, but in renewable energy sectors it is projected to decline. The drop in employment in solar energy and stagnation in wind energy is due to the fact that a large proportion of jobs are in manufacturing of equipment, not installation, and manufacturing has been moving off shore. The bulk of the growth in employment is in energy efficiency, buttressed by government programs to accelerate conservation. A large proportion of the energy efficiency employment is in the construction industry.

Table A. Energy Employment By Source, All Appalachia, 2002 to 2013

Source	2002	2007	2009	2013	2002 – 2007	2007-2009	2009 - 2013
Biomass	44,006	42,842	37,380	35,304	-2.6%	-12.8%	-5.6%
Coal	107,905	120,537	122,873	125,399	11.7%	1.9%	2.1%
Efficiency	418,537	478,222	421,108	474,288	14.3%	-11.9%	12.6%
Fuel cells	2,700	2,145	1,830	1,465	-20.6%	-14.7%	-19.9%
Gas oil	190,893	205,295	210,037	217,139	7.5%	2.3%	3.4%
Geothermal	9,803	8,003	7,014	6,261	-18.4%	-12.4%	-10.7%
Hydroelectric	9,032	6,864	7,161	7,015	-24.0%	4.3%	-2.0%
Nuclear	24,840	25,041	25,195	26,509	0.8%	0.6%	5.2%
Solar	39,061	32,756	30,313	29,134	-16.1%	-7.5%	-3.9%
Wind	111,106	117,724	106,911	111,471	6.0%	-9.2%	4.3%
Total	959,885	1,041,436	971,831	1,035,998	8.5%	-6.7%	6.6%

Source: EMSI and Pennsylvania State University, historical complete employment (2002 to 2009) and projected employment (2010 to 2013).

Findings

- Total energy related employment and many individual energy sectors experienced severe job losses during the recent recession with renewable energy sectors bearing most of the declines. Employment in non-renewable energy sectors was more stable between 2007 and 2009.

- Energy efficiency is expected to make a full recovery from the recession by 2013, with much of the job increases in the specialty contractor industries that retrofit existing and new residential and non-residential infrastructure.

- Although the manufacturing portion of solar energy is declining, increased consumer demand for solar energy products is resulting in increases in employment in retail and installation.

- Most of the forecast growth in the gas and oil sector is due to drilling and extraction activities primarily related to the extraction of natural gas in Appalachia.

- Outside of natural gas exploration and extraction employment overall employment in the coal and gas and oil sectors is expected to decline or grow slowly between 2009 and 2013.

Education and training opportunities

There are more than 180 public and private educational institutions – community colleges, career and technical education centers, and universities – and 82 programs related to the specific training of workers in the energy sector located in the ARC region. Information about current and future energy programs in higher education are based on (1) Federal data on higher education programs and graduation and completion rates from relevant programs, and (2) an online survey of community and technical colleges to identify programs teaching skills relevant to the energy sectors.

The survey (Table B) revealed that only small numbers of community or technical colleges had programs of study that targeted an energy-specific occupation. Instead, most learning was embedded in existing occupational programs as elective or minors. The largest number of customized training programs for energy industries were for the utility companies, with energy efficiency next. Only 18 percent of the colleges offered entrepreneurial education with nearly none targeting the energy sector.

Table B. Percent of ARC Colleges with Energy Programs, by Level, 2009

Programs in Energy	Less than 1 year	1-year Certificate	2-year AAS	Elective Courses	Noncredit Courses	Contract Training	None
Coal Mining	7.1	2.0	2.0	2.0	5.1	6.1	86.7
Operation of Coal Utility	1.0	3.1	7.1	0.0	3.1	3.1	79.6
Nuclear Plant Operation	1.0	1.0	3.1	0.0	0.0	1.0	89.8
Biofuels	2.0	2.0	1.0	5.1	7.1	2.0	86.7
Solar Installation/Repair	12.2	4.1	5.1	5.1	14.3	5.1	70.4
Solar Manufacturing	2.0	2.0	1.0	0.0	3.1	2.0	89.8
Wind Power Installation/Repair	6.1	6.1	5.1	3.1	6.1	1.0	83.7
Wind Power Manufacturing	1.0	1.0	1.0	0.0	3.1	2.0	89.8
Energy Auditor	6.1	1.0	2.0	1.0	24.5	8.2	65.3
Energy Efficiency Analysis	6.1	1.0	1.0	4.1	20.4	8.2	65.3
Energy Management Systems	3.1	0.0	1.0	3.1	11.2	11.2	76.5
Weatherization	9.2	2.0	1.0	2.0	21.4	4.1	66.3
Other Alternative Energy	5.1	3.1	2.0	3.1	8.2	3.1	79.6
Other Fossil Fuels	4.1	1.0	4.1	2.0	5.1	6.1	85.7
Introduction to Energy	6.1	1.0	3.1	8.2	12.2	4.1	70.4

Source: Online survey of Appalachian educational institutions conducted by RTS, Inc., 2009-2010

Enrollment in Programs

In addition to the programs available it is important to examine the level of interest in the programs by looking at enrollment information in credit and noncredit programs. For enrollment data the survey combined the various programs within an energy production area separating the credit and noncredit figures. For example, the respondents were asked to provide the enrollment figures for all programs in coal mining and coal technology within credit and noncredit areas. The data reflect 2009 enrollment (Table C).

Table C. Energy Program Enrollment, 2009

Energy Production Area	Credit Enrollment	Noncredit Enrollment	Total Enrollment
Coal mining and coal technology	2,806	5,593	8,399
Nuclear power	147	24	171
Natural gas	30	453	483
Alternative energy	203	328	531
Energy efficiency	1,200	333	1,533
Total	4,386	6,731	11,117

Source: Online survey of Appalachian educational institutions conducted by RTS, Inc., 2009-2010

Findings

- Colleges and universities are providing general programs of studies related to science, engineering, and technology in the region while using add-on degree and specialization options as a way to tailor more general degree options towards alternative energy areas.

- Specialized degrees and awards tend to focus on the more traditional sources of energy.

- While many colleges offer certificates and degrees in programs for specific occupations, much of the training is non-credit or customized to specific companies. The historic importance in coal mining and related fields is supported by only a small number of programs but serve a large number of students – three-fourths of the total enrollment in energy-related programs.

- Lack of demand in green manufacturing results in few programs, yet some offer programs in green installation and repair/maintenance, particularly wind and solar.

- Many green energy programs are non-credit or offered as electives, with few one- or two-year degree programs, possibly reflecting demand for new skills by incumbent workers. Many programs in energy auditing, efficiency, and management also are contract-related or noncredit, and aimed at increasing knowledge of energy conservation and rising energy prices within the existing management workforce.

- Companies report that two-thirds or more of entry-level workers need improved basic (e.g., work ethic, punctuality) and field-specific training (technical workers).

Gap Analysis

For the gap analysis, the team selected those occupations in the energy sectors most likely to have educational requirements. The selection of 216 energy occupations was based on a broad view of the knowledge and skills needed across all ten energy sectors based on conversations the team had with educational providers and energy associations, review of knowledge and skills of occupations gathered from O*NET (The Occupational Information Network – O*NET – is the primary source of occupational information for the US), and occupational composition within each sector. Of the 216 occupations, 33 do not match any education program.

Overall, 106 occupations are projected to have labor shortages in the near future in at least one ARC state. The largest gaps, or projected shortages, in labor demand are in specialty trade, production, and maintenance and repair type occupations (Table D). Shortages in the supply of graduates are projected in nearly all ARC states for carpenters, construction laborers, first line supervisors/managers of construction trades and extraction workers, operating engineers and other construction equipment operators, electricians, pipelayers, sheet metal workers, helpers of electricians, electrical power-line installers and repairers, and team assemblers. Demand for industrial, construction, and engineering managers is projected to be high in most states, however the estimated annual supply of graduates will most likely meet or exceed the demand.

In each state, gaps differ. Therefore, each state is analyzed separately. For example, Pennsylvania has the most occupations with estimated labor shortages in the energy sector and Maryland and Mississippi have the least number of occupations in the energy sector expected to have workforce shortages.

Table D. Workforce Gaps and Shortages by ARC State

ARC State	Annual Surplus	Annual Gap
Alabama	Engineering Managers (+323) Computer Systems Analyst (+178) Architectural and Civil Drafters (+109)	Carpenters (-295) Electricians (-270) Plumbers, Pipefitters, and Steamfitters (-234)
Georgia	Architectural and Civil Drafters (+126) Welders, Cutters, Solderers, and Brazers (+119) Machinists (+19)	Electricians (-371) Carpenters (-306) Plumbers, Pipefitters, and Steamfitters (-295)
Kentucky	Welders, Cutters, Solderers, and Brazers (+170) First-line Supervisors/Managers of Construction Trades and Extraction Workers (+136) Heating, Air Conditioning, and Refrigeration Mechanics and Installers (+62)	Operating Engineers and Other Construction Equipment (-68) Construction Laborers (-65) Plumbers, Pipefitters, and Steamfitters (-55)
Maryland	Contruction Managers (+11)	Electricians (-49) Carpenters (-26) First-line Supervisors/Managers of Construction Trades and Extraction Workers (-26)
Mississippi	Construction Managers (+57)	Carpenters (-45) Plumbers, Pipefitters, and Steamfitters (-40) Electricians (-37)
New York	First-line Supervisors/Managers of Construction Trades and Extraction Workers (+44) Construction Managers (+37) Mechanical Engineers (+29)	Carpenters (-69) Electricians (-43) Painters, Construction and Maintenance (-26)
North Carolina	Welders, Cutters, Solderers, and Brazers (+70) Machinists (+19) Construction Managers (+12)	Carpenters (-298) Electricians (-208) Construction Laborers (-188)
Ohio	Construction Managers (+118) Heating, Air Conditioning, and Refrigeration Mechanics and Installers (+23) Electrical Engineers (+22)	Electricians (-60) Electrical Power-line Installers and Repairers (-45) First-line Supervisors/Managers of Production and Operating Workers (-33)
Pennsylvania	Engineering Managers (+1258) Chemists (+241) Construction Managers (+228)	Plumbers, Pipefitters, and Steamfitters (-256) Carpenters (-205) Construction Laborers (-194)
South Carolina	Civil Engineers (+73) Mechanical Engineers (+54) Heating, Air Conditioning, and Refrigeration Mechanics and Installers (+46)	Carpenters (-104) Plumbers, Pipefitters, and Steamfitters (-91) Electricians (-83)
Tennessee	Engineering Managers (+402) Civil Engineers (+59) Architectural and Civil Drafters (+43)	Carpenters (-428) Electricians (-327) First-line Supervisors/Managers of Construction Trade (-259)
Virginia	Construction Managers (+69) Welders, Cutters, Solderers, and Brazers (+13) Team Assemblers (+4)	Carpenters (-83) First-line Supervisors/Managers of Construction Trades and Extraction Workers (-60) Construction Laborers (-54)
West Virginia	Civil Engineers (+58) Electrical Engineers (+39) Mechanical Engineers (+37)	Electricians (-170) First-line Supervisors/Managers of Construction Trades and Extraction Workers (-140) Carpenters (-107)

Findings

- Projected workforce shortfalls are greatest in occupations related to construction trades and extraction, maintenance and repair, and production workers.

- While a few states have shortages in managerial occupations such as industrial production manager, construction manager, and engineering manager, overall the demand can be filled through the annual supply of graduates.

- Many states are producing an oversupply of people trained to be construction managers and welders, cutters, solderers, and brazers.

- Replacement job needs (jobs that arise not from newly created jobs but from worker turnover and attrition) often dominate the demand for labor in the nonrenewable energy sectors.

Case Studies

To learn more about how postsecondary education addresses the needs of the energy industry, the study conducted interviews that led to 14 vignettes of higher educational institutions. The colleges and universities profiled exhibit a number of innovative practices, but each approaches education and training in a slightly different way and develops its own ideas on how to prepare the workforce.

Alfred State College in **New York**, incorporates training in green practices and technologies across the college, has renewable energy sources, three photovoltaic systems and four wind turbines on its campuses. A team of students led a four-day workshop at the U.S. National Arboretum on solar photovoltaic systems attended by homeowners, contractors, and engineers, with students installing a one-kilowatt hour solar array to power the irrigation system.

Appalachian State University (ASU) in Boone, **North Carolina** began its green revolution more than thirty years ago when it first started training students to build more energy efficient homes and develop new ways to harness the power of the wind and sun. In 2008 ASU's Research Institute for Environment, Energy, and Economics became an umbrella organization for the Appalachian Energy Center, Center for Economic Research and Policy Analysis (CERPA) and Southern Appalachian Environmental Research and Education Center (SAEREC).

Calhoun Community College in **Alabama** offers an open enrollment seven-week, 280-hour non-credit pre-apprentice line worker program aimed at meeting on-going needs of the energy industry for line workers.

Cleveland State Community College in southeastern **Tennessee** is leading efforts to promote energy conservation in homes. Its program in energy efficient residential construction since 2005 has developed six courses related to energy efficiency and alternative energy, including one in solar photovoltaic system design and one in ground source heat pumps that could be taken as part of an AAS degree in construction technology, as a Zero Energy Home Certificate program, or individually in any program based on interests.

Frostburg State University in western **Maryland** offers a not-for-credit Wind and Solar Energy program to install residential wind and solar system, an eight-week online course that includes a self-assessment test to gauge progress and an intense three-day workshop at the campus that includes hands-on demonstrations. At the end of the program, students can choose to sit for a Photovoltaic Entry Level Certificate of Knowledge Exam offered by the North American Board of Certified Energy Practitioners.

Hocking College in **Ohio** has an advanced energy and fuel cell program aimed at developing the fuel cell industry cluster in the state, and a vibrant clean energy sector in its own distressed rural area. In 2003, the Hocking College Energy Institute, established in the 1980s to focus on gas-powered vehicles, shifted to address the needs of advanced energy and fuel cells and automotive hybrids. Although called a "fuel cell" program, graduates are prepared for technician positions to support a range of renewable energy sources and systems including solar, geothermal, biofuels, and hydroelectric.

Kentucky Coal Academy in **Kentucky** is an open entry/exit workforce training program for the coal industry operating at four community and technical colleges: Big Sandy, Hazard, Madisonville, and the lead college, Southeast Kentucky, that is aimed at finding replacements for the declining and aging workforce of the coal industry that are qualified, safety-conscious, and have career pathways.

Lanier Technical College in **Georgia** offers three new programs under its Electrical Utility Technology program that prepare students for the electrical power industry: a two-year Associate in Applied Science electric utility technology degree; a 90-hour electrical utility technology diploma; and an entry-level 42-hour electrical utility technician certificate. The degree program was the result of collaboration with the Georgia Energy and Industrial Construction Consortium.

Mississippi State University's Industrial Assessment Center audits energy and resource usage at no cost for small and mid-sized manufacturers located within 150 miles of the university. Audits, which are conducted by teams of undergraduate and graduate students and faculty evaluate energy-consuming processes, waste generation and handling, and production methods and report opportunities to reduce waste, save energy, and improve productivity. These audits have documented savings to client companies of about $5 million per year.

Penn Technical College's Marcellus Shale Education and Training Center (MSETC) in Pennsylvania is a cooperative venture with Cooperative Extension, began in 2008 as a resource for workforce development and education for communities around the Marcellus Shale, believed to be the country's largest unconventional natural gas deposit. Penn College offers short term and customized training for new and incumbent workers and in 2010 began awarding dual credit to high school students to introduce them to the field and began preparing to offer a two-year AAS degree program. In July 2010, MSETC was awarded a $4.9 million grant from the US Department of Labor, Employment and Training Administration to create

ShaleNET.org. ShaleNET.org is a consortium between Penn Tech, Westmoreland County Community College (lead agency), West Virginia Northern Community College, Eastern Gateway Community College in Ohio, and Broome Community College in New York. Their mission is "to design a comprehensive recruitment, training, placement, and retention program" for the natural gas exploration and production industry.

Tri-County Technical College in **South Carolina** has a welding program that prepares students to work in the region's nuclear power industry for the contractors that provide maintenance services to nuclear plants. The program is planning an expansion into a new welding facility and is in the early phase of developing programs specific to the nuclear power industry.

Virginia Tech University is one of three Appalachian universities offering degrees in mining engineering, graduating an estimated 25 percent of all U.S. graduates, plus a smaller number of Masters and PhDs. The university has had a 100 percent placement rate for mining engineers. The Virginia Center for Coal and Energy Research focuses on technical aspects of coal mining and assisting Virginia's general energy plans. The Center for Advanced Separation Technologies, a consortium of five universities supported by DOE, focuses on "the production of clean solid, liquid and gaseous fuels from domestic energy resources in an efficient and environmentally acceptable manner."

West Virginia University's Petroleum and Natural Gas Engineering department offers BS, MS, and PhD degrees with students gaining industry experience through the National Energy Technology Laboratory. Students not only have the ability to design experiments and analyze data, design a system, component or process to meet needs of an employer, and work on multi-disciplinary teams but will evaluate and understand the impact of engineering practices in a global context.

West Virginia University's Advanced Virtual Energy Simulation Training and Research Facility is a joint program of DOE's National Energy Technology Laboratory and its Regional University Alliance and West Virginia University National Research Center for Coal and Energy's Advanced Energy Initiative. The simulator's installation will be complete by March and courses ready for enrollment by June 2011.

Findings

- Institutions offer a variety of programs from non-credit through post-graduate to respond to local and regional needs.

- Most institutions have chosen to specialize and develop particular expertise in a specific area and used that to branch out into related energy sectors.

- The most successful colleges offering programs in alterative energy were early adopters, gaining a foothold in renewable energy before it was popular and developing a reputation that now serves them well.

- Enrollments in educational programs for the energy industry in many institutions are low and depend on external sources of funding.

- Successful programs have close ties to industry partners and engage industry leaders in their communities in planning and developing the programs needed to grow their industry, offering work experience, and teaching courses. Many use close ties to related economic and community development organizations to strengthen their programs.

- Several profiled institutions embed alternative energy approaches into their standard curricula rather than develop independent programs.

- Flexible scheduling is needed to meet the needs of incumbent workers and older students unable to attend regular daytime classes. For many, careers and skills in energy fields are pursued to add new career enhancing skills in current jobs or to change careers.

- The universities profiled are able to meet the large demand for qualified managers and engineers.

- No institution profiled significantly emphasized entrepreneurship in energy. It was assumed the goal was employment, yet there are many opportunities in the energy sectors for new companies and self-employment.

Policies affecting the energy industry

Federal policy establishes the paradigm for energy development and creates the framework for energy development. While much of the legislation addresses regulatory matters, it also supports research, provides tax incentives, and funds infrastructure, such as America's electric power grid, and, especially in recent years, job training for the energy sector. The federal legislation and regulations create a framework in which states develop energy policies and initiatives that can affect the growth or decline of particular energy sectors.

The two recent major energy bills passed by Congress are the Energy Policy Act of 2005 (EPAct05) and the Energy Independence Security Act (EISA) of 2007. EPAct05 advanced energy policy designed to increase energy production, promote and support energy conservation and encourage investment in new energy technologies and sources. EISA focuses on increasing energy efficiency and the availability of renewable energy. It also increased federal R&D funding for solar energy, geothermal energy and marine hydrokinetic renewable energy technologies; expanded federal research on carbon sequestration technologies; and created green jobs training programs for energy efficiency and renewable energy workers.

A key policy issue in many Appalachian states surrounds natural gas exploration and production. The states within the footprint of the Marcellus Shale deposit, particularly Pennsylvania, New York, Ohio and West Virginia, are developing policies that deal with both the opportunities for natural gas exploration and production and related job implications along with the environmental issues surrounding the new technologies needed to access this resource. New York has instituted a moratorium on horizontal/directional drilling, also known as hydraulic fracturing, over concerns related to water quality. Other states are moving forward with drilling while examining the environmental issues. Pennsylvania Governor Tom Corbett's *Marcellus Shale Advisory Commission* is an example of efforts to deal with the various issues.[1]

Findings

- States that emphasize particular types of renewable energy will likely see increased employment demand in those areas that will produce demand for greater education and training capacity for the emphasized energy sectors.

- States within the Marcellus Shale deposit are grappling with policy issues surrounding natural gas exploration and production involving horizontal/directional drilling. States are attempting to balance the economic opportunities created by exploration and production with environmental concerns over new production methods.

- Identifying and monitoring the areas and sectors of emphasis within state energy policies and legislative actions is an opportunity for ARC to align its support for new energy-related job opportunities more directly with its own member state priorities on a state-by-state basis.

- Jobs are created and training programs implemented within regional economies at the state level, and each ARC state's energy interests are based on their distinctive assets and aspirations. Therefore, what matters most concerning federal energy policy and legislation is how the states react to them.

Recommendations

Trends in the supply and demand for employment in Appalachia's energy sectors suggest a number of actions for state and regional leaders and for the Appalachian Regional Commission. Some will require additional resources, some reallocating existing resources, and some simply changing practices. These recommendations are based on both the research conducted within this project as well as our experiences, knowledge and

---

[1] See http://www.portal.state.pa.us/portal/server.pt/community/marcellus_shale_advisory_commission/20074 for information on the Advisory Commission.

expertise gained from previous work in innovative approaches to workforce development, much of it conducted for ARC.

Institutions and Training Programs

1. **Develop specialized centers of excellence or cluster hubs in various energy subsectors.** Specialization and centralization of expertise and experience – not educational programs – in a particular niche of the energy sector allows colleges cost efficient ways to develop high levels of expertise and knowledge and provide resources for sharing across the ARC region.

2. **Establish regional industry councils for each subset of the energy sector.** The councils would need to reflect multi-county effective economic and labor shed regions to be successful. Such councils would monitor trends, advise companies on new and emerging skill requirements for each of the energy fields, inform the educational systems, and help identify internship positions for students. The ShaleNET program associated with Penn Tech's Marcellus Shale Education and Training Center is an example.

3. **Strengthen the contextual entrepreneurial content of educational programs for energy sectors.** Energy efficiency and solar installation are particularly conducive to consulting and microenterprises, but the support system for all energy fields depends on microenterprises.

4. **Expand online capabilities for those courses that do not require "hands-on" learning to make it easier for working adults to enroll and to take specialized courses not offered locally.** Using the Internet, students would have a wider array of classes and possibly exposure to different cultures.

5. **Expand the use of blended models of training that include both online training elements augmented by "hands-on" learning.** *Blended models* combine online instruction with supervision and personal interaction between students and faculty.

6. **Encourage more articulation agreements among secondary schools, community colleges and four-year institutions.** This would enable students to pursue higher levels of education more easily and minimize dead end career paths.

7. **Educational institutions should develop or strengthen their relationships with community-based and non-profit organizations.** Community based organizations and non-profits have experience in reaching and working with lower-income and marginalized students, in making sure they get the support they need to succeed, and move them into career tracks.

8. **Support the participation of Appalachian community and technical colleges in inter-regional and international networks to encourage sharing and cross-fertilization of ideas, innovations, and curricula.** This offers rural colleges and their faculty and students access to ideas, programs, and innovations in other parts of the U.S. and world.

Economic Development

1. **Recognize the employment and entrepreneurial opportunities in both renewable and non-renewable energy production and energy conservation.** In the area of renewable energy, our research suggests that there are untapped entrepreneurial opportunities for self-employment and micro-enterprises. Within the non-renewable energy sectors, opportunities for economic advancement within Appalachia are related more to replacement employment needs, intensified by their aging workforces.

2. **Monitor changes in federal policy and opportunities or barriers they may imply for the energy sectors.** Increasing or relaxing environmental constraints can shift the balance towards or away from non-renewable energy sources. Targeted training funds have influenced college programs in recent years. It's important that states are aware of changes in these programs as the country deals with budget and economic challenges.

3. **Monitor changes in international renewable and non-renewable energy markets including technological change, increasing and declining energy supply regions and impacts from events such as armed conflict, the BP Gulf oil spill, and the Japanese nuclear disaster.** Market changes are likely to have both positive and negative impacts on energy-related job markets in the Appalachian Region and affect both demand and necessary skill sets.

Final Thoughts

This project and its report represent a sound and practical source for information needed by policymakers and workforce education and skill providers. It is based on a consistent and robust methodology that examines a broad range of renewable and non-renewable energy clusters within the Appalachian states. The case studies, interviews and surveys and state and federal policy analysis provide a wealth of practical guidance on building effective policy and programs needed to support and grow these important economic engines.

The data analysis provides a broad picture of energy clusters within the Appalachian counties of the 13 Appalachian states, detailing expected employment changes, workforce needs and workforce gaps in a variety of occupational categories serving the industries. The analysis is based on publicly available government data, so that the information can be easily validated and regularly updated by practitioners in the field. The interviews and surveys present a robust picture of the programs available to train the workforce as well as the challenges community colleges, universities and other training providers face in meeting the needs of their local, regional and state economies. The case studies demonstrate the many innovative steps education providers have taken throughout Appalachia to serve the present and future needs of these industries. Finally the policy analysis presents a clear picture of the policy framework in which states, regions and service providers work.

The reader should understand that we used a cluster approach in analyzing the energy economy in Appalachia. Cluster analysis is a comprehensive, holistic method of looking at an economy that accounts for all the industries and suppliers that contribute to the production of a given product or service. A cluster is a geographic concentration of interrelated competitive firms and institutions of sufficient scale to generate external economies…making the whole greater than the sum of its parts. They occur where a group of businesses, drawing on similar resources, exist in relationships with other nearby businesses and institutions that contribute to their competitiveness. Examples range from the high tech cluster of biotechnology in the Research Triangle of North Carolina to the low tech cluster of lobster fishing in Maine. Any concentration of similar businesses that draw on a common pool of suppliers, services, educational institutions, workforce skills, natural resources, or other assets that can be found in a region may be a cluster. Within Appalachia, the coal industry in West Virginia and Kentucky is a prototypical cluster. Taking the example of the coal industry, Appalachian coal mines have generated demand for customized transportation systems, mining technology, schools of engineering, mine worker training programs at community colleges and environmental control providers to name a few. There are also specialized organizations that connect, promote and research coal mining operations.

This more comprehensive analytical framework comes with certain limitations. In particular:

- Analysts examining industries using narrower *sector* definitions, e.g., examining only employment directly at coal mines, will generate lower employment estimates than analysts who look at the coal industry from a cluster framework. Sector analyses are an alternative method of examining economic conditions.
- The large regions covered by this analysis, some including entire states, do not always reflect the economic reality of local and sub-regional economies within each of the energy clusters. There are times when those working in the field are going to need to dig deeper into their regional and local economies.
- The need to use consistent methodology and data sources does not allow us to vary the analytical techniques and data for specific areas and specific sectors within clusters. Education providers may need to use ad hoc data sources, interviews and close relationships with the private sector that can provide more specific guidance for their areas and economies.
- The government data sources that were necessary for our analysis have a built in time lag and cannot fully reflect recent dramatic events and rapidly changing economic conditions. Communities, colleges, and local policymakers may need to adjust to dramatic game-changing events by using more recent data and

information. The rapid pace of natural gas exploration in parts of Appalachia are an example of such an event.

Training and educational providers, policymakers, and economic development specialists encounter a wide array of unique challenges and opportunities. It is our hope that this report and analysis, in combination with careful thought and a grounding in local conditions can lead to more economic development in the energy economy and build a stronger Appalachia.

Endnote

[i] There are a number of caveats within this analysis that readers should take into account.

- Readers should be careful when comparing the employment data within this report to other analyses. In particular methodological issues impact the sectors that are included within reports on energy employment within the Appalachian region. The definition used here is based on a cluster analysis approach and thus includes more than those industries that generate or transmit energy. This analysis starts with the supply chain of the various energy sectors and then examines staffing patterns throughout the supply chain. Definitions of the supply chain vary widely between different studies because of methodological reasons and analytical goals. In addition, other analyses use different data as the basis for their analyses. For example, other industry studies start with the number of wells and use an average number of full-time-equivalent employees needed to staff those wells. Since estimates about the number of wells expected to be drilled in the future vary quite widely, employment estimates based on those projections will vary considerably as well. These varying definitions, methodologies and data will produce different results.
- The economic and workforce estimates that drive the results in this and other reports on emerging renewable energy sectors are based on a number of assumptions about state, national and international policies, rates of technological change and adoption in emerging energy sectors and the prices of competing non-renewable energy sources. As a result the estimates vary substantially based on these assumptions.
- The economic and workforce estimates that drive the results in this and other reports on new non-renewable energy sources are based on a number of assumptions about costs of recovery, the actual size of energy reserves and the environmental impacts of new methods. This is particularly relevant in this report with regard to the ultimate economic and workforce impacts of exploration and production from the Marcellus Shale deposit within Appalachia. For example, the US Geological Survey recently (August 23, 2011) released estimates of undiscovered, technically recoverable natural gas within the Marcellus Shale deposit that are nearly 80 percent lower than previous estimates by the US Energy Information Administration. The report is available here: http://energy.usgs.gov/Miscellaneous/Articles/tabid/98/ID/102/Assessment-of-Undiscovered-Oil-and-Gas-Resources-of-the-Devonian-Marcellus-Shale-of-the-Appalachian-Basin-Province.aspx. These estimates are not reflected within this report.

1. INTRODUCTION

1.1 Purpose

Appalachia's economy has been closely linked to energy throughout its history, from the early discovery and production of oil, to the mining of coal to fuel the nation's industrial growth, to the development of hydropower and building of power lines to bring prosperity and progress to remote rural communities. But that growth has led to a continual depletion of reserves and degradation of the environment bringing increasing pressure to conserve and to shift to renewable and cleaner energy sources.

By using its full range of energy resources and staying at the forefront of emerging energy technologies and practices, Appalachia has the potential to increase the supply of locally produced clean energy and at the same time create and retain jobs. This will help the region find new ways to satisfy domestic energy demand, minimize environmental impacts, and attract service and supplier companies and industries. Moreover, because of the importance of energy production and conservation to the growth and competitiveness of so many sectors of the economy, from agriculture to automobiles, this will help generate and retain wealth within the region.

In 2006, the ARC released *Energizing Appalachia: A Regional Blueprint for Economic and Energy Development* to provide a strategic framework for the promotion of new energy-related job opportunities throughout the Appalachian Region. Approved by the governors of the 13 Appalachian states and the ARC Federal Co-Chair, the blueprint was developed in response to the changing environment concerning the supply and use of energy. The report includes three broad strategic objectives: promoting energy efficiency in Appalachia to enhance the region's economic competitiveness; increasing the use of renewable energy resources to stimulate the growth of new jobs; and supporting the development of clean conventional energy resources to retain the existing economic infrastructure.

All of this has huge ramifications for the region's labor market. National research suggests and current Department of Labor policy and programs assume that both renewable energy production and conservation will produce millions of new or replacement jobs. Energy efficiency alone is projected to grow four times over the next decade and eventually employ 1.3 million workers.[2] Yet fewer than one in ten of the nation's community colleges have begun to develop curricula for renewable energy and energy efficiency career tracks.[3] Another industry-sponsored study estimated that renewable energy and energy efficiency together accounted for nine million jobs and

---

[2] Charles Goldman, et al, *Energy Efficiency and Services Sector: Workforce and* Training *Needs*, Lawrence Berkeley National Laboratory, March 2010.

[3] Powerpoint presentation to Certification Accreditation Program Accreditation meeting by Dr. Michelle Fox, Chief Strategist, Education and Workforce Development, Energy Efficiency and Renewable Energy, February 23, 2011.

more than $970 billion in revenue in 2007.[4] Many of the jobs, experts contend, will require new skill sets but many others, such as construction and maintaining transmission lines to connect rural wind energy farms to cities, will require mainly conventional skills.

Research sponsored by the Appalachian Regional Commission indicates that new economic opportunities in the energy sector are robust.[5] For example:

- Energy efficiency investments could create 77,000 net new jobs in Appalachia by 2030, while cutting projected energy use by 24 percent resulting in energy savings of over $21 billion in the region and;

- Approximately 70,000 new jobs are projected in the renewable energy sector in the 13 Appalachian states as a result of the production of 74 gigawatts (GW) of renewable energy nationally.

The educational institutions throughout the ARC region have been leaders in supporting rural communities, industry clusters, and community and industry innovation, often leading to bold new initiatives. The success of responding to changing demands for energy conservation and production will depend heavily on the region's educational institutions, from elementary through graduate schools. But perhaps the most critical institutions are the region's community colleges that work in partnership with local businesses and communities to identify and capitalize on new opportunities in the energy industry and the importance of conservation efforts and renewable energy.

1.2 General Approach

This study uses the best available national data to project future supply and demand for occupations associated with the energy industry for each ARC state and the number of people enrolled in and graduating from programs in the region's institutions of higher education that will be available to meet or exceed the demand. In addition, information from a survey of educational institutions complements the national database with more detailed information about skill sets and non-credit programs. Finally, brief case studies of 13 educational institutions, one in each ARC state, will be used to provide more contextual analysis.

1.3 Reviewing the Literature

To prepare for the analysis and learn what other sources were discovering, learning, and/or concluding about scale, growth and employment patterns and the skill needs of the

---

[4] Roger Bezdek, *Green Collar Jobs in the U.S. and Colorado: Economic Drivers for the 21st Century,* Boulder, Colorado: American Solar Energy Society, January 2009.
[5] Marilyn A. Brown, et al, *Energy Efficiency in Appalachia: How Much More is Available, and by When?* Southeast Energy Efficiency Alliance, Washington, DC: Appalachian Regional Commission, 2009.

energy industry nationally, the team reviewed 28 recent studies and reports. Seven of the reports targeted Appalachia and the rest were either national or targeted other regions. Half of the studies addressed employment, skill issues, and/or career paths. A number of the studies targeted green jobs and industries and thus included non-energy specific sectors.

1.3.1 Findings from the literature

These findings are used to describe the context but also, in some cases, can be treated as hypotheses. The cited numbers reference the articles that led to the findings, as listed in the bibliography at the end of the literature review in Appendix A.

- Fossil fuels – coal, oil, and natural gas – provided more than 85 percent of all the energy consumed in the United States and 84 percent of the energy consumed in Appalachia in 2002. Reliance on these fossil fuels is projected to increase over the next ten years. As aggressive federal and state energy efficiency policies take effect analyses indicate that the reliance on fossil fuels may stabilize or decline. On the other hand, increasing natural gas exploration and extraction using horizontal fracturing techniques is leading to employment gains in areas within the Marcellus Shale natural gas deposits within Appalachia. 2, 26

- The Appalachian Region leads the nation in coal and electricity production, exporting its excess to other states, producing 35 percent of the nation's coal, and 15 percent of total electrical output. 2, 26

- Coal remains an important source of jobs and revenue for some states in Appalachia. While employment is declining, the high average age of workers produces a continuing replacement demand. The development of new jobs in the coal industry will likely come from new technologies that mitigate carbon emissions. 2, 17, 26

- The growth of renewable energy sources – especially solar and wind – will depend heavily on state-based renewable standards and incentives. Ultimately, it will be the response of the private sector to the new standards and incentives and the willingness of consumers to adopt energy-efficient practices that will accelerate the growth of alternate energy sources. Clean energy jobs grew in nine ARC states between 1998 and 2007, but only three of the Appalachian states grew faster than the U.S. average. 14, 25

- The region and the U.S. are under-investing in research and development and in engineering education in clean and renewable energy sources. The lack of investment is likely to lead to U.S. production of equipment and technologies moving to other nations. Less than 10 percent of the U.S. Department of Energy's 2011 budget $28.4 billion is for energy efficiency and renewable energy. The vast majority of patents between 1999 and 2008 were in batteries and fuel cell technology, with less than 15 percent in wind, solar, and geothermal combined. 3, 22

- Employment growth in green industries is dominated by mid-skilled jobs requiring less than a baccalaureate degree. 4, 7, 8, 20, 28

- The skilled energy workforce is most effectively developed by partnerships among community colleges, workforce investment boards, regional four-year colleges, universities, and non-profits. The pace and scale of growth will depend heavily on producing a workforce that is skilled in the new approaches and technologies. 8, 24, 28

- A number of studies identified emerging jobs in energy and energy efficiency. The O*NET framework (The Occupational Information Network – O*NET – is the primary source of occupational information for the US) uses the following three categories (1) increased demand occupations; (2) enhanced skills occupations; and (3) new and emerging occupations. 4, 7, 13, 28

- Much of the growth in energy jobs is likely to develop in the construction, manufacturing, and engineering occupational areas. Most of these jobs will not be new, but training curricula will have to be enhanced and modified to meet different skill and knowledge requirements. 1, 7, 22, 27

1.4 Report Format

The report begins with an analysis of employment by energy sector within the 13 Appalachian states and the region as a whole. This, together with the projected job replacement needs, produces an employment gap expressed as an over or under supply. Next, we analyze current and future energy training programs in the region based on Federal data and a survey of community colleges in Appalachian states. The following section details the gaps in trained workers in each state by occupational category. Then a series of case studies of educational institutions in the region provides a more in-depth view of a small number of programs and that is followed by an investigation of state and Federal policies that impact the energy sectors. The report ends with key findings, recommendations and some final thoughts and comments.

2. EMPLOYMENT BY ENERGY SECTOR IN THE APPALACHIAN REGION

2.1 Current employment by industry

The data used in this report were acquired from Economic Modeling Specialists, Inc. (EMSI), a company that provides labor market information data in a user-friendly format. EMSI collects information from federal and state sources including the Quarterly Census of Employment and Wages (QCEW), Non-Employer Statistics (NES), County Business Patterns (CBP), Regional Economic Information System (REIS), the Bureau of Labor Statistics' Occupational Employment Statistics and Employment Projections and then uses a proprietary algorithm to estimate suppressed job numbers and adds non-payroll employment that is not covered in QCEW. The final industry estimates are benchmarked against the REIS data. These data were used to produce the following preliminary quantitative analysis of employment trends in the ARC region. The complete data sources are listed in Appendix F, a more detailed description of the methodology used is available in Appendix J and a breakdown of the industries included in each energy sector is found in Appendix K. Endnote [i] contains a lengthy summary of methodological considerations in interpreting the analysis in this report.

Unless otherwise specified all references to economic and workforce data within this section refer to the Appalachian region and the specific economic sectors within the Appalachian region only.

2.1.1 All of Appalachia

Total energy employment, including supply chains and related industries, in Appalachia in 2009 was nearly one million, with the energy efficiency sector having the largest employment (Table 1).[ii] Historically, non-renewable energy sectors have experienced the highest rates of growth and are expected to grow through 2013 – but only marginally as the U.S. begins to construct the infrastructure and develop the will needed to rely more on renewable energy resources. Employment growth in renewable energy sectors may be hampered, however, by the loss of manufacturing jobs over the 2002 to 2009 period, a symptom of the overall decline in manufacturing in the region. Total energy employment in the region grew from 2002 to 2007, then fell significantly as the recent recession took hold. The period between 2008 and 2009 was especially difficult for most of the energy sectors, resulting in the largest one-year loss of jobs than in any of the previous years in this analysis. These losses are, for most of the industries within energy, expected to continue in the near future. Employment is projected to rebound and grow by 6.6 percent from 2009 through 2013.

Table 1. Energy Employment By Source, All Appalachia, 2002 to 2013

Source	2002	2007	2009	2013	2002 – 2007	2007-2009	2009 - 2013
Biomass	44,006	42,842	37,380	35,304	-2.6%	-12.8%	-5.6%
Coal	107,905	120,537	122,873	125,399	11.7%	1.9%	2.1%
Efficiency	418,537	478,222	421,108	474,288	14.3%	-11.9%	12.6%
Fuel cells	2,700	2,145	1,830	1,465	-20.6%	-14.7%	-19.9%
Gas oil	190,893	205,295	210,037	217,139	7.5%	2.3%	3.4%
Geothermal	9,803	8,003	7,014	6,261	-18.4%	-12.4%	-10.7%
Hydroelectric	9,032	6,864	7,161	7,015	-24.0%	4.3%	-2.0%
Nuclear	24,840	25,041	25,195	26,509	0.8%	0.6%	5.2%
Solar	39,061	32,756	30,313	29,134	-16.1%	-7.5%	-3.9%
Wind	111,106	117,724	106,911	111,471	6.0%	-9.2%	4.3%
Total	959,885	1,041,436	971,831	1,035,998	8.5%	-6.7%	6.6%

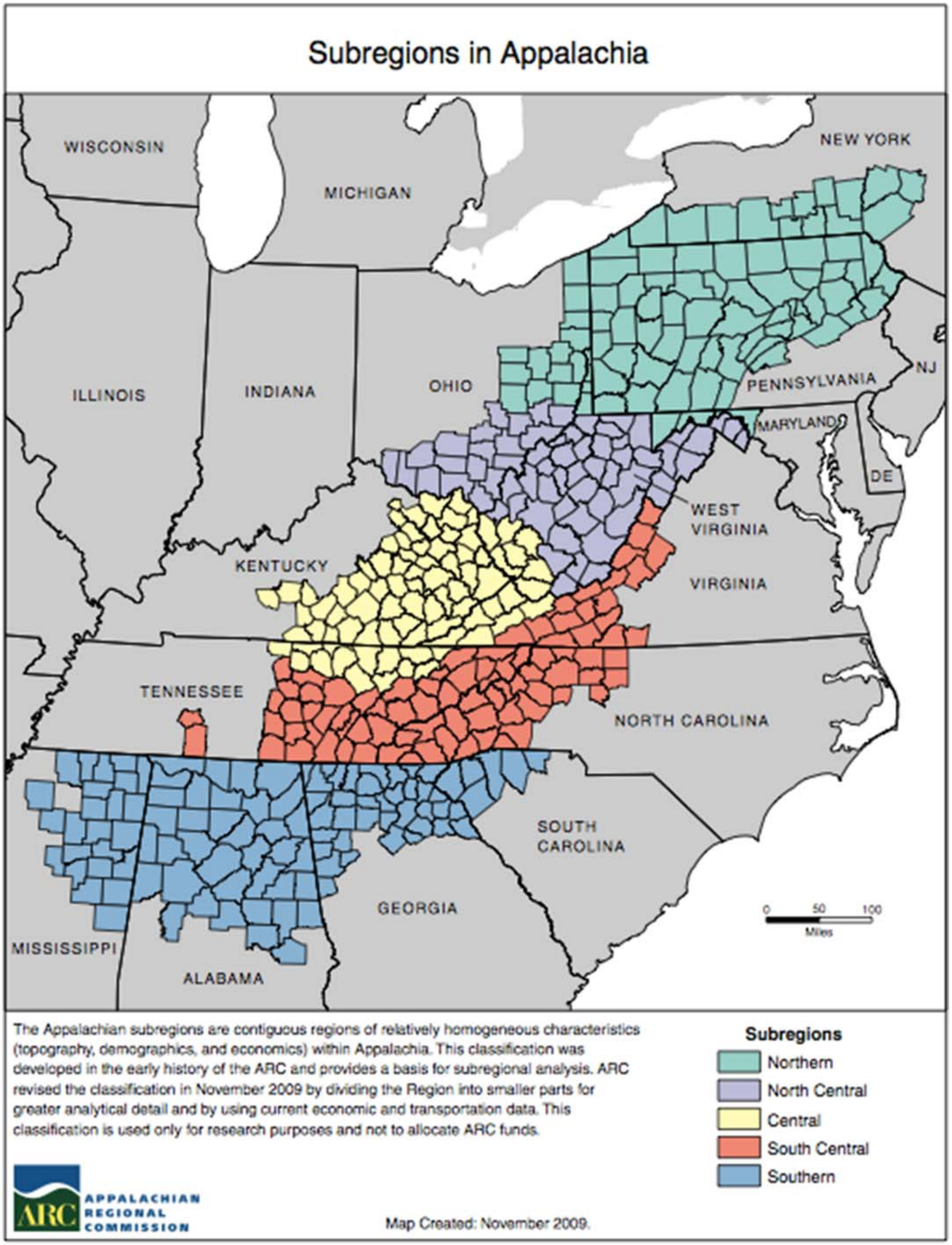
Source: EMSI and Pennsylvania State University, historical complete employment (2002 to 2009) and projected employment (2010 to 2013)

The text and maps that follow describe the relative concentration of each sector compared to the nation as measured by a common measure of employment concentration called the *location quotient or LQ*. The location quotient compares the size of a sector compared to overall employment of a region and then divides that by the size of the sector compared to overall employment within the nation. Any LQ above 1 indicates that, for the specific sector, the regional employment is more highly concentrated than for the nation as a whole. The formula is shown below:

$$\textbf{Location Quotient} = \frac{\textbf{(Regional Employment in Sector/Total Regional Employment)}}{\textbf{(National Employment in Sector/Total National Employment)}}$$

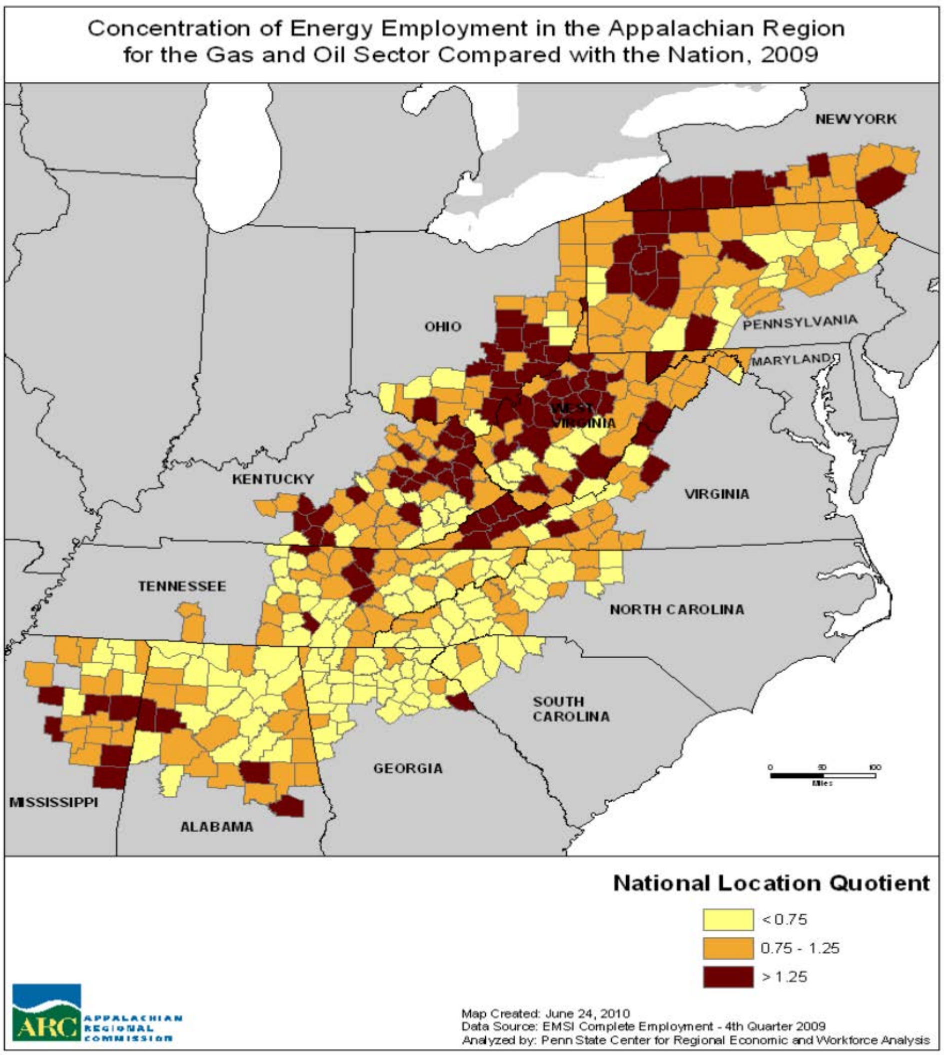
In the maps that follow light yellow represents counties with LQ<0.75 (low concentration), orange represents counties with LQ between 0.75 and 1.25 (average concentration), and maroon represents counties with LQ>1.25 (high concentration).

Some of the discussion below refers to the defined sub-regions of the Appalachian Regional Commission area. As reference the ARC Sub-Regional map is reproduced below.


Subregions in Appalachia
WISCONSIN
MICHIGAN
NEW YORK
ILLINOIS
INDIANA
OHIO
PENNSYLVANIA
NJ
MARYLAND
DE
WEST VIRGINIA
KENTUCKY
VIRGINIA
TENNESSEE
NORTH CAROLINA
SOUTH CAROLINA
GEORGIA
MISSISSIPPI
ALABAMA
0 50 100
Miles
The Appalachian subregions are contiguous regions of relatively homogeneous characteristics (topography, demographics, and economics) within Appalachia. This classification was developed in the early history of the ARC and provides a basis for subregional analysis. ARC revised the classification in November 2009 by dividing the Region into smaller parts for greater analytical detail and by using current economic and transportation data. This classification is used only for research purposes and not to allocate ARC funds.
Subregions
Northern
North Central
Central
South Central
Southern
ARC
APPALACHIAN REGIONAL COMMISSION
Map Created: November 2009.

2.1.2 Gas & Oil

In 2009 the gas and oil including those industries associated with the sector employed 210,000 in the ARC region. While this sector appears to be the largest energy sector in terms of employment alone, 29.1 percent of the estimated 210,000 jobs are associated with the retail industries within the sector. The sector employed a significant number of energy-related jobs in Appalachia and the share of employment for each region is roughly the same as the national average. The exception is the North Central region of Appalachia where employment is slightly more concentrated (LQ = 1.3) than the nation (see map below).



Employment in gas and oil grew by 10 percent between 2002 and 2009 with much of the growth occurring on the production side and likely affected by the Marcellus Shale, believed to be the country's largest unconventional natural gas deposit and covering much of Appalachia. Businesses in the support activities for gas and oil operations had a combined growth of 97 percent over the seven-year period. The gas and oil drilling industry (NAICS 213111) grew by 85 percent over the same period of time. Extraction of crude petroleum and natural gas as well as natural gas liquid extraction also saw significant growth over the period. Industries related to the pipeline transportation of crude oil and natural gas experienced double-digit growth (11-14 percent) since 2002.

Manufacturing in the gas and oil sector accounted for a little more than 4 percent of the sector. However, many of the manufacturing industries related to the sector experienced large job losses between 2002 and 2009, especially in petroleum refineries (-24 percent), petrochemical manufacturing (-43 percent), industrial gas manufacturing (-34 percent), and gas and oil field machinery and equipment (-44 percent).

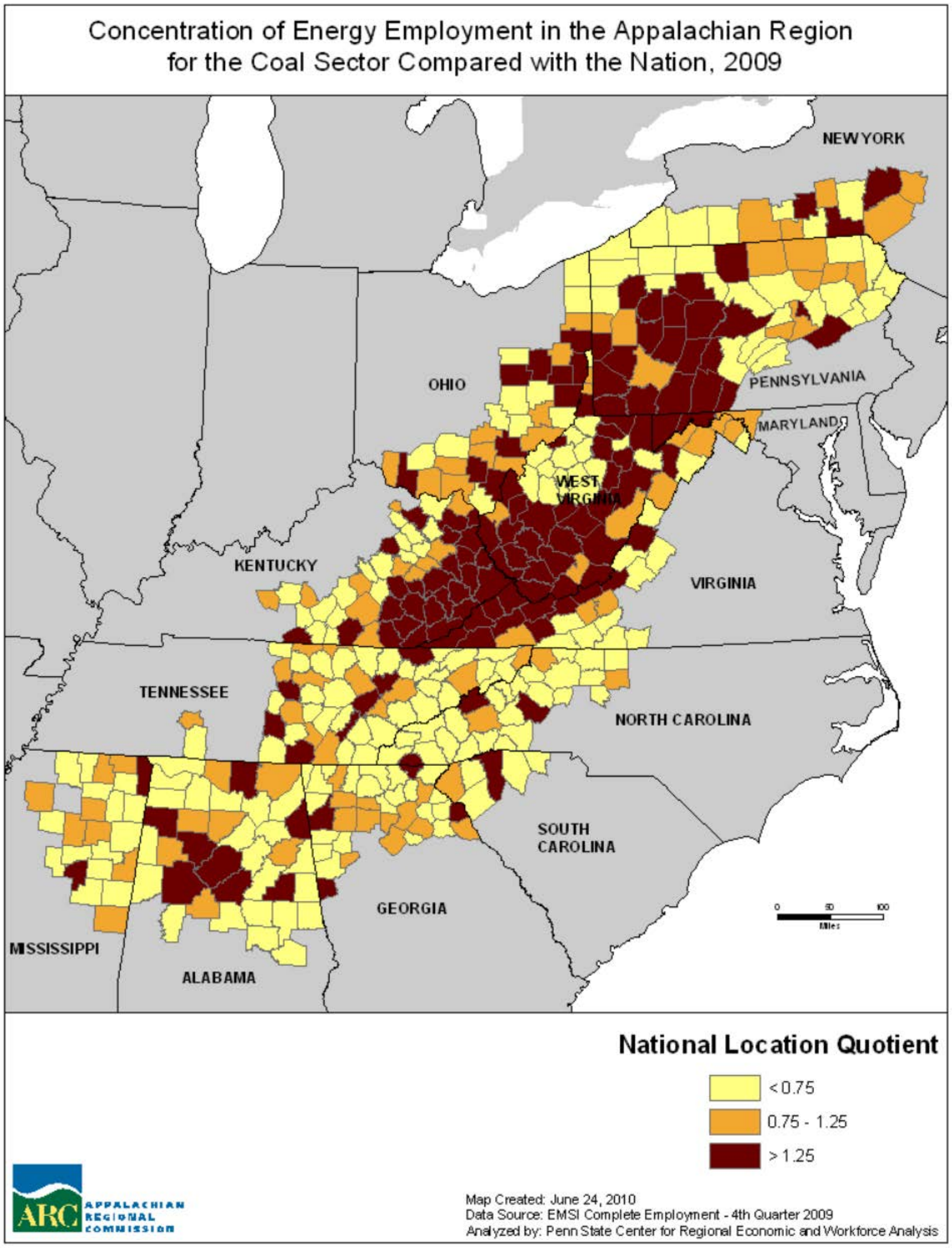
Between 2009 and 2013, this sector is projected to grow by 3.4 percent, an annual growth rate of 0.8 percent. Within the sector, the crude petroleum and natural gas extraction industry is expected to grow by more than 16 percent in the next few years. Other areas of strong growth include businesses involved in the drilling of natural gas and support activities for gas and oil operations. Fossil fuel electric power generation, however, is forecast to see a decline (-11 percent) in employment between 2009 and 2013.

2.1.3 Coal

Coal is the second largest energy sector in Appalachia (energy efficiency is the largest but not a *source* of energy). Total employment in the sector including industries associated with coal production was approximately 125,000 jobs in 2009. The largest industry in the coal energy sector was bituminous coal underground mining, with 22.4 percent of the 2009 employment. Bituminous coal and lignite surface mining is responsible for 14.5 percent of the jobs in 2009 while electric power distribution businesses made up 8.5 percent of the total 2009 jobs in the ARC region. Not surprisingly, the central Appalachian region has five times the share of workers employed in the coal energy sector than employed nationally. The North Central ARC region (LQ = 1.7) and the Northern ARC region (LQ = 1.4) also have LQ's that indicate a higher than expected concentration of employment.

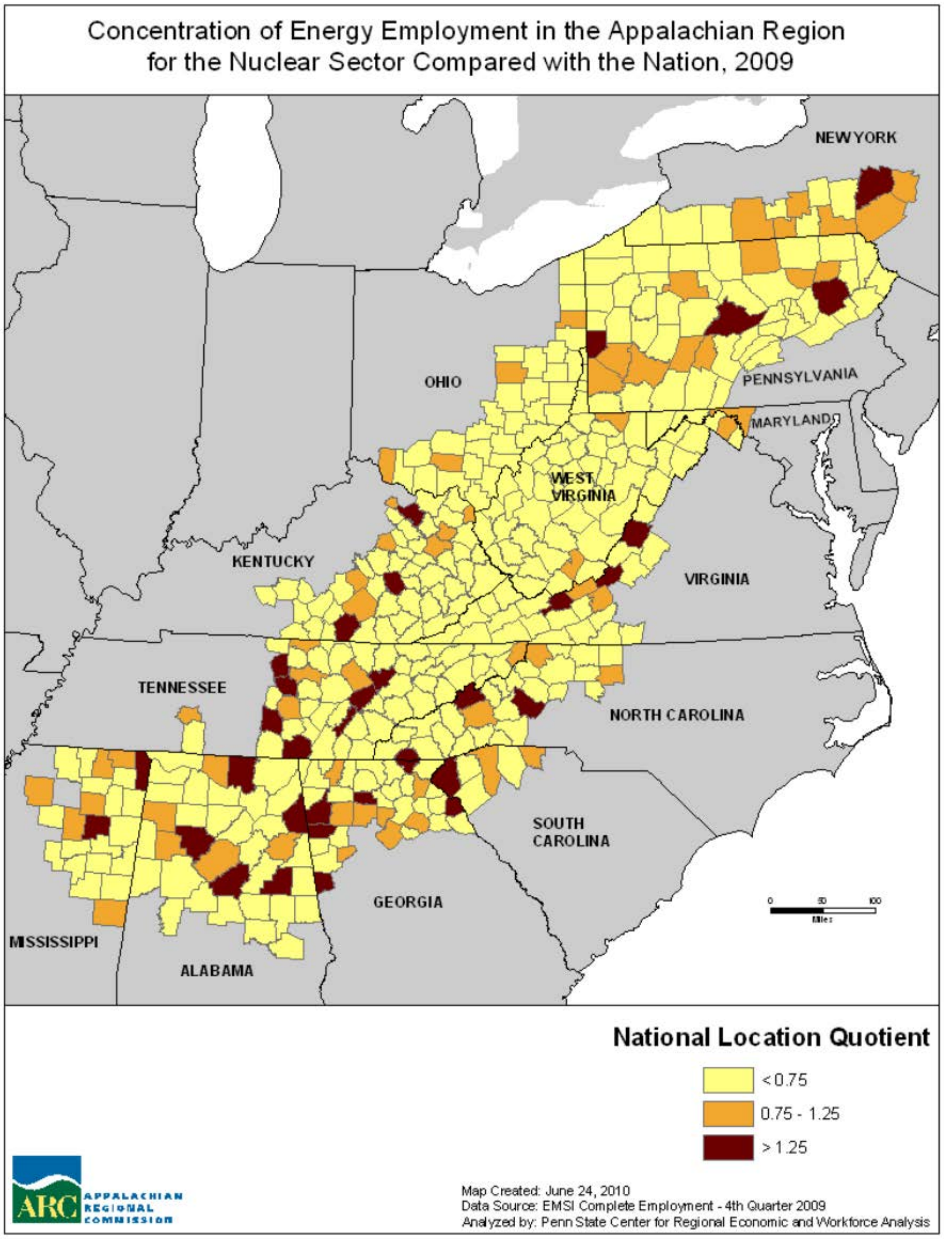
The coal energy sector has had the highest growth of all energy sectors since 2002. Its employment grew by nearly 14 percent between 2002 and 2009, an annual growth rate of 1.9 percent. Within the coal sector much of that growth occurred in the mining sectors (NAICS 212111 & 212112). Bituminous coal underground mining had employment growth of over 28 percent and bituminous coal and lignite surface mining, around 4.5 percent. Employment in support activities for coal mining more than doubled since 2002. As in many of the other industries, manufacturing experienced substantial job losses over the last seven years, mainly in industries that equip or supply mining.

Between 2009 and 2013 coal sector employment is projected to grow another 2.1 percent as worldwide demand, particularly in China, India and other rapidly developing economies continues to be strong. Growth in this sector is likely to occur in industries that deal with electric bulk power transmission and control (8.3 percent) and bituminous coal and lignite surface mining (3.9 percent), as well as the support activities to this sector. Job declines are still projected in fossil fuel electric power generation and in many of the manufacturing industries that turn coal into other products.



2.1.4 Nuclear

Most of the nuclear sector employment is in power generation (17.7 percent) and power distribution (15.7 percent) industries. In total, the nuclear sector including industries associated with nuclear energy production employed approximately 25,000 in the ARC Region in 2009, with jobs slightly more concentrated in the Southern ARC region (a LQ



of 1.2). Concentration in the Northern ARC region is similar to the nation while the other regions have relatively lower concentrations of employment.

Sector growth between 2002 and 2009 was 1.4 percent. Total sector employment growth in Appalachia was strongest between 2004 and 2007 with annual growth rates equal to 3-4 percent. Industries with the most growth between 2002 and 2009 were those dealing with the transmission and distribution of electricity and support industries like engineering services. Most job losses in the nuclear energy sector were in manufacturing industries.

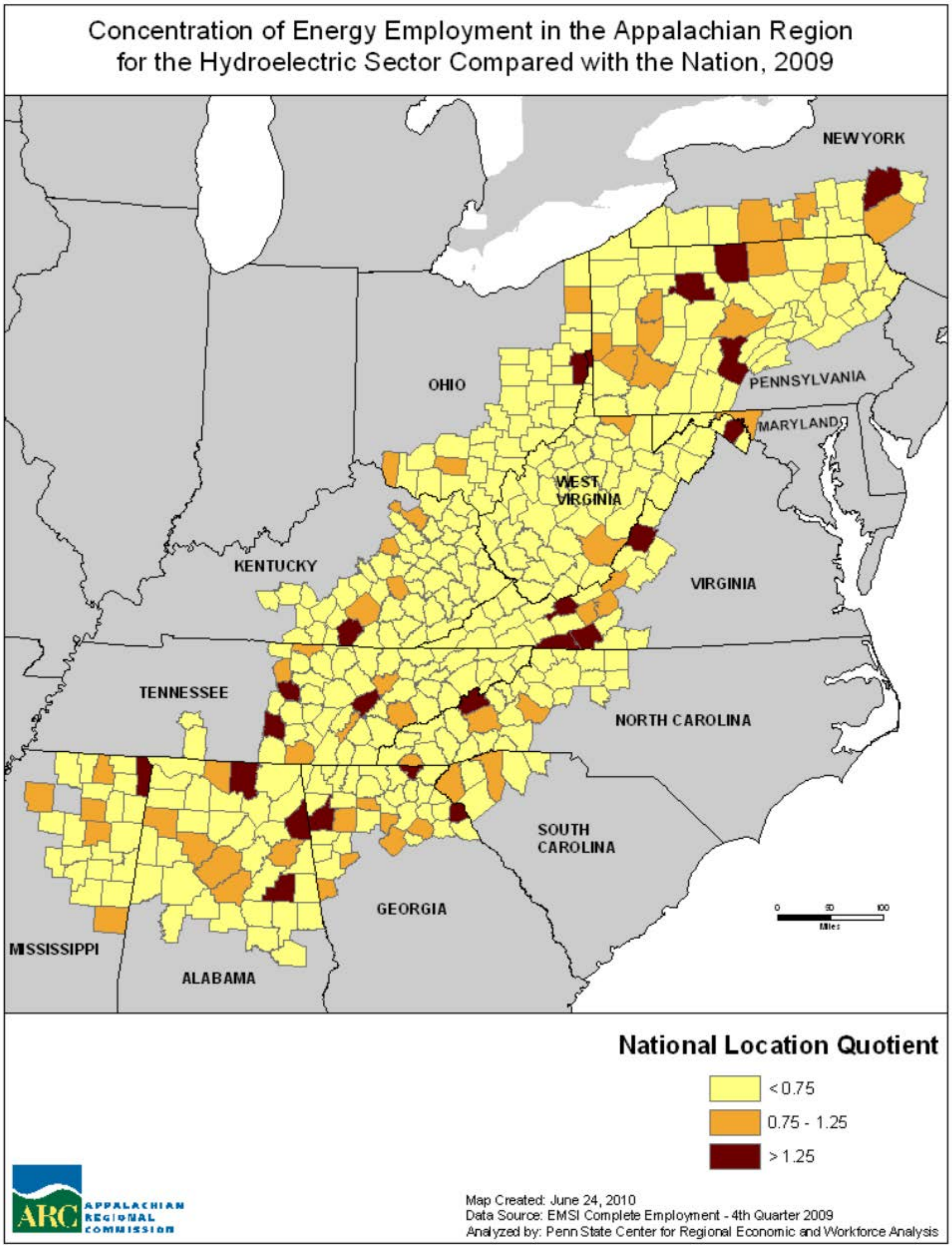
Employment growth in the nuclear energy sector between 2009 and 2013 is forecast at 5.2 percent. Employment in the electric transmission and distribution sectors is expected to see less growth, and in terms of electric power distribution, expected to decline by 5.4 percent by 2013. Most of the recent job losses in manufacturing industries in this sector are expected to recover between 2009-2013.

2.1.5 Hydroelectric

In terms of employment, hydroelectric power is among the smaller energy sectors, employing about 7,000 in 2009, much it in three main industries – hydroelectric power generation (13.2 percent of Appalachian hydroelectric employment), electric power distribution (15.9 percent of Appalachian hydroelectric employment), and engineering services (17 percent of Appalachian hydroelectric energy employment). In 2009, hydroelectric energy had relatively low employment concentrations in all five ARC regions. Most of the region lacks the quantities of water necessary to capitalize on hydroelectric energy.

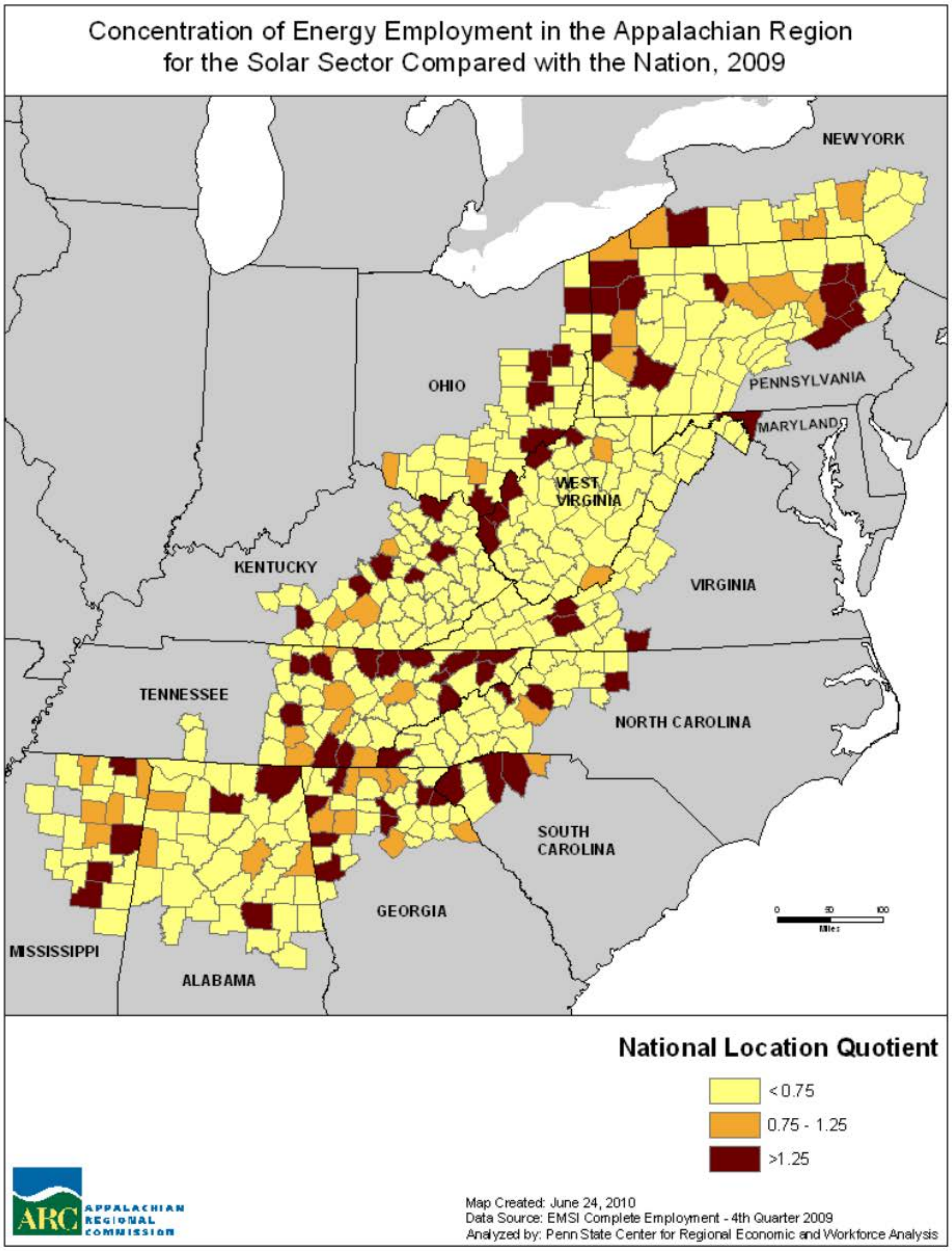
Between 2002 and 2009, employment in the sector in the ARC region declined by more than 20 percent. The decline in this sector was most severe between 2004 and 2005 in those sectors responsible for generating hydroelectric power, which suffered a 36 percent loss in employment. The industry then was hit with large employment cuts in 2007 when the hydroelectric power generation industry lost more than half of its 2006 employment. A slight recovery occurred in 2008, but since then the industry has been in decline.

From 2009 to 2013, the hydroelectric energy sector is projected to lose 2 percent of its jobs. In addition, the electronic power distribution industry is estimated to lose employment between 2009 and 2013, a contrast from the earlier part of the decade. Many of the manufacturing industries with significant job declines between 2002 and 2009 are forecast to gain employment in the next coming years. Most of the job gains in the sector, however, can be attributed to those industries involved in supporting the sector with their consulting and engineering services.



2.1.6 Solar

Employment in the solar sector including those in other sectors associated with the industry surpassed 30,300 in 2009 although overall, the sector lost jobs. Between 2002 and 2009, employment in the solar sector declined by 22.4 percent. Much of the employment in the solar sector is in production, not distribution or transmission of power. Employment in the solar energy sector is not highly concentrated in most of the ARC regions, except the South Central ARC region, which has a slight specialization in solar energy with a LQ of 1.3.



All of the manufacturing sectors involved in solar energy lost employment between 2002 and 2009 except sheet metal manufacturing, which increased by 7 percent. Since 2002 there has been a slight increase in employment in the electric bulk power generation and electric power distribution industries. Over 20 percent of the jobs in the solar energy sector in Appalachia were found in the plastics material and resin manufacturing industry. This industry, however, has lost a great deal of jobs in the sector since 2002. By the end of 2009 employment losses in the industry nearly reached 30 percent of the 2002 employment levels.

Solar sector employment is projected to drop 3.9 percent in the region between 2009 and 2013, but at an annual rate of decline slowing to 1.0 percent. Manufacturing employment is projected to continue to lose employment but less than at previous levels. In terms of the generation of energy from solar power, electric power generation is projected to lose a significant amount of employment in the sector between 2009 and 2013.

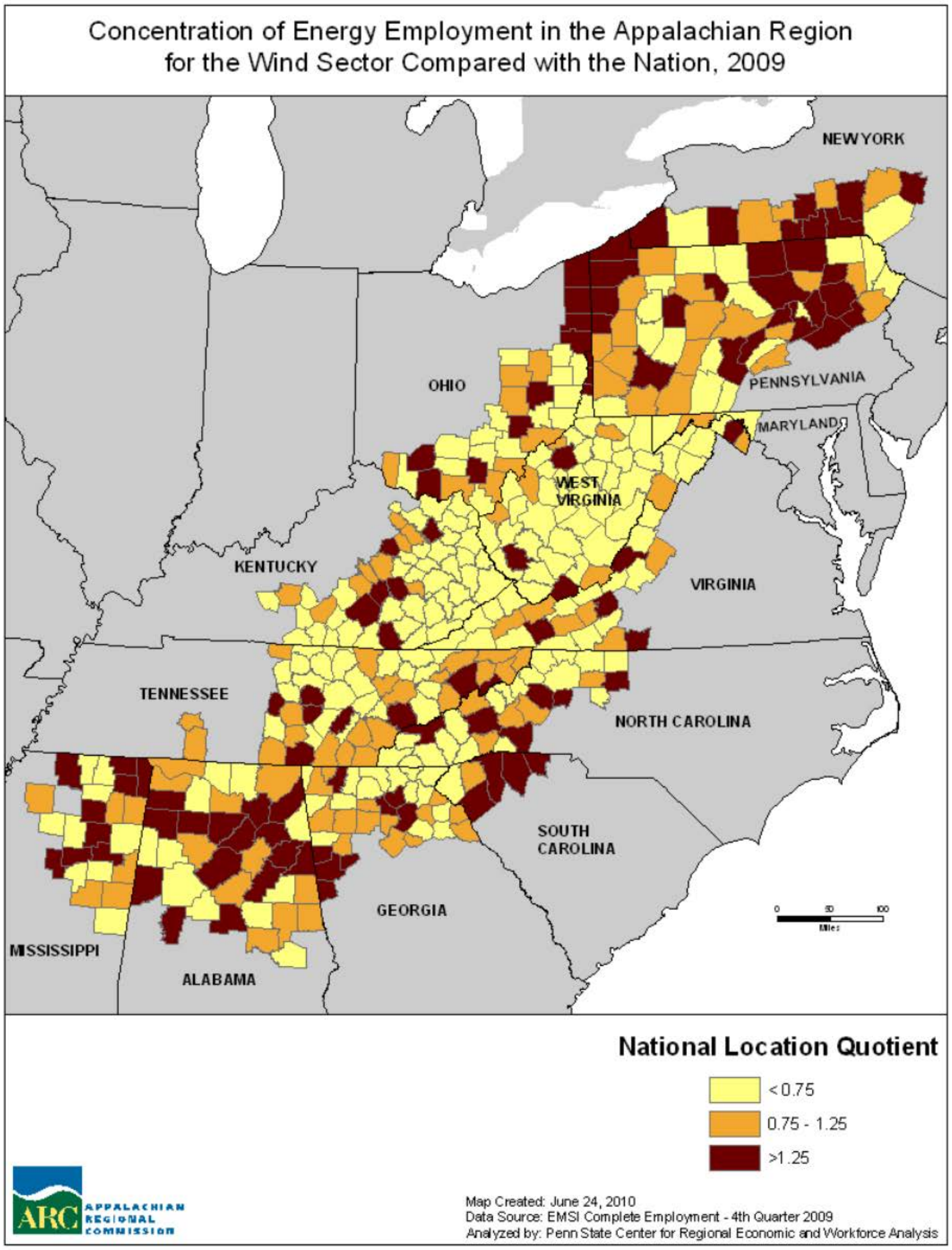
The retail portion of the sector is forecast to increase in the near future which could very well have an effect on future job demand. Unfortunately, any increases in demand may be fulfilled with manufactured products from outside of the region during the time period covered by this analysis.

2.1.7 Wind energy

Between 2002 and 2009, the wind energy sector and its associated industries lost 3.8 percent of its total jobs in Appalachia. Most of the jobs lost since 2002 were in the manufacturing sector while jobs added to the wind energy support sectors helping to mitigate some of the manufacturing loss. Much of the employment loss occurred between 2008 and 2009. A closer look at the sector's loss of jobs shows that almost all the industries were affected and not just a particular economic sector such as manufacturing or utilities, which suggests the recession had more to do with the losses than industrial change.

In 2009, most of the employment in the wind energy sector was in manufacturing, which accounted for over 61 percent of total Appalachian wind energy employment. All other plastics manufacturing accounts for 14 percent of the sector employment and machine shops more than 15 percent of total sector employment. Total employment for the wind energy sector was approximately 106,000 jobs in 2009 within the Appalachian region. (For a discussion of how and why the numbers are different from other analyses please point 2 in the endnote on p. 86.) The industry with the most growth was printed circuit assembly manufacturing which grew by 83 percent (or 1,100 jobs).

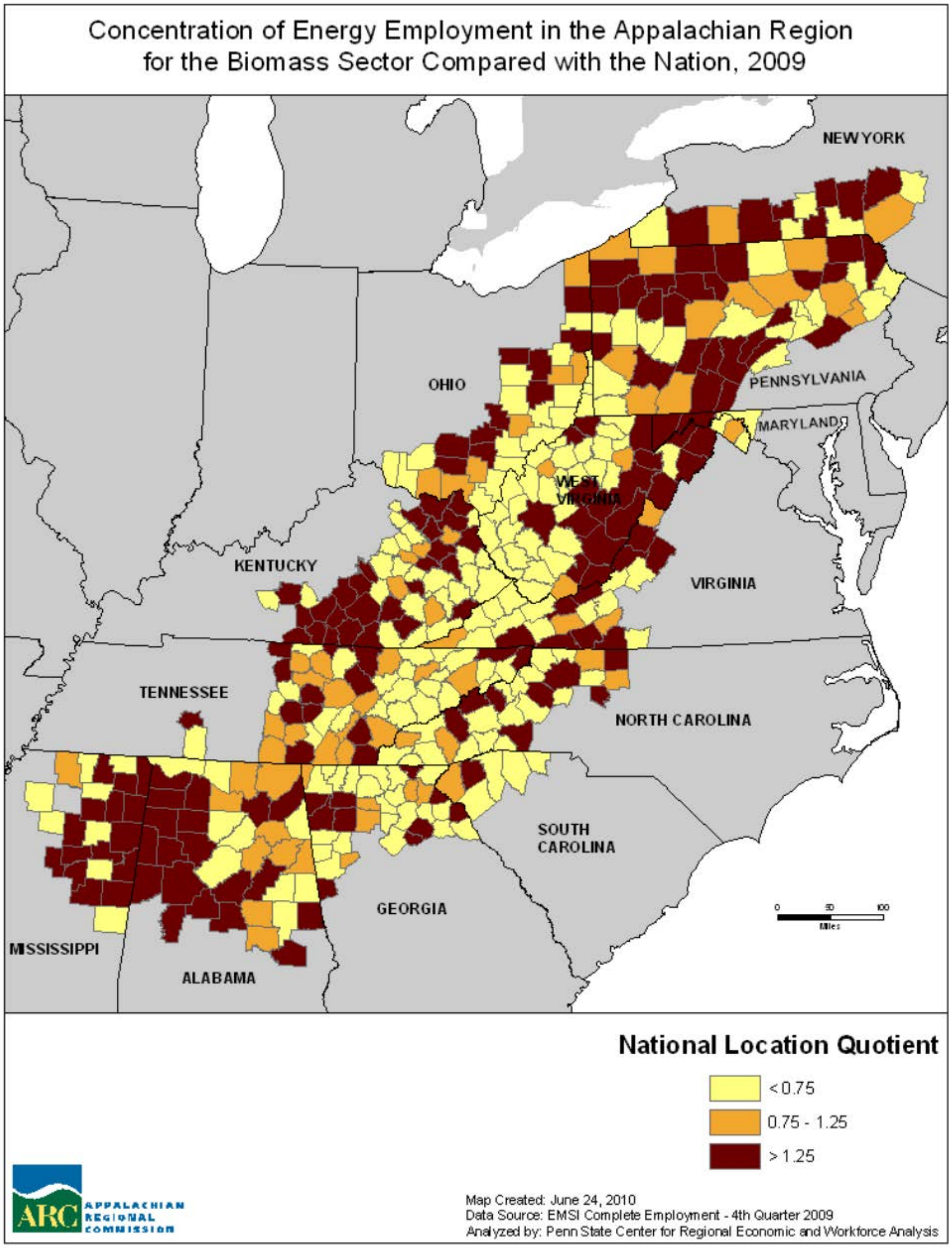
Between 2009 and 2013 employment is projected to grow by 4.3 percent. Much of the growth projected in the near future is likely to occur in three manufacturing industries – fabricated structural metal manufacturing, machine shops, and sheet metal work manufacturing – which suggest an increase in demand for wind energy infrastructure. Employment in the Northern and Southern ARC regions was slightly more concentrated than the nation.



2.1.8 Biomass

Measuring employment in the biomass industry is more difficult than other energy sectors because it is based in part on agricultural employment, which is collected and tracked by other Federal government agencies and is not necessarily consistently reported. The study team believes that many of the farm goods, products, and by-products produced by the agricultural economic sector could include employment that may be attributed to biomass; unfortunately the lack of comparable data available, and thus any estimates in this report, are most likely an undercount of jobs associated with the biomass sector.

Employment attributed to the biomass sector in Appalachia surpassed 37,300 jobs in 2009. Employment tends to be slightly more concentrated in counties in the Northern and North Central ARC regions with both regions having an LQ of 1.4.



As in many of the other renewable energy sectors, most of the 2009 employment in biomass is in manufacturing. Over 40 percent of the total sector employment in located in the three wood products manufacturing industries – sawmills (27.8 percent); paper mills, except newspaper (12 percent); and pulp mills (0.8 percent). Employment in the utility industries in the region is only 5.6 percent of 2009 total sector employment.

Employment in biomass lost 15 percent since 2002. Most of this can be attributed to the manufacturing sectors with wood products manufacturing sectors dominating the jobs losses. The average annual decline in employment during this period is 2.2 percent. The largest one-year loss in employment was between 2008 and 2009, when the sector lost over 10 percent of its jobs mostly due to the recession. The largest employment increase since 2002 has been in the air and gas compressor manufacturing industry that almost doubled in size, adding roughly 1,000 jobs by 2009.

Projections of overall biomass sector employment between 2009 and 2013 are estimated to reduce 2009 employment levels by 5 percent. Some growth is projected to occur in support industries.

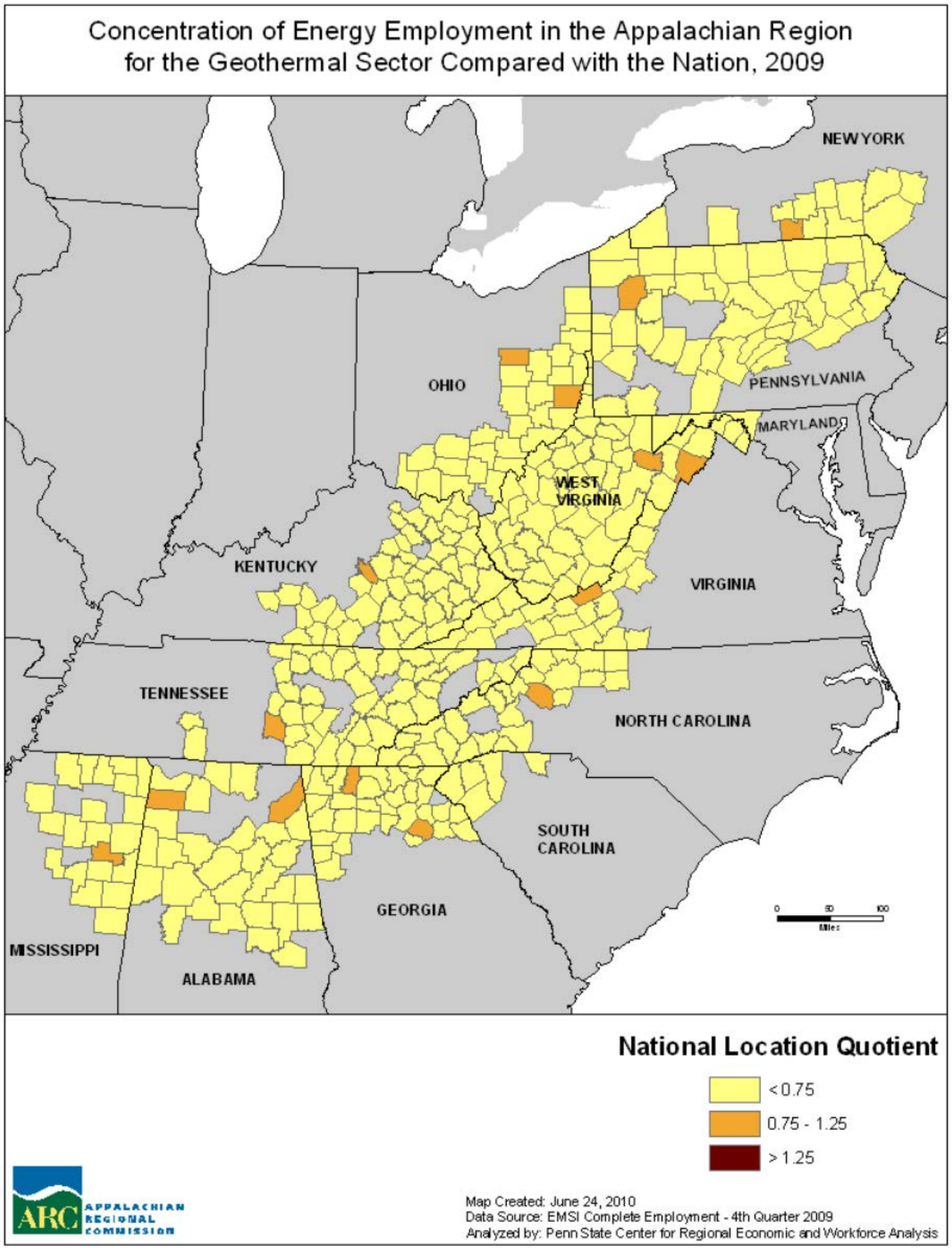
2.1.9 Geothermal

By 2009, geothermal employment including employment in related industries was down to just over 7,000 jobs from its 2003 high of over 9,800. The largest industry in the sector in total employment in 2009 was AC (air-conditioning), refrigeration, and forced air heating with over 62 percent of the sector employment. Geothermal energy employment concentration is roughly identical to the nation.

The geothermal energy sector has been negatively affected over the last several years, losing more than 40 percent of its 2002 employment over the subsequent seven-year period. Only 3.9 percent of the 2009 employment in the geothermal energy sector can be attributed to the utilities industries.

The geothermal energy sector lost 28.5 percent of employment from 2002 to 2009. Both the electric bulk power transmission and control and the electric power distribution industries grew between 2002 and 2009. Within manufacturing, the largest growth occurred in the metal tank, heavy gauge, manufacturing which increased employment by 7 percent. The metal tank, heavy gauge, manufacturing industry in 2009 was 15.3 percent of total sector employment.

Between 2009 and 2013 the sector is projected to lose another 750 jobs (10.7 percent) with much of the job loss in the AC, refrigeration, and forced air heating industry.



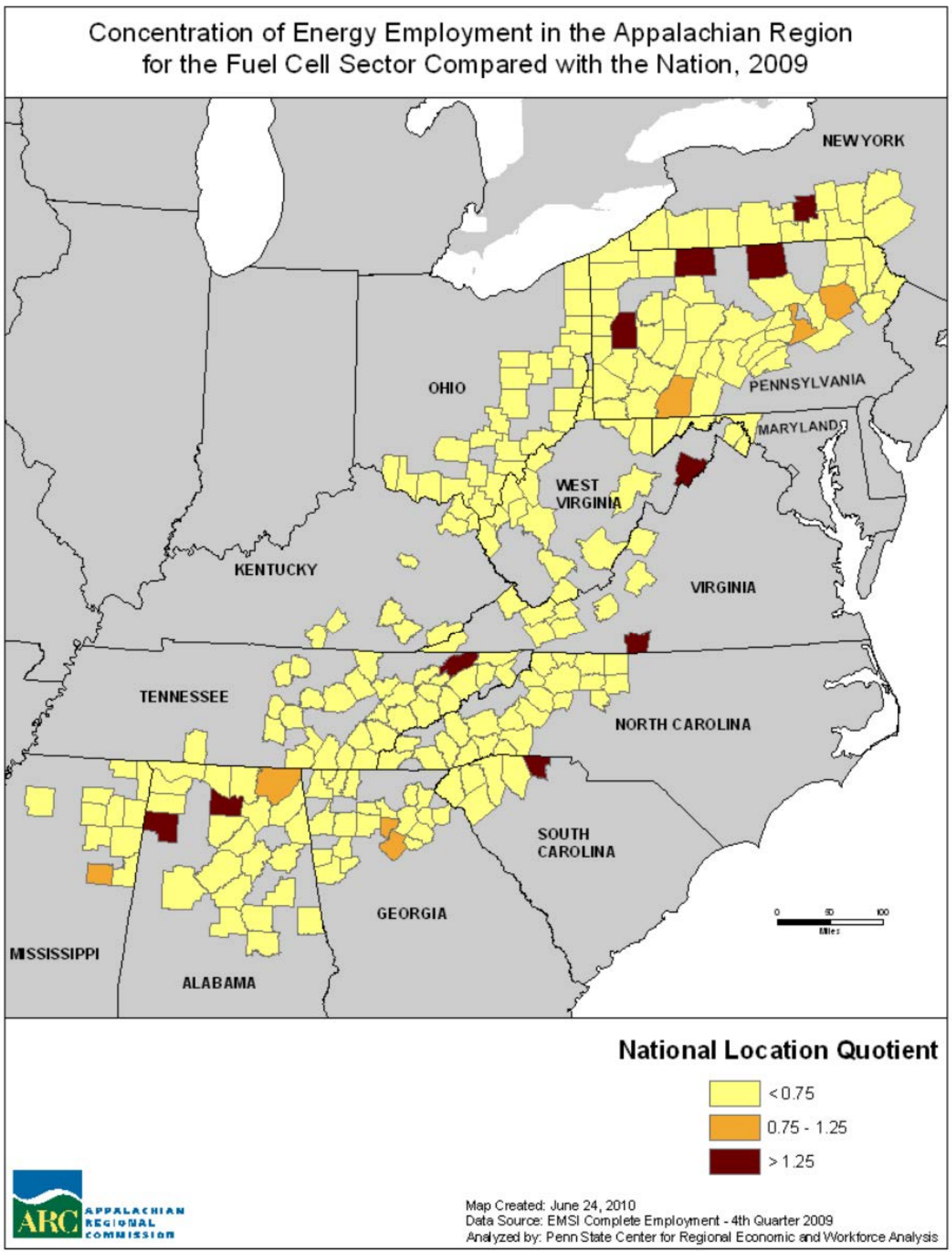
2.1.10 Fuel Cells

The fuel cell sector is not a source of energy but a way to convert a source of energy (or fuel) into energy current. The addition of fuel cells into this analysis was necessary in order to capture the key occupations in the category that are not captured in the other energy producing sectors. Also, the increase in interest of fuel cells to power transportation vehicles will most likely affect the skills and training needed in Appalachia in the near future.

Fuel cells is the smallest sector in energy employment. In fact, employment in the fuel cell sector does not exist in many of the Appalachian counties and is nearly absent in the

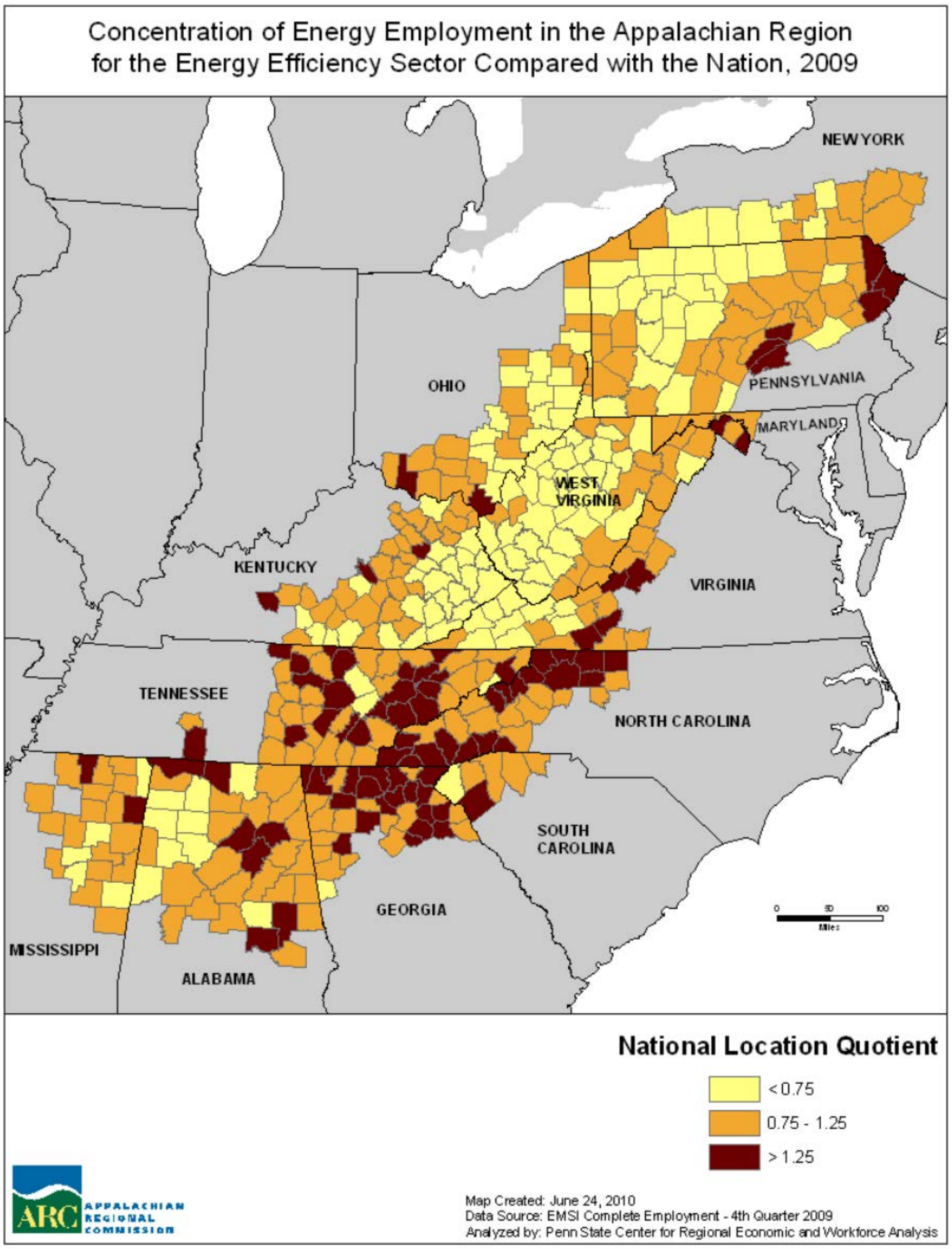
Central ARC region. Roughly 1,800 jobs were attributed to the fuel cells sector in 2009, 66 percent of those jobs in other electronic parts merchant wholesalers. The production of fuel cells, which accounts for the rest of total 2009 employment in the ARC region, is mostly (25.7 percent) in the semiconductor and related device manufacturing industry. There are not any significant employment concentrations by ARC region as exhibited in the map below.

Since 2002, the sector has lost close to 900 jobs, which is 32 percent of its employment. All of the industries in the sector lost employment over the seven-year period. This loss is expected to continue between 2009 and 2013, resulting in a 20 percent loss in jobs by 2013.



2.1.11 Energy Efficiency

While energy efficiency has the most jobs among all energy sectors, it is not an energy source and not comparable to energy producing sectors. It is a process that occurs across all industries and therefore has major implications for employment and workforce education. Many of the industries in this sector are involved in the construction industry or specialty trade contractors. Due to the use of industries within the construction sector for the energy efficiency definition, analysis was restricted to the employment directly related to energy. Thus, only a portion of the employment in these industries was used in our analysis.



Total employment in the energy efficiency sector in 2009 was about 421,000 jobs with 83 percent of the 2009 employment attributed to industries related to various construction-related jobs. While the energy efficiency sector is large the Appalachia employment concentration is similar in its share of workers to that of the nation. The South Central ARC region, however, has an LQ of 1.2, due mainly to high concentrations in some of the counties in North Carolina and Tennessee. The least concentrated areas of employment tended to be those counties with the higher share of their employment in the coal sector.

The total sector employment decreased from a 2007 high of 480,000 jobs, mostly a result of the housing market and credit crisis. Between 2002 and 2009, energy efficiency sector employment did not grow.

Growth for the sector for the 2009 to 2013 time period is projected to be 13 percent, recovering most of the jobs lost between 2007 and 2009. Growth rates for the energy efficiency sector likely reflect increased demand for workers who can weatherize and provide energy efficient inspections to the existing infrastructure. In addition, tax incentives for energy efficiency home improvements certainly increase the demand within some of the construction specialty trade industries.

2.2 Findings from the Employment Analysis

The analysis of employment patterns for the energy sectors leads to the following general key findings.

- Total energy related employment and many individual energy sectors experienced severe job losses during the recent recession with renewable energy sectors bearing most of the declines. Employment in non-renewable energy sectors was more stable between 2007 and 2009.

- Most of the forecast growth in the gas and oil sector is due to drilling and extraction activities primarily related to the extraction of natural gas in Appalachia in the Marcellus Shale natural gas field areas.

- Nuclear energy jobs are expected to see signs of growth between 2009 and 2013; however, this analysis is based on information and data that predates the Japanese earthquake and tsunami of 2011 and subsequent nuclear meltdowns that have sparked global debates about the safety of nuclear energy.

- Hydroelectricity, geothermal energy, and fuel cells have very little employment presence in Appalachia and are likely to maintain that limited presence in 2013.

- Although the manufacturing portion of solar energy is declining, the increased consumer demand for solar energy products is increasing employment in the retail and installation portions of the sector.

- The renewable energy sector that appears to have the most promise in Appalachia with regards to job creation is wind energy. Much of the forecast demand for labor through 2013 is in the industries related to the construction of wind energy infrastructure in the region.

- Employment related to biomass produced from wood and wood products is not projected to rebound by 2013.

- Energy efficiency employment was greatly affected by the recession, but is expected to make a full recovery before the end of the time period reviewed in this study. The job increases will likely occur in the specialty contractor industries that are retrofitting existing and new residential and non-residential infrastructure.

3. CURRENT AND FUTURE ENERGY PROGRAMS IN HIGHER EDUCATION

3.1 Sources and methodology

The information on current and future energy programs in higher education within the Appalachian Region is based on the analyses of the following two sources.

- Federal data on higher education programs and graduation and completion rates from these relevant programs.
- An online survey of community and technical colleges within the Appalachian region.

3.2. Overview of Education and Training Opportunities in the ARC Region

There are more than 180 public and private community colleges, career and technical education centers, and universities located in the ARC region and combined these institutions support 82 programs with education and training for the energy sector region that provide certificates, diplomas, or degrees from associate to doctorate.

3.2.1 Database of Credit programs in Higher Education

The following analysis uses a federally maintained database of credit programs at U.S. higher educational institutions. It catalogues the type of credit program at each institutions as reported to the National Center on Education Statistics (NCES) based on the designated classification of instructional program (CIP) codes. The CIP codes and their corresponding program descriptions typically are general and often they correspond to one or more specific majors at any given institution. Institutions that participate in federal aid programs are required by the Higher Education Act of 1965 and/or the Carl D. Perkins Career and Technical Education Improvement Act of 2006 to provide student data that includes number of enrollments, program completions, and graduation rates.

In compiling this database of energy-related programs, we aggregated data available through the Integrated Postsecondary Education Data System (IPEDS) on completions (number of graduates in an academic year) over a three-year period to determine if a category of programs actually existed at a particular institution in the Appalachian region. All relevant programs listed on IPEDS were included even if they did not have any (as a major or minor field of study) completions over the most recent three-year period used (2006-2008). Completion data was used to determine that a program is currently training for occupations in the energy sector in the Appalachian region. The programs were chosen based on their ability to provide education and training related to the ten energy sectors examined in this report. The colleges reviewed for the database are listed in Appendix E and a description of each program appears in Appendix G.

Overall, colleges and universities in the region offer credit programs that focus on general engineering, construction, maintenance and repair, technician and other science related programs that can train for energy occupations. General chemistry, physics, and geology programs are available in each ARC state region, and most of the states have HVAC (Heating, Ventilation, and Air Conditioning), industrial production or manufacturing technology, and electrician credit programs available within the region.

Higher education in the region offers few specialized baccalaureate degree programs. For example, engineering programs specifically related to geotechnical engineering and water resources engineering, which train specialty engineers for geothermal energy and hydroelectric energy, are not readily available in the region. Education programs related to nuclear power also were scarce in the region, and the region has no credit programs directly related to advanced vehicle technology maintenance and repair, although fuel cell technology and training in the maintenance and repair of advanced vehicles is included as part of some automotive service and repair curricula.

This database of energy programs is a compilation of programs that are physically located in the ARC region. There also are several educational institutions in counties and communities adjacent to the Appalachian region of each state that may provide additional educational resources for energy sector workers, particularly in the state's land grant institutions and of course there are many institutions with online credit and non-credit learning. However, incumbent workers looking to upgrade and enhance skills are more likely to enroll in programs and courses at educational providers within a reasonable commuting distance.

Below find sample highlights of specific educational and training credit offerings.

The University of Alabama offers programs in metallurgical engineering focusing on the selection, methods of production, heat treatment, and finishing of the materials involved in various sectors including power generation. Graduate programs in metallurgical engineering also are available at the University. Its Department of Metallurgical and Materials Engineering has laboratories for solidification processing, chemical metallurgy, mechanical processing, heat treating, specimen preparation, light and electron microscopy, X-ray diffraction, corrosion, and electrochemistry as new, specialized facilities for rapid and unidirectional solidification, containerless melting, chemical vapor deposition, sputtering of thin films, thermo gravimetric analysis, and surface studies.

Georgia is one of two states (the other being Mississippi) that offers a credit line worker program in its Appalachian region. While other states have non-credit line worker programs, North Georgia Technical College offers a 15-credit hour program to train individuals for gainful employment as a utility company electrical line worker apprentice. The program includes operation of hydraulic and pneumatic systems and principles of basic electricity, conductors, insulators, voltage current and power, and identifying and understanding electrical utility distribution blueprints. Students are given hands-on training for a commercial drivers' license on line worker vehicles and equipment.

Appalachian North Carolina is the only ARC region that offers a credit program explicitly for solar energy technology. Appalachian State University in North Carolina has a program in solar energy technology called “Appropriate Technology” aimed at renewable energy technologies and energy efficient solar building design and construction as well as waste management. The “Appropriate Technology” program also can be taken as a minor by students majoring in architecture or engineering.

Hocking College in the ARC region of Ohio offers training for servicing and repairing of automotive hybrid vehicles, fuel cell technology principles, and other advanced fuels vehicles (see Appendix B). Students in this program graduate with an AAS degree specific to Advanced Energy and Fuel Cells with a concentration in automotive hybrids. They are provided with hands-on training on plug-in hybrid electric vehicles, electric cars, and flex fuel vehicles.

Virginia Tech offers undergraduate and graduate programs in mining and minerals engineering. Students in this program learn about mining engineering, mineral exploration, extraction, processing and conservation. Courses are designed to introduce the students to the intersecting environmental and economic factors that affect resource development. Virginia Tech also is home to two research centers focused on coal and coal energy.

Table 3 shows the states that offer some of the more energy industry relevant programs.

Table 3: ARC states offering selected programs in ARC regions of the states, by type of certification or degree, 2006-2008

CIP Codes	CIP Program Name	AL	GA	KY	MD	MS	NY	NC	OH	PA	SC	TN	VA	WV
03.0509	Wood Science and Wood Products/Pulp and Paper Technology					B, M		L, C, A						B
14.0101	Engineering, General	M			A	A, D	A, M	B		L, A		B, M, D		M, D
14.0701	Chemical Engineering	B, M, D				B, M			L, B, M, D	L, B, M, D	B, M, D	B, M, D	B, M, D	B, M, D
14.0801	Civil Engineering, General	B, M, D				B, M			B, M	L, B, M, D	B, M, D	B, M, D	B, M, D	A, B, M
14.0802	Geotechnical Engineering													
14.0805	Water Resources Engineering													
14.0899	Civil Engineering, Other	B, M, D						L, A						
14.1001	Electrical, Electronics, and Communications Engineering	B, M, D				B, M, D	B, M, D		B, M, D	B, M, D	B, M, D	B, M, D	B, M, D	A, B, M
14.1101	Engineering Mechanics	M, D								L, M			B, M, D	
14.1201	Engineering Physics									B		B		B
14.1301	Engineering Science									A, B, M		B, M, D		B
14.1801	Materials Engineering	B, M, D					M, D		B	A, B, M, D	M, D	B, M, D	B, M, D	
14.1901	Mechanical Engineering	B, M, D				B, M	B, M, D		B, M	B, M, D	B, M, D	B, M, D	B, M, D	A, B, M
14.2001	Metallurgical Engineering	B, M												
14.2101	Mining and Mineral Engineering									B, M, D			B, M, D	B, M

CIP Codes	CIP Program Name	AL	GA	KY	MD	MS	NY	NC	OH	PA	SC	TN	VA	WV
14.2301	Nuclear Engineering									L, B, M, D		B, P, M, D		
14.2401	Ocean Engineering													
14.2501	Petroleum Engineering									B, M, D				B, M
14.2801	Textile Sciences and Engineering													
14.3101	Materials Science								A	B, M, D				
14.3501	Industrial Engineering	B, M, D				B, M	B, M		B, M	B, M, D	B, M, D	B, M, D	B, M, D	B, M
14.3601	Manufacturing Engineering							A		A, M				
14.3901	Geological/Geophysical Engineering													
14.9999	Engineering, Other	B, M, D		A		B, M, D			D	L, D	M, D		M, D	B
15.0000	Engineering Technology, General	L, C, A		L, C, A				B	A	B, M	A	L, C, A, B, M	A	
15.0303	Electrical, Electronic, Communications Eng. Technology/Technician	L, C, A, B				A	C, A, B	L, C, A, B	L, A, B	L, C, A, B	A	A	C, A	C, A, B
15.0399	Electrical/ Electronic Engineering Technologies/Technicians, Other	A, B					A		A	A, B	L		C, A	
15.0403	Electromechanical Technology/Electromechanical Eng. Technology				C, A		A, B	L, C, A	A	A				A
15.0404	Instrumentation Technology/Technician						C		A	A				
15.0499	Electromechanical/Instrumentation/Maintenance Tech./Tech., Other	B						L, C, A	L, A					
15.0501	Heating, Air Conditioning and Refrigeration Technology/Technician	L, C, A							L, C, A	A, B				L

CIP Codes	CIP Program Name	AL	GA	KY	MD	MS	NY	NC	OH	PA	SC	TN	VA	WV
15.0503	Energy Management and Systems Technology/Technician	L							A					
15.0505	Solar Energy Technology/Technician							B						
15.0506	Water Quality/Wastewater Treatment Management/Recycling Tech.	L, A	L	B				L, C, A						
15.0611	Metallurgical Technology/Technician									A				
15.0612	Industrial Technology/Technician	B, M	A	A, B, M	C, A	B	A, B	L, C, A, B, M	C, A, B			A, B	A	A, B
15.0613	Manufacturing Technology/Technician	L, C, A, B	A	A, B, M		A		L, A, B		L, C, A, B	L			A
15.0699	Industrial Production Technologies/Technicians, Other	A				B	C, A	A	A	A, B	L, A		C, A	
15.0805	Mechanical Engineering/Mechanical Technology/Technician				C, A		A, B	L, C, A	A, B	L, A, B	L, A	A		A, B
15.0899	Mechanical Engineering Related Technologies/Technician, Other	B						L, C, A		L, A			C, A	A
15.0901	Mining Technology/Technician			L						A			C, A	B
15.0903	Petroleum Technology/Technician								L					
15.0999	Mining and Petroleum Technologies/Technician, Other													
15.1199	Engineering-Related Technologies, Other													
15.1304	Civil Drafting and Civil Engineering CAD/CADD									C				
15.1305	Electrical/Electronics Drafting and Electrical/Electronics CAD/CADD						C							
15.1306	Mechanical Drafting and Mechanical Drafting CAD/CADD						C	L, C, A	A	L, A	L, A	C		A

CIP Codes	CIP Program Name	AL	GA	KY	MD	MS	NY	NC	OH	PA	SC	TN	VA	WV
15.1401	Nuclear Engineering Technology/Technician									A				
40.0403	Atmospheric Physics and Dynamics													
40.0501	Chemistry, General	B, P, M, D	B	B, M	B	A, B, M, D	B, M, D	B, M	B, M, D	A, B, M, D	B, M, D	B, M, D	B, M, D	B, M, D
40.0503	Inorganic Chemistry													
40.0508	Chemical Physics													
40.0601	Geology/Earth Science, General	B, M, D	B	B, M	B	B, M	B, M, D	B	B, M	B, M, D	B	B, M, D	B, M, D	B, M, D
40.0605	Hydrology and Water Resources Science						B							
40.0606	Geochemistry and Petrology													
40.0607	Oceanography, Chemical and Physical									L				
40.0801	Physics, General	B, M, D	B	B	B	A, B, M	B, M	B, M	B, M, D	A, B, M, D	B, M, D	B, M, D	B, M, D	B, M, D
40.0802	Atomic/Molecular Physics													
40.0804	Elementary Particle Physics													
40.0806	Nuclear Physics													
41.0204	Industrial Radiologic Technology/Technician	L												
41.0205	Nuclear/Nuclear Power Technology/Technician													
41.0299	Nuclear and Industrial Radiologic Technologies/Technicians, Other													

CIP Codes	CIP Program Name	AL	GA	KY	MD	MS	NY	NC	OH	PA	SC	TN	VA	WV
41.0301	Chemical Technology/Technician	L, A		A			A			A		C		A
46.0301	Electrical and Power Transmission Installation/Installer, General						C, A			A		L, C		L
46.0302	Electrician	L, C, A	L, C	L, C		C, A	A	L, C, A	C	C, A, X	L		C, A	C
46.0303	Lineworker		L			C								
46.0403	Building/Home/Construction Inspection/Inspector		L							L				
46.0502	Pipefitting/Pipefitter and Sprinkler Fitter						C, A							
46.0503	Plumbing Technology/Plumber	L, C	L					L, C		C, A				L
46.0504	Well Drilling/Driller													
46.0505	Blasting/Blaster													
47.0101	Electrical/Electronics Equipment Installation and Repair, General	C, A	L, C, A, X									L, C, X		C
47.0105	Industrial Electronics Technology/Technician	L, C, A		L, C, A				L, C, A		C, A, B	L, A	L, C, X	C, A	
47.0199	Electrical/Electronics Maintenance and Repair Technology, Other												C	X
47.0201	Heating, Air Conditioning, Ventilation, Refrigeration Maintenance	L, C, A	L, C, A	L, C, A		C, A	C, A	L, C, A	C	L, C, A, B	L, C, A	L, C, X	C, A	C, A
47.0302	Heavy Equipment Maintenance Technology/Technician		L							A, X				C
47.0303	Industrial Mechanics and Maintenance Technology	L, C, A	L, C, A, X	L, C, A		A				C, A	L, C, A	L, C, X		
47.0614	Alternative Fuel Vehicle Technology/Technician													

CIP Codes	CIP Program Name	AL	GA	KY	MD	MS	NY	NC	OH	PA	SC	TN	VA	WV
48.0508	Welding Technology/Welder	L, C, A	L, C	L, C, A		C, A			L, C, A	L, C, A, X	L, C	L, C, X	C	L, C, A
48.0801	Boilermaking/Boilermaker							L, C, A	L					

Source: National Center for Education Statistics (NCES), Integrated Postsecondary Education Data System (IPEDS), 2006 – 2008
*Note: The database of programs is based on degree-seeking students and does not include those educational opportunities like workshops, seminars, and non-credit courses. A survey was conducted to address these types of instruction.

KEY:
L = Award of less than 1 academic year
C = Award of at least 1 but less than 2 academic years
A = Associate's degree
X = Award of at least 2 but less than 4 academic years
B = Bachelor's degree
P = Postbaccalaureate certificate
M = Master's degree
D = Bachelor's degree

3.3 Results from a survey of community and technical colleges

To learn more about how community and technical colleges in the region prepare new and incumbent employees in the energy fields, we invited all of the community and technical colleges in the ARC region to complete a survey (see survey form in Appendix C). The questions covered production, manufacturing, maintenance, and conservation/energy efficiency in both renewable and non-renewable related sectors. Respondents were asked about current programs and plans for new programs.

In February 2009 the survey was posted on SurveyMonkey.com, links to the survey were sent and resent to ARC community college presidents and later to workforce development directors with follow-up emails and calls made consistently to maximize the response rate. Ultimately 98 colleges submitted usable responses.[5]

3.3.1 Programs in Energy

The following paragraphs describe the programs that the colleges are presently offering as reflected in the survey responses to the question: "Please indicate if your college offers programs or courses in the following fields." Possible categories were: *Awards of less than 1 year*, *1-year certificate*, *2-year AAS Degree, Elective Courses, Noncredit courses, Contract Training* and *None*. Table 4 summarizes the information for each of the categories.

Note that we use percentage responses in most of the discussion. Since the survey was completed by a significant subset of colleges, the percentages suggest the overall importance that ARC schools place on programs. The responses, e.g. 5 schools offering AAS degrees in wind power installation and repair, do not necessarily reflect the total number of ARC institutions offering programs in each educational category nor the total number of students enrolled in the programs. Since 98 schools completed the survey, the percentages are very similar to the actual numbers. For example, seven schools or 7.1 percent reported *Awards of less than 1 year* in coal mining.

When the number of schools reporting a program is small we indicate in the text below the states where these programs are located. Note that the number of states may be less than the number of schools reporting programs if one or more states have more than one college offering the program.

Coal Mining

Less than a quarter of the colleges reported any programs related to coal and, as is expected, these programs were located in areas of historical production such as West Virginia, Kentucky, and Alabama. The most programs were in *awards of less than 1 year* (7 percent of colleges: AL, KY, MD, OH, WV), *contract training* (6 percent: AL, KY, MD, PA, WV) and *noncredit* (5

---

[5] We began to contact colleges that had not responded in April with two rounds of emails to the presidents followed in May by emails to alternative workforce contacts. We began phone correspondence with non-responders during the last weeks of May and ended with a final email.

percent: AL, KY, MD, PA, WV). Two colleges reported AAS degrees (VA, WV). Over 2,800 students were enrolled in various coal mining programs.

Operation of Coal Powered Utility
About 80 percent of colleges reported no programs. The most common program reported is a *2-year AAS degree* (7 percent: GA, OH, TN, VA, WV), followed by a few schools with *contract training* (AL, GA, PA), *noncredit* (AL, GA, NC) and *1-year certificate* (GA, OH, WV) with 3 percent each.

Nuclear Power Plant Operation
A handful of colleges (10 percent, all in areas with existing nuclear power plants), reported programs in plant operation. Three schools had a *two-year AAS degree* (PA, TN).

Biofuels (biodiesel, algae, ethanol, etc)
13 colleges reported programs in biofuels. The most common programs are *noncredit* (7 percent: AL, MS, NC, OH, TN, VA) and *elective course* (5 percent: NC, OH, TN, WV).

Solar (photovoltaic installation, repair)
Nearly 30 percent of schools reported one or more types of training in solar repair and installation.   Most training is in *noncredit* (14 percent) and *awards of less than one year* (12 percent). Five schools offer *two-year AAS degrees* (AL, OH, TN).

Solar (photovoltaic manufacturing)
Only 10 percent of schools reported any type of training program for solar photovoltaic manufacturing.   Three schools provided *noncredit* courses (GA, NC, VA) and two *contract training* (AL, GA). One school offers a *two-year AAS degree* (TN).

Wind Power (wind turbine installation, repair)
Seventeen schools reported programs in wind turbine installation and repair,17 percent of the total. The most commonly reported programs are *awards of less than one year* (NC, TN, VA), *one-year certificates* (MD, OH, TN, VA, WV), and *noncredit* (NC, OH, TN, VA, WV) all 6 percent. Five schools offer *two-year AAS degrees* (OH, TN, WV).

Wind Power (wind turbine manufacturing)
As with solar photovoltaic manufacturing, only 10 percent of schools reported any type of training program for wind turbine manufacturing.   *Noncredit* (3 schools: NY, VA, WV)) and *contract training* (two schools: TN, SC) lead. One school offers a *two-year AAS degree* (TN).

Energy Auditor
Energy auditor is commonly taught in the region’s schools with over one-third offering at least one type of training. *Noncredit* courses are by far the leading training offering representing 24 schools followed by *contract training* (8 percent) and *awards of less than one year* (6 percent: NC, KY, OH, TN, WV)). Two schools offer a *two-year AAS degree* (TN).

Energy Efficiency Analysis
Like energy auditor, over one-third of schools offer training in energy efficiency. It follows the same pattern of training offerings led by *noncredit* (20 percent) *contract training* (8 percent) and *awards of less than one year* (6 percent: GA, KY, OH, TN, WV)). One school offers a *two-year AAS degree* (TN).

Energy Management Systems
Some 25 schools have offerings in energy management systems. *Noncredit* and *contract* training lead the way with 11 percent of schools each. One school offers a *two-year AAS degree* (OH).

Weatherization
One-third of schools have an offering in weatherization. Most offer *noncredit* (21 percent) and *awards of less than one year* (9 percent). One school offers a *two-year AAS degree* (TN).

Other Alternative Energy (geothermal, etc)
A fifth of the colleges have at least one program focused on alternative energy such as geothermal. *Noncredit courses* (8 percent) and *awards of less than one year* (5 percent: OH, SC, TN, VA) predominate. Two schools offer a *two-year AAS degree* (TN).

Other Fossil Fuels
Only 14 percent of colleges have programs in other fossil fuels such as natural gas. The leading categories of training are *contract* (6 percent: AL, OH, PA, TN, WV), *noncredit* (5 percent) and *awards of less than one year* (5 percent: AL, OH, PA, TN, WV). Four schools offer a *2-year AAS degree* (TN, OH). It should be noted that several schools indicated interest in creating a natural gas track due to exploration and production in the Marcellus shale areas of Appalachia in the open-ended questions of the survey.

Introduction to Energy
Nearly 30 percent of schools offer training in the broad field of energy. Most of the programs are in *noncredit courses* (12 percent) *electives* (8 percent) and *awards of less than one year* (6 percent: KY, MD, NC, OH, TN). Still four schools offer either a *two-year AAS degree* (OH, TN) or *one-year certificate* (TN).

Summaries of the data follow below in Table 4.

Table 4. Percent of ARC Colleges with Energy Program, by Level of Degree, 2009

Programs in Energy	Awards of less than 1 year	1-year Certificate	2-year AAS Degree	Elective Courses	Noncredit Courses	Contract Training	None
Coal Mining	7.1	2.0	2.0	2.0	5.1	6.1	86.7
Operation of Coal Utility	1.0	3.1	7.1	0.0	3.1	3.1	79.6
Nuclear Plant Operation	1.0	1.0	3.1	0.0	0.0	1.0	89.8
Biofuels	2.0	2.0	1.0	5.1	7.1	2.0	86.7
Solar Installation/Repair	12.2	4.1	5.1	5.1	14.3	5.1	70.4
Solar Manufacturing	2.0	2.0	1.0	0.0	3.1	2.0	89.8
Wind Power Installation/Repair	6.1	6.1	5.1	3.1	6.1	1.0	83.7
Wind Power Manufacturing	1.0	1.0	1.0	0.0	3.1	2.0	89.8
Energy Auditor	6.1	1.0	2.0	1.0	24.5	8.2	65.3
Energy Efficiency Analysis	6.1	1.0	1.0	4.1	20.4	8.2	65.3
Energy Management Systems	3.1	0.0	1.0	3.1	11.2	11.2	76.5
Weatherization	9.2	2.0	1.0	2.0	21.4	4.1	66.3
Other Alternative Energy	5.1	3.1	2.0	3.1	8.2	3.1	79.6
Other Fossil Fuels	4.1	1.0	4.1	2.0	5.1	6.1	85.7
Introduction to Energy	6.1	1.0	3.1	8.2	12.2	4.1	70.4

Source: Online survey of Appalachian educational institutions conducted by RTS, Inc., 2009-2010

3.3.2 Enrollment in Programs

In addition to the programs available it is important to examine the level of interest in the programs by looking at enrollment information in credit and noncredit programs. For enrollment data the survey combined the various programs within an energy production area separating the credit and noncredit figures. For example, the respondents were asked to provide the enrollment figures for all programs in coal mining and coal technology within credit and noncredit areas. The data reflect 2009 enrollment (Table 5 and Figure 1). It should be noted that not all respondents who indicated that they have programs included data on enrollment.

Table 5. Energy Program Enrollment of ARC Colleges, 2009

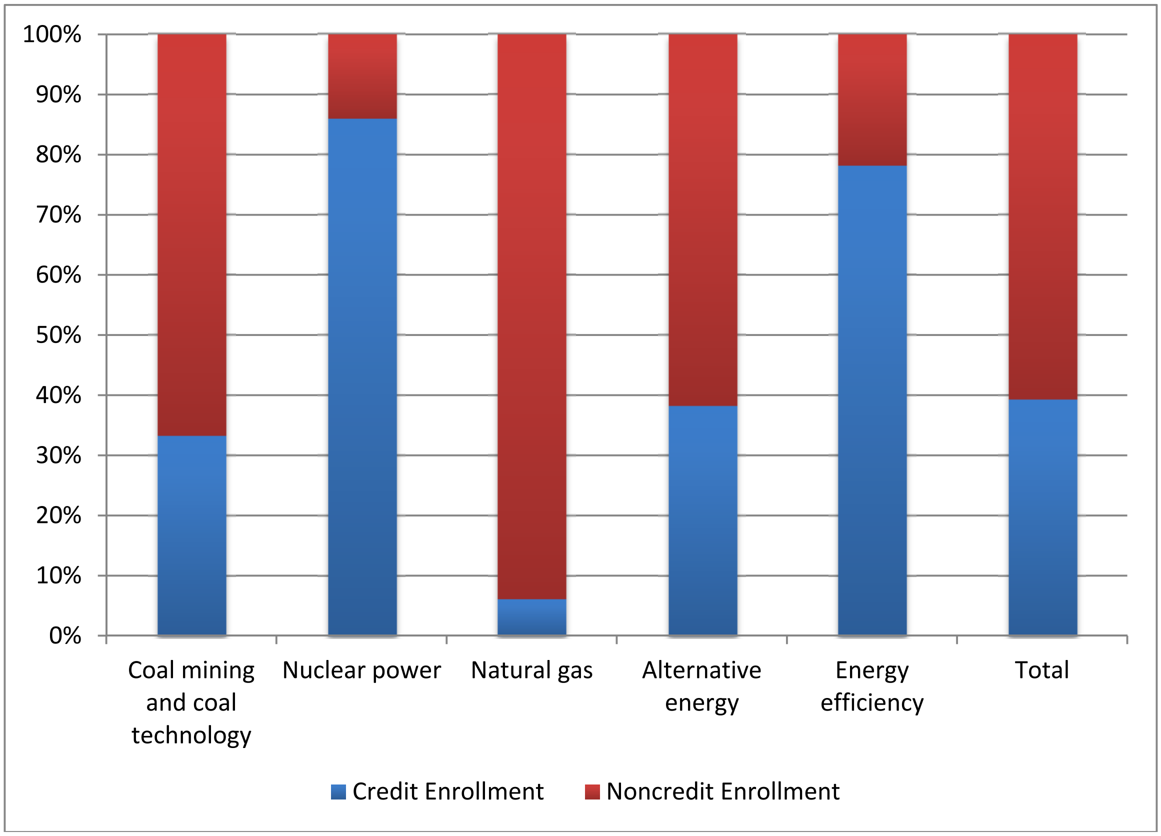
Energy Production Area	Credit Enrollment	Noncredit Enrollment	Total Enrollment
Coal mining and coal technology	2,806	5,593	8,399
Nuclear power	147	24	171
Natural gas	30	453	483
Alternative energy	203	328	531
Energy efficiency	1,200	333	1,533
Total	4,386	6,731	11,117

Source: Online survey of Appalachian educational institutions conducted by RTS, Inc., 2009-2010

The data reflects the continuing historic importance of coal mining in the economy. Enrollment in coal related programs represents 64 percent of credit enrollment, 83 percent of noncredit enrollment and 76 percent of total enrollment.

The data is also revealing in the split between credit and noncredit enrollment. While noncredit courses overall represent 61 percent of enrollment, the split varies dramatically between the energy production areas. Coal, natural gas and alternative energy enrollments are more often noncredit. On the other hand energy efficiency and nuclear power enrollment are dominated by credit enrollment. (Figure 1)

Figure 1. Credit and Noncredit Enrollment by Energy Area, 2009



Source: Online survey of Appalachian educational institutions conducted by RTS, Inc., 2009-2010

3.3.3 Noncredit or Customized Training

The survey asked respondents to indicate noncredit and customized training they provide that are relevant to extractive and green energy production. Table 6 details the percentage of colleges providing noncredit and/or customized training within each of the occupational categories.

Table 6. Percent of Colleges with Noncredit and Customized Training, 2009

Do you provide non-credit training and/or customized training to companies in any of the following fields?	Noncredit	Customized Training
Construction	51.0	30.6
Electrical Technician	43.9	44.9
Welding	42.9	49.0
HVAC	40.8	33.7
Manufacturing	40.8	54.1
Industrial Mechanics Technician	34.7	52.0
Automotive Technician	21.4	20.4
Electrical Engineering Technician	15.3	18.4
Mechanical Engineering Technician	8.2	13.3
Architectural Engineering Technician	6.1	8.2
Chemical Engineering Technician	4.1	6.1

Source: Online survey of Appalachian educational institutions conducted by RTS, Inc., 2009-2010

3.3.4 General Customized Training

The percent of colleges offering customized training in broad-area skill areas by energy sector is shown below in Table 7.

Table 7. Percent of Colleges offering Customized Training in Broad Skill Areas by Energy Sector, 2009

Energy Sector	Workplace skills (team building leadership)	General soft skills (word processing, general computer)	Foundational manufacturing skills (blueprint reading, welding)	Field specific skills (information on specific energy technology)	Did Not Provide
Coal mining	11.2	10.2	8.2	8.2	64.3
Electric utilities	24.5	24.5	28.6	20.4	46.9
Alternative energy	11.2	10.2	12.2	19.4	54.1
Energy efficiency	13.3	12.2	18.4	20.4	49.0
Nuclear power	2.0	2.0	4.1	4.1	69.4
Natural gas	7.1	9.2	4.1	6.1	41.8

Source: Online survey of Appalachian educational institutions conducted by RTS, Inc., 2009-2010

3.3.5 *Workforce Skill Needs as Reported by Companies*

To learn about overall skill needs respondents were asked "In interactions with energy-related companies, what do you hear companies saying their greatest workforce or training needs are?". Two-thirds of respondents noted that companies reported basic and technical skill needs in entry-level workers. For incumbent workers those figures fell to 33 percent for basic skills and 46 percent for technical skills. Only 18 percent reported skill needs in management and upper-skilled workers. (Table 8)

Table 8. Workforce Skill Needs Reported by Companies, 2009

Skill Needs	Percent Reporting Need
Basic skills of entry-level workers (work ethic, punctuality, etc)	69.4
Technical skills of entry-level workers (field-specific training)	64.3
Basic skills of incumbent mid-skilled workers	32.7
Technical skills of incumbent mid-skilled workers	45.9
Skills of management or upper-skilled workers	18.4

Source: Online survey of Appalachian educational institutions conducted by RTS, Inc., 2009-2010.

3.3.6 Open Ended Responses

The survey also asked respondents about broader questions of interest.

Entrepreneurship in Energy Programs

A small number of the colleges (17) indicated that they have programs relating to entrepreneurship. Most programs are broad and non-specific to energy but are still relevant. Programs and classes that are energy specific are all focused on green and renewable energy as opposed to non-renewable energy.

Field Specific Customized Training

Colleges offer field specific customized training in both green and non-renewable energy including nuclear. The offerings are broad including non-destructive testing, line worker, blueprint reading, safety and various construction related skills. Several are offered for certification and recertification. As of 2009, twenty-five colleges offered one or more programs.

Potential New Programs

Many colleges (68) are looking at adding programs for both green and/or non-renewable energy. Several focus on responding to opportunities driven by the Marcellus Shale natural gas formation. Within green energy and sustainability, programs are envisioned in wind, weatherization/green construction, biofuels, solar and various manufacturing related areas, e.g. turbines. Several colleges are looking at starting programs related to nuclear energy as well.

3.4 Findings on Programs in Higher Education

The analysis of the Federal databases on educational options relevant to the region's energy sections and the survey of educational providers suggest the following findings.

- Colleges and universities provide general programs of studies related to science, engineering, and technology in the region while using minors, add-on degree and other specialization options to tailor more general degree options towards alternative energy.

- Specialized degrees and awards tend to focus on the traditional sources of energy. For example, Ohio and Pennsylvania offer engineering degrees specific to the petroleum industry and Virginia Tech offers a degree in mining and minerals engineering specific to the coal energy sector.

- While many community colleges offer certificates and degrees in programs aimed at specific occupations, much of their energy education is delivered as non-credit programs or customized training tailored to specific companies. The historic importance of coal mining and related fields is supported by only a few programs located in coal producing areas but serving a large number of students with both credit and non-credit programs (see Table 5 and Figure 1). They account for three-fourths of the total enrollment in energy-related programs, reflecting the colleges' responses to continuing demand for coal workers and skill needs as well as the historic importance of the industry to the region.

- The existing programs and interest in developing new programs for nuclear energy and natural gas suggest that recent developments and potential demand in these fields are driving colleges to re-examine their offerings.

- The location of existing and new programs serving coal, natural gas and nuclear energy reflects the geography of coal production, natural gas activity and operating nuclear plants. As expected, few programs are found in states without proximity to production in these energy sources.

- Conversely, the lack of existing economic activity and concomitant demand for workers in green manufacturing in the region has led to a paucity of programs and low enrollment levels. Still, schools are tracking this area as reflected in responses on potential new programs.

- Colleges are beginning to provide programs to fill demand in green installation and repair/maintenance, particularly in wind and solar, although there are few programs for manufacturing in these sectors.

- Much of the green energy education is found in non-credit programs or as electives, with few in certificate or AAS degree programs. Much of this reflects the need to add new skills to augment skills of existing workers, for example teaching weatherization skills to the existing construction workforce.

- Many of the programs in energy auditing, efficiency and management are contract-related and/or noncredit. This suggests a need among companies for skills and knowledge enhancement due to increased emphasis on energy conservation and rising energy prices, but not for credentials.

- Many programs in traditional fields such as HVAC and construction have strong relevance to emerging energy workforce needs. Workers with skills in HVAC, construction and other traditional skills areas have employment opportunities in green construction, energy efficiency, weatherization and other emerging areas in green industries. Upgrading and tailoring the skills to these industries will play an important role in expanding employment opportunities.

- Colleges estimate, based on discussions with local employers, that two-thirds or more of all entry-level workers need improved basic (e.g., work ethic, punctuality) and field-specific training (technical workers). Need for increased proficiency for incumbent workers was lower but still significant. This finding is not surprising, as manufacturers and other employers have long reported that basic work habits and basic technical skills like blueprint reading are poor among entry-level workers. This is a nationwide problem not specific to Appalachia.

4. GAP ANALYSIS

4.1 Methodology

A key and overarching goal of this analysis and report is to provide the Appalachian Regional Commission and the states within the ARC region information that can be used to plan for and address the workforce needs of the renewable and non-renewable energy sectors and energy efficiency industries within their purview. This section provides key information to strategically address these needs. In simple terms, we look at the projected supply of qualified and trained workers needed to meet the employment growth and replacement worker demands for the industries within the energy industries in Appalachia. This answers the question, "Are the educational institutions in Appalachia prepared to meet the demand for energy-industry workers and if not, where are the gaps that need to be filled?"

The quantitative portion of the gap analysis identifies particular needs in a target region in the entire energy sector. Thus, a researcher can get a sense of where there might be excess demand for labor regardless of which energy sector is driving that demand. The methodology serves these different needs by using state data on occupational projections coupled with data on for-credit completions (graduations) in educational programs within the Appalachian region of each state. These data paint a broad picture of occupational supply and demand as well as provide detailed analyses of occupational surpluses and gaps. While sector specific information provides educational institutions with detail about which energy sectors are likely to have gaps or surpluses in targeted energy occupations, policy often is crafted at a more comprehensive level. Thus, the gap analysis was conducted by occupation for the Appalachian region of each state. The operating manual, found in Appendix J, includes a more detailed description of this methodology and full instructions for analyzing workforce needs at regional levels and by energy sectors.

This methodology for calculating workforce gaps and surpluses has certain limitations. One is the method used for estimating supply and demand by occupation. The primary limitation is that the estimated allocation of completers to occupations that is part of the more detailed analysis is based on the overall demand for an occupation. That is, the methodology assumes that the completers from a given educational program will distribute themselves across occupations more or less in line with the demand for those occupations throughout the regional economy, not just within the energy sectors. In addition the methodology does not account for unemployment, those who go into another field, or those who drop out of the labor force. Nor does it account for in-migration of already-prepared workers, the retraining of dislocated workers (who may be able to transition quickly with on-the-job training), or for the role that other educational institutions located outside of the ARC region have in preparing workers for specific occupations. Lastly, it does not reflect the non-credit training needed for many energy-related jobs

The analysis started with the study team selecting occupations that have an annual demand (annual openings) of at least 10 jobs and/or had annual replacement needs of at least 10 jobs during the years 2009-2013.

The team then matched each occupation to the corresponding instructional program(s) whose coursework has a strong relationship with the knowledge and skills needed in that occupation. We then compare the estimated number of completers from each program to the total projected demand. The difference between the two is the labor market gap or surplus for that occupation with respect to post-secondary educational programs.

4.2 The States

Overall, 106 occupations are projected to have labor shortages in at least one ARC state in the near future. In each ARC state the gaps are different so each state is reviewed separately. For example, Pennsylvania has the most occupations with estimated labor shortages in the energy sector and Maryland and Mississippi have the least number of occupations in the energy sector expected to have workforce shortages.

There are some over-arching themes in terms of workforce gaps across all the states. Overall, the ARC region appears to have the most gaps or estimated shortages in labor demand in the specialty trade, production, and maintenance and repair type occupations. While many of the managerial jobs tend to require some combination of a bachelor's degree with some on the job training, specialty trade, production, and other "hands-on" occupations tend to rely heavily on local educational institutions to fulfill the skills training and knowledge needed to be successful on the job. Production-type occupations also tend to be heavily dependent on on-the-job training with supplemental customized training and workshops usually found at career centers, technical, and community colleges.

Most of the projected shortages in each state are in the construction trade, maintenance and repair, production, and transportation type occupations. Nearly all of the states have gaps (estimated shortages in the supply of graduates) in carpenters, construction laborers, first line supervisors/managers of construction trades and extraction workers, operating engineers and other construction equipment operators, electricians, pipelayers, sheet metal workers, helpers of electricians, electrical power-line installers and repairers, and team assemblers. It should be noted that our analysis does not account for in- or out-migration of workers. Some occupations such as engineers and perhaps oil and gas exploration workers are more willing to relocate than others.

According to the O*NET Center construction laborers and sheet metal workers will also see a change in how training will be provided in the coming years. The impact of energy efficiency and greening of the economy most likely will require a "significant change" to the currently accepted skills, knowledge and abilities needed to be successful in those occupations. Thus, not only will those gaps, represented by state in Appendix I, need to be filled by increasing the pipeline of entrants into these occupations, many of the existing construction laborers and sheet metal workers working in the energy sector will require additional course work and re-certifications to continue to be relevant in the changing workforce.

Demand for industrial, construction, and engineering managers was high in most of the states; however, the estimated annual supply of graduates is expected to meet or exceed this demand. The exception is in the states of Alabama, Georgia, and Tennessee. In Tennessee, annual demand for construction managers is in excess of 220 jobs, but annual supply is only around 168 jobs. The annual gap is expected to be around 55 jobs. Much of the demand is driven by the increase in new jobs over the four-year period ending in 2013. Based on research conducted for the O*NET Center, engineering managers and construction managers are also expected to see a shift in the training needs for people currently in those occupations as well as changes in training in education for new entrants into these occupations. Conversely, Pennsylvania appears to have a glut of recent graduates trained as engineering managers – 1,258 more than is needed to go into the energy sector – that could move to other regions in Appalachia.

While most of the in-demand occupations continue to have projected workforce shortages when the supply of average graduates are distributed across the Appalachian state economies, there are a few occupations where there appears to be a glut of graduates, meaning there are more graduates than appear to be needed in the region. Construction manager occupations are forecast to be in great demand in the future energy sector but are also projected to have a surplus of graduates in ten of the thirteen ARC states. Also showing significantly more labor supply than demand are those jobs in the welders, cutters, solderers, and brazers occupation. Eight of the thirteen states have surpluses in this category with Alabama, Georgia, Kentucky and North Carolina projected to have the greatest surpluses.

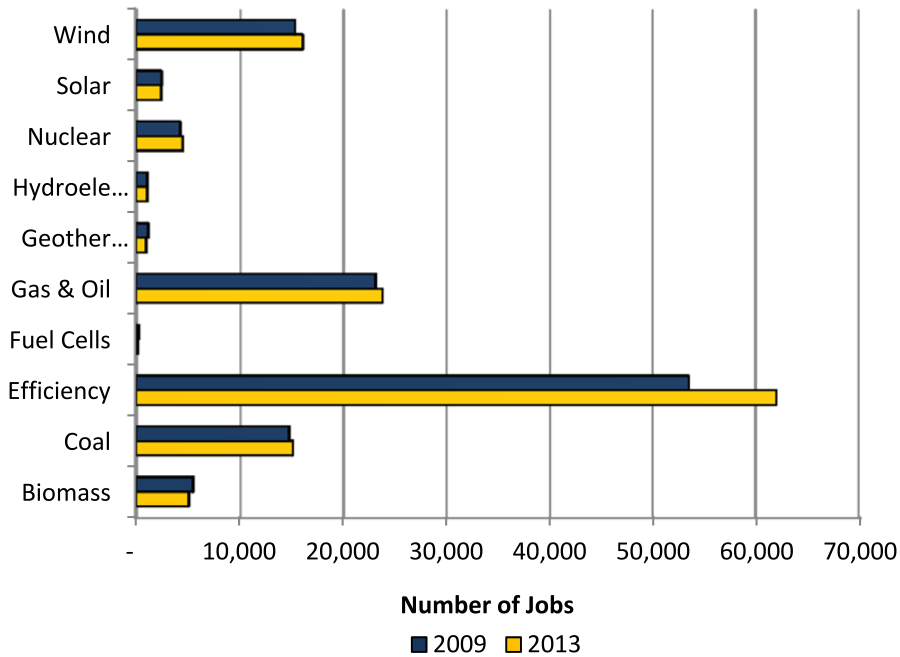
Selected findings for the Appalachian regions of each of the thirteen ARC states are presented in the following pages. Unless otherwise specified all references to economic and workforce data within this section refer to the specific Appalachian state and the specific economic sectors within the specific Appalachian state only.

4.2.1 Alabama

The energy sector in Alabama employed 121,400 jobs in 2009 representing a 3.8 percent increase from 2002. Most of the employment growth in Alabama's energy sector occurred between 2002 and 2007, where the ARC region of the state had a 14.7 percent increase in new jobs since 2002. Then employment declined significantly from 2007 to 2009 when the sector shed nearly 10 percent of jobs during the recession. Jobs in the energy sector of ARC Alabama are projected to grow by nearly 9 percent by 2013.

Energy efficiency had by far the greatest number of jobs in the energy sector followed by the gas and oil sector in both 2009 and projected for 2013. The number of jobs for each energy sector in Appalachian Alabama is displayed in Figure 2 below. All of the sectors are heavily dependent on production type jobs like team assemblers, machinists and first line supervisors of production lines with the exception of energy efficiency. More than half of the jobs in the energy efficiency sector are in construction and extraction occupations. Architecture and engineering occupations cover a large percentage of total employment in coal, gas and oil, hydroelectric, and nuclear energy sectors.

Figure 2. Employment by Energy Sector, ARC Alabama, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

Across all the energy sectors, 76 occupations will need more than 10 jobs annually. After examining demand for these occupations across all sectors of the economy and distributing completers proportionally, the study team found 62 energy occupations in Alabama with estimated labor shortages. Those with the largest projected labor shortages tend to be specific to the energy efficiency sector. The estimated workforce gaps by energy occupation for ARC Alabama are in Appendix I.

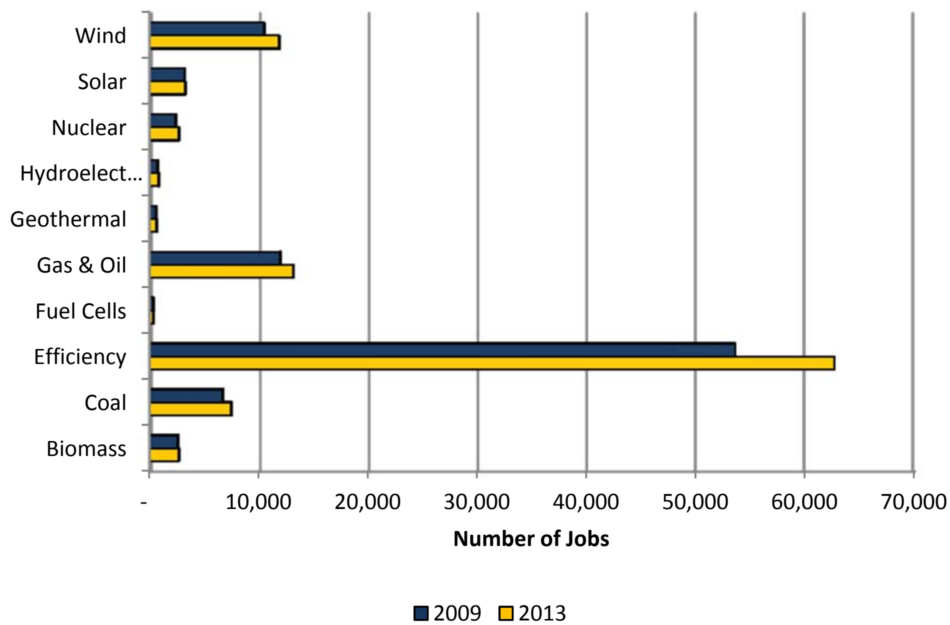
There are also some workforce shortages specific to ARC Alabama or only found in a few other states in the ARC region. For example, it is the only state with a projected gap in environmental engineers, forecast to add 27 new jobs between 2009 and 2013. In addition, the replacement needs will be nearly 10 percent of the 2009 employment level of 183 jobs, or about 11 jobs per year through 2013. The demand for environmental engineers is highest in the gas and oil energy sector followed by the coal sector and is the result of anticipated new jobs in these sectors, although there are some replacement needs for existing environmental engineers. Alabama, like Pennsylvania, has a significant projected surplus in the number of graduates in programs that train for engineering managers – 323 more than needed on a yearly basis, which could potentially be moved into environmental engineering with some retraining and skills upgrading.

Alabama is also the only state with a projected shortage in chemical plant and system operators even though this occupation appears to be shedding jobs in this region. The demand for chemical plant and system operators is forecast to come strictly from the need to replace existing workers in the gas and oil, biomass and solar energy sectors.

4.2.2 Georgia

Employment in the energy sector in Georgia has been in flux since 2002 (Figure 3). From 2002 to 2007 it experienced considerable growth, more than 19 percent, only to decline between 2007 and 2009 when losses in the region surpassed 16,000 jobs. Growth from 2009 to 2013 is expected to rebound some with employment gains estimated to add 13,000 jobs by 2013. The increases in energy efficiency are not surprising or unique to the ARC region. In addition, many of the non-renewable energy sectors are expected to see employment growth of more than 10 percent between 2009 and 2013 in Georgia. On the renewable energy side, wind is the most promising for new job creation in the near future.

Figure 3. Employment by Energy Sector, ARC Georgia, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

Fifty-five energy-related occupations are projected to experience workforce shortages by the end of 2013. As elsewhere, the energy efficiency sector generates much of the construction and extraction and maintenance and repair occupational needs. A full list of the in-demand occupations and their projected annual surpluses and gaps can be found in Appendix I.

Unlike many of the other ARC regions, Georgia is projected to have shortages in engineers mainly the result of new engineering job requirements in the non-renewable energy sectors. Electrical engineer and industrial engineer needs are primarily driven by replacement needs in Appalachian Georgia. All of the engineering occupations with projected workforce shortages require at least a BS degree and in some cases advanced training or a degree plus work experience based on the BLS' eleven category system that reflects the most common path into an occupation based on data collected on the existing workforce.

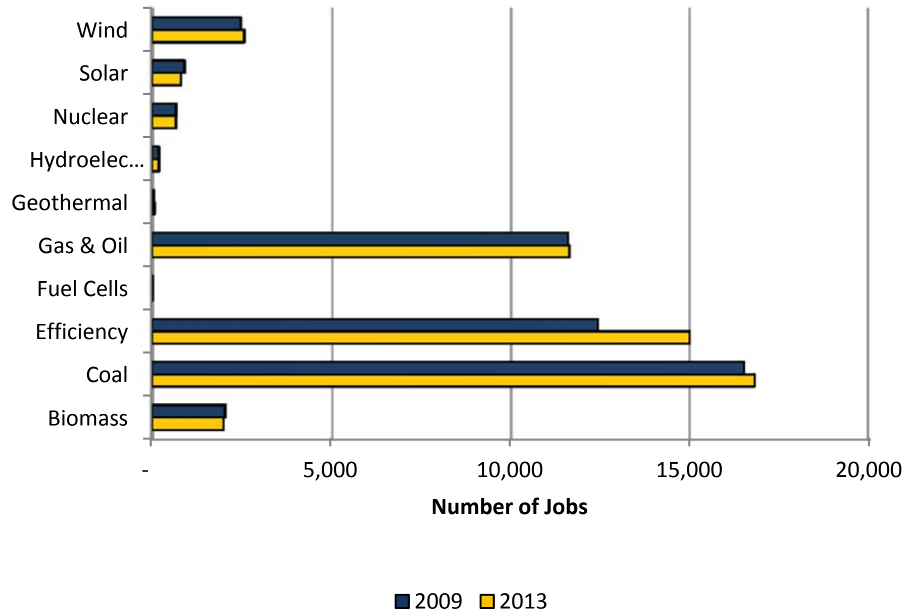
Annual surpluses in Georgia's trained workforce exist as well, but most are less than 20 jobs. The average number of graduates in educational programs that train for architectural and civil drafters and welders, cutters, solderers, and brazers on an annual basis far exceed the demand for those occupations in the counties in Georgia that occupy the ARC region. An average of 147 graduates are trained as architectural and civil drafter while only 21 jobs are needed in the region on an annual basis which results in an estimated annual surplus between 2009 and 2013 of 126 jobs. For welders, cutters, solderers, and brazers the surplus is 119 jobs.

4.2.3 Kentucky

The energy sector in Appalachian Kentucky comprised 46,900 jobs in 2009. Since 2002 the sector's employment growth has been almost 10 percent and is expected to continue creating 2,800 additional jobs by 2013. The largest energy sector in Kentucky, based on employment, is coal with over 16,000 jobs in the ARC region, with expected growth of two percent of the 2009 employment by the end of 2013. Along with West Virginia, Kentucky is one of two states with more employment in an energy sector other than energy efficiency. The occupational mix within the coal energy sector is dominated by construction and extraction, installation, maintenance, and repair, and transportation and material moving occupations. Together the jobs associated with these occupational categories account for 74 percent of the total coal workforce. Conversely, the renewable energy sectors in the Appalachian Kentucky have a large percentage of jobs in the production occupations. Figure 4 below provides a visual representation of total employment by energy sector for the ARC region of Kentucky.

Kentucky has few needs in the occupations categorized under management, computer-related, architecture and engineering, and physical science technicians and thus the region does not have any projected gaps or workforce shortages. Based on the comparison of the average annual graduates and estimated annual demand between 2009 and 2013, Appalachian Kentucky is close to meeting the needs of the industries within the energy sector.

Figure 4. Employment by Energy Sector, ARC Kentucky, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

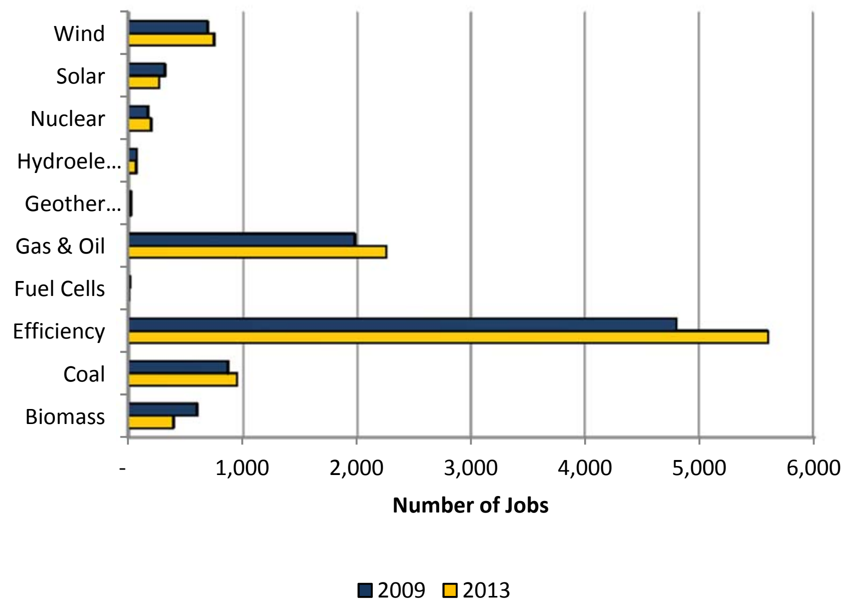
Overall, the study team found 32 in-demand occupations in the region with 26 of them having projected shortages by 2013. The majority of the workforce shortages are in construction and extraction and transportation and material moving type occupations. The five occupations with the largest projected workforce shortages are carpenters, construction laborers, operating engineers and other construction equipment operators, painters, construction and maintenance, plumbers, pipefitters, and steamfitters. A full list of the surpluses and gaps can be found in Appendix I. Kentucky is also one of only two ARC states with projected shortages in mobile heavy equipment mechanics. The other is West Virginia, also with a large coal energy workforce.

Kentucky has a surplus of potential labor of construction managers, heating, air conditioning, and refrigeration mechanics and installers, industrial machinery mechanics. The state is also the only region that has a surplus of labor, based on training via credit programs, trained for the electrician occupation. Considerable oversupply of labor is, however, projected to occur in first-line supervisors/managers of construction trades and extraction workers – an occupation projected to have large workforce shortages in several of the other ARC state regions – and welders, cutters, solderers, and brazers.

4.2.4 Maryland

Job growth in the energy sector occurred between 2002 and 2007 with employment increasing from more than 9,300 jobs to over 10,000 jobs by 2007. During the recent recession, however, the sector began to shed jobs in the region, which resulted in a 6 percent loss of employment between 2007 and 2009, leaving employment totals in the region at roughly 9,500 jobs at the end of 2009. Appalachian Maryland does not have a lot of energy resources and thus employment in all the energy sectors is rather limited. Energy efficiency, as in most ARC states, is the largest energy sector in the ARC region with 50 percent of energy employment. Gas and oil employment make up another 21 percent while coal employment is roughly 9 percent of total energy employment. Figure 5 displays employment for 2009 and projections for 2013.

Figure 5. Employment by Energy Sector, ARC Maryland, 2009 & 2013



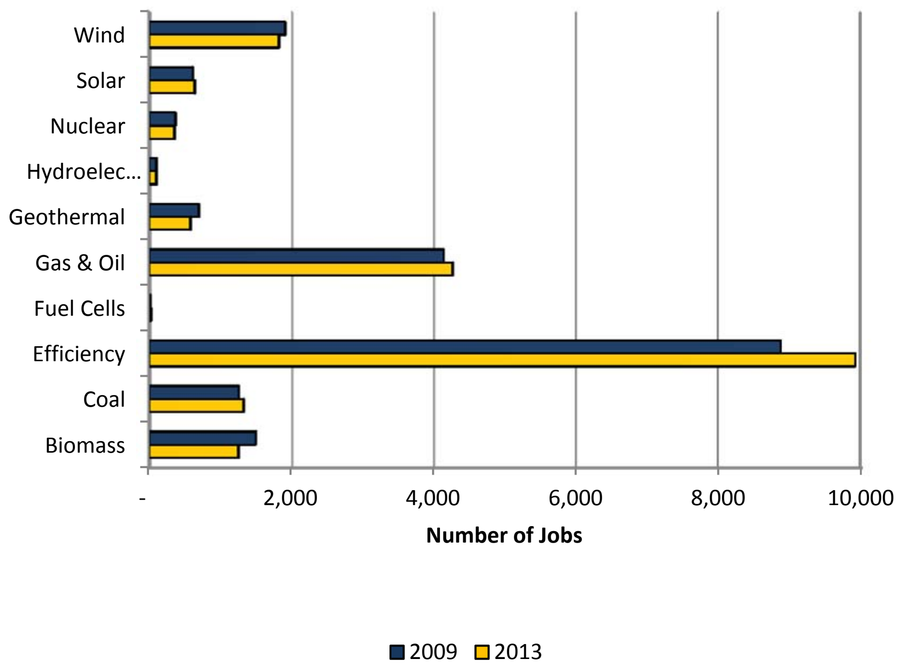
Source: EMSI Complete Employment and Penn State University.

The study team found eight in-demand occupations across the ARC Maryland energy sector, all of which are projected to have workforce shortages in the coming years except for construction managers. The shortages in the other seven occupations are a result of the lack of credit programs located in the Appalachian region of the Maryland. Jobs associated with the electrician occupation have the greatest projected annual workforce needs with 49 annual openings. Slightly more than half of the workforce needs in the electrician category are from new job creation with the rest, 22 jobs annually, due to replacement needs. Most of the demand is spurred by the growth in employment in the energy efficiency sector.

4.2.5 Mississippi

The ARC Mississippi energy sector experienced modest job growth over the last several years. Between 2002 and 2007 employment grew by 1.7 percent, a much smaller growth rate than shown in several other ARC states. Nearly 800 energy-related jobs were lost from 2007 to 2009 resulting in a 3.9 percent decline in sector employment. Job growth is expected to rebound over the coming years, with a four percent expected increase between 2009 and 2013. The energy efficiency sector employs the most jobs based on 2009 and 2013 employment, as shown in Figure 6 below, and is expected to experience the most growth over the time period.

Figure 6. Employment by Energy Sector, ARC Mississippi, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

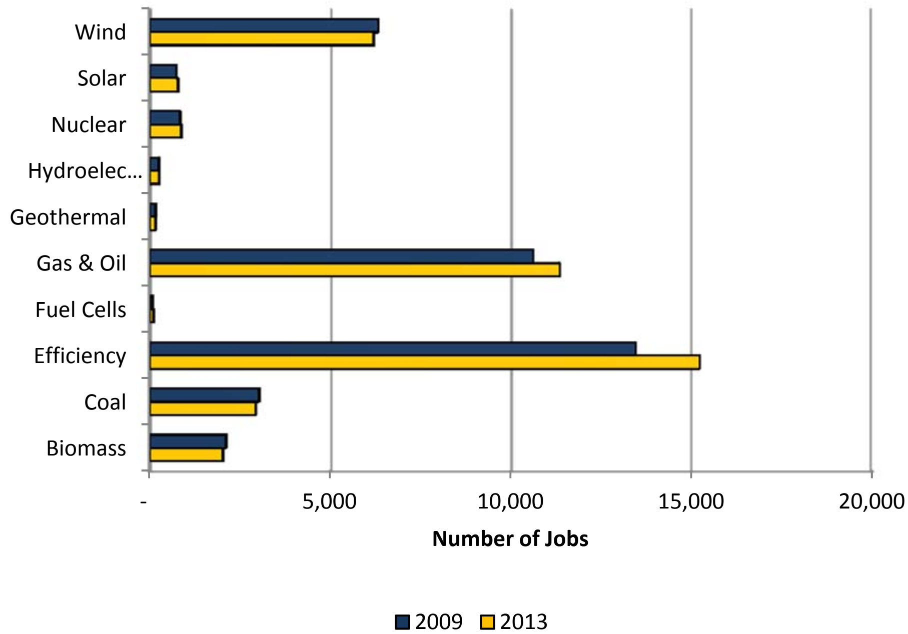
Energy sector workforce shortages are projected for nine occupations in ARC Mississippi, mostly in construction and extraction occupations. The projected shortages are similar to many of other ARC states, e.g., carpenters, construction laborers, electricians, plumbers, pipefitters, and steamfitters, sheet metal workers, and heating, air conditioning, and refrigeration mechanics and installers. Mississippi, unlike other ARC regions does not have any shortages in occupations in the production or transportation and materials moving occupations.

4.2.6 New York

Overall the Appalachian region of New York had strong employment gains in energy-related sectors. Between 2002 and 2007 employment in the sector grew by 6.2 percent, from 35,400 jobs to over 37,600 jobs. While the energy sector experienced significant job losses in the Appalachian region of most ARC states from 2007-2009, New York was a different story. Employment in the energy sector suffered very little during the last recessionary period. Reported employment in 2007 was 37,640 jobs, just 38 jobs more than the 37,602 jobs reported in 2009. Growth over the next four years is projected to be six percent with total projected employment in 2013 of just under 40,000 jobs.

The largest energy sectors are energy efficiency and gas and oil with 13,400 and 10,600 respectively (Figure 7). The energy efficiency and the gas and oil sectors are projected to grow modestly in the next few years, while employment in the wind energy sector is forecast to decrease. The projected 13 percent increase in jobs in energy efficiency from 2009 and 2013 is primarily due to job creation in the construction and extraction trade occupations. Conversely, the growth in the gas and oil energy sector is primarily due to the increased demand for jobs in transportation and material moving occupations. Also, the gas and oil energy sector in Appalachian New York has significant replacement needs.

Figure 7. Employment by Energy Sector, ARC New York, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

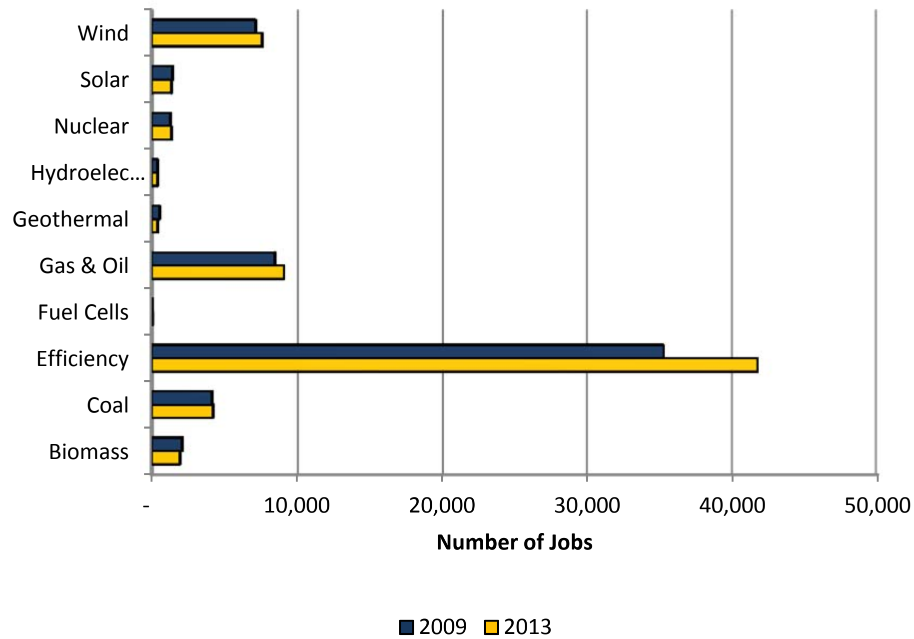
New York does not have any unique occupational workforce shortages, but the region does have 17 occupations that are likely to experience some shortages before 2013. Like several of the other states, the demand for carpenters and electricians is expected to be greater than the supply from credit programs in the area. A list of all the in-demand occupations and their workforce surpluses and shortages are identified in Appendix I.

4.2.7 North Carolina

Employment in 2009 in the energy sector of Appalachian North Carolina was about 60,800 jobs, well below the employment high of 69,700 jobs in 2007 and below the 64,600 jobs employed in energy in 2002. North Carolina was hit hard during the recession, shedding nearly 13 percent of the jobs in energy in its ARC counties during the recession. Energy sector employment in 2013 is likely to reach 68,000 jobs, a 12 percent increase from 2009 to 2013.

The energy efficiency sector represents, by far, the largest job producing economic engine in the state. The largest job producers outside of energy efficiency are gas and oil and wind. Both are expected to grow by 6-7 percent between 2009 and 2013, however for differing reasons. Job growth in gas and oil will be felt by those occupations related to pump operators, both wellhead and other, and is driven by the need for jobs that do not exist in 2009. Job growth in the wind energy sector is primarily the need for replacement jobs. The primary occupations within the wind sector are team assemblers and machinists. Figure 8 displays employment for 2009 and projections for 2013.

Figure 8. Employment by Energy Sector, ARC North Carolina, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

While the demand for machinists is among the highest in the ARC region, the educational providers in the region are more than able to meet those needs. A review of average annual graduates in the region exceeds the annual demand by more than 19 graduates a year. Other occupations in the region with a projected surplus in employment in the near term are construction managers, heating, air conditioning, and refrigeration mechanics and installers, and welders, cutters, solderers, and brazers.

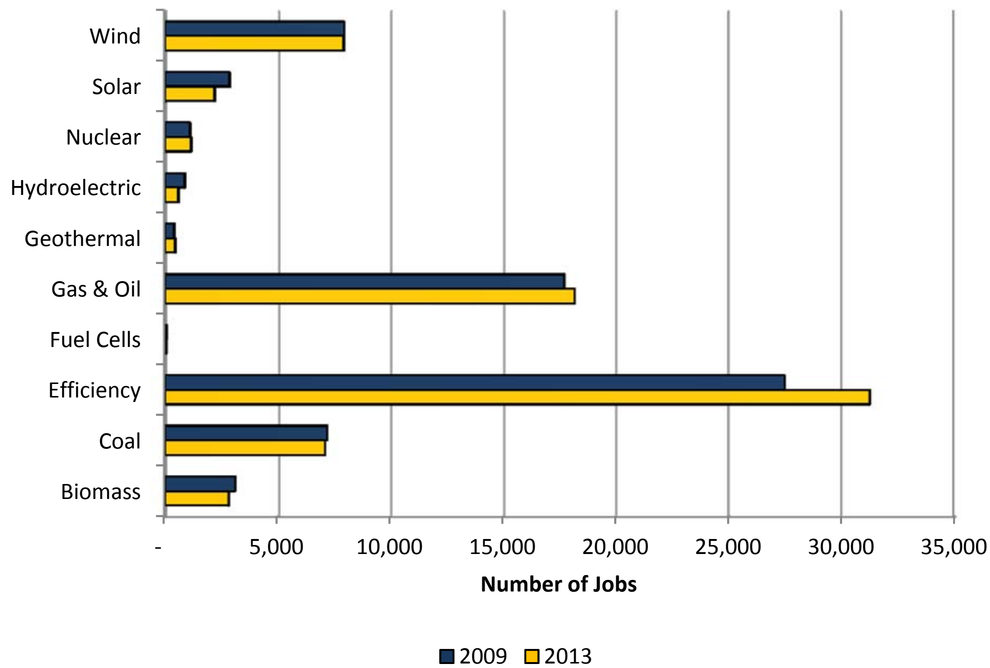
Because energy efficiency is so dominant in terms of employment, most of the needs are related to occupations in the construction trades. The occupations with the greatest workforce shortages, after reviewing the number of graduates in the region, are carpenters, construction laborers, electricians, painters, construction and maintenance, plumbers, pipefitters, and steamfitters.

North Carolina is one of the few states that has a shortage in the number of civil engineers in Appalachia though it should be noted that the state's engineering schools are not in the NC ARC counties. The demand for civil engineering occupations in North Carolina is driven by the need for new jobs in the non-renewable energy sectors (coal, gas and oil, and nuclear). Overall, the energy sector in Appalachian North Carolina has 31 in-demand occupations with projected workforce shortages, which are detailed in Appendix I.

4.2.8 Ohio

Appalachian Ohio's energy sector employed 68,600 in 2009, roughly 7,000 less than the sector employed in 2007. Employment growth is expected to rebound in the coming years, but 2013 employment of almost 72,000 jobs is still shy of the employment in the years leading up to the recession. Employment by energy sector for 2009 and projected 2013 is displayed in Figure 9.

Figure 9. Employment by Energy Sector, ARC Ohio, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

In 2002, the energy sector in the ARC region of Ohio was responsible for the employment of 74,000 jobs, which grew to 75,300 in 2007.

Appalachian Ohio produces more graduates than needed in programs related to industrial production management and electrical engineering. The same is true of construction managers, which has a projected workforce annual surplus of 118 graduates. Ohio has surpluses in five of the in-demand occupations found in the state's Appalachian region, including construction laborer occupations where Ohio is the only ARC state not to have a projected shortage.

Projected workforce shortages are expected to be greatest in installation, maintenance, and repair; production; and transportation and material moving occupations. The largest shortage is likely to be electricians, with an average of 60 more jobs than available graduates. However, this portion of the analysis does not account for those trained in non-credit and apprenticeship programs.

4.2.9 Pennsylvania

Pennsylvania has the greatest number employed in the energy sectors in the ARC region, with over 234,000 in 2009. Employment declined by four percent from 2007 to 2009 and employment levels are lower than earlier in the decade when the Appalachian region employed 239,000 in the various industries in energy. Forecasted growth through 2013 suggests a turnaround for the energy sector as a whole, with 7,300 jobs added over the four-year period, 2009 to 2013 (Figure 10). The newly created jobs will push employment totals for the sector above 2002 levels, but employment in the sector is not expected to reach the 2007 high of 244,000 jobs.

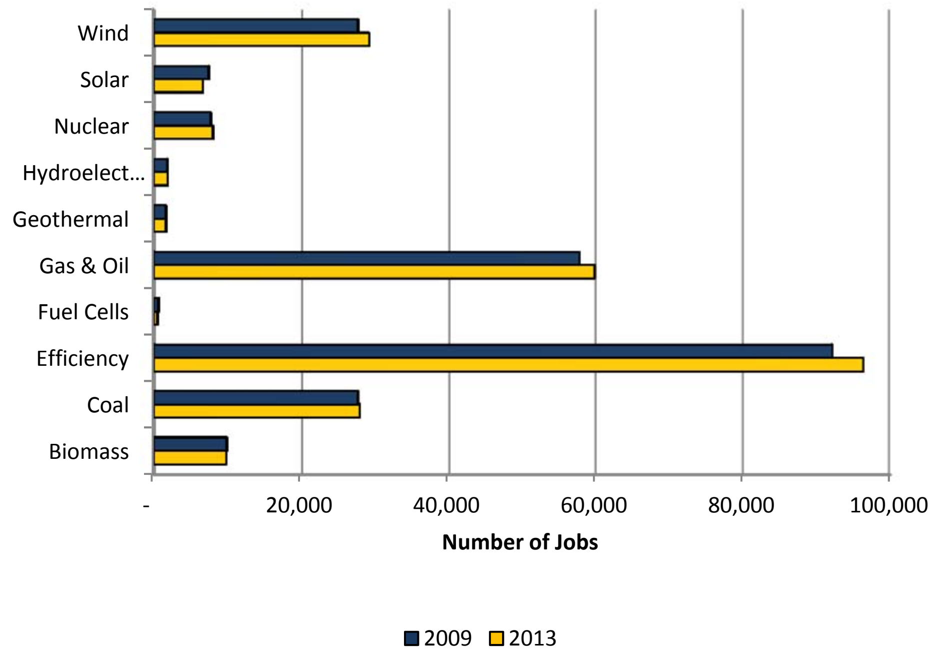
The largest energy sector in Appalachian Pennsylvania is efficiency, but the non-renewable sector of gas and oil also is a large employment generator. Combined, the two sectors employ 149,000 or roughly 64 percent of the total 2009 energy employment. Coal and wind energy each employ around 27,000 jobs; however, growth between 2009 and 2013 for the coal sector is projected to be one percent while the wind energy has a brighter employment growth outlook of five percent growth.

Natural gas exploration and extraction employment in Appalachian Pennsylvania is growing rapidly. A recent report prepared by the Marcellus Shale Education and Training Center and Penn State, found at www.msetc.org/docs/NeedsAssessmentwithcoverSW.pdf, suggests substantial employment impacts over the next five years. If the projections of this analysis, based on projections of new wells drilled, are accurate employment needs in non-renewable energy production may be greater than estimated in our analysis.

The ARC region of Pennsylvania is rather unique in that it has more graduates on average in engineering and in engineering and scientific technician programs. The large number of engineers produced annually suggests that Penn State, in particular, may be exporting engineers to other regions in the country. Regardless of what happens to the graduates of these programs after they complete their training, there were very few needs in the engineering and scientific technician related occupations in Appalachian Pennsylvania. Where there were shortages projected, they tend to be in relation to specialized engineering occupations, like mining and geological engineers (including mining safety engineers and petroleum engineers) or in electrical and electronics and mechanical drafters.

Overall, the ARC region of Pennsylvania has the greatest number of occupations with projected workforce shortages in the ARC region. Much of the shortage is in construction and extraction trade occupations. For example, the top five occupations with the greatest projected workforce shortages are: carpenters, construction laborers, electricians, plumbers/pipefitters/steamfitters, and machinists.

Figure 10. Employment by Energy Sector, ARC Pennsylvania, 2009 & 2013



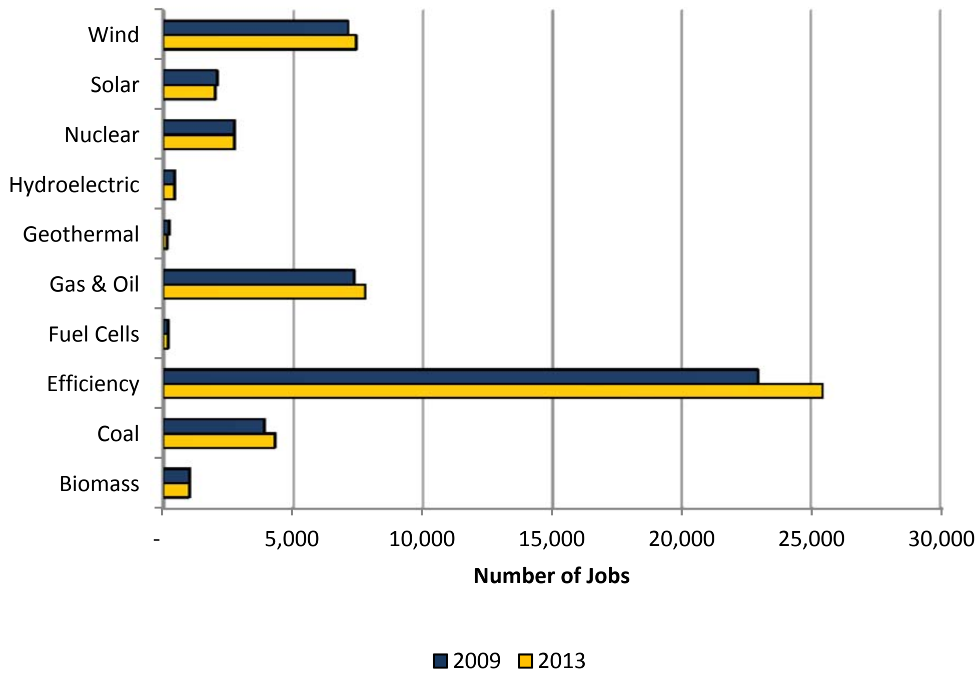
Source: EMSI Complete Employment and Penn State University.

The Pennsylvania ARC region has projected workforce shortages that do not show up in other ARC states. For example, Pennsylvania is the only region with shortages in petroleum engineering, despite having education directly related to the training of engineers for the petroleum sector. Also, the region has a projected workforce shortage in structural iron and steel worker, rock quarry splitters, control and valve installers and repairers, numerical tool and process control programmers, electromechanical equipment assemblers, crane and tower operators, welders, and a host of other production occupations. For a full list of the surplus and gaps projected for the state of Pennsylvania see Appendix I.

4.2.10 South Carolina

Between 2002 and 2007 employment in the energy sector in Appalachian South Carolina increased by nearly 10 percent from 46,500 jobs to 51,000 jobs. During the recession, employment decreased to 47,900. South Carolina's energy sector is expected to make a full recovery by the end of 2013, with employment levels above the year 2007 high of 51,400. The forecast increase in employment is the result of 10-11 percent increases in jobs in the coal, energy efficiency and gas and oil sectors of the energy sector in the ARC region of the state (Figure 11).

Figure 11. Employment by Energy Sector, ARC South Carolina, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

South Carolina has 24 occupations within the energy sector that are forecast to have more annual labor demand than graduates to meet the demand in the region. Much of the workforce shortages are likely to occur in the construction and extraction trades. The one occupation with a forecast shortage in workers that is unique to South Carolina is architectural and civil drafters, driven by the jobs created in the gas and oil, coal and nuclear sectors. This occupation is also estimated to have replacement needs.

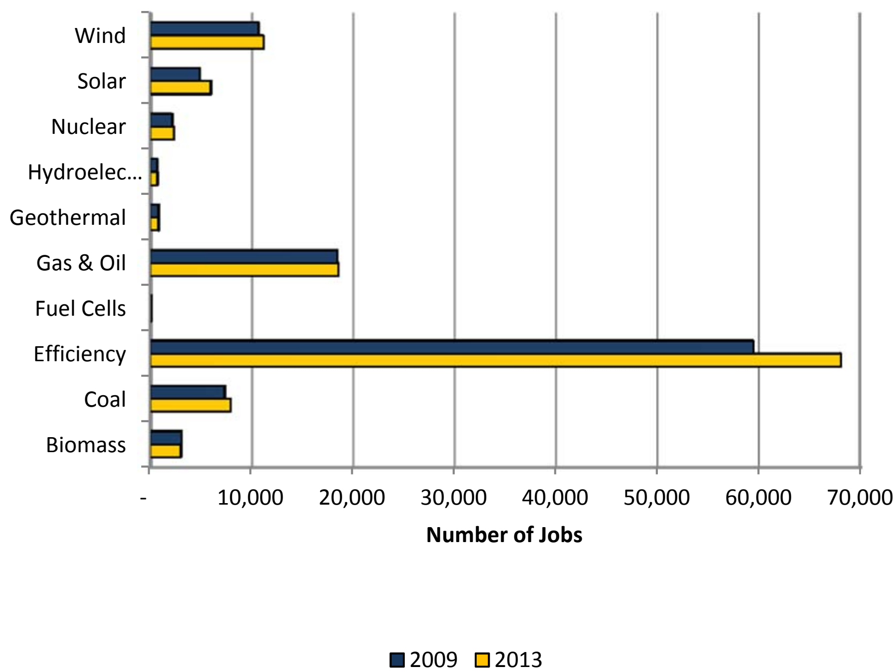
While the ARC region is projected to have a shortage of architectural and civil drafters, the region has a surplus in architects and civil engineers. Although not ideal for recent graduates in these occupations that require at least a BS degree, it could be possible for them to apply for jobs at a more advanced level of the architectural and civil drafting position that requires only a postsecondary vocational award. Other occupations in the region with projected surpluses of graduates are electrical engineers, construction managers, and industrial engineers. A full list of the projected workforce shortages and surpluses can be found in Appendix I.

4.2.11 Tennessee

Even with a rocky period from 2007 to 2009, the energy sector in Appalachian Tennessee has seen significant employment growth since 2002. Employment between 2002 and 2007 grew from 100,000 to 113,850, an almost 14 percent increase over the five-year period. The contraction of jobs during the recession reduced employment to 107,500 jobs by the end of 2009. Job losses were greatest in the construction trades and extraction occupations during that period.

Employment growth is expected to increase by more than 10 percent from 2009 to 2013, reaching a high of 118,000 at the end of the time period. Growth will occur in many energy segments, as shown in Figure 12, but energy efficiency and solar have the most pronounced growth forecasts. Within the energy efficiency portion, growth is projected to affect the construction trades and extraction and installation, repair, and maintenance occupations. Production occupations like team assemblers, machinist, and cutting, punching, and press machine setters, operators, and tenders, metal and plastic are expected to see job growth within the solar energy sector between 2009 and 2013.

Figure 12. Employment by Energy Sector, ARC Tennessee, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

The projected employment needs of Tennessee's energy efficiency and solar sectors, based on the analysis of labor supply and demand, influence the labor shortages through 2013. Most of shortages are in the same occupations – carpenters, electricians, plumbers, pipefitters, and steamfitters, construction laborers and managers – that are in greatest demand in the energy efficiency sector. The production occupations mentioned above as being in greatest demand also have some of the greatest shortages in all of the energy segments, some of which is due to new job creation in the solar energy sector and some of which is due to replacement job needs in the wind energy sector of ARC Tennessee.

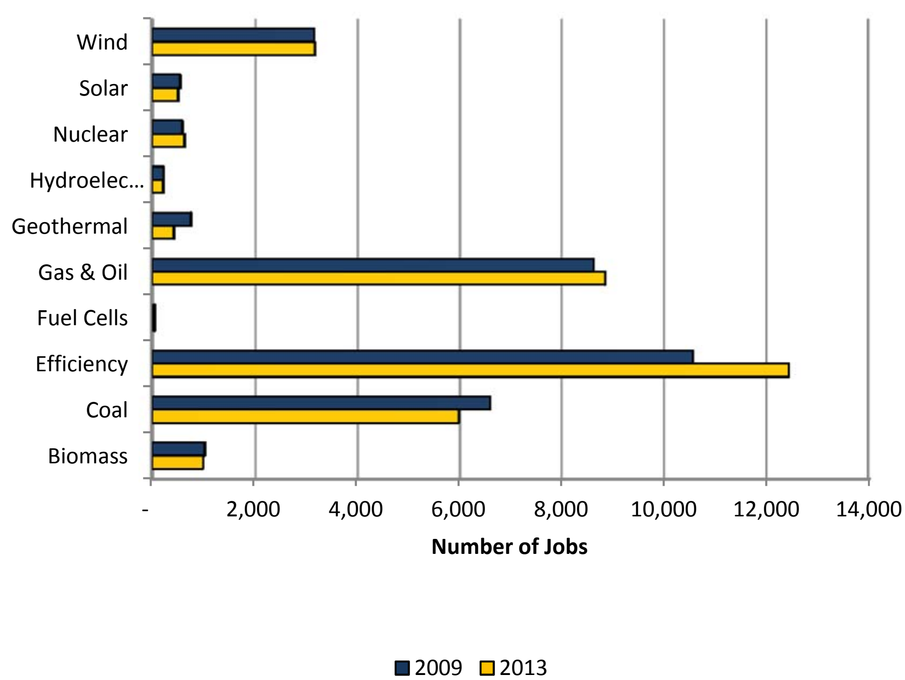
4.2.12 Virginia

Energy employment in Appalachian Virginia has stayed relatively the same since 2002 fluctuating between 31,000 and 33,000 jobs. Growth between 2002 and 2009 resulted in a four percent increase in jobs in the region. However there was a dip in employment of 1,000 jobs between 2007 and 2009. The forecast for employment in 2013 is expected to bring energy employment to its highest level of 33,200.

The dominant employment sectors within energy, shown in Figure 13, are energy efficiency, gas and oil, and coal. Through 2013, energy efficiency and gas and oil are expected to grow 18 percent and 12 percent respectively. However, employment in the coal sector is projected to decrease by nine percent from the 2009 employment level. Occupations in the coal sector have some significant replacement needs, but unfortunately those needs do not offset the large job losses in occupations like operating engineers and other construction equipment operators, continuous mining machine operators, shuttle car operators, and mine cutting and channeling machine operators.

Thirteen occupations are expected to have annual workforce shortages in the energy sector in the region. The shortages in Appalachian Virginia are similar to those in other ARC region. The construction trades and extraction workers occupational category has the occupations – carpenters, electricians, etc. – with the greatest projected workforce shortages.

Figure 13. Employment by Energy Sector, ARC Virginia, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

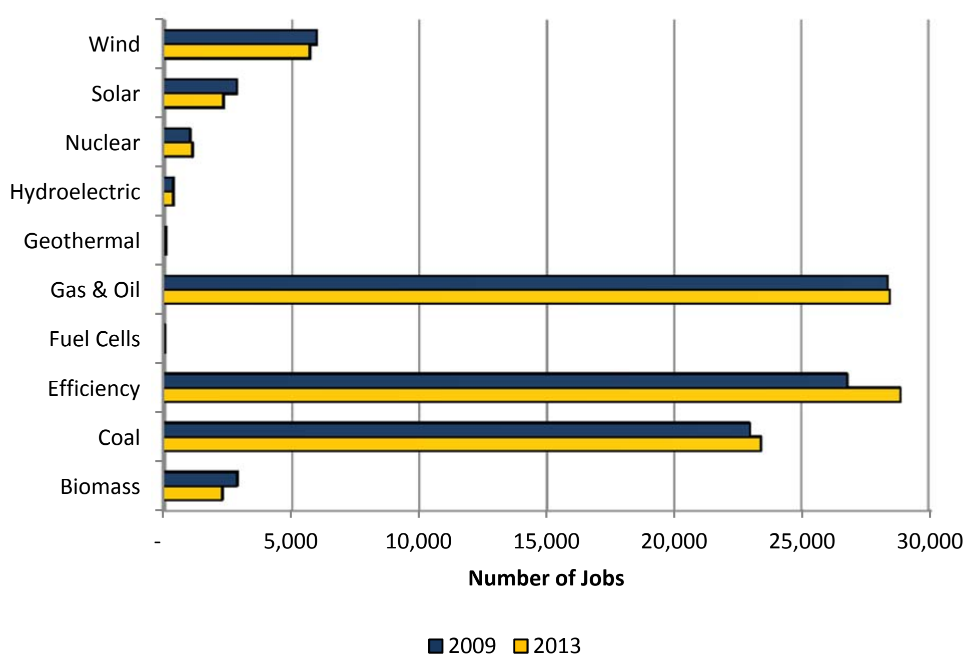
4.2.13 West Virginia

Employment in the energy sector of West Virginia grew from 86,200 in 2002 to 93,800 in 2007. The state is dominated by gas and oil, coal, and energy efficiency. These three sectors make up 86 percent of total 91,200 jobs in the energy sector in 2009. Figure 14 shows the employment by energy sector for 2009 and projected employment for 2013.

Future job growth is minimal in the energy sector with employment expected to increase 1.5 percent from 2009 to 2013. Employment in gas and oil is expected to remain stagnant over the time frame while coal is forecast to grow by just two percent of 2009 jobs. Energy efficiency and nuclear energy are both estimated to have employment growth of 8-9 percent. Employment growth in energy efficiency is projected to grow due to increased demand for new jobs. Coal is shedding jobs in the region but replacement needs far outweigh the loss of jobs in the region.

The gap analysis conducted for West Virginia looks very much like that of Pennsylvania. The state has 54 in-demand occupations, and 44 are projected to have annual workforce shortages by 2013. For the most part, the state has surpluses in jobs in managerial and engineering sectors of the economy, with the exception of mining and geological engineers, including mining and safety engineers, which has an average annual workforce shortage of ten jobs. However, the region has large shortages in most of the jobs that do not require four-year degrees, e.g., construction trades and extraction workers, installation, maintenance and repair, and production workers.

Figure 14. Employment by Energy Sector, ARC West Virginia, 2009 & 2013



Source: EMSI Complete Employment and Penn State University.

4.3 Findings from the Gap Analysis

- Workforce shortages are greatest in occupations related to construction trades and extraction, maintenance and repair, and production workers.

- While a few states appear to have some shortages in managerial occupations like industrial production manager, construction manager, and engineering manager, overall the labor needs for these jobs can be filled through the annual supply of graduates in each state ARC area.

- Many of the state Appalachian institutions are producing a glut of people trained to be construction managers and welders, cutters, solderers, and brazers.

- Replacement job needs (those jobs that arise not from newly created jobs, but from worker turnover and attrition) oftentimes dominate the demand for labor in the nonrenewable energy sectors.

5. LEARNING FROM THE CASE STUDIES

To continue to capture the employment and economic development benefits of the energy sectors, Appalachia's post-secondary institutions will have to respond and, in some places, lead the changes underway. To gain additional insights into the ways that higher education is doing that, we chose 14 higher educational institutions, one in each state and two (at one university) in West Virginia for more in-depth study. The following vignettes, provided in full in Appendix B, are based on a common protocol, which also is described in Appendix B.

Each institution profiled exhibits certain exemplary and/or innovative practices, although each approaches education and training in a slightly different way and develops its own spin on how to prepare the workforce based on the sector it targets and the economics of its region.

5.1 Capsulized Summaries

Alfred State College (ASC), which is part of the State University of **New York**, incorporates training in green practices and technologies into various courses and degree programs across the college. For example, the approximately 90 students earning an associate's degree in electrical construction and maintenance receive four weeks of coursework and hands-on lab work dedicated exclusively to renewable energy sources. ASC is installing renewable energy sources on its campus and already has three photovoltaic systems and four wind turbines on its Wellsville campus that were built by teams of students. One of the installed systems provides nearly half the energy demands of the School of Applied Technology's library and administrative offices. Though the college's renewable energy courses and training has, to date, focused on small-scale solar and wind systems and residential installations, several students have found jobs on new commercial wind farms that are starting to spring up in the upstate New York region as well as with firms that are looking for employees with skills in renewable energy source installation and maintenance. A team of students led a four-day workshop at the U.S. National Arboretum on the benefits, functions, design and installation of solar photovoltaic systems that was attended by homeowners, contractors, and engineers, culminating with the students installing a one kilowatt hour solar array to power the arboretum's irrigation system. This is part of a five-year cooperative agreement between ASC and the arboretum.

Appalachian State University (ASU) in Boone, **North Carolina** began its green revolution more than thirty years ago when it first started training students to build more energy efficient homes and develop new ways to harness the power of the wind and sun. In 2008 ASU's Research Institute for Environment, Energy, and Economics became an umbrella organization for the Appalachian Energy Center, Center for Economic Research and Policy Analysis (CERPA) and Southern Appalachian Environmental Research and Education Center (SAEREC). The Center offers training programs for the construction industry on retrofitting buildings to meet new energy standards and to make new construction more energy efficient. It also works in renewable energy fields, operating a site on Beech Mountain, NC to test small-scale wind turbines and capturing gas from smaller scale landfills in rural areas. The university's renewable energy program is embedded in its construction management and architectural technology and its appropriate technology program. Learning to install solar panels on a house is included in both programs. The programs are also hands-on. In the Renewable Energy Initiative (REI), students conceive, install and manage different energy-related programs at the campus, including installing North Carolina's largest wind turbine and installing solar panels to power the university's student union. This academic year, the college will offer its first "sustainable business" concentration in its MBA program.

Calhoun Community College in **Alabama** has a more focused approach to training for the energy industry. It offers an open enrollment seven-week, 280-hour non-credit pre-apprentice line worker program aimed at meeting the on-going needs of the energy industry for line workers. Developed in collaboration with two other community colleges, the program relies on the private sector and existing programs such as those offered by the Tennessee Valley Authority and Alabama Rural Electric Coop, and the college relies on retired industry workers as instructors. Offered twice a year, the program attracts only about 10 students per class and only about 60 percent of those complete, often due to the physical demands of the work.

Cleveland State Community College (CSCC) in southeastern **Tennessee –** where average energy consumption is among the highest and energy costs among the lowest in the U.S – is leading efforts to promote energy conservation in homes. Its program in energy efficient residential construction (EERC) began in 2005 with a Community Based Job Training Grant from the U.S. Department of Labor. Under the grant, CSCC developed six courses related to energy efficiency and alternative energy, including one in solar photovoltaic system design and one in ground source heat pumps that could be taken as part of an AAS degree in construction technology, as a Zero Energy Home Certificate program, or individually in any program based on interests. The college's rationale for embedding energy efficiency courses into construction technology is that there are many common elements in the job descriptions for traditional construction jobs and energy efficiency construction and retrofitting jobs. With about two in three students already working in the industry, the scheduling is very flexible. Enrollments have risen despite a weak labor market because students viewed the training as a competitive advantage and had the time for the program. CSCC also educates people about the need for energy efficiency and the opportunities for energy savings afforded by renewable energy sources. The college owns a trailer equipped with a solar panel array that travels to career fairs and events to raise interest in the program and provide a visual representation of the idea of green jobs and clean energy. In addition, CSCC partners with the local workforce investment agency to offer EERC courses as a series of modules leading to a certificate, typically taught over a 15-week quarter, offered as a 40-hour, week-long class.

Frostburg State University, a four-year university in western **Maryland**, offers a not-for-credit program to install residential wind and solar systems. The Wind and Solar Energy (WISE) program is offered in two stages. The first is an eight-week online course that includes a self-assessment test to gauge progress. The second is an intense three-day workshop at the campus that includes hands-on demonstrations. Faculty members are drawn primarily from private industry. At the end of the program, students can choose to sit for a Photovoltaic Entry Level Certificate of Knowledge Exam offered by the North American Board of Certified Energy Practitioners (NABCEP). Students, many of whom are contractors, tend to enroll to enter directly into the energy field or use the residential installation as a way to enhance their current position. Completers are able to enter the energy field with the ability to understand and install residential wind and solar systems. In the first two offerings, nearly 200 individuals went through the program, and in 2009, forty took the NABCEP test and thirty-six passed. Frostburg State recently received funding for a new building to house the Sustainable Energy Research Facility, including the WISE program.

Hocking College in **Ohio** has an advanced energy and fuel cell program that has been aimed at developing the fuel cell industry cluster in the state, and a vibrant clean energy sector in its own distressed rural area. In 2003, the Hocking College Energy Institute (HCEI), established in the 1980s to focus on gas-powered vehicles, re-oriented its curricula to address the needs of advanced energy and fuel cells and automotive hybrids. The new associate of applied science degree in advanced energy and fuel cells program was launched with three students. By the fall of 2009 it had 61 first-year students, double the previous year. Hocking now has an articulation agreement with the University of Minnesota at Crookston whereby students can complete an additional 45 credits in the School of Agriculture and Natural Resources and receive a B.S. in agricultural systems management with an emphasis in biofuels and renewable energy technologies. Although called a "fuel cell" program, graduates are prepared for technician positions to support a range of renewable energy sources and systems including solar, geothermal, biofuels, and hydroelectric. While focusing on fuel cells at the state level and working hand-in-hand with the Ohio Fuel Cell Coalition, the program targets the local concentration of solar and wind installation companies. As with any training initiative, there is a fine line between preparing students for future job opportunities in anticipation of industry development and training them for jobs that do not yet exist. Currently, jobs in research and development outnumber those in manufacturing though this is predicted to change as Ohio strives to be a leader in fuel cell manufacturing. To date, HCEI has had no trouble placing students in jobs in the fuel cell and advanced energy industries, probably due to the small size of the program and the fact that there are already a number of fuel cell firms in the state. HCEI also operates at the Logan-Hocking Industrial Park, which is owned and operated by the Hocking County Community Improvement Corporation (CIC), as an incubator, a business recruitment tool for alternative energy firms, and workforce development resource.

Kentucky Coal Academy in **Kentucky** is an open entry/exit workforce training program for the coal industry operating at four community and technical colleges in the Kentucky Community and Technical College System (KCTCS): Big Sandy, Hazard, Madisonville, and the lead college, Southeast Kentucky, that is aimed at a declining and aging workforce. Despite an expected loss of half of the mining workforce in the next five to seven years, the Academy aims to find replacements for the coal industry that are qualified and safety-conscious and have career pathways. Before the Academy was formed, all four colleges had mining programs but only two were active. The colleges have associate degree programs, certificate programs, and – an innovation in Kentucky – customized non-credit courses that can be converted to credit. A New Miner Cohort Program at Big Sandy, offered in partnership with local coal companies, is an accelerated 30-week program with job training and course work. Participants are evaluated by area coal companies and hired at $10 per hour to work while also attending training classes. The Mining Technology program enrolls mostly full time employed miners seeking retraining and certification to upgrade to a higher paying job. Many companies will either allow time in the schedule of an employee or pay for them to attend courses at the Academy, and the programs have no trouble attracting students. One challenge is finding qualified instructors and appropriate facilities and equipment to meet the rapidly evolving technology of the coal mining industry.

Lanier Technical College in **Georgia** offers three relatively new programs under its Electrical Utility Technology (EUT) program that prepare students for work in the electrical power industry. The three programs are a two-year Associate in Applied Science (AAS) electric utility technology degree, a 90-hour electrical utility technology diploma, and an entry-level 42-hour electrical utility technician certificate. The degree program was the result of a collaboration with the Georgia Energy and Industrial Construction Consortium, itself a partnership among the state's electrical and natural gas utilities and utility associations, nuclear, oil and gas industries, industrial construction industry, and state and federal offices of workforce development, labor and education. The coalition formed in 2007 to engage the energy industry in a plan to address the workforce needs of the energy sectors across the state, and particularly the aging of line workers. Enrollments jumped from 25 students the second year to 38 in its third year, with three out of four of the students employed at least part time. Power company employees serve as program instructors and members of the program's advisory board. In the near future, the college plans to add curricula in solar photovoltaic and solar thermal technologies through the Electronics Technology department of the school's division of industrial technology, and is currently preparing for the accreditation process. Individuals with some knowledge of electricity fundamentals now can take a 40-hour course in solar installation offered through the economic development arm of the technical college.

Mississippi State University's Mississippi State Industrial Assessment Center (IAC) audits energy and resource usage at no cost for small and mid-sized manufacturers located within 150 miles of the university. The audits, which are conducted by teams of undergraduate and graduate students and faculty, evaluate a site's energy-consuming processes, waste generation and handling, and production methods and report opportunities to reduce waste, save energy, and improve productivity. The program has been in effect since 1994, tries to conduct 25 assessments per year, and has documented savings to client companies of about $5 million per year. IAC takes on 6-7 engineering students who must commit to remaining at least three semesters at the IAC. Participating students, who are paid $7.50 to $9.00 per hour by IAC while conducting audits, can also get a certificate from the U.S. Department of Energy, which has supported the IAC in the past but has reduced its support. The reduction in funds meant that most faculty donate their time to the Center. But with the American Recovery and Reinvestment Act (ARRA) requiring companies to complete an audit before being considered for funds, there is now increased interest in the program among companies.

Penn Technical College's Marcellus Shale Education and Training Center (MSETC) is a cooperative venture with the Penn State Cooperative Extension program. The Marcellus Shale, believed to be the country's largest unconventional natural gas deposit, stretches from New York's Southern Tier region through Pennsylvania, Kentucky, West Virginia, Virginia and Ohio. The Center was launched in 2008 as a central resource for workforce development and education for the actors and communities involved in the burgeoning industry. Part of MSETC's mandate is to act as a central coordinating body for the fast growing Marcellus Shale industry. MSETC convenes an annual workforce forum that brings together workforce developers, educators and oil and gas exploration, production and service company representatives to share information on issues and industry needs. In November 2009, Penn College offered its first classes under the auspices of the MSETC and since has trained 275 incumbent workers from the oil and gas industries and companies looking for employment in natural gas. These courses can be as short as one day or up to three weeks. Many are non-credit and customized for individual companies, and offered through the Workforce Development and Continuing Education arm of Penn College of Technology, a four-year college. The school also trained about 100 new unemployed, underemployed or displaced workers for the industry referred by the state's one-stop career center system. Penn College offers a short-term pre-employment program called "Fit For Natural Gas", designed to prepare workers to be roustabouts, i.e., entry-level oil field laborers. In 2010, Penn College received a three-year grant from the National Science Foundation to offer courses to high school students for college credit that introduce them to the natural gas industry, and it is preparing to offer a two-year AAS degree program.

In July 2010, MSETC was awarded a $4.9 million grant from the US Department of Labor, Employment and Training Administration to create ShaleNET.org. ShaleNET.org is a consortium between Penn Tech, Westmoreland County Community College (lead agency), West Virginia Northern Community College, Eastern Gateway Community College in Ohio, and Broome Community College in New York. Their mission is "to design a comprehensive recruitment, training, placement, and retention program" for the natural gas exploration and production industry. In addition to the consortium members, MSETC has added additional key partners to this initiative including 15 Workforce Investment areas serving 69 counties across Pennsylvania, West Virginia, Ohio, and New York (if/when the moratorium is lifted), the Pennsylvania Independent Oil and Gas Association, the Veterans Administration and other education and training resources within the Marcellus Shale footprint.

Tri-County Technical College (TCTC), which serves three counties in the upstate region of **South Carolina**, has a welding program that prepares students to work in the region's nuclear power industry and for the contractors that provide maintenance services to nuclear plants. In the past five years the welding program has doubled in size, and day and evening sessions keep the program's 35 welding stations in constant use. The program is planning an expansion into a new welding facility that will allow the program to double again, as well as the early phases of developing training specific to the nuclear power industry. Welding is housed within the industrial technology and maintenance program at the college. A handful of the approximately 120 students are enrolled in two certificate programs, but the majority of students are in the 42-credit diploma program or 67-credit associate's degree program. The AAS degree program provides the closest fit to the nuclear power industry because it provides experience in tungsten inert gas (TIG) welding for small-diameter piping, jobs that pay upwards of $25 an hour. Students have traditionally found employment with Duke Energy and other contractors in the area, such as DZ Atlantic. Recently, some students completed work co-op rotations at Duke Energy while enrolled at TCTC to gain professional experience and, in some cases, academic credit.

Virginia Polytechnic Institute and State University (Virginia Tech) is one of only three universities in the ARC region that offers degrees in mining engineering. It consistently awards more than 30 BS degrees in mining engineering each year, an estimated 25 percent of all U.S.

graduates, plus a smaller number of Masters and PhD degrees – almost always with a 100 percent placement rate. While geared towards coal production, the program trains individuals for a variety of mining-related sectors including aggregate mining. Undergraduate students are given a standard introductory course in geology and courses in various aspects of coal mining, such as mine reclamation and environmental management, resource recovery, and underground mine design. In recent years the proportion of engineering students going into coal production has increased. Virginia Tech houses two research centers on campus that specialize in advancing mining technology. The Virginia Center for Coal and Energy Research, created by the Commonwealth of Virginia, focuses on technical aspects of coal mining and assisting Virginia's general energy plans. The Center for Advanced Separation Technologies is a consortium of five universities supported by DOE funds, including Virginia Tech, that focuses on "the production of clean solid, liquid and gaseous fuels from domestic energy resources in an efficient and environmentally acceptable manner."

West Virginia University's Petroleum and Natural Gas Engineering (PNGE) department offers BS, MS, and PhD degree options and is fully accredited by the Accreditation Board for Engineering and Technology. Students interact with industry through the U.S. Department of Energy's National Energy Technology Laboratory in Morgantown, West Virginia and gain hands-on experience working on production sites, secondary and enhanced oil recovery projects, compressor stations, gas storage fields, and corporate offices. Graduates not only have the ability to design experiments and analyze data, design a system, component or process to meet needs of an employer, and work on multi-disciplinary teams but will evaluate and understand the impact of engineering practices in a global context. As the demand for oil continues to increase, interest and enrollment in the PNGE program continues to increase dramatically, and in the spring semester of 2011, 200 undergraduate, excluding freshman, and 43 graduate students were enrolled. The program is very hands-on, and graduating seniors complete a capstone course for which industry is consulted about establishing real-life projects for the graduates of the program to complete. Those members of industry participate in the development of the project and in determining the grade of the graduating senior. Most faculty have prior industrial experience, however, teaching ability and research potentiality are highly valued assets. The College of Mineral Resources enlists a freshman recruiter to travel to area high schools with a presentation of the college's programs and career opportunities available with offered degrees. The program allows students within the common market states to pay in-state tuition so recruitment is not exclusive to the state of West Virginia.

West Virginia University's Advanced Virtual Energy Simulation Training and Research Facility (AVESTAR), is a joint program of the Department of Energy's National Energy Technology Laboratory (NETL) and its Regional University Alliance and West Virginia University National Research Center for Coal and Energy's (NRCCE) Advanced Energy Initiative. The simulator's installation will be complete by March and courses will be ready for enrollment by June 2011. The Department of Energy and the energy industry are seeking ways to effectively meet current demand and carbon management requirements and determine whether or not new technologies should be implemented. The Department of Energy has studied integrated gasification combined cycle (IGCC) as a new clean coal technology and, as West Virginia and Pennsylvania are regionally marketed as the nexus for energy solutions, the organization is supporting the development of the AVESTAR program at West Virginia University.

5.2 Findings from the case studies

- Institutions offered a wide range of programs for the sector, from a few non-credit courses, through certificates, diplomas, concentrations in existing AAS or BS programs, to – among universities – post-graduate programs.

- Most of the institutions have chosen to specialize and develop particular expertise in a specific area and use that to branch out into related energy sectors. These choices typically reflect a close connection to local and regional economic and workforce needs. Fuel cells, green construction, natural gas, nuclear energy, coal, and wind and solar are all areas in which colleges chose to specialize. A few, such as the ShaleNET.org natural gas consortium program, address multi-state needs.

- The most successful colleges offering programs in alterative energy were early adopters, gaining a foothold in renewable energy sectors before it was popular and building a reputation that now serves them well. Appalachian State, Mississippi State, and Hocking all have at least 15 years experience.

- Enrollments in programs for the energy industry in many institutions are low and some have depended recently on federal stimulus funding. As a result, programs will be forced to attract more students to become self-sufficient, find other sources of funding, or cut back.

- Successful programs have close ties to industry partners and engage industry leaders in their communities in planning and developing the programs needed to grow their industry, offering work experience, and teaching courses. They also prepared their students for industry-based certifications.

- A number of programs used close ties to related economic and community development organizations to strengthen their programs.

- Several profiled institutions are embedding alternative energy approaches into their curricula rather than developing stand-alone programs. For example, a construction technology program would make sure that weatherization practices are made standard practice in basic classes.

- Flexible scheduling is required to meet the needs of incumbent workers and older students. For many, careers and skills in energy fields are pursued to add new career enhancing skills in current jobs or to change careers. Thus, they may not be able to attend or need a full-time program. Effective programs understand this reality and design curricula with the flexibility to accommodate a wide range of students. For instance, Frostburg State University offers an online curriculum supplemented with a short on-site workshop to train individuals in the installation of residential wind and solar systems.

- The universities profiled, especially those focused on non-renewable sectors, meet the large demand for qualified managers and engineers. The near 100 percent placement rate of mining engineers at Virginia Tech University, for instance, is a testament to the quality of the program and demand for its graduates.

- No institution appears to place enough emphasis on entrepreneurship and opportunities for new business development or self-employment as consultants. In community colleges in particular, programs are driven by employment and it is generally assumed that completers will join an existing business. Yet the developing fields of energy efficiency and installation of renewable energy sources offer many opportunities for start-ups and self-employment.

6. POLICIES AFFECTING THE ENERGY INDUSTRY

6.1 Federal Policy

Federal policy helps establish the paradigm for energy development and creates the framework for types of energy development. To that end, RTS uses three precepts to inform its analysis of federal energy policy.

First, federal legislation helps establish the emphasis and approach to energy issues. While much of the legislation addresses regulatory matters, it also funds research, provides tax incentives, and funds infrastructure, such as America's electric power grid. The results of these functions promote growth in certain energy sectors, may cause new occupations to emerge, and may decrease jobs in other energy sectors. For example, the provision of stricter air quality standards for mining or burning coal may reduce the demand for jobs in the coal industry, while providing tax breaks or incentives might foster the construction of nuclear power plants and thus increase jobs in nuclear energy. In addition, it is useful to examine some of the trends in proposed legislation because they are a useful predictor of which energy sectors are likely to grow. An example is the Kerrey-Lieberman Cap-and-Trade Bill, which may pass in some form in the future and would affect jobs across the energy spectrum.

Second, there are cases where federal funds have a direct effect on job training in the energy sector. The stimulus funds provide two examples, which we describe below. First, the USDOL-ETA used stimulus funds to competitively award nearly $500 million to states and local areas for energy workforce training, primarily at community colleges. Second, the Department of Energy has used stimulus dollars to provide nearly $8 billion for activities in weatherization and energy efficiency. This has spurred a large increase in energy efficient construction.

Third, the federal legislation and regulations create a framework for states to develop energy policies and initiatives that have a direct impact on the growth or decline of particular energy sectors. State activity as a whole exceeds federal activity and has a more immediate impact on job growth and the development of new occupations.

The two major pieces of energy legislation passed by Congress over the last six years are the Energy Policy Act of 2005 (EPAct05) and the Energy Independence Security Act (EISA) of 2007. The first comprehensive energy bill in 13 years, EPAct05 advanced energy policy designed to increase energy production, promote and support energy conservation and encourage investment in new energy technologies and sources. The second omnibus energy policy law passed in recent years, EISA, focuses on increasing energy efficiency and the availability of renewable energy. According to the Congressional Research Service, the bill contained four major provisions. It increased Corporate Average Fuel Economy (CAFE) standards; set annual Renewable Fuels Standards (RFS) for blending of biofuel with gasoline and increased taxpayer funding for the production of biofuels; set a variety of new energy efficiency equipment standards for lighting and for commercial and residential appliance equipment; and repealed two oil and gas tax subsidies to offset the estimated cost of implementing the new CAFE provisions. Additionally, EISA addresses a number of other energy efficiency and renewable energy source areas. It increased federal R&D funding for solar energy, geothermal energy and marine hydrokinetic renewable energy technologies; expanded federal research on carbon sequestration technologies; created green jobs training programs for energy efficiency and renewable energy workers; launched new initiatives for highway, sea and railroad infrastructure and established a new Office of Climate Change and Environment within the Department of Transportation; provided for a new program to offer small business loans for energy efficiency improvements; and addressed the modernization of the electricity grid to improve reliability and efficiency. That federal legislation influences this analysis and resultant findings and recommendations in at least three ways.

1. First and foremost, the impact of these laws is reflected in state actions and reactions and, to the extent these new policies and programs have affected energy employment demand, they are reflected in our energy-related employment projections.

2. Two of the major thrust areas of EPAct05 have been reported as generating significant job impacts soon after the law's enactment. According to the Senate Energy and Natural Resource Committee, in a report issued by the Committee, the ethanol requirement in the energy bill would create 234,840 jobs during its first year. With respect to nuclear energy the Committee reported that utility companies and consortia are in the process of preparing application for 25 new nuclear power plants due to EPAct05's provisions for loan guarantees, production tax credits, and insurance protection against licensing delays and litigation. These plants would in turn create 40,000 – 45,000 construction jobs and 10,000 new high paying jobs within these plants though the recent Japanese nuclear disaster is likely to impact this projection. Increases in energy employment demand in states such as Kentucky, South Carolina and West Virginia with programs to encourage ethanol application development and ethanol production or North Carolina, South Carolina and Pennsylvania with very strong nuclear production profiles could well be generated and reflected in this analysis' employment projects due to EPAct05.

3. The EISA's provision to create green jobs training programs also will have a direct impact on energy jobs training and demand in the ARC states. It instructed the Secretary of Labor, in concert with the Secretary of Energy, to establish energy efficiency and renewable energy training programs within six months of EISA's passage. The programs established under this provision include National Energy Training Partnerships Grants, State Labor Market Research, Information, Labor Exchange Research Program Grants, State Energy Training Partnership Program Grants, and the Pathways Out Of Poverty Demonstration Program. Energy training funding levels associated with these programs received a big boost through the federal stimulus package.

6.1.1 Energy Training Funding Provided to States from The American Recovery and Reinvestment Act

The Employment Training Administration of the United States Department of Labor used the federal stimulus funds (American Recovery and Reinvestment Act of 2009 - ARRA) to target specific occupations for training. This was a bold new step at the federal level because 80 percent of Workforce Investment Act funding goes to states by formula, and the states and local workforce boards have the flexibility to decide on training targets. Nearly $500 million was focused on preparing workers for jobs in the following energy and energy efficiency fields.

Nearly $500 million was focused on preparing workers for jobs in the following energy fields:

- The energy-efficient building construction, and retrofit industries
- The renewable electric power industry
- The energy efficient and advanced drive train vehicle industry
- The biofuels industry
- The deconstruction and materials use industries

Each of the grants has significantly increased the training of energy workers, and has had the corollary effect of causing the states for the first time to reorient their training efforts, primarily at community colleges, for jobs in the energy field. It should be pointed out that these are the programs that are most explicitly geared towards enhancing employment and training in the energy sectors; individual grants or allotments under other programs may have assisted in energy training in a more limited manner.

Table 9 shows the amount of ARRA grants made to the thirteen Appalachian Region states. The state level grants – Energy Sector Partnership, Labor Market Information Improvement, and Weatherization – are funding activities for every part of the state. The local grants – Energy Training Partnership, Pathways Out of Poverty, and Green Capacity Building – are directed at specific localities. But even if a local grant is not in an ARC county, the innovation, reorientation to energy training, and the development of new curriculum will change the way all of these institutions are conducting training, and has the potential to cause changes in the entire state. There is a third method for funding some of these grants, and that is in a consortium where several locales or several states are funded together. If any of the consortium members were in the Appalachian Region, that grant was included. While it is impossible to estimate the exact amount of increased training or job placements, the dollar amounts do point to a large increase in energy training activity. As shown in the Table 9, New York, Pennsylvania, North Carolina, Ohio, and Maryland all participated in multiple training consortium grant awards.

A total of $1,796,783,523 has been awarded to individual ARC states through the American Recovery and Reinvestment Act. The figure is dominated by the state allocations from DOE's Weatherization program ($1,714,272,141). The DOL-related energy training program awards totaled $82,511,382 in individual awards for the ARC states.

Table 9. US Department of Energy and US Department of Labor Energy Grants to ARC States, 2010

Grant	Alabama	Georgia	Kentucky	Maryland	Mississippi	New York	North Carolina
Green Jobs Capacity Building Awards	$70,736	$100,000	$100,000	$197,128		$200,000	$100,000
Energy Training Partnership Grants- Single						$2,802,269	
Pathways Out of Poverty Grants- Single		$3,753,579				$3,715,931 $4,000,000	
State Energy Sector Partnership and Training Grants	$6,000,000		$4,740,457	$5,793,183			$5,976,512
State Labor Market Information Improve. Awards Individual	$1,145,210	$1,177,975	$1,250,000			$1,112,207	$946,034
Weatherization Formula Grants 2009 Allocations	$71,800,599	$124,756,312	$70,913,750	$61,441,745	$49,421,193	$394,686,513	$131,954,536
Total	$79,016,545	$129,787,866	$77,004,207	$67,432,056	$49,421,193	$406,516,920	$138,977,082

Table 9. US Department of Energy and US Department of Labor Energy Grants to ARC States, 2010, continued

Grant	Ohio	Pennsylvania	South Carolina	Tennessee	Virginia	West Virginia	Total ARC States
Green Jobs Capacity Building Awards	$100,000	$199,524			$335,793	$98,700	$1,501,881
Energy Training Partnership Grants-Single	$8,795,129	$1,408,601			$3,865,480		$16,871,479
Pathways Out of Poverty Grants- Single		$2,732,719					$6,486,298
State Energy Sector Partnership and Training Grants	$6,000,000	$6,000,000				$6,000,000	$40,510,152
State Labor Market Information Improvement Awards Individual	$1,015,700	$1,250,000	$763,175	$765,340			$9,425,641
Weatherization Formula Grants 2009 Allocations	$266,781,409	$252,793,062	$58,892,771	$99,112,101	$94,134,276	$37,583,874	$1,714,272,141
Total	$282,692,238	$264,383,906	$59,655,946	$99,877,441	$98,335,549	$43,682,574	$1,796,783,523

Source: US Department of Labor, Employment Training Administration, 2010; US Department of Energy, Weatherization and Intergovernmental Program, EE-2K, Office of Energy Efficiency and Renewable Energy, 2010.

State Labor Market Information Improvement Grants: This solicitation was for state workforce agencies to "collect, analyze, and disseminate labor market information" and help individuals find employment in the energy efficiency and renewable energy sectors. The $50 million announcement was followed up by research done by O*NET to define "Green Jobs". Results were intended to help show clear career pathways in the energy sector. The information to be collected under the grant is to be for both state and regional levels in order to allow for macro and micro level data analysis. Additionally, there is a strong outreach component of the grant: the data collected is to be disseminated to help the public workforce system, educational institutions and other organizations that offer workforce development training to enable individuals to pursue a career in green jobs occupations. Forty-five states, the District of Columbia and Puerto Rico were awarded $48.8 million for this effort. A total of just over $9.4 million was awarded to ARC states.

State Energy Sector Partnership and Training Grants: The centerpiece of the U.S. Department of Labor's energy workforce training efforts is directed specifically to state workforce investment boards. ARC states were awarded over $40.5 million in Energy Sector Partnership and Training grants and 34 states received awards between $2 million and $6 million. Seven ARC states – Alabama, Kentucky, Maryland, North Carolina, Ohio, Pennsylvania and West Virginia – received between $5 and $6 million to train 9,700 participants over three years in renewable energy and energy efficiency.[6]

In addition, the focus on energy training will encourage community colleges to retool their curricula and training approaches and promote changes in their WIA- and state-funded training. As community colleges network and share curricula, energy training will expand in these states.

Energy Training Partnership Grants: The DOL sought to encourage new partnerships that focused on training dislocated workers, youth, and unemployed individuals for jobs in the energy fields. Partners included labor organizations, employers in energy efficiency/renewable energy industry, and the workforce system. The $100 million was awarded to 25 grantees, in most cases to an organized labor entity. Ohio received two grants to assist the efforts of the Ohio Electrical Labor Management Cooperative Committee and the International Training Institute for the Sheet Metal and Air Conditioning Industry. The Community Housing Partners Corporation in Virginia received a grant to train and employ workers to weatherize homes. One result of these grants will be the development of new approaches to energy workforce training, with input from both labor and business. ARC state grant awards for this program totaled just under $16.9 million.

Pathways Out of Poverty Grants: The U.S. Department of Labor focused this grant opportunity on providing individuals in high poverty areas with workforce training and supportive assistance for jobs in the energy field. Some $150 million was awarded to 30 local grantees and 8 recipients with a national scope on energy-efficient construction and retrofit, renewable energy, biomass, solar energy, and energy auditing/assessment. This grant targets dislocated workers, minorities and women for training in energy-related fields. Most of the training will occur at community colleges, but some will be provided by local branches of

[6] ETA News Release 1/10/2010. Each grant offered estimations on numbers of individuals expected to be trained.

national community action agencies, such as Goodwill Industries, Opportunities Industrialization Centers, and SER, which focus on services to the Hispanic population. ARC states were awarded a total of $14.2 million from this program.

Green Capacity Building Grants: A total of $5 million was made available to active grantees to expand training programs to include green jobs. The grants were primarily for capacity building to build infrastructure to increase training and job placement activities in green jobs. The DOL intended that the workforce training funds would help support individuals seeking entry-level positions in the green industry, including energy-related occupations, which would lead to a career and advancement of a career in the industry. The Department funded $5.8 million for this award and a total of 62 awards were made in 30 states and the District of Columbia. Awardees targeted specific populations that had been affected by the economic downturn such as American Indians, women, at-risk youth, and farm workers. The Green Capacity Building program awarded $1.5 million to ARC states.

U.S. Department of Energy: The Department of Energy (DOE) plays a major role in shaping energy trends in the nation and in the states through tax incentives that stimulate private sector investments in specific energy sectors, such as wind and solar, energy efficiency, and alternate energy. It promulgates regulations to slow down the use of fossil fuel by requiring reductions in carbon emissions and invests in infrastructure, such as improving the power grid, which results in additional jobs for line workers, electrical workers, and electrical engineers. DOE's Weatherization Assistance Program provides funds to each state and territory to construct or retrofit homes for people below the poverty line in order to increase insulation replace doors and windows and do everything possible to homes so that they will need less heat in winter and less air conditioning in summer. The funds go to the states, which fund local offices that in turn fund community action agencies, which then directly hire individuals to make these homes more energy efficient or subcontract with other groups for construction.

The $4.7 billion in federal stimulus funds more than quadrupled the DOE funding to the states. Eligibility was reduced from 150 percent of the poverty level to 200 percent of the poverty level, which increased the eligible population by 53 percent. In addition, the amount that can be spent on each home was raised from $2,000 to $6,500. If the maximum is reached on each project, over 615,000 homes will be weatherized by June 30, 2011 generating many skilled jobs in the construction and electrical fields. Over $1.7 billion dollars was allotted to ARC states through the DOE funding formula.

6.2 State Policy Trends

Overall, state legislative policies are focused on promoting stable and adequate energy infrastructure and supplies, incentivizing particular energy sources based on a state's energy assets and goals, and catalyzing energy sectors for economic development potential.

6.2.1 Energy Efficiency and Renewable Energy

Most recent state legislative activity related to energy has been in the realm of energy efficiency and renewable energy. The spike of oil prices in 2008, the recession, and concerns about both the environment and energy security have combined to focus on clean energy and energy efficiency as routes to improving the economy, stimulating job growth and protecting the planet. While the ARC states have been active participants, overall they have not been at the forefront in terms of strength and scope of legislation passed according to national rankings. According to the American Council for an Energy Efficiency Economy, only three ARC states (NY, PA, MA) are in the top half of states in terms of strength and scope of energy efficiency measures. Five ARC states (NY, TN, AL, MD, VA) are in the top half of all states in terms of electricity from renewable energy, according to the federal government's National Renewable Energy Laboratory.

More encouragingly, according to Pew Charitable Trusts' national rankings of clean jobs in 2007, nine of the thirteen ARC states were in the top half of all states in terms of absolute numbers. Five ARC states (SC, MS, TN, NC, GA) were among the top 25 in terms of clean energy job growth in the previous decade. In addition, seven ARC states (NY, PA, OH, MD, WV, VA, and NC) have Renewable Portfolio Standards (RPS) that require electric utilities to include a specific minimum percent of renewable energy sources within their energy portfolio. These renewable sources tend to be important drivers for job growth.

Within renewable energy a review of state legislation and programs reveals evidence that states emphasize different sources based on their renewable energy assets and potential. For example, Mississippi, South Carolina, Alabama, Georgia, Kentucky and West Virginia are supporting biomass, especially from wood products. Virginia, North Carolina, Maryland and New York are particularly emphasizing wind power. Maryland, Ohio and Virginia have preferential treatment for solar power in their state energy policies. South Carolina is emphasizing hydrogen and fuel cell development. South Carolina, Georgia, Alabama and Kentucky are focusing on biodiesel. The selected comparison states, California, Illinois and New Jersey, generally have made stronger commitments to energy efficiency in recent years than ARC states, with California also the national leader in promoting renewable energy.

6.2.2 Coal, Natural Gas, Oil and Nuclear

Kentucky, West Virginia, Ohio and Pennsylvania place emphasis on policies supporting energy from coal and in particular promoting the development of clean coal technologies, including carbon sequestration, through research and development investments and tax incentives. Utilizing coal bed methane is a priority in West Virginia and Pennsylvania. Mississippi, Kentucky, West Virginia, and New York emphasize policies for natural gas storage. Offshore oil and natural gas exploration has been a topic of policy debate in Virginia and North Carolina, and a reality for Mississippi. However, the Gulf oil spill may limit further development of these resources. South Carolina and North Carolina are focusing on nuclear power with South Carolina taking the lead. Pennsylvania is also a major nuclear power producer. Among comparison states, Illinois focuses heavily on nuclear and clean coal technologies and New Jersey is a large nuclear power producing state.

The states within the footprint of the Marcellus Shale deposit, particularly Pennsylvania, New York, Ohio and West Virginia, are developing policies that deal with both the opportunities for natural gas exploration and production and related job implications along with the environmental issues surrounding the new technologies needed to access this resource. New York has instituted a moratorium on horizontal/directional drilling, also known as hydraulic fracturing, over concerns related to water quality. Other states are moving forward with drilling while examining the environmental issues. Pennsylvania Governor Tom Corbett's *Marcellus Shale Advisory Commission* is an example of efforts to deal with the various issues.

6.2.3 Workforce Implications

As mentioned earlier in this section, it is difficult to draw direct connections between state energy policies and workforce impacts. However, it is reasonable to expect that those states with stronger energy efficiency measures in place will see more demand for those skills, at least at the margin. And states that emphasize particular types of renewable energy may see more demand in those areas. Increased demand will likely result in additional education and training capacity for the emphasized energy sectors. This information needs to be weighed and balanced against federally supported energy policies and initiatives, company and labor market data, and other project data to more completely ascertain the energy workforce needs and opportunities for the ARC region.

6.3 Findings on Federal and State Policy

It would be somewhat of a reach to assert a direct connection between legislative priorities and significant job growth. Over time, however, state policies will affect the mix of skills the energy sector requires. For example:

1. States that emphasize particular types of renewable energy will likely see increased employment demand in those areas that will produce demand for greater education and training capacity for the emphasized energy sectors.

2. States within the Marcellus Shale deposit are grappling with policy issues surrounding natural gas exploration and production involving horizontal/directional drilling. States are attempting to balance the economic and employment opportunities created by exploration and production with environmental concerns over new production methods.

3. Identifying and monitoring the areas and sectors of emphasis within state energy policies and legislative actions would enable the ARC to better align its support for new energy-related job opportunities more directly with member state priorities on a state-by-state basis. With state budgets likely to remain tight for the foreseeable future, focused ARC support could help to strengthen education and training programs in areas of strong energy job growth and/or strategic importance to the region. The projections in this report can be used as an effective source for prioritizing areas where investment would be effective across the ARC region and its states.

4. In terms of investing time and resources into monitoring legislation and policy changes, what happens at the state level, from the ARC perspective, appears to represent a higher priority for two reasons. First, jobs are created and training programs implemented at the state level. Second, each ARC state emphasizes certain energy sectors based on their historic assets and their aspirations. What matters most is not that federal energy policy and legislation is passed or changed but how the states respond to and apply it.

7. KEY FINDINGS

Based on the literature review, survey, interviews and case studies, and data analyses, the following observations summarize what was learned about skill gaps in various Appalachian states and in Appalachia as a region.

7.1 Findings related to Educational Institutions and Training Programs

1. **The region's workforce has access to a wide array of programs at universities and four-year colleges to meet the professional needs of the workforce.**

   Eight ARC states have undergraduate and graduate science and engineering programs that match the needs of the energy sectors. The remaining five states have access to land grant universities that lie outside the ARC region but serve its ARC counties. Three universities in the region have mining and mineral engineering programs and two have nuclear engineering programs. (See Table 4, pg. 36 for details)

2. **Community colleges are the primary sources of skilled labor and entrepreneurs for the energy sectors.**

   Based on the 98 colleges that responded to a survey, only a small proportion of them address any single energy sector. Three in four, however, have committed to developing new courses for other energy sectors. Recognizing the opportunities, especially in energy efficiency, management, and renewable energy, for self-employment and new business formation, about two in five colleges include an entrepreneurial component in their energy programs. (See Section 3.3 for details)

3. **The majority of education or training for renewable energy and energy efficiency are either not-for-credit or courses within other programs.**

   The vast majority of "green" skills are new requirements for existing occupations, not entirely new occupations. Therefore, the most effective way to teach energy conservation and management is to integrate it into existing curricula and/or to develop modules that can fit into other programs such as construction, automotive, engineering, and agriculture. For example, a construction technology program would make sure that weatherization practices are made standard practice in basic classes. "Green" is a context in which students learn as well as a skill set. About 39 percent of industrial maintenance programs, 29 percent of construction programs, 32 percent of manufacturing programs, and 13 percent of architecture programs devote three hours or more to energy efficiency or management. (See Section 3.3 for details)

4. **Some of the most successful programs in renewable energy or conservation were early adopters.**

   The programs that have gained a foothold in renewable energy sectors before it was popular have built a reputation that now serves them well. Appalachian State, Mississippi State, and Hocking all have at least 15 years experience. In addition, some community colleges such as Chattanooga State and Cleveland State in Tennessee and Zane State in Ohio have added AAS degrees in several areas. (See Section 5 for details)

5. **Close ties to industry and economic development partners enable success in developing effective programs.**

   Successful programs engage industry leaders in their communities in planning and developing the programs needed to grow their industry, offering work experience, and in teaching courses. They also prepare their students for industry-based certifications. A number of programs used close relationships to economic and community development organizations to strengthen their programs. (See Section 5 for details)

6. **Flexible scheduling of training and coursework is required to meet the needs of incumbent workers and older students.**

   Effective programs are those that understand the constraints of their market and design programs with the flexibility to accommodate a wide range of students. For many students, careers and skills in energy fields are pursued as add-ons to current careers or as basic skills enhancement. They may not be able to or need to devote a full time course of study. Effective programs offer flexibility with online and accelerated curricula plus remedial programs. (See Section 5 for details)

7. **Most institutions do not appear to place enough emphasis on entrepreneurship.**

   Colleges tend to assume that students' goal is employment yet there are many opportunities in energy sectors for new companies and self-employment. Most of the class offerings in entrepreneurship are generic and do not reflect the specific entrepreneurial needs within the various energy sectors, particularly green energy opportunities. (See Section 3.3 and Section 5 for more information)

7.2 Findings related to Economic Development

1. **The largest employment in energy is in energy efficiency.**

   Employment in energy efficiency fields accounted for about 43 percent of all energy-related employment (renewable energy, non-renewable energy and energy efficiency) in 2009 and is the field on which much of the federal funds for green jobs have been focused, although in 2013 employment still will not have returned to its 2007 employment level. (See Section 2 for details)

2. **Certain regions, especially in central Appalachia, are still dependent on employment in non-renewable energy production.**

   Within the renewable and nonrenewable energy production sectors, fossil fuels and nuclear accounted for about two-thirds of the region's energy employment in 2009 and renewable sources, about one-third. Employment in fossil fuels is expected to grow slightly from 2008 to 2013 while employment in renewable energy sources will decline about 8 percent, much of it due to the importing and outsourcing of manufacturing. Increasing natural gas exploration and extraction using horizontal fracturing techniques is leading to significant employment gains in areas within the Marcellus Shale natural gas deposits within Appalachia. (See Section 2 for details)

3. **The greatest workforce needs are for lower skilled jobs.**

   Overall, the region appears to project the largest labor shortages in specialty trade, production, and maintenance and repair occupations. Nearly all of the states have gaps (estimated shortages in the supply of graduates) in carpenters, construction laborers, first line supervisors/managers of construction trades and extraction workers, operating engineers and other construction equipment operators, electricians, steam & pipefitters, sheet metal workers, helpers of electricians, electrical power-line installers and repairers, and team assemblers. To fulfill these skill needs, workers and employers tend to rely heavily on less-than baccalaureate credit programs, non-credit courses, and on-the-job training provided by regional career centers and community/technical colleges. (See Section 4 for details)

4. **There is likely to be a surplus of applicants for highly skilled jobs in the near future.**

   Many of the managerial jobs require some combination of a bachelor's degree with some on the job training, specialty trade, production, and other "hands-on" learning. Demand for industrial, construction, and engineering managers was high in most states. For example, nearly all of the mining engineering graduates at Virginia Tech take jobs in their field. However, the estimated supply of graduates is projected to meet or exceed this demand. These workers also tend to be mobile and are willing to move for employment opportunities. (See Section 4 for details)

5. **Demand for programs can be high even in occupations showing little absolute growth due to labor market turnover and as a result of new skill requirements in existing occupations.**

   Many energy jobs are in sectors with a relatively aged workforce. Both coal mining and various manufacturing industries tend to have a large number of workers nearing retirement age. Demand for replacement workers due to retirement will continue to be strong. In addition, most energy fields are undergoing significant changes in production methods and technology and require retraining of existing workers to remain competitive. (See Section 3 and Section 4 for details)

6. **Response by the private sector and consumer behavior will largely influence the growth of renewable energy development and demand for new workers and new skills.**

   The growth of renewable energy sources – especially solar and wind – will depend heavily on state-based renewable standards and incentives. Ultimately, it will be the response of the private sector to the new standards and incentives and the willingness of consumers to adopt energy-efficient practices that will cause the increased development and growth of alternate energy production. Clean energy jobs grew in nine ARC states between 1998 and 2007, but only three grew at above the U.S. average. (See Section 6 for details)

8. RECOMMENDATIONS

The research into trends in Appalachia's energy sectors and in the supply and demand for employment in those sectors suggests a number of action items for the region and for the Appalachian Regional Commission. Some require additional resources, some reallocating existing resources, and some simply changing practices. These recommendations are based on both the research conducted within this project as well as our experiences, knowledge and expertise gained from previous work in innovative approaches to workforce development, much of it conducted for ARC.

8.1 Educational Institutions and Training Programs

1. **Develop specialized centers of excellence or cluster hubs in various energy subsectors.**

   The specialization and centralization of expertise and experience (not delivery of education) in a particular niche of the energy sector allows colleges to cost effectively develop high levels of expertise and knowledge and provide resources that can be shared within the ARC region. BioNetwork in North Carolina has done this very successfully for that state's biotech cluster by designating six different community colleges to serve as centers of excellence for various aspects of biotech. The web site http://www.rtsinc.org/clusterhubs describes dozens of other examples in the ARC region and around the world.

2. **Establish regional industry councils for each subset of the energy sector.**

   The councils would need to reflect multi-county effective economic and labor shed regions to be successful. Such councils would have responsibility for monitoring trends, identifying new and emerging skill requirements, coordinating the educational systems, and identifying internship positions for students. They would be organized similarly to the skills councils that are common in Europe and have been adopted successfully in the state of Washington. See http://www.washingtonskillscenters.org/ or http://www.evta.net/evta_employment_html/new_skills_for_new_jobs.html for examples. Within the Appalachian region the ShaleNET program associated with Penn Tech's Marcellus Shale Education and Training Center is an example.

3. **Strengthen the contextual entrepreneurial content of programs for employment in energy sectors.**

   The support system for energy fields – particularly energy efficiency and solar installation – is conducive to freelance consultants and microenterprises. Whereas most colleges and universities have strong entrepreneurial programs, very few are aimed at the energy fields or the specific context in which those entrepreneurs will be working. Entrepreneurial teaching models, such as the Institute for Virtual Enterprises, could provide that context.

4. **Expand online capabilities for those courses that do not require "hands-on" learning to make it easier for working adults to enroll and to take specialized courses not offered locally.**

   Because so many students are already in the workforce and/or have family commitments, and because travel in the mountains can be difficult, the schools should take advantage of distance learning wherever feasible. Using the Internet, students would have access to a wider array of classes and possibly to work environments under different economic, political, and social conditions.

5. **Expand the use of blended models of training that include both online training elements augmented by "hands-on" learning.**

   Blended models combine online instruction with supervision and personal interaction between students and faculty. This model has been shown to be more effective than online only training and allows for lab and other hands-on learning in a supervised setting.

6. **Encourage more articulation agreements among secondary schools, community colleges and four-year institutions.**

   Articulation is a systematic, seamless student transition process from secondary to postsecondary education that maximizes use of resources and minimizes content duplication. These agreements can, for example, allow high schools students to simultaneously take classes in a local community college with a goal of attaining both a high school and community college degree in a shorter period of time.

   Articulation agreements are generally developed one by one between institutions. State or regional agreements would enable more students to pursue higher levels of education more easily and minimize dead end career paths. See http://www.ncpublicschools.org/docs/cte/publications/administrative/articulationagreement.pdf for an example agreement.

7. **Educational institutions should develop or strengthen their relationships with community-based and non-profit organizations.**

   Community-based organizations and other non-profits often have the trust of, and more experience in reaching and working with, lower-income and marginalized students. These non-profits could help ensure these populations get the support they need to succeed and move them into career tracks.

8. **Support participation of Appalachian community and technical colleges in inter-regional and international networks to encourage sharing and cross-fertilization of ideas, innovations, and curricula.**

   Community college faculty and administrators have few opportunities to learn from places outside of Appalachia. Networks offer rural colleges that are often isolated from ideas and innovations in other parts of the U.S. and world a chance to be connected and be part of the emerging energy sustainability networks. Examples include the Alliance for Sustainability (http://wwwccsustaiabilityalliance.com) and the Trans-Atlantic Technology & Training Alliance (http://www.ta3online.org).

8.2. Economic Development

1. **Recognize the employment and entrepreneurial opportunities in both renewable and non-renewable energy production and energy conservation.**

   In the area of renewable energy, our research suggests that there are untapped entrepreneurial opportunities for self-employment and micro-enterprises. Within the non-renewable energy sectors, opportunities for economic advancement within Appalachia are related more to replacement employment needs, intensified by their aging workforces.

2. **Monitor changes in federal policy and opportunities or barriers they may impact employment levels in energy sectors.**

   Federal policy regulatory and financial incentives and disincentives can greatly affect employment in energy sectors. Increasing or relaxing environmental constraints can shift the balance towards or away from non-renewable energy sources. Targeted training funds have influenced college programs in recent years. It's important that states are aware of changes in these programs as the country deals with budget and economic challenges.

3. **Monitor changes in international renewable and non-renewable energy markets including technological change, increasing and declining energy supply regions and impacts from events such as armed conflict, the BP Gulf oil spill, and the Japanese nuclear disaster.**

   International competition – especially in manufacturing renewable energy equipment – is likely to have both positive and negative effects on energy-related job markets in the Appalachian Region and affect both demand and necessary skill sets.

9. FINAL THOUGHTS

This project and its report represent a sound and practical source for information needed by policymakers and workforce education and skill providers. It is based on a consistent and robust methodology that examines a broad range of renewable and non-renewable energy clusters within the Appalachian states. The case studies, interviews and surveys and state and federal policy analysis provide a wealth of practical guidance on building effective policy and programs needed to support and grow these important economic engines.

The data analysis provides a broad picture of energy clusters within the Appalachian counties of the 13 Appalachian states, detailing expected employment changes, workforce needs and workforce gaps in a variety of occupational categories serving the industries. The analysis is based on publicly available government data, so that the information can be easily validated and regularly updated by practitioners in the field. The interviews and surveys present a robust picture of the programs available to train the workforce as well as the challenges community colleges, universities and other training providers face in meeting the needs of their local, regional and state economies. The case studies demonstrate the many innovative steps education providers have taken throughout Appalachia to serve the present and future needs of these industries. Finally the policy analysis presents a clear picture of the policy framework in which states, regions and service providers work.

The reader should understand that we used a cluster approach in analyzing the energy economy in Appalachia. Cluster analysis is a comprehensive, holistic method of looking at an economy that accounts for all the industries and suppliers that contribute to the production of a given product or service. A cluster is a geographic concentration of interrelated competitive firms and institutions of sufficient scale to generate external economies…making the whole greater than the sum of its parts. They occur where a group of businesses, drawing on similar resources, exist in relationships with other nearby businesses and institutions that contribute to their competitiveness. Examples range from the high tech cluster of biotechnology in the Research Triangle of North Carolina to the low tech cluster of lobster fishing in Maine Any concentration of similar businesses that draw on a common pool of suppliers, services, educational institutions, workforce skills, natural resources, or other assets that can be found in a region may be a cluster. Within Appalachia, the coal industry in West Virginia and Kentucky is a prototypical cluster. Taking the example of the coal industry, Appalachian coal mines have generated demand for customized transportation systems, mining technology, schools of engineering, mine worker training programs at community colleges and environmental control providers to name a few. There are also specialized organizations that connect, promote and research coal mining operations.

This more comprehensive analytical framework comes with certain limitations. In particular:

- Analysts examining industries using narrower *sector* definitions, e.g., examining only employment directly at coal mines, will generate lower employment estimates than analysts who look at the coal industry from a cluster framework. Sector analyses are an alternative method of examining economic conditions.

- The large regions covered by this analysis, some including entire states, do not always reflect the economic reality of local and sub-regional economies within each of the energy clusters. There are times when those working in the field are going to need to dig deeper into their regional and local economies.
- The need to use consistent methodology and data sources does not allow us to vary the analytical techniques and data for specific areas and specific sectors within clusters. Education providers may need to use ad hoc data sources, interviews and close relationships with the private sector that can provide more specific guidance for their areas and economies.
- The government data sources that were necessary for our analysis have a built in time lag and cannot fully reflect recent dramatic events and rapidly changing economic conditions. Communities, colleges, and local policymakers may need to adjust to these dramatic game-changing events by using more recent data and information. The rapid pace of natural gas exploration in parts of Appalachia are an example of such an event.

Training and educational providers, policymakers, and economic development specialists encounter a wide array of unique challenges and opportunities. It is our hope that this report and analysis, in combination with careful thought and a grounding in local conditions can lead to more economic development in the energy economy and build a stronger Appalachia.

Endnotes

[i] **Methodological issues**
The methodology has certain limitations:

1. The definition of each of the energy sub-sectors, as aforementioned, is based on a cluster analysis and thus includes more than those industries that generate or transmit energy. Varying definitions will produce different results.

2. Since the data was collected at the county level some suppression still exists due to confidentiality issues. Thus, aggregation of the data to the regional level is likely to underestimate employment in certain categories.

3. Within a given industry, job estimates may vary because it is difficult to know with accuracy what portion of an industry's employment or output is dedicated to the supply chain or manufacture of components for another industry. For example, a composites manufacturer may be producing materials for wind turbines that are also used in a variety of other products. Estimating apportionment of its output and employment to various downstream products is an imperfect process. Although adjustments were made using the BEA Make and Use tables to help deflate industry employment numbers appropriately, these numbers are only broad estimations.

   Any changes to the underlying data sources, including the BEA Make and Use tables used for employment adjustments, will ultimately affect the employment levels reported in this study.

4. The method of estimating supply and demand of graduates to occupations is based on the ultimate distribution demand. That is, the methodology assumes that the graduates from a given program will distribute themselves across occupations more or less in line with the demand for those occupations. It thus does not account for unemployment, those who go into another field, or those who drop out of the labor force. The study team feels, however, that labor market demand was still the best available basis of estimating how program graduates would be allocated, and goes much farther in attempting this allocation than most other labor market gap analyses. In addition, the methodology does not account for in-migration of already-prepared workers, the rapid relocation of dislocated workers (who may be able to transition quickly with on-the-job training), or for the role of other educational institutions in preparing workers for specific occupations.

In addition there are caveats regarding the comparability of the analyses in this report with other analyses of the energy industries.

1. Readers should be careful when comparing the employment data within this report to other analyses. In particular methodological issues, as noted above, impact the sectors that are included within reports on energy employment within the Appalachian region.

The definition used here is based on a cluster analysis approach and thus includes more than those industries that generate or transmit energy. This analysis starts with the supply chain of the various energy sectors and then examines staffing patterns throughout the supply chain. Definitions of the supply chain vary widely between different studies because of methodological reasons and analytical goals.

2. Definitional issues especially limit the ability to compare reports on economic and employment impacts for new clean renewable energy sectors. The RTS report is a NAICS-based analysis within a cluster and supply chain methodology for wind energy production, generation, services, and other elements of the cluster such as workforce training providers. We rely on definitions developed for the Appalachian Regional Commission in 2009 by Penn State researchers Susman and Glasmeir to define the wind energy cluster (see Appendix A of this report, pp. A-3 – A-4).

   An alternative report by the American Wind Energy Association (AWEA) that reflects fewer jobs is an economic impact analysis of specific projects that are likely to come online based on a 20% Wind Energy scenario (meaning 20% of the energy in the country would be generated by wind energy by 2030). (See http://www.awea.org/_cs_upload/learnabout/publications/5094_1.pdf). Within their report the AWEA uses the JEDI model developed by the US Department of Energy (see http://www.windpoweringamerica.gov/filter_detail.asp?itemid=707). The JEDI model looks at investment in construction and operating wind energy turbines, etc. (see report at http://www1.eere.energy.gov/windandhydro/wind_2030.html) but it does not include all the suppliers to the industry cluster included in the RTS method. The AWEA report references supply chains, but they are effectively looking at the direct, induced and indirect economic effects based on multipliers from the IMPLAN input-output (IO) model. For a comprehensive review on the issues surrounding definitional issues see the Brookings Institute report *Sizing the Clean Economy* published in 2011 and available at http://www.brookings.edu/reports/2011/0713_clean_economy.aspx and the US Department of Energy report *20% Wind Energy by 2030* published in 2008 and available at http://www.nrel.gov/docs/fy08osti/41869.pdf. The Brookings report details the differences between their results and other research sources that sometimes show substantial differences, with Brookings reporting up to three to five times higher employment estimates than other sources in one case (p. 17).

3. In addition, other analyses use different data as the basis for their analyses. For example, other industry studies start with the number of wells and use an average number of full-time-equivalent employees needed to staff those wells. Since estimates about the number of wells expected to be drilled in the future vary quite widely, employment estimates based on those projections will vary considerably as well. These varying definitions, methodologies and data will produce different results.

4. The economic and workforce estimates that drive the results in this and other reports on emerging renewable energy sectors are based on a number of assumptions about state, national and international economic and environmental policies, rates of technological change and adoption in emerging energy sectors and the prices of competing non-

renewable energy sources. As a result the estimates vary substantially based on these assumptions.

5. Similarly, the economic and workforce estimates that drive the results in this and other reports on new non-renewable energy sources are based on a number of assumptions about costs of recovery, the actual size of energy reserves and the environmental impacts of new methods. This is particularly relevant in this report with regard to the ultimate economic and workforce impacts of exploration and production from the Marcellus Shale deposit within Appalachia. For example, the US Geological Survey recently (August 23, 2011) released estimates of undiscovered, technically recoverable natural gas within the Marcellus Shale deposit that are nearly 80 percent lower than previous estimates by the US Energy Information Administration. The report is available here: http://energy.usgs.gov/Miscellaneous/Articles/tabid/98/ID/102/Assessment-of-Undiscovered-Oil-and-Gas-Resources-of-the-Devonian-Marcellus-Shale-of-the-Appalachian-Basin-Province.aspx. These estimates are not reflected within this report.

Lastly, Bureau of Labor Statistics projections are based on a careful and vetted methodology and are superior to other ad hoc methods in the vast majority of cases. Still workforce and economic practitioners and policy makers should use all data and analyses at their disposal.

In cases of extreme economic change BLS estimates can be less reliable. For example, the BLS algorithms may be less effective in adequately reflecting the impacts of events such as Hurricane Katrina or the rapid rise of new oil developments in North Dakota. In these cases, careful analyses based on proven methodologies should be used to supplement BLS analyses, including the projections in this report.

Within the Appalachian region the increasing exploration and extraction of natural gas from the Marcellus Shale deposit may prove to be such a game-changing event especially in states such as Pennsylvania with significant drilling activity. A relevant report is a very labor intensive analysis recently conducted by the Marcellus Shale Education and Training Center and Penn State examining workforce needs. The report, which can be found at www.msetc.org/docs/NeedsAssessmentwithcoverSW.pdf, is an important source for up-to-date information and projections on workforce issues in Appalachian Pennsylvania and reflects significant annual employment impacts from 8,753 in 2009 to 22,603 in 2013. Our report projects that employment impacts from the broader gas and oil cluster in Pennsylvania are approximately 58,000 in 2009 and 60,000 in 2013. We cannot be sure if the two analyses are inconsistent because we are looking at the broader cluster and some elements of the cluster are in decline. Those declines will offset increases within the narrower natural gas exploration and extraction industry.

[ii] There are a number of caveats within this analysis that readers should take into account.

- Readers should be careful when comparing the employment data within this report to other analyses. In particular methodological issues impact the sectors that are included within reports on energy employment within the Appalachian region. The definition used here is based on a cluster analysis approach and thus includes more than those industries that generate or transmit energy. This analysis starts with the supply chain of the various energy sectors and then examines staffing patterns throughout the supply chain. Definitions of the supply chain vary widely between different studies because of methodological reasons and analytical goals. In addition, other analyses use different data as the basis for their analyses. For example, other industry studies start with the number of wells and use an average number of full-time-equivalent employees needed to staff those wells. Since estimates about the number of wells expected to be drilled in the future vary quite widely, employment estimates based on those projections will vary considerably as well. These varying definitions, methodologies and data will produce different results.

- The economic and workforce estimates that drive the results in this and other reports on emerging renewable energy sectors are based on a number of assumptions about state, national and international policies, rates of technological change and adoption in emerging energy sectors and the prices of competing non-renewable energy sources. As a result the estimates vary substantially based on these assumptions.

The economic and workforce estimates that drive the results in this and other reports on new non-renewable energy sources are based on a number of assumptions about costs of recovery, the actual size of energy reserves and the environmental impacts of new methods. This is particularly relevant in this report with regard to the ultimate economic and workforce impacts of exploration and production from the Marcellus Shale deposit within Appalachia. For example, the US Geological Survey recently (August 23, 2011) released estimates of undiscovered, technically recoverable natural gas within the Marcellus Shale deposit that are nearly 80 percent lower than previous estimates by the US Energy Information Administration. The report is available here: http://energy.usgs.gov/Miscellaneous/Articles/tabid/98/ID/102/Assessment-of-Undiscovered-Oil-and-Gas-Resources-of-the-Devonian-Marcellus-Shale-of-the-Appalachian-Basin-Province.aspx. These estimates are not reflected within this report.

List of Appendices

Appendix A: Literature review

Strengthening Clean Energy Competitiveness: Opportunities for America Competes Reauthorization (2010)

Rob Atkinson, et al., Breakthrough Institute, The Information Technology and Innovation Foundation, and The Brookings Metropolitan Policy Program

Scope and Purpose: This report addresses the difficulties the U.S. faces in competing with other countries in the clean energy industry and offers suggestions for how the U.S. can strengthen and update its energy innovation and policy.

Methodology: Challenges that the U.S faces in competing with other nations in the clean energy industry are addressed and are detailed below. Recommendations are evaluated along three themes:

- Increase investment in clean energy education, innovation, and production.
- Provide funds for programs that accelerate the pace of clean energy innovation.
- Leverage federal investments through partnerships between existing and new programs in order to influence regional public-private support, to further develop clean energy clusters, and to accelerate technology, production, and commercialization.

Findings:

- Clean energy innovation is an environmental and economic imperative. The U.S. is trailing behind other countries due to its lack of an effective strategy. To address this, the U.S. must prioritize investments in clean energy technology.
- The U.S. has ceded its lead in this industry over the last ten years. It is behind in the commercialization and manufacturing of clean energy technology, and therefore, is not producing jobs in manufacturing, which has the greatest need for workers. There is a large competitive educational gap in clean energy science and engineering, and there are growing trade deficits.
- Through the AMERICA COMPETES reauthorization, Congress could strengthen four key areas:
    - Education in clean energy science and engineering
    - Clean Energy Research and Innovation
    - Production and Manufacturing of Clean Energy Innovation
    - Clean Energy Industry Clusters
- Clean Energy Programs recommended include: provide additional funding for STEM through RE-ENERGYSE initiative; double clean energy R&D budgets for appropriate technology agencies, and increase budgets for research centers, The Advanced Research Projects Agency for Energy (ARPA-E), and energy innovation hubs; increase the R&D Tax Credit; create a clean energy supply chain initiative; offer low-cost financing for manufacturing; establish a National Institute on Energy Innovation; extend the 48C Advanced Energy Manufacturing Tax Credit; offer grants to support clean energy clusters; create a pilot program

for research consortia funding; and create a Federal Clean Energy Innovation Council.

- Several recommendations were made for funding these programs including: eliminating existing subsidies for older technologies, such as fossil fuels; dedicating revenue from carbon permits and fees to clean energy technology; charging an electricity wires fee for the modernization energy technology; and using revenues from the production of oil and gas.

Building Effective Green Energy Programs in Community Colleges (2010)

Maureen R. Bozell and Cynthia D. Liston, Workforce Strategy Center

Scope and Purpose: In this report, Workforce Strategy Center examines the response of community colleges offering green energy education programs to key issues facing the emerging green energy economy. The intent of this report is to aid community colleges in developing green energy training programs for low-income, low-skilled individuals so that they might gain family-supporting employment.

Methodology: Community Colleges leading in green energy workforce education were identified through a literature review and environmental scan. Site visits and interviews were conducted with 11 community colleges. Eight leading colleges—all but one in New York and on the west coast— and one consortium of colleges were chosen to be included in this study.

Key challenges facing colleges developing green energy programs are outlined and addressed individually. Workforce development practices are discussed as solutions to each of the key challenges previously addressed, including how the featured colleges are applying these practices.

Findings:

- The growth in the green economy is currently dominated by mid- and high-skilled jobs. In order for low-skilled individuals to benefit from the development of these emerging industries, an effort will have to be made to focus on offering training programs that will prepare students for career advancing opportunity instead of short-term programs for immediate job placement.
- Community colleges attempting to offer training programs in the green energy industries must address labor market demand and respond with combined education, workforce development, and economic development resources.
- Community colleges will be an integral part of the ability of the green economy to fully reach its potential.

Going Green: The Vital Role of Community Colleges in Building a Sustainable Future and "Green" Workforce (2009)

Mindy Feldbaum, with Hollyce States, Academy for Educational Development and National Council for Workforce Development

Scope and Purpose: This report assesses the role of community colleges in supporting the growing clean energy economy. Ten community colleges that have designed training curriculum for "Green" jobs are showcased. The community colleges listed are not in ARC counties, but the examples are useful for developing strategies for workforce training.

Methodology: The report examines innovative strategies and practices used by community colleges to address climate change, environmental stewardship, and green workforce development. Opportunities for the growth of these programs at community colleges were addressed by evaluating the fastest growing sectors and jobs in the clean energy economy.

Findings:

- "Many of the jobs in the green building sector will require the reorientation of existing jobs. For example, a company that retrofits and updates the heating, cooling, and lighting systems of a building will need a construction worker with traditional skills who is also trained in the most recent energy efficient methods." Many of the jobs for energy efficiency occupations are at the technician level requiring no more than an associate degree and have the potential for career advancement through attainment of certifications. Thus, they are very accessible to community college students.

Industry Structure and Company Strategies of Major Domestic and Foreign Wind and Solar Energy Manufacturers: Opportunities for Supply Chain Development in Appalachia (2009)

Gerald I. Susman and Amy K. Glasmeier, Pennsylvania State University

Scope and Purpose: This document reports the findings of a two-phase study that assesses the status of solar and wind industries in the U.S., focusing on product and service suppliers in the Appalachian region, and addresses the challenges faced in preparing and competing in these rapidly emerging industries. The report did an excellent job of analyzing the 2005 Federal Legislation and its effect on the demand for wind and solar powers, as well as a state-by-state policy analysis, including Renewable Energy Standards Portfolio, tax abatement, location incentive, and grant and loan programs.

Methodology: Phase I includes an in-depth look at both industries, including supply chain variables as well as demand for these industries and stimulation of demand by government mandates, feed-in tariffs, tax incentives, rebates, price of conventional energy and carbon offsets. The ARC identified solar and wind companies in the region to evaluate their competitive strategies and address the challenges that firms within these industries face now and in the future.

Phase II of this study uses NAICS codes associated with manufacturing solar and wind components to identify the concentration and dispersal of businesses in the region. Those firms identified were surveyed to determine their characteristics, means of market entry, competitive context, resource needs, and involvement in international markets. Finally, the ARC conducted an evaluation of the policy environment and supportive programs that would stimulate the development of renewable energy industries in the region.

Findings:

- Both the solar and wind industry are going to depend on state-based renewable portfolio standards and incentives to spur demand.
- Foreign companies dominate the wind industry and the solar industry is dominated by Non-ARC states, and vertical integration for solar power companies is the only effective strategy.
- Only 20 percent of the companies that the six-digit NAICS Codes identified as solar or wind-power companies are actually in this business.
- Due to the fact that many firms in the Appalachian region have the ability to contribute to the supply chain of both wind and solar industries, with supportive policy and incentives in place, there is a great deal of potential in the region for the growth of these industries.

Measurement and Analysis of Employment in the Green Economy (2009) Workforce Information Council

Scope and Purpose: The intent of this report is to define green jobs, identify which variables need to be measured, develop alternative methods of measuring these jobs as well as develop an appropriate action plan. This study includes guidance on constructing survey questionnaires, underscoring the importance of ensuring that the questions relate to the specific purpose of the survey, and includes definitions.

Approach: The Workforce Information Council is a working group of state Labor Market Information (LMI) directors who are responsible for the collection, analysis and promulgation of all information on jobs, unemployment statistics, labor force characteristics, and occupational projections. The Council reviewed studies of green jobs from Washington, Michigan, Oregon, and California to provide guidance to other states for measuring green jobs, and for conducting surveys on the topic.

Findings:

- They developed a working definition that: "A green job is one in which the work is essential to products or services that improve energy efficiency, expand the use of renewable energy, or support environmental sustainability. The job involves work in any of the green economic activity categories." The Proposed Green Economic Activity Categories, adapted from the Pew Charitable Trust Framework, are:

- Renewable Energy and Alternative Fuels
- Energy Efficiency and Conservation
- Pollution, Waste, and Greenhouse Gas Management, Prevention and Reduction
- Environmental Cleanup and Remediation and Waste Cleanup and Mitigation
- Sustainable Agriculture and Natural Resource Conservation
- Education, Regulation, Compliance, Public Awareness and Training, and Energy Trading

The Impact of Coal on the Kentucky State Budget (2009)

Melissa Fry Konty and Jason Bailey, MACED

Scope and Purpose: Due to the dramatic changes taking place in the energy economy, it is essential for Kentucky to evaluate the implications of these changes on the coal economy in the state. Kentucky has long been reliant on coal for jobs, electricity, and tax revenue; however, the industry also imposes costs, such as infrastructure expenses, and environmental and health impacts.

Methodology: The intent of this report is to analyze the fiscal impact of Kentucky's coal industry by estimating tax revenues and expenditures associated with the industry. Coal revenues and expenditures are examined in three parts: industry-generated revenues and expenditures, revenues and expenditures attributable to direct employment by the industry, and revenues and expenditures related to indirect employment attributable to the coal industry.

Findings:

- Kentucky provided an estimated net subsidy of almost $115 million to the coal industry in 2006.
- About $528 million dollars in state revenues and $643 million in state expenditures were due to the coal industry in Kentucky.
- In 2008, only one percent of Kentucky employment was in coal mining. However, mining's higher wages make it a larger share of county income. Those counties, with mining jobs ranging from 3 to 23 percent of employment base, are projected to face significant unemployment and poverty rates possibly as high as 37 percent.
- Easy-to-mine coal is being depleted, aging coal-fired power plants are retiring, and new carbon emissions laws are raising the price of coal.
- Carbon Capture and Sequestration are new technologies embraced by the coal industry; however, they are expensive and have significant risk and uncertainty.
- Recommendations include:
    - Compare investment in energy alternatives to investments in coal.

- Because coal is not a renewable resource it is important to pursue economic diversification.
- Examine the taxation and subsidization of coal in Kentucky.

The Clean Energy Economy: Repowering Jobs, Businesses and Investments Across America (2009)

The Pew Charitable Trusts

Scope and Purpose: This study describes the growth of the clean energy economy from 1998 – 2007 by measuring the increase in the number of clean energy companies, venture capital, patents, and jobs. The description is national as well as state-by-state. The study also addresses state policy development that stimulates the growth of this sector of the economy.

Methodology: This report defines the clean energy economy as, "A clean energy economy generates jobs, businesses and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emissions, waste and pollution, and conserving water and other natural resources." The clean energy economy comprises five categories:

- Clean Energy
- Energy Efficiency
- Environmentally Friendly Production
- Conservation and Pollution Migration
- Training and Support

Pew built its own dataset starting with companies that received venture capital, then used the National Establishment Time Series database based on Dun & Bradstreet data. Pew used website searches and interviews to validate that all the companies were in the definition. Using eight-digit SIC codes the Foundation projected the number of jobs by state for each of the five categories; Clean Energy, Energy Efficiency, Environmentally Friendly Production, Conservation and Pollution Migration, and Training and Support.

The study examines state policies in three areas: regional initiatives, renewable portfolio standards, and energy efficiency resource standards. National policy was examined with respect to the potential of the Cap and Trade bill, but made no conclusions.

Findings:

- Nationally, jobs in the clean energy economy grew by an average of 1.9 percent annually from 1998 to 2007, compared to total employment growth of 0.4 percent.
- Venture capital investment grew from less than $1 billion in 1998 to $12.4 billion in 2007.
- Most of the clean energy patents that were issued during this time frame were for batteries and fuel cells (72.2 percent).

How to Prepare Jobseekers for the Green Economy (2009)

Economic Modeling Specialists, Inc.

Scope and Purpose: This report aims to define what green jobs are and how to identify them. It also addresses the training that is necessary to prepare for these careers and how local planners, colleges, and career centers can aid in preparing the green workforce. Finally, it addresses the effect of this movement on the local economy.

Methodology: Occupational data is examined in an attempt to determine the impact of policy, the reaction of specific industries or training programs, and which occupations will be most in demand. The development of the green movement is discussed in terms of two driving forces, governmental intervention and social and market trends. The purpose of reviewing occupational clusters was to understand the training requirements for green jobs in these sectors.

Findings:

- Many of the new green occupations will come from the construction, manufacturing, and engineering occupational sectors. Because the green economy is not clearly defined, it will be up to creative thinkers and entrepreneurs to produce functional, green products. Because of this reliance on the invention of new greener products, all types of training and education could be useful.
- With appropriate market data and analysis, it is very easy to address the issue of training and finding workers.
- Because much of the activity of green jobs will take place in construction, manufacturing, and engineering sectors, where training is already available, there seems to be no need to develop radically new training programs.
- Engineering positions are the only ones that require more than an associate's degree.
- Most green jobs can be filled without the development of new programs. Traditional training programs, combined with short-term programs implemented where necessary, will suffice.
- Because of the existence of a large labor pool for these occupations due to dramatic cutbacks and layoffs, the job markets may become very competitive.
- There is not yet a clear definition of a "career pathway" for the green economy.

Which Infrastructure Project Will Have the Best Impact? (2009)

Economic Modeling Specialists, Inc.

Scope and Purpose: The purpose of this report is to evaluate and provide clear understanding of infrastructure projects by conducting a regional cost/benefit analysis. Because the author concluded in a previous article that projects fostering long-term job creation, instead of construction or infrastructure projects, would benefit from more attention, this report focuses on recognizing local opportunities and how best to apply stimulus package funding.

Methodology: The report uses input-output models to estimate economic and fiscal impact. It uses three example scenarios, state highway construction, railroads, and broadband, to determine which programs are considered green and what benefit they would provide for the local economy.

Findings:

- A regional cost/benefit analysis, including input-output models, economic impact, and fiscal impact analyses, is helpful when evaluating the benefits of infrastructure programs in order to provide the best outcome for the investment.
- Many jobs considered green are associated with infrastructure programs, so that while an occupation might not appear to be a green job, the results from an investment in training for occupations associated with certain infrastructure programs could be green.

Energy Efficiency in Appalachia: How Much More is Available, At What Cost, and By When? (2009)

Marilyn A. Brown, et al., Appalachian Regional Commission

Scope and Purpose: As a follow-up to the 2006 ARC report, *Energizing Appalachia: A Regional Blueprint for Economic and Energy Development*, this report is an assessment of the potential long-term energy efficiency gains in the Appalachian Region. The study addresses the question of economic impacts in Appalachia if energy efficiency policies were put in place. The assessment addresses the availability and size of energy efficient resources in the area, how quickly they could be utilized, which policies and programs are most effective at supporting energy savings, and what impact these policies and programs could have on employment and wages in the region.

Methodology: The effect on the economy of adopting energy policies and programs is examined in terms of energy-efficiency in

- Residential Buildings
- Commercial Buildings
- Industry
- Transportation

The policy inventory by local, state, regional, and federal levels was divided into twelve categories: Research, development, and demonstration; Financing; Financial incentives; Pricing; Voluntary agreements; Regulations; Information Dissemination and Training; Procurement; Market reforms; Market obligations; Capacity building; and Planning techniques.

This project uses a variety of data, models, and energy-engineering analyses to estimate Appalachia's energy-efficiency program potential. Results of past energy-efficiency program evaluations are the basis of estimating the administrative and implementation costs of each energy-efficiency policy bundle. The specific data sources and methodologies are summarized in each of the sector chapters and are described in greater detail in Appendices B through G. The results of these policy analyses are then input into a dynamic input-output model to evaluate the macro-economic impacts of proposed policies. (In addition, the project team created an Advisory Committee and Stakeholder group to review and guide the research.)

Findings:

- Over 200 policies promoting energy efficiency were identified in this study's inventory. The primary finding germane to our study is that "An early program stimulus that drives a higher level of efficiency investments can create more than 15,000 net new jobs each year in the first five years, rising to an average of 60,000 net new jobs per year for the next ten years."

Energy Efficient Occupations (2009)

San Francisco Bay and Greater Silicone Valley Centers of Excellence

Scope and Purpose: Centers of Excellence at two California community colleges worked with research and industry partners in the Bay area to evaluate five segments of the clean energy sector in a 12-county region. The five segments evaluated were:

- Utilities and energy resource management
- Design and construction of houses and buildings
- Energy Retro-fitting in homes
- Retro-commissioning in buildings and facilities
- Facility operations and management

The goals of this study were to: estimate geographic concentration, number and size of existing firms; project future job growth over the next three years in energy efficient occupations; determine employer needs and challenges; clearly define education requirements for green energy occupations; recognize opportunities and methods for advancement in energy efficient careers; examine and compare current and future salary ranges for these occupations; and determine industry interest and need in community college training programs.

Methodology: A survey was administered to employers in the energy sector in the Bay region to evaluate workforce needs and project demand for energy efficiency occupations. 700 employers completed the survey for eight energy efficiency occupations.

Findings:

- The survey projects the creation of thousands of jobs over the next three years for seven of the eight occupations included in the survey, with two emerging occupations, energy auditor and building performance/retrofitting specialist, projected to experience significant growth.

- Employers expressed interest in the development of programs at community colleges, as many are challenged with finding qualified employees for all eight occupations. Half of community colleges in the region offer energy efficiency-related courses. However, the findings report a need for increased availability of training for these eight occupations.

Green Pathways: A Data-Driven Approach to Defining, Quantifying, and Harnessing the Green Economy (2009)

Economic Modeling Specialists, Inc.

Scope and Purpose: According to this report, decisions on investments in green jobs should be rooted in local data. Suggestions for a data-driven approach are offered to aid local planners in analyzing the potential growth of green jobs and industries.

Methodology: To analyze the potential growth of green industries in a region, this report first differentiates between occupations and job titles and identifies and categorizes specific regional groups of green occupations. A case study of green pathways analysis shows how to estimate the impact of green investments, employ displaced workers into green occupations, and connect green occupations to green job titles.

Findings:

- Regional analyses of green occupations become much more accurate when occupation titles and groups of green occupations are identified and categorized. In this case, data can be reviewed to accurately estimate potential impacts of investments, to ease transitioned, displaced workers in an appropriate position, and to determine where funding might be most appropriately used.

Which (Green) Project is Best for Your Region? (2009)

Economic Modeling Specialists, Inc.

Scope and Purpose: Workforce investment, economic development, and educational stakeholders are developing plans to compete for "stimulus package" funds, how to most efficiently use these funds, and how to account for the results. This report demonstrates how to review economic stimulus investments by addressing the following major issues: accountability, infrastructure vs. stimulus, and regional workforce and economic impact assessments. Fiscal impact modeling is a new service offered by EMSI.

Methodology: This study uses input-output models from EMSI's Strategic Advantage web-based data tool to determine which of three proposal examples given would have the greatest long-term job impact, and therefore would be most likely to receive funding.

Findings:

- Rigorous accountability is required for using funds allocated by the President's stimulus package. Organizations and regions will need solid data to support potential projects and post-project reports. Reviewing EMSI's economic and workforce data is a first step to determining which investments will have the greatest impacts.

*Greening of the World of Work: Implications for O*NET-SOC and New and Emerging Occupations (2009)*

Eric C. Dierdorff, et al., North Carolina State University and The National Center for O*NET Development

Scope and Purpose: This research was undertaken in order to look at the impact of emerging "green" economy activities on SOC codes and to provide a starting point for redefining existing occupations as well as identifying new occupations. The researchers reviewed over 60 publications.

Methodology: Their definition of the green economy is: "the green economy encompasses the economic activity related to reducing the use of fossil fuels, decreasing pollution and greenhouse gas emissions, increasing the efficiency of energy usage, recycling materials, and developing and adopting renewable sources of energy."

The most useful part of the research is the separation of occupations into three distinct categories: (1) Increased Demand Occupations; (2) Enhanced Skills Occupations; and, (3) New and Emerging Occupations. However, there is too little information on new and emerging occupations to make a complete analysis. The remainder of this report provides a listing of these occupations, as well as all green O*NET –SOC occupations.

Findings:

- 64 occupations qualified as increased demand occupations
- 60 were found to qualify as green enhanced skills occupations
- 45 existing occupations were found to qualify as green new & emerging occupations

Green Collar Jobs in the U.S. and Colorado: Economic Drivers for the 21st Century (2009)

Roger H. Bezdek, American Solar Energy Society

Scope and Purpose: This report summarizes and updates a previous study conducted in 2007 by American Solar Energy Society (ASES) and Management Information Services, Inc. (MISI) entitled, "Defining, Estimating, and Forecasting the Renewable Energy and Energy Efficiency Industries in the U.S. and in Colorado".

Methodology: Three elements of the 2007 work were updated and summarized in this edition. The first was a recommendation for standardizing the definition of the renewable energy industry and the energy efficiency industry. The second detailed the size and composition of these industries. Lastly, the report predicts the rate of growth for these two industries to 2030 under three forecast scenarios: a base case scenario, a moderate scenario, and an advanced scenario. The base case represents the "business as usual" scenario, assuming no policy change or development in Renewable Energy or Energy Efficiency initiatives and the continuation of trends seen over the past two decades. The moderate scenario studies the growth potential of the industry with moderate and incremental expansion of policy and federal and state initiatives. The advanced scenario examines the potential of industry growth and development under a long-term, aggressive renewable energy development program, examining all possibilities of using current technologies and assuming that the industries will be able to take the U.S. in a new direction.

Findings:

- The work in 2007 estimated the size and scope of renewable and energy efficiency industries. These organizations found that there are no existing standard definitions for the renewable energy industry or the energy efficiency industry. Therefore, only specific sub-sets of the sectors were reviewed, which did not permit the creation of complete, aggregated industry data.
- This report defines jobs in the Renewable Energy (RE) industry as those within one of the clean energy technologies; wind, photovoltaic, solar thermal, hydroelectric power, geothermal, biomass, fuel cells, and hydrogen. A job in the Energy Efficiency (EE) industry is one within a sector that is entirely part of the Energy Efficiency industry and includes jobs such as working for an energy service company, or in the reuse, recycling, and remanufacturing sector.
- A job in the EE industry can also be one that is within a sector in which only a portion of the outcome is considered energy efficient, such as HVAC systems, construction, and automobile manufacturing. Also included in this definition are jobs that involve Renewable Energy or Energy Efficiency activities in federal, state and local government, universities, non-profits, and other related organizations
- These industries can create well-paying jobs in two categories, college-educated professionals and highly skilled technical workers, which do not face the threat of foreign outsourcing.
- If the U.S. fails to invest in these industries, it runs the risk of losing ground to similar programs in other nations. The U.S. must address policy and regulatory barriers to the development of these industries.

Green Industries & Jobs in California (2009)

Evgeniya Lindstrom, California Community Colleges Center of Excellence

Scope and Purpose: This study examines the green industries in California in order to match green industries with occupations and occupational groups that could provide new and evolving career opportunities.

Methodology: Green firms and green jobs were defined: "A Green Firm is an organization that provides products and/or services that are aimed at utilizing resources more efficiently, providing renewable sources of energy, lowering greenhouse gas emissions, or otherwise minimizing environmental impact."

"A Green Job is an occupation that 1) directly works with policies, information, materials, and/or technologies that contribute to minimizing environmental impact, and 2) requires specialized knowledge, skills, training, or experience in these areas." The following six major sectors were identified:

- Renewable Energy: Energy Generation, System Installation & Storage
- Green Building and Energy Efficiency
- Biofuels Production & Farming
- Transportation & Alternative Fuels
- Water, Wastewater & Waste Management
- Environmental Compliance & Sustainability Planning

Each of these sectors was then cross-walked with the relevant green industries and job clusters. Our study has used a similar approach for the energy definition; the seven top jobs were identified, and skills and competencies established. Recommendations addressed how community colleges could provide training for identifying these jobs and best practices.

Greener Pathways: Jobs and Workforce Development in the Clean Energy Economy (2008)

Sarah White and Jason Walsh, Center on Wisconsin Strategy

Scope and Purpose: This report focuses specifically on green jobs and the skills needed to perform in clean energy positions and how existing industrial plants can compete in and move to the center of the emerging clean energy economy.

Methodology: In order to clearly define and address the issues of key clean energy sectors, this report details current economic and workforce opportunities in three industries: energy efficiency, wind, and biofuels.

Federal resources, such as programs in the Departments of Energy and Labor and the Green Jobs Act, are examined to determine their ability to support state green job initiatives. A plan of action for state policymakers is outlined, including reform opportunities.

Findings:

- The clean energy future will be comprised of middle-skill workers in traditional occupations. Skills required for the green energy industry are similar to the skills required for today's energy industry.

- Policy innovation and the development of workforce training for the clean energy industry are further complicated by the need for the development of and focus on key clean energy sectors.
- Three recommendations of Greener Pathways when addressing the development and application of green initiatives are to be smart, build partnerships, and deliver equity.
- Job training alliances for the clean energy industry can aid legislators in attracting and retaining businesses and will put them in a position to receive benefits from the Green Jobs Act.

Defining Energy Technologies and Services (2008)

Advanced Technology Environmental and Energy Center

Scope and Purpose: A panel of experts in energy technology, representing the Department of Energy, Universities, Community Colleges, and National Energy Groups, met to define energy technology occupations, revising a 2000 report, “Energy Services Careers”.

Methodology: Specific job descriptions were defined in a spectrum of nine energy technician occupational categories. Job descriptions for each of the technician occupations can be found at www.ateec.org

Findings:

The nine occupational categories are:

- Buying and Selling Energy
- Energy Assessment
- Energy Efficient Building Construction, Project Engineering, & Implementation
- Exploration
- Generation & Utility Scale Construction
- Operations & Maintenance
- Regulatory Affairs
- Transmission & Distribution
- Transportation (mobile) Services

Partial list of emerging jobs:

- Carbon Trading Analyst
- Energy Portfolio Planner
- Renewable energy site assessment tech
- Renewable systems energy installer
- Biofuels processing tech
- Building systems automation tech
- Electrical energy storage distribution tech

A Look at "Green" Occupations (2008)

Economic Modeling Specialists, Inc.

Scope and Purpose: This edition of Data Spotlight attempts to determine what constitutes a "green investment" and what distinguishes a "green job" from other occupations. Clearly defining these terms will enable regions to forecast the economic impacts of green development and which green initiatives should be pursued.

Methodology: Economic Modeling Specialists, Inc.'s Strategic Advantage Suite of web-based tools was used to address these issues. EMSI's Economic Forecaster Module was used to analyze industries and occupations for specific regions and to run input-output scenarios for industries or industry clusters. Among the green investments analyzed were Building Retrofitting, Mass Transit, Smart Grid, Wind Power, Solar Power, and Cellulosic Biofuels. These "green investments" were reported in "Green Recovery," produced by the Center for American Progress and Political Economy Research Institute.

Findings:

- The U.S. Conference of Mayors released a catalog of green projects that included the funding necessary for the development of infrastructure and estimated number of potential jobs that could be implemented in almost every city in America. Analyzing the input-output scenarios using EMSI's Economic Impact Module can aid in the effective placement of priority on these projects.
- A consensus among economists has designated the term "green" to refer to the outcome of an occupation, instead of the task associated with that occupation.
- Green jobs cannot be categorized using the standard occupation codes. Because no standardization is currently in place, jobs can be defined as "green" when they are related to the production of green products or services.

Green Economy Workforce Study (2008)

Modesto Junior College Center of Excellence

Scope and Purpose: Due to rising energy prices, new legislative requirements for reduction in greenhouse gas emissions, consumer demand, and reduced supply of natural resources and clean water, there is a push for a green economy. The California Community Colleges Economic and Workforce Development Program (EWD) enlisted the Centers of Excellence to study the impact of a greener economy on the Central Region. The Centers were charged with identifying which industries will likely be the first to experience impacts and evaluate the changing workforce demand and training needs of the region.

Methodology: Secondary research was reviewed, as well as executive interviews of industry and regional experts. In 2008 the project surveyed 59 businesses in the region that had at least five employees and were in one of five impacted industries; engineering and environmental services, energy and utility firms, local government and public administration, building and design services, and agriculture firms or firms servicing them.

Findings:

- Several occupations were identified that are likely to experience growth in the Central Region due to the development of a green economy. Within several, such as utilities and renewable energy, green building and design, and engineering and environmental services, occupations such as energy technician, sales representative, cost estimator, manufacturing technician, and resource conservation manager are likely to increase.
- Over 60 percent of employers identified themselves as owning a green business or a "somewhat" green business, which indicated to the surveyors the employers' awareness of the importance of being perceived as a green business.
- Almost two-thirds of employers surveyed agreed that the demand for lower energy costs is very important to the growth and development of the green economy and specifically, their business.
- 49 percent of employers stated that they had some difficulty recruiting non entry-level employees with appropriate skills and experience for the job. 22 percent of employers indicated that they had great difficulty finding adequately skilled employees to fill available positions. Over 70 percent of employers are finding some level of difficulty in finding trained employees in these emerging industries.
- According to the survey, an associate degree in a specific green field of study was not a requirement or priority for hiring employees. These employers viewed a short-term certificate as more desirable.

Green Jobs in Minnesota: Analysis and Action Plan (2008)

GSP Consulting, Minnesota Green Jobs Task Force

Scope and Purpose: Minnesota's Green Jobs Task Force was charged with developing a statewide action plan to aid in the growth and development of the green economy by addressing policies previously adopted in the region including: achieving the renewable energy standard established by increasing the amount of energy used from a renewable source; developing and supporting the conservation investment program to achieve statewide energy savings; meeting previously defined goals of greenhouse gas emission reduction; addressing the "25 by 2025" initiative by expanding the use of biofuels; and protecting and preserving service waters to further meet the goals established by the Clean Water Legacy Act.

This report includes primary industry classification and occupational and innovation research related to green jobs, analysis of training infrastructure and green job opportunities, and a comparison of Minnesota to ten other states in terms of strength of the green economy in Minnesota and policies and actions in place in the region.

Methodology: Primary and secondary sources were used by GSP Consulting in order to create a research definition of green jobs, to understand existing levels of green activity in the U.S. and produce estimates for 2020, to identify NAICS codes that represent green industries, to use "green share" formulas to determine actual number of green establishments and jobs in the region, and to review innovation, research, and patenting activity in the green industries. This information is combined to assist in the assessment of Minnesota's competitive advantage in the green marketplace compared to 10 other states in the nation.

Findings:

- Because of the environmental policies noted, Minnesota is in a good position to attract green jobs to the state.
- Minnesota has an estimated 52,827 jobs that can be considered "green," and it is estimated that this number will increase by more than 2000 jobs by 2020.
- Minnesota's Green Jobs task force believes that, with the adoption of their Action Plan, growth of green jobs can be accelerated above the estimated increases noted.
- The Market Analysis revealed a growth rate for green jobs in all market sectors, but noted that Minnesota's Green Jobs Task Force Action Plan should be focused on the Renewable Energy, Buildings Products, and Energy Conservation industries, as well as the Green Service sector that serves the Renewable and Green Products industries.

Green Recovery: A Program to Create Good Jobs and Start Building a Low-Carbon Economy (2008)

Robert Pollin, et al., Center for American Progress

Scope and Purpose: This report outlines a green economic recovery program that aims to strengthen the U.S. economy over the next two years by expanding job opportunities, stimulating economic growth, stabilizing oil prices, and fighting global warming with the development and support of a green, low-carbon economy. This green economic recovery program is an initial step towards the 10-year policy program recommended in 2007 by the Center for American Progress in its "Progressive Growth" series.

Methodology: The green economic recovery program and its funding and implementation are discussed in this report. How to expand job opportunities by stimulating economic growth, how to stabilize oil prices, how to fight global warming, and how to develop and support a low-carbon economy are detailed. The benefits of investing in six strategies for energy efficiency and renewable energy are assessed. Included is a table of jobs that represents some of the occupations that will be essential for the advancement of investments in each of the six areas discussed.

Findings:

- The proposed program would spend $100 billion dollars over two years in the six green infrastructure investment areas, outlined in the CAP report as being key areas to the development of a low-carbon economy and new green jobs. It is proposed that auctioning carbon permits under a greenhouse gas cap-and-trade program could fund this initiative.

- It is estimated that investing in the following six strategies would create 2 million jobs:
    - Improving energy efficiency by retrofitting buildings
    - Increasing mass transit and freight rail transportation
    - Constructing and installing “smart grid” transmission systems
    - Increasing use and availability of wind power
    - Increasing use and availability of solar power
    - Increasing use and availability of next-generation biofuels
- The proposed energy stimulus would result in widespread employment gains, reduced unemployment rates, renewed work in the construction and manufacturing industries, more stable oil prices, and self-financing energy efficiency.
- It proposed that, if recommendations of the report are fully implemented, the unemployment rate would decrease from 5.7 percent to 4.4 percent.

2008 Washington State Green Economy Jobs (2008)

Alan Hardcastle, Washington State University and Washington State Employment Security Department

Scope and Purpose: The report identifies the number and types of jobs that can be defined as green and establishes a measure to track industry and job growth in the green economy in Washington. The report was a response to a legislative request that is now outlined in the Engrossed Second Substitute House Bill passed in 2008 for the provision of a framework to reduce greenhouse gas emissions.

Methodology: Over 9,500 private-sector Washington State employers from a broad range of industries were surveyed regarding green jobs. The results were combined with other research to identify high-demand green industries, create new jobs in green sectors, and guide policy to support the growth of green industries in Washington. A thorough scientific survey design and sampling procedures were used and the results were weighted to represent the distribution of green jobs over a broader population of employers in the private sector. This allowed for the creation and assessment of statewide estimates for green jobs by industry and occupation.

Findings:

- A 2005 study, reporting 8,400 individuals working in green jobs at the time, was used as a baseline to establish a goal of 25,000 green jobs by 2020.
- Green jobs are defined in this report as those that promote environmental protection and energy security and include businesses and industries engaged in energy efficiency, renewable energy, and the prevention, mitigation, and reduction of pollution.
- 47,194 jobs exist in the private sector in four green core areas; energy efficiency, prevention or reduction of pollution, mitigation and cleanup of pollution, and renewable energy. About 13 percent of these jobs are part-time positions.

- Green jobs represent a relatively small portion of jobs in Washington as a whole, only 1.6 percent of all employment in the private sector. Only direct employment in a green industry was measured and public-sector jobs were not considered.
- Over half of all green jobs were in the energy efficiency core area, with 70 percent of those in construction-related industries. Professional and technical services, such as architecture and engineering are just behind the construction related industries in terms of number of green jobs.
- The second largest core area discussed was preventing and reducing pollution and includes one-third of green jobs studied. Agriculture-related industries provide half of the jobs in this core area, followed by construction and waste management and remediation services.
- Nine percent of all green jobs were in Mitigation and Cleanup of Pollution core area, with professional and technical services and waste management and remediation services accounting for two-thirds of this green core area.
- Just over four percent of all green jobs reviewed were in the Renewable Energy core area, with construction-related and professional and technical services accounting for almost half of the jobs in this area, and the agriculture-related and electrical equipment manufacturing sectors followed.
- The largest number of jobs represented by the six industry classes comes from the construction and agriculture-related industries. The major construction-related occupations account for 40 percent of all green employment.
- Energy efficiency employment is considerably greater for urban workforce development areas than for rural areas.
- Surveyed employers identified no new or unique job titles that were not already part of the Standard Occupation Code classification. Either traditional occupation titles are being retained and used for green jobs or employers find it unnecessary to give new titles to jobs that are similar to those in traditional sectors.
- Secondary analysis suggests that total earnings in green jobs accounts for $2.2 billion annually.
- Secondary analysis suggests that modest growth is expected in green jobs with the largest current employment rates and that the growth rates for architects and several other engineering occupations are projected to exceed the statewide average for all occupations.
- Recommendations include:
    - Conduct green jobs survey every two to three years to measure changes and progress against state goals.
    - Estimate the number of green jobs in the state by implementing a green jobs study of public-sector organizations.
    - Identify growth factors and project employment rates through analysis of green industries and create a standardization of education and skills required of green occupations.
    - Address anticipated labor shortages with analyses of green industries and occupations.
    - Estimate the impact of the emerging green industry and employment on the Washington economy.

Energizing Appalachia: Global Challenges and the Prospect of a Renewable Future (2007)

Dr. Amy Glasmeier, et al. The Pennsylvania State University

Scope and Purpose: This study focuses on the ability of companies to manufacture components for use in the biomass, solar, and wind industry. Nine out of the ten largest manufacturers of components for these three energy industries are global companies located throughout Europe and Asia. The only American company in the top ten is GE Wind Power. The question addressed is whether or not manufacturing companies within ARC have the potential and the ability to produce components for solar, wind and biomass energy, and what policies should be in place to promote and develop this manufacturing capacity in the Appalachian region. This study also explores opportunities for producing cellulosic ethanol.

Methodology: Information was compiled on existing manufacturing establishments, employment totals, location and sector concentration. Using the six-digit NAICS Codes, all ARC counties and each ARC state were analyzed for similarities in manufacturing major components in the biomass, solar, and wind energy industries.

Findings:

- There are over 41,000 jobs in more than 650 establishments in Appalachia for manufacturing components for the solar industry.
- There are over 89,579 jobs in 1,318 establishments in the wind industry that manufacture components that can be used in turbines.
- There are almost 82,000 jobs and over 900 establishments in Appalachia that are manufacturing components related to those needed by the biomass industry.

Energizing Appalachia: A Regional Blueprint for Economic and Energy (2006)

Appalachian Regional Commission

Scope and Purpose: The Appalachian Regional Commission's energy goal is to develop the Region's energy potential for increasing the supply of locally produced, clean, affordable energy, and to create and retain jobs. Its three strategic objectives are: promote energy efficiency, increase the use of renewable energy resources, and support the development of conventional energy resources, especially advanced clean coal.

Methodology: Based on several initial research projects, the ARC hosted a series of three public roundtables in 2006—which included participation of more than 100 industry experts, educators, government officials, and entrepreneurs—in order to develop an "Energy Blueprint" for the region and assess its energy assets. The Energy Advisory Council (EAC), composed of high-ranking representatives from the energy offices of each of the thirteen Appalachian states and representatives from the local development districts, was formed out of these sessions to develop energy strategies for the region.

The ARC identified five key "action areas" that would aid the agency in achieving its objectives: Public Sector Investments, Research and Analysis, Workforce Development, Public Awareness and Outreach, and Supportive Policies. It also noted the importance of the roles of federal, state, and local governments, particularly the U.S. Department of Energy and state energy offices; business and industry; research and educational institutions; public and private utilities; and non-governmental organizations. Partnerships with these organizations are vital to the success of the ARC in reaching its energy objectives.

Findings:

- The Energy Policy Act of 2005 set forth supply-side policies to increase the availability and diversity of fuel sources, advance technologies for using fuels more efficiently, and develop alternative energy sources. EPACT also set forth demand-side policies and programs to reduce the need for energy and encourage more efficient use of energy.
- Appalachia leads the nation in coal and electricity production, exporting its excess to other states. Appalachian mines produced 35 percent of the nation's coal in 2005, generating $16 billion of output. In 2004 electrical power utilities in the Region generated 15 percent of the nation's total electrical output, although Appalachia's population is only 8 percent of the U.S.
- 1,079,000 people are directly employed in America's energy industry, and 146,300 direct energy workers are employed in Appalachia. [The challenge for our study is to more discretely define those energy jobs and forecast the growth of existing energy jobs, and determine the emergence of new occupations.]
- Fossil fuels—coal, oil, and natural gas, currently provide more than 85 percent of all the energy consumed in the United States, and reliance on fossil fuels will increase in the next 20 years. Appalachia's coal reserves are abundant.
- Workforce development is a key action area necessary for ARC to achieve its three strategic objectives: Promote energy efficiency; Increase the use of renewable energy resources; and support the development of conventional energy resources, especially advanced clean coal. Appalachia needs a skilled workforce to support existing and new energy and energy-related industries. The ARC intends to partner with those who offer workforce training, such as community colleges, technical schools, and workforce investment boards, to develop programs for training workers in existing and emerging renewable energy sectors. These partnerships will identify future jobs in advanced coal and other fossil energy sources, and develop training for a new generation of coal miners, mining engineers, oil and gas workers, and propane industry workers. The partnerships will work with universities to train architects, scientists, and engineers to design energy-efficient communities and the next generation of energy industries. [This study will focus on the state of these partnerships; identify the training gaps; and, recommend methods to fill those gaps.]

Energy Efficiency and Renewable Energy in Appalachia: Policy and Potential (2006)

Marshall University

Scope and Purpose: This report examines the promotion and development of alternative and renewable energy resources in the ARC states. It establishes three measures for "energy intensity" and attempts to explain the variation among the states in the amounts of energy consumed. The study includes a state-by-state policy analysis, and examples of specific programs that are working well, as well as a review of fourteen companies that have achieved energy efficiency or developed renewable energies.

Methodology: The primary sources of information for this report were interviews with energy officials in each of the thirteen ARC states and the Tennessee Valley Authority. Secondary sources included published works generated by public bodies, research organizations and industry. [For purposes of the current ARC study, there are methodological drawbacks that make it not very useful. It had no survey protocol for the interviews conducted with state energy officials, broad definitions of energy not related to industry codes, and little discussion of jobs or skills requirements for occupations in the energy industry.]

Findings:

- The distribution of these resources varies widely across the ARC, which means that one single policy for all ARC states will not be useful. The southern states in the ARC are not as energy-efficient as the northern ARC states.
- There is potential for wind power, biomass, biofuels and some hydroelectric power. There is little potential for solar power, and geothermal energy production.
- The most useful part of the study is the state-by-state analysis of state policies, including Net Metering, Renewable Energy Portfolio Standards, Public Benefit Funds, Grant and Loan Programs, Tax Incentives, and Rebate Programs.
- Less than one percent renewable sources are being generated in the ARC counties.

Recommendations for Education for a Sustainable and Secure Future (2003)

National Council for Science and the Environment

Scope and Purpose: This report is a summary of key issues and recommendations discussed at NCSE's third National Conference on Science, Policy, and the Environment.

Methodology: More than 800 scientists, educators, managers, and policymakers attended this conference and first discussed the creation of the current era of environmental awareness and how it led to the development of environmental education programs. Intent on building upon this foundation, conference participants attended twenty-one sessions to offer recommendations for the development and growth of environmental and sustainability education, including all levels of learning from elementary school to professional schools, as well as community education. Participants addressed these goals in relation to health, diversity, research, and conservation education, as well as how to transfer the education into practice.

Findings:
- A new approach to education is essential in protecting the environment and providing economic and social well being, which in turn provides security.
- The concepts of sustainability must be incorporated into all levels of learning so that it is a life-long lesson.
- Sustainability is an interdisciplinary approach that is integrated across all levels of learning and should not be looked upon as a separate field.
- Curricula, as well as the criteria to measure the effectiveness of training, need to be developed and implemented.
- The gap between education and practice can be addressed by linking with and integrating sustainability concepts into use in business and daily life activities.

A Study on the Current Economic Impacts of the Appalachian Coal Industry and its Future in the Region (2001)

Eric C. Thompson, et al., Center for Business and Economic Research

Scope and Purpose: The report examines the significance of the coal industry on the economy of the Appalachian region and projects a forecast of the future of the industry. Active coal areas are identified, as well as which local and regional economies are most impacted by the industry. It addresses the questions: How is the impact of the coal industry changing over the next ten years? How would that impact vary based on alternative economic scenarios or environmental regulations? Which areas in the Appalachian region would be most affected by these changes?

Methodology: The study was based on 1997 data collected from 118 major coal producing counties in the region. Data relating to production and price was gathered from the Department of Energy's Energy Information Administration, and data regarding employment and earnings was gathered from the Department of Commerce.
Results are reported within three regional groups: Northern Appalachia, including Pennsylvania, Ohio, Maryland, and Northern West Virginia; Central Appalachia, including Kentucky, Virginia, and Southern West Virginia; and Southern Appalachia, including Alabama and Tennessee. Forecast scenarios are based on two publications published by the Energy Information Administration, "Annual Energy Outlook 1999" and "Impacts of the Kyoto Protocol on U.S. Energy Markets and Economic Activity".

Findings:
- Employment in the coal industry is concentrated in the Central Appalachian region, where Kentucky, Virginia, and West Virginia intersect. There are small areas of high employment in Alabama and several counties in Pennsylvania.

- Measured in terms of gross county product, the coal mining industry represents a large part of the economy in the Appalachian region.
- Employment and earnings within the coal industry are expected to decrease over the next ten years, with estimates of decreases of 25 percent to 30 percent. The tax impact of the industry is expected to decline 20 percent, with the largest decline in the Southern Appalachian region.

References

1. Advanced Technology Environmental and Energy Center. 2008. *Defining Energy Technologies and Services*. Iowa: Eastern Iowa Community College District. http://www.ateec.org/store/catalog/Defining-Energy-Technologies-and-Services-report-164.html

2. Appalachian Regional Commission. October 2006. *Energizing Appalachia: A Regional Blueprint for Economic and Energy*. District of Columbia: Appalachian Regional Commission. nwww.arc.gov/images/newsroom/.../energyblueprint/energyblueprint.pdf

3. Atkinson, Rob, Darrene Hackler, Jesse Jenkins, et al. June 2010. *Strengthening Clean Energy Competitiveness: Opportunities for America Competes Reauthorization*. New York: The Breakthrough Institute, ITIF, and The Brookings Metropolitan Policy Program.

4. Bezdek, Roger H. January 2009. Green Collar Jobs in the U.S. and Colorado: *Economic Drivers for the 21st Century*. Boulder, CO: American Solar Energy Society. http://www.ases.org/images/stories/ASES/pdfs/CO_Jobs_Final_Report_December2008.pdf

5. Bozell, Maureen R. and Cynthia D. Liston. May 2010. *Building Effective Green Energy Programs in Community Colleges*. New York: Workforce Strategy Center. www.workforcestrategy.org/images/.../green_energy_programs_2010-05.pdf

6. Brown, Marilyn A., John A. "Skip" Laitner, Sharon "Jess" Chandler, et al. March 2009. *Energy Efficiency in Appalachia: How much more is available, at what cost, and by when?* District of Columbia: Appalachian Regional Commission. http://www.arc.gov/research/researchreportdetails.asp?REPORT_ID=70

7. Dierdorff, Erich C., Jennifer J. Norton, Donald W. Drewes, et al. February 2009. *Greening of the World of Work: Implications for O*NET-SOC and New and Emerging Occupations*. Raleigh, NC: The National Center for O*NET Development. http://www.onetcenter.org/reports/Green.html

8. Feldbaum, Mindy and Hollyce States. 2009. *Going Green: The Vital Role of Community Colleges in Building a Sustainable Future and "Green" Workforce*. Academy for Educational Development and National Council for Workforce Development. www.aed.org/Publications/upload/GoingGreen.pdf

9. Economic Modeling Specialists, Inc. May 2009. *How to Prepare Jobseekers for the Green Economy*. Moscow, ID: Economic Specialists, Inc.

http://www.economicmodeling.com/2009/05/20/green-jobs-part-5-chapter-two-and-conclusion/

10. Economic Modeling Specialists, Inc. April 2009. *Which Infrastructure Project Will Have the Best Impact?* Data Spotlight. http://www.economicmodeling.com/2009/04/02/green-jobs-part-4-which-infrastructure-project-will-have-the-best-impact/

11. Economic Modeling Specialists, Inc. March 2009. *Green Pathways: A Data-Driven Approach to Defining, Quantifying, and Harnessing the Green Economy*. Data Spotlight. http://www.economicmodeling.com/2009/03/04/data-spotlight-green-pathways/

12. Economic Modeling Specialists, Inc. February 2009. *Which (Green) Project is Best for your Region? Green Jobs, Part 2*. Data Spotlight. http://www.economicmodeling.com/2009/02/04/which-green-project-is-best-for-your-region/

13. Economic Modeling Specialists, Inc. December 2008. *A Look at "Green" Occupations*. Data Spotlight. http://www.economicmodeling.com/2008/12/19/data-spotlight-a-look-at-green-occupations-part-1

14. Glasmeier, Amy, Ron Feingold, Amanda Guers, et al. The Pennsylvania University. September 2007. Energizing Appalachia: *Global Challenges and the Prospect of a Renewable Future*. District of Columbia: Appalachian Regional Commission. www.arc.gov/assets/research.../EnergizingAppalachiaGlobalChallenges.pdf

15. GSP Consulting Corp. December 2008. *Green Jobs in Minnesota: Analysis and Action Plan*. Minnesota: Minnesota Green Jobs Task Force.

16. Hardcastle, Alan. January 2008. *2008 Washington State Green Economy Jobs*. Olympia, WA: Washington State Employment Security Department. www.workforceexplorer.com/.../9463_Green_Jobs_Report_2008_WEXVersion.pdf

17. Konty, Melissa Fry, and Jason Bailey. June 2009. *The Impact of Coal on the Kentucky State Budget*. Kentucky: Mountain Association for Community Economic Development.

18. Lindstrom, Evgeniya. January 2009. *Green Industries & Jobs in California*. San Jose, CA: California Community Colleges Center of Excellence. www.coeccc.net/green/documents/Emerging_Green_09.pdf

19. Marshall University. Center for Business and Economic Research. August 2006. *Energy Efficiency and Renewable Energy in Appalachia: Policy and Potential*. District of Columbia: Appalachian Regional Commission. www.marshall.edu/.../research/Marshall_U_ARC_Renewables_and_Efficiency_FINAL_REPORT.pdf

20. Modesto Junior College Center of Excellence. December 2008. *Green Economy Workforce Study*. Modesto, CA: California Community Colleges Center of Excellence. www.coeccc.net/Environmental_Scans/GreenEcon_Scan_CV_08.pdf

21. National Council for Science and the Environment (NCSE). 2003. *Recommendations for Education for a Sustainable and Secure Future*. David E. Blockstein and Julie Green, Eds. Washington, DC. ncseonline.org/ncseconference/2003conference/

22. Pew Charitable Trusts. June 2009. *The Clean Energy Economy: Repowering Jobs, Businesses and Investments Across America*. District of Columbia: The Pew Charitable Trusts. www.pewcenteronthestates.org/.../Clean_Economy_Report_Web.pdf

23. Pollin, Robert, Heidi Garrett-Peltier, James Heintz, et.al. September 2008. Green Recovery: *A Program to Create Good Jobs and Start Building a Low-Carbon Economy*. Center for American Progress.www.americanprogress.org/issues/2008/09/pdf/green recovery.pdf

24. San Francisco Bay and Greater Silicone Valley Centers of Excellence. March 2009. *Energy Efficient Occupations*. California: California Community Colleges Centers of Excellence. www.coeccc.net/Environmental_Scans/ee_scan_sf-gsv_09.pdf

25. Susman, Gerald I. and Amy K. Glasmeier. The Pennsylvania State University. November 2009. *Industry Structure and Company Strategies of Major Domestic and Foreign Wind and Solar Energy Manufacturers: Opportunities for Supply Chain Development in Appalachia*. District of Columbia: Appalachian Regional Commission www.arc.gov/assets/research_reports/WindandSolarEnergy.pdf

26. Thompson, Eric C., Mark C. Berger, Steven N. Allen, et. al. March 2001. *A Study on the Current Economic Impacts of the Appalachian Coal Industry and its Future in the Region*. Lexington, KY: Center for Business and Economic Research University of Kentucky. www.arc.gov/research/researchreportdetails.asp?REPORT_ID=54

27. Workforce Information Council. October 2009. *Measurement and Analysis of Employment in the Green Economy*. District of Columbia: Workforce Information Council. www.workforceinfocouncil.org/.../WICGreenJobsStudyGroupReport-2009-10-01t.pdf

28. White, Sarah and Jason Walsh. 2008. *Greener Pathways: Jobs and Workforce Development in the Clean Energy Economy*. Madison, WI: Center on Wisconsin Strategy. www.cows.org/pdf/rp-greenerpathways.pdf

Appendix B: Full Case Studies and Protocol

This appendix includes the following case studies of workforce training programs in the Appalachian region.

College	Type	State	Energy Focus	Case Study Program
Alfred State College	University/CC hybrid	New York	Alternative	Renewable energy Green building and energy efficiency
Appalachian State	University	North Carolina	Alternative	Building Sciences and Appropriate Technology
Calhoun Community College	Community College	Alabama	Utilities/line worker training	Pre Apprenticeship Line worker Program
Cleveland State	Community College	Tennessee	Alternative/energy efficiency	Energy Efficient Residential Construction
Frostburg State	University	Maryland	Alternative/Energy Efficiency	WISE (Wind and Solar Energy) Program
Hocking College	Community College	Ohio	Alternative/fuel cell	Advanced Energy and Fuel Cell Technology
Kentucky Coal Academy	Community Colleges	Kentucky	Worker training in coal mining	KCA at Southeast Kentucky Community & Technical College
Lanier Technical College	Community College partnership with utilities	Georgia	Worker training in utilities	Electrical Utility Technology (EUT) program
Mississippi State	University	Mississippi	Efficiency and Energy Auditing	Industrial Assessment Center (IAC)
Pennsylvania College of Technology	University/CC hybrid	Pennsylvania	Worker training in natural gas production	Marcellus Shale Education and Training Center (Natural Gas)
Tri-County Community College	Community College	South Carolina	Foundational skills for energy	Welding for Nuclear Power
Virginia Tech	University	Virginia	Coal (mining) engineering	Degrees in Mining Engineering
West Virginia	University	West Virginia	Coal/Natural gas	Petroleum and Natural Gas Engineering degree programs (PNGE)
West Virginia*	University	West Virginia	Energy research	Advanced Virtual Energy Simulation Training & Research Facility (AVESTAR)

* Vignette

Spreading Clean Energy Across the College

Alfred State College, New York

Background: Alfred State College (ASC) is part of the State University of New York public education system and offers both four-year and two-year degrees. The college enrolls approximately 3,300 students. ASC operates two campuses, one in Alfred and one in nearby Wellsville. The town of Alfred is approximately 70 miles south of Rochester, New York.

Alfred State College is a small college with a large green agenda. By incorporating green practices and technologies into different courses and degree programs spread across the college, and by installing renewable energy sources on the campus, ASC is playing a central role in New York's efforts to become a leader in green employment and clean energy use.

ASC is part of the State University of New York public education system, and one of its few technology colleges. The main campus is located in Alfred, NY, a town of nearly 6,000 people in the region of the state known as the Southern Tier. ASC was founded in 1908 and incorporated into the SUNY system in 1948. The college offers 53 associate in applied science and associate in occupational studies degrees and 17 bachelor's degrees, as well as certificates and continuing education courses. Current full-time student enrollment is about 3,300.

Institutional Commitment to Sustainability: ASC has made an institutional commitment to the idea of sustainability and renewable energy. The college is a signatory to the American College and University President Climate Commitment, and in 2008, ASC President John Anderson was one of only three college presidents to attend the Clinton Global Initiative summit, an annual event convened by former President Bill Clinton to bring together leaders from the business, governmental and non-governmental spheres to find solutions to some of the most pressing global issues, including energy and climate change.

But, as Glenn Brubaker, an assistant professor in the electrical construction and maintenance program, pointed out, vision alone does not translate into a greener college. Rather, as Brubaker notes, there is interest in and support for renewable energy at all levels of the college's leadership. Individual faculty members with interests in renewable energy receive support for professional development and demonstration technologies from the school's leadership. In turn, interested and capable faculty members provide the staffing for implementing special demonstration and training projects for which the college has leveraged resources from public and private funding sources, including the Appalachian Regional Commission.

Integrating Renewable Energy into Existing Programs: Much of the activity related to renewable energy at ASC has been centered at the 22-acre Wellsville campus, where the School of Applied Technology has been located since it opened in 1968. There, energy efficiency, and solar, wind and other renewable energy technologies and techniques are being integrated into the curricula for several of the school's Associate of Occupational Studies (AOS) degrees, most notably the building trades/building construction, electrical construction and maintenance technician, and air conditioning and heating technology programs.

For example, the approximately 90 students earning an associate's degree in electrical construction and maintenance receive four weeks of course and lab work that is dedicated exclusively to renewable energy sources, according to Brubaker. This integration of renewable energy technologies and applications into existing programs reflects the college's commitment to providing students with strong foundations in the theory and application of their chosen technical field of study. Further, Brubaker thinks that the use of renewable energy technologies as demonstrated in these courses provides a more engaging way for students to learn the foundational theories that they must master in order to work in any electrical field, renewable or traditional.

Craig Clark, Dean of the School of Applied Technology, believes that the hands-on approach sets ASC apart and is a reason why the school draws students from every county in New York and from other states. Whereas at other colleges, students may have the chance to gain experience in renewable energy sources through extracurricular activities and clubs, the way in which renewable energy has been incorporated into existing courses of study at ASC assures students that they will learn these theories and skills in fulfilling their degree requirements.

A Wealth of Opportunity for Hands-On Learning: The commitment of the college to using renewable energy sources provides students with further opportunities for hands-on learning. Leading by example in its commitment to reduced environmental impact, the college has installed three photovoltaic systems and four wind turbines on the Wellsville campus. When it comes to "greening" ASC's operations, "students do all the work," according to Clark.

For example, one of the installed PV systems provides nearly 50 percent of the energy demands of the School of Applied Technology's library and administrative offices. Students in the electrical construction and maintenance technician program were involved in the four-day installation process, under the guidance of a program faculty member and someone from the local solar industry, and had a great deal of autonomy in deciding on the specifics of the installation.

With the support of the Educational Foundation of Alfred, a private foundation with the mission of enhancing learning opportunities for students, faculty and staff, ASC students in the building trades, heavy machinery and electrical construction and maintenance electrician programs have been learning by doing, building homes from the ground up in a subdivision owned by the foundation. These houses, whose construction is financed by the foundation, are sold at market rates, upwards of $200,000. The 49th house built was constructed to Energy Star standards, and uses geothermal pumping.

Construction of the 50th student-built house started in the fall of 2009. But unlike the other student-built houses, this one will not be put up for sale. Rather, it will serve as a showcase Green Home, built to meet the standards of the federal Energy Star program and the green building guidelines of the National Association of Home Builders.

As such, it will serve several purposes. First, it will be a learning laboratory for students, as it will be constructed in such a way that energy-saving and energy–producing elements of the home can be observed and monitored for energy usage. Secondly, it will be open to business, industry and community members as a way of raising awareness and understanding of the latest technologies in green building. Lastly, it will house the administrative offices of the School of Applied Technology and include several guest rooms for visitors.

Opportunities for hands-on learning are not confined to the ASC campuses. In 2009, a team of students traveled to Washington, DC under the supervision of Jeff Stevens, an instructor in the electrical construction and maintenance electrician program. There, they led a four-day workshop at the United States National Arboretum on the benefits, functions, design and installation of solar photovoltaic systems. The workshop was attended by homeowners, contractors, engineers and other interested parties, and culminated in the ASC students installing a 1 kilowatt hour solar array, which will power the arboretum's irrigation system. This workshop and installation experience is part of a five-year cooperative agreement between ASC and the arboretum, initiated by the arboretum, with the goal of receiving technical assistance in making their operations more environmentally friendly.

Going Commercial: Though the college's renewable energy courses and training has, to date, focused on small-scale solar and wind systems and residential installations, several students have already found jobs on the commercial wind farms that are starting to operate in the upstate New York region as well as with firms that are looking for workers with skills in renewable energy source installation and maintenance.

Further, the college is exploring the viability of a commercial-scale wind farm on the main campus in Alfred. Last year, electrical construction and maintenance students installed a commercial-scale meteorological tower, used for metering weather conditions and wind speeds in order to determine the feasibility of a commercial wind farm. President John Anderson is committed to developing a commercial wind farm that can offset the college's energy use and thereby minimize its environmental impact—but also as a means of giving back to the greater Alfred community. Ideally, the wind farm would generate energy in excess of the college's needs, which could then be fed into the local grid.

Though there is not yet a roll-out date for the wind farm, the magnitude of the undertaking speaks volumes about ASC's commitment to being a leader in its region, and amongst its peer institutions, in using education and training to strengthen the link between energy production, economic development and environmental stewardship.

Leading the Green Revolution

Appalachian State University, North Carolina

Background: Appalachian State University (ASU) is a part of the University of North Carolina System. ASU is located in Boone and draws students from around the state and the nation. Of the 17,000 students enrolled in the fall of 2009, approximately 1,500 were from out of state. The university offers both undergraduate and graduate programs.

Over the past ten years, universities and community colleges around the nation have been frantically creating programs aimed at training their students to enter the green workforce. Whether these programs are created as independent programs or are modules within existing departments, they all tend to represent a new direction for the post-secondary institution that develops them. But for Appalachian State University in Boone, North Carolina, the green revolution started more than thirty years ago. Since the mid-1970s, ASU has been training its students on ways to construct homes more efficiently and develop new ways to harness the power of the wind and sun. In the process, the university serves as a model for institutions seeking to enter the fields of energy-focused green technology.

Reaching out to the community: ASU is located in the beautiful Blue Ridge Mountains of North Carolina. The university enrolls 14,872 undergraduates and 2,086 graduate students.

One of the highest profile activities at ASU is the Research Institute for Environment, Energy, and Economics, an umbrella organization started in 2008 to oversee three main activities at the university: the Appalachian Energy Center, the Center for Economic Research and Policy Analysis (CERPA) and the Southern Appalachian Environmental Research and Education Center (SAEREC). The Appalachian Energy Center pursues a wide range of activities aimed at helping communities around the region become more energy efficient. Although there is some applied research, most of the work of the center is in outreach.

"The best way to think about it is that we try to improve the energy efficiency of buildings in the state and beyond," Jeff Ramsdell, who directs the Center, stated. "We do outreach to improve the construction techniques of builders and create standards for energy efficiency."

The Center offers a variety of training programs aimed at helping people involved in the construction industry to understand how to retrofit their buildings to meet new energy standards and to make new construction more energy efficient.

Workshops offered through the center have included obvious targets such as sub-contractors, but they have also included realtors and financial institutions. According to Ramsdell including these types of actors is critical to making energy efficiency ingrained in the home buying process.

"One big thing, there is a movement towards getting recognition of home energy efficiency in the valuation of a home," Ramsdell said. "Right now when an appraisal is done, energy efficiency is not really counted for. [The Center] put together a conference to help certify raters to perform a diagnostic to help determine the energy efficiency of homes."

The Center also works closely in renewable energy fields. The Center operates a site on Beech Mountain to test small-scale wind turbines. Manufacturers will send their products to the Center for testing on the site.

The Center also promotes the idea of capturing energy from landfills. A particular area of emphasis is in developing ways to capture gas from smaller scale landfills that exist in many small communities in the Appalachian region. The Center works with businesses and communities to help them harness this often untapped energy source.

An Emphasis on Training: The heart of ASU's efforts around energy, however, continues to be on the academic side of the equation. The university offers two main programs, both housed in its Department of Technology: building sciences, including concentrations in either construction management or architectural technology, and appropriate technology, which is the term ASU uses to describe its renewable energy program.

The building design program offers students a comprehensive program in making residences and buildings more energy efficient.

"What has really differentiated our construction program is the emphasis on energy efficiency," Ramsdell said. "We were doing it before it was cool."

Students who graduate from the program find work as project managers for construction companies or enter graduate programs in architecture. Despite the downturn in the construction economy, Ramsdell says that ASU graduates are still in demand.

"What is great is that even with the last two years, our students are still getting jobs," Ramsdell said. "They are finding work in high performance and green building. There is a huge market for the installation of building systems that save money."

The appropriate technology program, although separate from the building sciences offering, contains significant overlap. For instance, a student who studies how to install solar panels on a house will have to be well versed in the overall construction of the building.

Students who get a degree in Appropriate Technology receive extensive training on renewable energy systems and find jobs with many of the renewable energy companies throughout the region. Dennis Scanlin who chairs the Appropriate Technology Program says that those with a BS in Appropriate Technology are in high demand.

"People are in need of our graduates," he said. "You may be able to hire an electrician but you need some who understands the system as a whole to make sure it is installed." Ged Moody, a graduate of the program, says he was drawn to ASU in part because of its ability to teach the practical side of the work.

“One thing that really appealed to me was the applied approach,” he said. “It is not an engineering school—it is an applied program. The other thing that led me here was that the university has offered the program for decades. I knew they weren’t bandwagon people.”

In addition to the undergraduate program, the school offers an MS in Technology with a concentration in either appropriate technology or building sciences. The program is flourishing, attracting students from around the country. A planned program in building science engineering will add to the graduate level offerings at ASU.

A Holistic Approach: The academic environment at ASU is enhanced by the overall commitment to sustainability at the university. Moody, the former student, returned to the college as Sustainability Director. That level of administrative commitment is also shared by the university’s students. Students voted overwhelmingly to raise their fees by $10 to help in powering the campus through renewable energy.

Through the Renewable Energy Initiative (REI), students are conceiving, installing and managing different energy related programs at the campus. Projects have included installing the state of North Carolina’s largest wind turbine and installing solar panels to provide power to the university’s student union.

Moody believes that efforts like the REI show that the entire university is embracing the idea of sustainability not just the Energy Center and its related programs.

“We have this approach that everyone at ASU will leave with a holistic approach to sustainability,” he said. “Whether you major In English, health care, or another subject, you will leave understanding elements of green building and renewable energy. We believe that sustainability is the new paradigm. Businesses that don’t promote sustainability, I don’t think are going to make it.”

An example of how sustainability is being embedded in campus is in the College of Business. This academic year, the school will offer its first “sustainable business” concentration for its MBA program. Continually imbuing the school with the idea of sustainability creates an institution that can stay at the forefront of promoting a green economy.

“When you start with the value set already built into the institution, it really is a head start,” Moody said.

Pre-Apprentice Line Worker Program

Calhoun Community College, Decatur, Alabama

Background: The pre-apprentice line worker program offered at Calhoun Community College began with a two-year grant from the Alabama Governor's Office of Workforce Development. Calhoun was one of three state community colleges receiving grants.

The Pre-Apprentice Line Worker program offered at Calhoun Community College began with a two-year grant from the Alabama Governor's Office of Workforce Development awarded to 3 community colleges in the region; Wallace (Dothan) Community College, Central Alabama Community College, and Calhoun Community College. These three schools represent the Northern, Central, and Southern Alabama regions.

Industry Involvement: This continuing education, open-enrollment non-credit program was built on input received from industry, as well as from several other public and private institutions offering similar training. First, the three schools met with Tennessee Valley Public Power Association Apprentice Program, including all utilities and municipalities in the Tennessee service area, as well as with Alabama Rural Electric Co-op, to present the intended curriculum for the program. Best practices were examined in the Georgia Technical College System, as well as at the Southeast Lineman Training Center in Trenton, GA. A curriculum developer was hired to model the program after the training observed within the Georgia Technical College System and later input was added to the original development from technical workbooks written by industry consortia. The result was a 7-week Pre-Apprentice Line Worker program that provides 280 contact hours of training including both soft skills and technical skills, such as Line Worker Fitness, Safety (OSHA 10 hr), CPR/First Aid, Electrical Fundamentals, Ratios & Proportions, AC Theory, Line Worker Tools, Map Reading, Pole Climbing School (TVPPA Lab), Measurements, Line Hardware, CDL Training and Certification, and Line Worker Field Observations.

The students involved in the Pre-apprentice Line Worker program benefit from their trainer's previous knowledge and experience of the industry. In all three schools, the instructors of this program are retired industry workers that bring with them specific knowledge of industry needs and how training offered can best meet those needs. Calhoun Community College's instructor began his career as an Apprentice line worker, became a Journeyman, was hired as a Training Manager for a local utility, and then retired as a General Manager. The program instructor for Wallace Community College retired as a senior line worker and was involved with training at a local utility company. Central Alabama Community College's instructor began his career as a line worker, then moved on to establish his own national safety training program.

Although the program is a non-credit program, several certifications are offered throughout the 7-week training. TVPPA's training division participates in the program by training and certifying all completers of the Pole Climbing TVPPA Lab, and Emergency Medical Services (EMS) offers an on-site, one-day first aid CPR Certification. A 10-hour OSHA Safety Certification is offered through the program, and training and road tests are offered for those interested in receiving a Commercial Driver's License Certification. Upon completion of the program, each college presents its graduates with a Certification of Completion of the Pre-Apprenticeship Line Worker Program.

Building awareness: The community college system faces many challenges when offering technical programs, such as the Pre-Apprentice Line Worker Program, especially in the areas of enrollment and recruitment. The program is offered twice throughout the regular school year, once in the spring and once in the fall. Although, generally, each class has 10 participants, each school has the potential to accommodate 14 to 15 students in each session. Out of the 10 participants, only an estimated 60% will actually complete the program. This low completion rate is often due to attrition because of the physical nature of the work as well as the height.

The greatest ongoing challenge that Calhoun Community College and other technical institutions face in their attempt to provide the technical skills necessary for a fruitful career as a line worker or other technical occupation is in the area of recruitment. Recruiting individuals that are interested in working hard and dedicating themselves to a physical career is not an easy feat. However, those who are interested in becoming a line worker love the work, as they see it as a mission to provide their community with uninterrupted power and to service that power in times of inclement weather. In order to encourage local high school students, Calhoun Community College works with industry and the educational community in offering a recruitment video produced by the National Association of Manufacturers "Dream It, Do It" Campaign, a national campaign launched to address the shortage of skilled workers in U.S. manufacturing.

It is an ongoing effort of these institutions to bring awareness to potential students of the careers available in technical fields. It is a commonly held belief that in order to have a viable, successful career, one must attend a four-year university program; however, according to Mr. Jim Swindell, Assistant Dean for Technology Education at Calhoun Community College, only 30% of technical jobs require a four-year degree, whereas 70% of manufacturing work requires technical skills and training. The industry recognizes the value of technical and basic training, as some of the best engineers apply for a two-year technical degree before attending engineering school. Career coaches at all three institutions provide information on available technical occupations and visit area high schools to show a promotional video to juniors and seniors each year. The video was created using Pathways to Technology, an online resource of the National Science Foundation and the American Association of Community Colleges, as a guide, as well as video clips of interviews with faculty, industry representatives, and students. A summer camp for high school faculty and advisors also provides awareness of the potential of technical training leading to a successful career. The participants spend a half-day in each technical program offered, as well as attend industry tours and U.S. Economic Development Administration presentations that offer facts about salaries of technical occupations.

It is the opinion of Mr. Swindell that training at a technical institution can better prepare a student for a higher paying entry-level position than a four-year institution. Social workers train for five to six years for an entry-level position that may start out paying $30,000-35,000 per year. A two-year technical program can prepare a student for an entry-level position offering around $45,000 as a base wage. Also, technicians have the opportunity to increase their yearly income by working overtime hours.

Awareness must also be brought to the level of high school administrations. Oftentimes, it is the goal of the superintendent and administration within the high school system to enroll all of their students in four-year institutions upon completion of the high school program. Community college programs are viewed as a stepping-stone to other academic programs, a means to an end, rather than an end in itself. However, in the four county service area of Calhoun Community College, the community college has more students enrolled than any of the four-year schools.

With a majority of post-secondary students attending community colleges, an important goal is to change the current mindset of administrations to see community college training as a viable career track. It is also common practice for high school administrations to recommend these programs only to problem students. It would benefit the industry to have high school administrators recommend these programs to all students, especially those interested in seriously pursuing a viable career in a technical field, instead of solely recommending these programs to students that high school administrators do not know where to place for continued education.

Student body diversity: The average age of enrollers in the program at Calhoun Community College is 27 years old; indicating that some students are enrolled straight out of high school and others are adults retooling or changing careers. Many students attending this program are displaced workers from plant closures or lay-offs that are interested in taking advantage of state funding offered for up to two years of training for approved high-wage, high-demand jobs. Seventy-five percent of students enrolled in programs in career and technical fields are part-time students, usually because they are employed full-time while they are training for new skills.

Most students entering into technical training in energy fields are entry-level, lacking previous industry knowledge or experience. Internships are not required, but are encouraged. The Technical Cooperative Program at Calhoun Community College is a joint effort of industry and local area businesses, the college, and its students. The student, the college, and the business enter into an agreement of understanding, allowing the student to gain valuable hands-on experience within their field of study. The company interviews and hires the students and then evaluates their performance. If the students receive an evaluation of 80% or higher, as well as maintain a minimum “B” average in school, they receive a 50 cent raise at the end of the evaluation period. Internships are offered for students pursuing A.A.S degrees in Aerospace Technology, Design Drafting, Electrical Technology, HVAC, Machine Tool Technology, Industrial Maintenance, or Process Technology.

Cooperative partners include 3M, Automatic Screw Machine Products, AZ Technology, BASF, Brown Precision, Inc., Calpine, Defco, Delmonte Meow Mix, Dixie MetalCraft Corporation, Eaton Hydraulics, Electricfil Corporation, Federal Mogul, Hexcel Industries, IMS, Micor Industries, National Packaging Co., Nucor Steel, Pilgrim's Pride, Snap-on, Solutia, Sonoco, Tanksley Machine, Teledyne Brown Engineer, Toray, and United Launch Alliance.

Future plans at Calhoun: The future of technical training programs at Calhoun Community College includes the development of a three-phase Technical Robotics Park, adding a dimension of high-tech technologies to the institution. A $3.5 million dollar grant from the Department of Labor will aid in the development of a green energy complex, which will enable the college to add green energy technologies to the curriculum. Over the past 8 years, Calhoun's president, Dr. Marylin Beck, has been dedicated to expanding the technology programs offered at Calhoun with a Department of Labor grant for advanced manufacturing. A new Allied Health building will expand the capacity of the surgical technician, EMS, paramedic, dental assistant, and physical therapy programs. A new math and science complex has allowed for the addition of biotechnology programs to the campus, and an NSF-funded grant has enabled innovation and the restructuring of the aerospace technology program. All of these advancements enable Calhoun Community College to continue serving a key function in community education, not only as a short-term stepping-stone, but also as a valuable provider of focus training for business and industry.

Energy Efficient Residential Construction

Cleveland State Community College, Tennessee

Background: Cleveland State Community College (CSCC) is located in Cleveland, Tennessee, in the state's southeast corner. The school serves the five-county area of Bradley, Meigs, McMinn, Monroe, and Polk counties and has an enrollment of approximately 3,500 credit-seeking students and 1,500 non-credit students.

Cleveland State Community College (CSCC), located in southeastern Tennessee, is a community college at the helm of efforts to transform the way energy is used in its region. Through its program in energy efficient residential construction (EERC), CSCC is re-vamping its curriculum in construction technologies to attract students and companies who see the economic benefits of using energy efficiency to brand themselves in the marketplace.

Cleveland State's program in energy efficient residential construction began in 2005 with a grant of $861,840 from the U.S. Department of Labor, one of 70 Community Based Job Training Grants. The project that CSCC designed with the CBJTG funding incorporated concepts of green building, energy efficiency and sustainability into the existing construction technology curriculum; reached out to the local education community to raise awareness of energy-efficient construction; purchased equipment and technologies to support classroom learning; and offered continuing education to local contractors and the construction industry.

Curriculum: With the DOL grant, CSCC created six courses in topics related to energy efficiency and alternative energy that could be taken as part of the A.A.S. degree in construction technology, as a stand-alone certificate program called the Zero Energy Home Certificate, or on a one-off basis with students taking only the classes that are interesting or relevant to them. The six courses were Renewable Energy; Solar Photovoltaic (PV) System Design and Installation; Energy Efficient Residential Elements; Ground Source Heat Pumps; Home Energy Rating System; and Service Learning. CSCC is in the process of developing an articulation agreement with the University of Tennessee at Chattanooga (UTC) for a bachelor's of science degree in construction management.

Greening the Construction Industry: The decision to integrate energy efficiency into existing curricula is considered best practice in designing industry-specific training and has been recommended for green job training. The rationale for embedding energy efficiency courses into the construction technology program is that the descriptions of traditional construction jobs and energy efficiency construction and retrofitting jobs are not very different[1]. In fact, in response to the overwhelming enthusiasm over the promises of green jobs, more cautious analysts have warned that many green jobs are not new; they are traditional jobs using new or different inputs[2].

---

[1] Center on Wisconsin Strategy. (2008). *Greener Pathways: Jobs and workforce development in the clean energy economy.* Madison: Center on Wisconsin Strategy.
[2] Chapple, K. (2008). *Defining the Green Economy: A primer on green economic development.* Berkeley: Center for Community Innovation.

In the case of energy efficient construction, this is largely true. Differences between traditional and energy efficient construction are in materials, equipment and techniques not requiring different technical competencies but rather awareness and knowledge of how to apply them. For example, the way a house is framed has an effect on the way it can be insulated, which in turn influences the energy savings that can result from better insulation. The energy efficient framing technique does not require a different set of basic competencies for a framer, but it does mean that a framer needs additional or different knowledge to build an energy efficient home.

Because energy efficiency techniques and principles are taught within the context of a construction curriculum, and the program has flexible enrollment options, the EERC sequence of course at CSCC is being used by some incumbent construction industry workers as a means of upgrading their skills. The average age of students in the EERC program is 28 to 29, reflecting the fact that students are coming to the program "from both sides", Dean of Business & Technology, Allan Gentry says. He estimates that approximately two-thirds of the students in the program are incumbent workers from the construction industry - owners and employees of local construction and building companies.

Several people also noted that they thought the weak job market, combined with the buzz around green jobs, was helping to attract students who wanted to have some first-mover advantage in the energy efficient construction industry. In this sense, participation in the program is anticipatory of changes that are seen as inevitable in the construction industry. Some of the students are also enrolling with the idea of pursuing opportunities for contracting and self-employment in the areas of weatherization and energy auditing and rating.

For other students, who may already be self-employed or business owners in the construction industry, gaining new skills related to energy efficiency is a way of expanding the scope of services they can offer clients. Further, building these competencies is a low-cost way of improving firm competitiveness—particularly important in an economic downturn.

John Proffitt, outreach coordinator for the EERC program, noted that when the national housing boom was at its height, it was harder to get people to slow down enough to listen to pitches about the benefits of energy efficiency. Now, when the market for new construction is soft, energy efficiency is seen as a way of distinguishing one’s products and services from those of other firms. Although some of firms have disappeared as a result of the recession, Proffitt senses that the ones that remain are there to stay, and he sees the value in continuing to educate them about the importance of energy efficient construction because of the lasting influence it will have in the region.

Finding the Right Mix of Alternative Energy: Summarizing the launch of the EERC curriculum, Allan Gentry said that the greatest challenge was figuring out how to package the concepts and elements of renewable energy in a way that make sense for the region in which the program operates. There were several layers to this challenge.

The first is the culture of energy supply and demand. Tennessee is part of the East South Central census division, which also includes Alabama, Kentucky and Mississippi. In 2008, this census division had the highest average monthly energy consumption—twice that of the New England—and Tennessee had the highest of the group with 1,302 average monthly kilowatt-hours. Furthermore, even with one of the lowest average retail prices per kilowatt-hour, at 8.92 cents, the average monthly residential electricity bill was $116.02.[3] For this reason, a large part of what the EERC program aims to accomplish - both in the classroom and through its outreach activities - is raise awareness about the concepts and benefits of energy efficiency and renewable energy.

A second layer to the challenge of packaging renewable energy for the region was determining which energy sources should be emphasized based on their potential benefits for the region given its climate and local economic conditions. For example, Gentry noted that the popular image of renewable energy, wind turbines, is not a viable option in the Tennessee Valley because of local climate conditions. On the other hand, the local climate does make solar energy a viable option, particularly in conjunction with energy efficient construction because the solar installation can be downsized as a result of a building's reduced energy demand.

The choice to emphasize energy efficiency is obvious. As a strategy for reduced fossil fuel use and stimulating economic activity, energy efficiency is a "green" jobs sector that has no geographic constraints. Energy efficient construction and retrofitting is estimated to create 18 times more direct and indirect jobs than the renewable energy sectors in the United States.[4,5] When combined with the trends of high-energy consumption and low energy costs in Tennessee, there is a clear rationale for a training program that emphasizes energy efficient construction.

Cleveland State Community College as Catalyst: One of four areas of activity funded by the grant that launched the program, outreach has been an important emphasis by program faculty. Part of the DOL grant that launched the EERC program was to cover the cost of seminars and workshops for the local construction and utilities industries to highlight the benefits of energy efficient construction and negative effects of inefficient construction on energy consumption.

EERC also educates people about the need for energy efficiency and the opportunities for energy savings afforded by renewable energy sources. The college owns a trailer equipped with a solar panel array that travels to career fairs and events to raise interest in the program and provide a visual representation of the idea of green jobs and clean energy.

In early 2010, at "Save Green, Go Green," an event at a local mall, CSCC staff described how an energy efficient home and changes to energy-use behavior can save homeowners and renters

---

[3] U.S. Energy Information Administration. 2010. Average monthly bill by census division and state, 2008. Retrieved on March 6, 2010 from http://www.eia.doe.gov/cneaf/electricity/esr/table5.html.

[4] Center on Wisconsin Strategy, 2008.

[5] Tennessee Department of Labor and Workforce Development. (2008). *Growing Green: The potential for green job growth in Tennessee*. Tennessee Department of Labor and Workforce Development, Employment Security Division, Labor Market Information Section.

money. They were joined by Local Workforce Investment Area 5, the agency with which CSCC is partnering to offer courses to displaced workers.

CSCC responds to the needs of displaced workers by partnering with the local workforce investment agency to offer the EERC courses as a series of modules leading to a certificate. The program follows a week-on, week-off schedule that allows for the classes to be taught to two cohorts, at two locations, over the same 10-week time period.

Challenges: Continued Outreach and Strengthened Links to Industry: As the EERC program continues to develop three issues must be addressed to strengthen the impact and value of the program to the region. The first is creating employment opportunities. Finding a job after program completion is of central concern for students who are not incumbent workers. Further, the degree to which technical training programs are able to develop strong ties with local industries—engaging them in curricular design and, in exchange, securing hiring commitments for their students—is often considered a metric of success for training initiatives. Enrollment in EERC courses has grown each year but remains quite small. In the fall of 2009, 32 students were enrolled in at least one EERC course. Because many students are adults working full-time, it can take several years to complete the sequence of courses, assuming that's the student's goal. Thus, the pool of people who have taken all or some of the EERC courses remains quite small. This small pool, the fact that many participants already work in the construction industry, and a soft job market, are ample explanations for why the program has no formal job placement service and why connections between program and industry remain largely informal.

The second and third issues have to do with the skills that the EERC program teaches. The program's focus is on hard skills and knowledge, the technical skills and know-how to diagnose residential energy use and design and implement retrofits and new construction that minimize energy use. However, the nature of the work that the EERC program prepares students to do lends itself to entrepreneurship—launching new ventures, adding new services to existing businesses, or seeking contract employment for home energy rating and retrofitting work available through government agencies (with federal money), nonprofit organizations and utilities. This suggests the need for CSCC to provide EERC students with parallel training and support in skills related to entrepreneurship and business management.

Similarly, EERC program graduates are faced with the challenge of raising awareness of and demand for energy efficient construction among homeowners and renters. They do this by targeting different populations with the message of energy conservation and efficiency: the general public, through participation in fairs and other events; high school students, through partnerships with schools with vocational education programs in fields related to construction; and the construction industry, through seminars that were held as part the initial grant-funded project that launched the EERC program.

However, since the outreach capacity of the EERC program is limited by the size of its faculty, there is an argument to be made for preparing students to be ambassadors for the program and for energy efficiency, in general. This would require training in soft-skills related to public speaking and presentation, and marketing. It would also require the creation of new venues for outreach activities so that EERC students can find channels for promoting their skills and the EERC program can reach a wider audience with its message about energy conservation.

Banking on Wind and Solar

Frostburg State University, Maryland

Background: Frostburg State University is a four-year institution that is part of the University of Maryland System. Located in Frostburg in the western part of Maryland, the school enrolls approximately 5,000 undergraduates and 900 graduate students.

Not all post-secondary programs concerning energy are offered on a for-credit basis. Frostburg State, a four-year university in western Maryland, offers a not-for-credit program that provides participants with the knowledge needed to install residential wind and solar systems.

The program, WISE (Wind and Solar Energy) is offered as a two-stage program to interested participants. In the first stage, students complete an eight-week, on-line course. In the second part of the course, students travel to Frostburg for an intense three day workshop allowing them hands on demonstrations of these complicated systems. At the end of the course, students can choose to sit for a PV Entry Level Certificate of Knowledge Exam offered by the North American Board of Certified Energy Practitioners (NABCEP). Students who complete the course are able to enter the energy field with the ability to install residential wind and solar systems and an understanding of how these systems work.

The WISE program began in 2007, funded in part through a grant from the Appalachian Regional Commission. Initially separate modules were offered for solar and wind installation. However, almost all of the first attendees signed up for both modules, so Frostburg decided it made much more sense to offer the combined curriculum.

From the start, the university designed the program to reach non-traditional students. The only pre-requisite for the class is a high school degree.

"We have a very diverse group, which makes class challenging," said Oguz Soysal, one of the program's founders and managers. "In terms of knowledge and background we have people who have no background and people with electrical engineering degrees and post-docs. This makes our work more challenging."

The individuals not only come from diverse educational backgrounds, they are in diverse careers. Some students come into the program hoping to enter directly into the energy field, and others want to use the residential installation as a way to enhance their current position. The majority of participants are contractors but some unexpected occupations are included. For instance, Soysal mentions one student, a full time real estate agent, who believed that knowledge of residential power systems would be valuable in selling and pricing properties.

Of the 120 students that attended the first three sessions of the program, 89% came from ARC states of Maryland, Virginia, Pennsylvania, West Virginia, and New York. The on-site component of the class does allow for participation from more far-flung locales, however.

Several international students have taken the class, although they, like all students are expected to participate in the intensive workshop.

Course structure: The online component of the course is divided into 8 week sessions that cover the basics of wind and solar power and their applications in the residential environment. Specifically the eight-week modules are:

- Electricity Basics
- PV and Wind Markets and Applications
- Solar Energy Fundamentals and PV Module Characteristics
- Wind Energy Fundamentals and Turbine Characteristics
- Residential Generation Types and Components
- System Sizing and National Electric Code
- Mechanical Design Considerations
- Safety Basics, OSHA Requirements

At the end of each self-guided week students are invited to take an online self-assessment "test" to gauge their progress. Feedback is given so students can understand what elements they need to work on before progressing to the next module. The classes can be accessed throughout the day, a necessity for participants who are not-full time students.

The on-site workshop offers an intensive introduction to the practical world of installation. Students attend labs where they receive instruction for installing a small grid-connected PV system and given hands-on demonstrations on wind turbine characteristics. Students are also instructed on inspecting residential generation systems and information about regulatory standards for the installation.

Faculty members for the workshops come primarily from private industry, ensuring that students receive real-world instruction about this technology. Also key is the university's having adequate technology on site to demonstrate the installation techniques. A portion of the $850 tuition goes to ensuring that the program has adequate facilities for instructing their students. In addition, Frostburg State has received funding to construct a new Sustainable Energy Research Facility, which among other activities, will house the WISE program.

Program impacts: To date, nearly 200 individuals have completed the program, which has been offered twice yearly since the fall of 2007. Many graduates have gone directly into renewable energy fields while others have used the knowledge to supplement their careers or even to install systems in their homes or businesses. One way to measure the impact has been the number of students sitting for the NABCEP Certificate of Knowledge Exam, which is specifically geared towards solar installation. In the spring of 2009, thirty-six of forty students took and passed the test administered by Frostburg State.

Challenges: The program's main challenges come from its non-traditional nature. While community colleges are accustomed to offering non-credit classes, such programs are more unusual at the university level. Consequently getting university administrators to embrace the program has been a challenge. Universities are accustomed to dealing with traditional students in the 18 to 22 year old range, a cohort that is only a partial component of the Frostburg State program. The success of the program, demonstrated both in terms of impact on students and its financial self-sufficiency, should alleviate the concerns that are brought by university administrators.

Advanced Energy and Fuel Cell Technology

Hocking College, Ohio

Background: Hocking College has lengthy experience in advanced energy technology going back to an innovative natural gas-powered vehicle program begun in the 1980s. Now many of the college's 6,000 students prepare for skills and degrees and find employment in the fuel cell industry.

Hocking College and its advanced energy and fuel cell program are a critical piece in a statewide strategy for fuel cell industry development and local efforts at building a vibrant clean energy sector to revitalize a distressed rural area. Hocking College demonstrates the integral role that community colleges have to play in building and anchoring clean energy firms and clusters by training a mid-skilled workforce that can meet industry needs. The school also illustrates how a community college, as a prominent local asset in a distressed rural area, can encourage the growth of clean energy related firms, and thus encourage local development that creates good jobs.

Early innovation: Hocking College (HC) is a two-year college with its main campus in Nelsonville, Ohio, 60 miles southeast of Columbus. The college's service area is Hocking, Athens and Perry counties, but the college enrolls students from every county in the state, 17 other states, and 30 foreign countries. Enrollment in the winter 2010 semester was approximately 6,000 students.

Hocking College offers associate of applied science degrees in advanced energy and fuel cells, and automotive hybrids through the Hocking College Energy Institute (HCEI), which was founded in 2003. A degree in regenerative sustainable agriculture, also to be offered through HCEI, is planned to begin in the fall of 2010.

While the institute and its course offerings are still relatively new, the roots of HCEI and Hocking College's leadership in clean energy dates back to the early 1980s when Dr. Jerry Hutton, who grew up on a farm in southeastern Ohio and had been a student at HC seven years earlier, helped start the International Energy Center, no longer in existence, focusing on natural gas-powered vehicles.

In the early 2000s, Hutton was working for Quantum Technologies in California, a company making fuel cell systems and other advanced energy technologies. Hutton, who maintained his ties to southeastern Ohio and to Hocking College's then-president, Dr. John Light, suggested starting a program in fuel cells. In 2002 Dr. Light asked Hutton to start such a program, and in 2003, HCEI's curricula in advanced energy and fuel cells and automotive hybrids were launched "with three students and a briefcase." In the fall of 2009, the programs enrolled 61 first-year students, twice the number who had enrolled the previous year.

Degree Program Structure: The associate of applied science degree in advanced energy and fuel cells requires between 102 and 107 credit hours of which approximately 60 percent are technical courses that cover fundamental theories and practice of energy and energy components for fuel cells, solar, wind and hydroelectric, and cryogenics as well as the fundamental processes and technologies associated with batteries, instrumentation and controls. The remaining 40 percent of required classes are in general education and have a clear relationship to the technical content of the curricula and the general emphasis of community colleges on preparing students for the workforce.

HCEI's program prepares students to maintain and service installed fuel cells, or to be research assistants. The course of study covers the basics of fuel cell technology for residential, commercial, industrial, and vehicles settings, and the requirements for testing, configuring, assembling, and troubleshooting single and stacked FC systems.

For students interested in continuing their education, HC has a new articulation agreement with the University of Minnesota, Crookston (UMC) whereby students can complete an additional 45 credits in the School of Agriculture and Natural Resources and receive a B.S. in agricultural systems management with an emphasis in biofuels and renewable energy technologies.

While the name of the program includes the term "fuel cells", graduates are actually prepared for technician positions that support a range of renewable energy sources and systems; solar, geothermal, biofuels, and hydroelectric. This is an important distinction because HCEI's programs relates to energy industry activity at two levels, local and the state. At the state level, there is a tie-in to a well-defined cluster strategy for the fuel cell industry. At the local level HCEI relates to a more general strategy to promote alternative energy and green companies, and a concentration of local solar and wind installation companies is the major provider of job opportunities for students.

Supporting and Anchoring Cluster Development: Community colleges have an important role to play in strategies for developing new or strengthening existing clusters, as Ohio's Fuel Cell Initiative does. At its most basic level, the match between community colleges and clusters is based on the college's core competency in training students to fill the ranks of the mid-skilled labor force[6,7]

There is a critical need in Ohio for a larger number of workers to service fuel cells than to manufacture them; a need filled by HCEI graduates according to Pat Valente of the Ohio Fuel Cell Coalition. Further, the availability of service providers will be particularly important given that Ohio seeks to stimulate the demand and use for fuel cells by end-user industries within the state.

Part of the rationale behind Ohio's decision to pursue fuel cell cluster building as an economic development strategy is the state's manufacturing history, particularly in the automotive industry. Ohio's goal of becoming a leader in fuel cell manufacturing is also a bid to restore job opportunities to the workers displaced as a result of contraction of the domestic automotive market which hit Ohio particularly hard. The establishment of fuel cell curricula at HCEI and

[6] Grubb, W. N. (1996). *Working in the Middle*. San Francisco: Jossey-Bass Publishers.
[7] Rosenfeld, S. A. (2002). *Just Clusters: Economic development strategies that reach more people and places*. Carrboro: Regional Technology Strategies

Stark State Community College, in North Canton, is a way of preparing displaced workers for the emerging fuel cell industry. Accordingly, Jerry Hutton estimates that 35 percent of students enrolled in HCEI's fuel cell programs are displaced adult workers; while the younger students represent the next generation of Ohio's workforce.

As with any training initiative, though, there is a fine line to walk between preparing students for existing job opportunities, and training them for jobs that do not yet exist. Currently, jobs in research and development outnumber those in manufacturing; though this is predicted to change as the end-goal is for Ohio to be a leader in fuel cell manufacturing.[8] To date, HCEI has not had trouble placing students in jobs in the fuel cell and advanced energy industries. This is probably due to the small size of the program so far, and the fact that there already are a number of fuel cell firms in the state; however, this could change if the program continues to grow at a pace mismatched to the growth in relevant job opportunities.

Beyond training students for existing employment opportunities, though, HCEI is playing a critical role in encouraging and anchoring the growth of the fuel cell industry in Ohio. The existence of HCEI's training program—and a similar one offered at Stark State—is a powerful signal to fuel cell companies because it demonstrates the commitment of the state to developing a mid-skilled workforce that will meet the needs of the nascent industry. By building a local supply of mid-skilled labor, Ohio is sending a clear signal to existing and new fuel cell firms that it is committed to encouraging and retaining fuel cell manufacturing within the state, rather than seeing these blue-collar opportunities shipped overseas.

Further, Ohio is giving teeth to whatever incentives it may use in encouraging Ohio firms to diversify production into fuel cell components, and attracting national or international firms—some that may already have a presence in the state—to locate their fuel cell operations in Ohio.

By way of example is the case of the successful recruitment of Rolls Royce's fuel cell operations to Ohio. Ohio Fuel Cell Coalition Executive Director, Patrick Valente, was the deputy director of the technology division of the Department of Development when the state entered into recruitment discussions with Rolls Royce. At that time, Rolls Royce had operations in Ohio, but none of its fuel cell work was there and they were considering two other states as locations to headquarter this work. Valente recounts that the president of the division said to him, "I'm not interested in the [financial] incentives that you have. Let's talk about the other things I need", and then listed half a dozen issues that he considered critical, including available training programs and providers.

Encouraging Local Green Growth: At the local level, HCEI benefits from being located in a multi-county area that has embraced the movement towards clean energy as an opportunity for economic development and job creation. HCEI plays two roles in these efforts. The first is as an institutional asset that can bolster efforts to attract and retain clean energy industries by guaranteeing access to skilled workers. The second role that HCEI plays is as a partner in local

---

[8] Ohio Department of Development Technology Division. (2009). *An Update on Ohio's Fuel Cell Roadmap.* Columbus: Ohio Department of Development Technology Division.

efforts, working with economic development actors and firms to promote the transition to a clean energy economy.

Since its inception, HCEI has operated at a satellite location, the Logan-Hocking Industrial Park in the town of Logan. The relationship between HCEI and the Logan-Hocking Industrial Park (LHIP) is indicative of how HCEI fits into a broader picture of local economic development strategy. The LHIP opened in 2003 and is owned and operated by the Hocking County Community Improvement Corporation (CIC).

Until recently, the CIC's approach to recruiting was to go after "any and every company", according to Executive Director Bill Rinehart. In 2009, the CIC commissioned a study from the Voinovich School of Leadership and Public Affairs at near-by Ohio University to determine the feasibility of adopting a green focus for the marketing and recruitment strategy for the LHIP. The study confirmed the instinct that the CIC leadership had: that there was an opportunity for the LHIP to brand and market itself as a green industrial park because of what makes the LHIP unique—its relationship with HCEI. LHIP can offer companies access to a prepared workforce, as well as the prospect of increased visibility by virtue of proximity and informal affiliation with HCEI, which is attracting a lot of attention and visitors because of its unique programs and its new, LEED-certified building with its distinctive look that stands out in the surrounding rural landscape.

The relationship between HCEI and LHIP is not just about proximity; it is much deeper than that of tenant and landlord. Around 2003, the Hocking County commissioners approached Bill Rinehart with the idea of pursuing a grant in partnership with Hocking College to have a workforce development facility located in the county as a tool to attract companies. Six years later this finally happened with $1.6 million in funding from the Economic Development Administration (EDA), nearly $200,000 from the Appalachian Regional Commission, and a matching amount from bonds issued by the CIC.

Classes are taught in the HCEI building located on Hocking College-owned land, across the road from the existing LHIP building, which houses HCEI's administrative offices as well as two local start-ups, both of which fit with the new green strategy. EMEGA Technologies is actually two research and development companies with the same owner and a shared mission of producing advanced, sustainable materials that can facilitate "near-zero energy use" for homes and buildings.

The other tenant, Spark Production, produces a rack system used for solar installations. Patrick Preston, founder of the company, lived in the area, but his career in building specialized machinery took him out of the state. After attending a seminar offered by the state of Ohio on alternative energy and talking to some solar installation companies, Preston saw a need for racking for local solar installation. Most of the mounting equipment that was used came from the West Coast and was unsuited for Ohio's winters, plus installers were having trouble getting timely deliveries.

Working closely with Dovetail Solar and Wind, a solar and wind installation firm headquartered in Athens, Preston designed racking systems for a number of their solar installations projects.

The collaborative process has allowed him to continually refine his product, and while each installation to date has been customized, Preston is hoping to move to mass production.

Proximity to HCEI has had multiple benefits for Preston and his young company. The first has been assistance in building his pipeline of interested customers as Jerry Hutton brings more and more visitors to Preston's offices. Preston also has used HCEI as an educational resource by taking a one-week, 40-hour course in solar photovoltaic energy offered at HCEI. In a nice bit of synergy, the participants in the course used Spark Production's racks to install a full solar array on the roof of HCEI as a hands-on learning experience.

Though EMEGA Technologies and Sparks Industries are small, they hope to provide internships for students soon. More importantly, though, retaining companies like EMEGA Technologies and Spark Production in southeast Ohio increases the opportunity to effect change in the local economy, provide needed employment opportunities, and help stem the tide of workers who commute to Columbus.

Alternative and sustainable energy is one of the three target industries of the Athens County Economic Development Council (ACEDC). The focus on alternative and sustainable energy emerged about five years ago and reflects both the culture and assets of the county, as well as its needs. In addition to the asset that HCEI represents, the county is home to several companies involved in alternative and advanced energy, has faced chronic unemployment issues, and has interest and support for alternative energies and moving away from reliance on coal (Shelton, 2010).

There are five solar and wind installation companies in Athens County, not insignificant for a rural county of approximately 63,000[9] people (Shelton, 2010). The critical mass of these firms is important to HCEI because it ultimately will mean employment opportunities for HCEI students and graduates.

Both CIC and ACEDC now are focusing efforts on supporting existing and aspiring local clean energy firms to help them grow in place. CIC had retained the services of a consulting group to study the feasibility of launching an incubator at LHIP. Incubation is a proactive approach on the part of Athens and Hocking Counties to support the growth of local firms that can contribute to their economic development strategies. Incubation can provide support that will fill gaps that may exist in firms between technological know-how and product innovation and application and the fundamentals of business management including access to funding and patents.

For HCEI, county-level support to businesses is promising because it helps ensure that existing solar and wind companies in the area survive and continue to grow. As with Spark Production, the potential incubator at LHIP can use proximity to HCEI's resources, physical plant and students as an extra benefit of being a tenant and HCEI's students will continue to benefit from the opportunities for learning and exchange, whether formal or informal, that proximity to new firms can provide. Finally, the presence of an incubator provides encouragement and support for

[9] U.S. Census Bureau. 2008. State and County Quick Facts: Athens County, Ohio. Retrieved March 11, 2010 from http://quickfacts.census.gov/qfd/states/39/39009.html.

HCEI graduates to pursue self-employment or entrepreneurship as an option once they complete their course of study.

HCEI's presence helps shape the qualitative nature of economic development in the region, acting as a resource and support for firms looking to establish themselves and grow in southeast Ohio—where, because of the region's economic distress, there are a number of financial incentives from the federal government for business establishment and job creation. HCEI's presence has an influence on the types of firms that are attracted to the region, which is important for economic development actors that are concerned with not just the quantitative measures of economic growth (e.g. jobs and tax revenue), but with the qualitative aspects of economic development such as job quality and industry environmental impact.

Challenges: Increasing Access and Opportunity: HCEI's associate degree programs now function more like a residential four-year college than most community colleges. Students come from a broader service area, and courses are offered during the business day. This creates barriers for local people who work full-time, as well as those who cannot relocate to the Hocking College area to seek full-time training or lack transportation from urban areas.

Further, because the curricula is taught in a community college setting, HCEI is inadvertently excluding individuals that have struggled within the institutional setting of public education, and therefore are unlikely to seek training at a community college—minorities, high-school dropouts, and other disadvantaged groups.

To date, HCEI has not had trouble with students not being able to find jobs; though Jerry Hutton notes that this could change, as the program has grown faster than expected. Interestingly, as the fuel cell industry moves toward greater maturity in Ohio, training programs like HCEI's will likely need to be brought to scale to train the number of workers that are necessary to maintain and service fuel cells once installed. This scaling-up may call for expansion of the curricula to other schools, repackaging the curricula for delivery through different channels (e.g. distance learning), or distilling the broad fuel cell curriculum into shorter certificate-granting programs focused on different technologies (e.g. solid oxide fuel cell technology versus porous exchange membrane technology) or end-uses of fuel cells (e.g. transportation versus utilities). This repackaging of curricula is well within the realm of the community college's core competencies, as flexibility in adopting new and adapted curricula is one way that community colleges have proven to be strong partners to industry.

Replacing an Aging Workforce in Coal Mining

The Kentucky Coal Academy, Southeast Kentucky Community and Technical College, Cumberland Kentucky

Background: Southeast Kentucky Community and Technical College is one of four colleges participating in the Kentucky Coal Academy. The academy is trying to deal with the employment needs in an industry with little to no growth in employment but with replacement needs presented by an aging workforce.

The Kentucky Coal Academy is an open entry/exit workforce training program operating within four community and technical colleges in the Kentucky Community and Technical College System (KCTCS): Big Sandy Community and Technical College, Hazard Community and Technical College, Madisonville Community College, and Southeast Kentucky Community and Technical College. With an estimated loss of half of the mining workforce in the next five to seven years, Kentucky Coal Academy aims to supply the coal industry with qualified and safety-conscious workers, provide career pathways for area miners, and create and sustain jobs in the industry.

The Kentucky Coal Academy partners with the Kentucky Office of Mine Safety and Licensing, the Mine Safety and Health Administration and other mining associations and training programs throughout the nation, as well as with 34 coal companies operating in the state of Kentucky, to develop training programs that meet current industry needs.

Dealing with the impact of an aging workforce: The four colleges in the KCTCS system that house the Kentucky Coal Academy already had mining technology programs in place when the Academy was formed, however, only two sites were active, Southeast Kentucky Community and Technical College in the East and Madisonville Community College in the West. In 2005, the year that the Kentucky Coal Academy was formed, the coal industry was attempting to fill high levels of demand with an aging workforce. Because of the expected turnover, Southeast Kentucky Community and Technical College saw the need to expand their mining technology offerings. In 2005, funding under the Kentucky Coal Academy enabled the addition of mine simulators and facilitated the development of other areas of mining training.

Educators at the Kentucky Coal Academy include former coal miners, safety inspectors, electricians, and mine foremen, providing their students with the benefit of prior industry experience. Faculty members are generally recruited by word-of-mouth through industry and among retired personnel. In addition to prior experience, Kentucky Coal Academy educators also receive instructor certification training in order to comply with regulatory agencies. Because most instructors have experience working in the industry, the Mining Technology includes instruction in all areas of the mining industry.

Dealing with the range of skill needs: Course offerings include training in the self rescuer device, transportation controls, communication controls, mining conditions, mining methods, mining cycle, escape ways, emergency procedures, roof control, ground control, ventilation health hazards, clean-up and rock dusting, health and safety aspects of assigned task, mine gasses, explosives, compressed cylinders, electric hazards, first-aid, operator of equipment, electrical knowledge and troubleshooting, repairing electrical and fluid power equipment, maintenance of equipment, fabricating, supervising, and the engineering aspects of mining.

Southeast Kentucky Community and Technical College offers a variety of customized and certificate programs including training for new miners, new electricians and mechanics, emergency mine technicians, and new operators, as well as annual retraining needs for regulatory compliance. The program primarily offers college credit for customized training courses designed specifically for a particular company; however, some training is offered as continuing education.

A.A.S. Degrees are offered with five specialization options; Operators Option, Electricians Option, Supervisors Option, Mechanic Option, and Engineering Operations Option. Certificates are offered in the following: Underground Operator, Underground Mechanic/Electrician, Underground Supervisor, Surface Operator, Surface Supervisor, Surface Field Mechanic, Surface Technician/Greaser, Apprentice I, Apprentice II, Technician I, and Technician II. Certificates are offered at the completion of most individual classes and specialized training programs. Training courses offer modular credit that can be applied towards an associate degree at the college.

The New Miner Cohort Program, offered at Big Sandy Community and Technical College, in partnership with area coal companies, is an accelerated 30-week training program providing on the job training in addition to the course work. Program participants are evaluated by area coal companies and are hired at $10 per hour to work while also attending training. The coal company then has the ability to hire the participant full-time upon completion of the certification program.

Students attending the Mining Technology program through the Kentucky Coal Academy are of all ages and most are employed full-time. In many cases, students enrolled in the program are upgrading to a higher paying job and are looking for new certification or retraining opportunities. Many companies in the industry will either arrange the schedule of an employee or pay for them to attend courses at the Academy. Some state and federal workforce development organizations match funds for providing customized training in order to improve skill levels in the region.

The program does not have difficulty in attracting students and has always operated at near-capacity levels in electrical classes and annual retraining. Enrollment figures of new miner training courses, however, depend on industry needs. Recruitment is done through job fairs at area high schools, and the Kentucky Coal Academy sponsors educational events to increase interest in mining technology, such as annual summer youth programs.

Challenges: qualified instructors and modern technology: The greatest challenges of the Kentucky Coal Academy program are finding qualified instructors and having appropriate facilities and equipment to meet the rapidly evolving technology of the coal mining industry. Grant resources are limited for funding the state-of-the art equipment necessary to keep up with these changes. Although the equipment is generally specialized for individual programs, collaboration among the curricular programs has been positive, allowing for shared facilities.

The Kentucky Junior Coal Academy extends coal education to secondary students, providing a career path with a combination of academic and technical instruction. Seven components make up the curriculum for The Kentucky Junior Coal Academy; high-level academic courses, advanced technical courses, computer-based training modules in mining, simulator mining equipment training, pre-engineering (for students pursuing mining engineering), agriculture (for students pursuing a wildlife/forestry tract), and a work-based learning program.

The first Kentucky Junior Coal Academy opened in Lawrence County Schools in Louisa, Kentucky in 2006. A partnership with Kentucky Tech Area Technology System in 2007 spurred the opening of 12 new academies, primarily in the eastern coal region. Currently, Kentucky Junior Coal Academies are operating in Louisa, Pineville, Belfry, Jackson, Manchester, Corbin, Martin, Hindman, Barbourville, Hyden, Whitesburg, Inez, Pikeville, and Greenville.

Filling Needs in the Utility Industry

Lanier Technical College, Lanier, Georgia

Background: Lanier Technical College, part of the Technical College System of Georgia, is a leader in workforce development for individuals and industries in an eight-county region of northeastern Georgia. Its associate degree, diploma, and certificate programs, short-term workshops, continuing education and customized trainings are spread out across the school's five campuses. Undergraduate enrollment is approximately 3,100.

Electrical Utility Technology Programs: Lanier Tech offers three courses of study that prepare students for work in the electrical power industry. Courses of study range from a 42 credit-hour certificate program to a two-year Associate in Applied Science (A.A.S.) degree.

The 42 credit-hour program leads to an electrical utility technician certificate. The certificate program is intended for incumbent workers in the electrical utility industry and is meant as a way for them to upgrade or enhance their academic or professional skills. Required courses include three in core subjects—English, algebra and trigonometry—and six in occupational subjects, including direct and alternating current circuits, computers and power fundamentals. The certificate offers incumbent workers a way to move up within their industry—for example, from a physically demanding or low-skill job to a mid-skilled technician job.

The electrical utility technology diploma program is meant to prepare students for entry-level positions in the electrical utilities field. Along with a focus on electrical theory, the diploma program emphasizes basic work skills, and practical application of electrical theory as a way of preparing students for success in the workplace. Diploma seekers must complete 90 credit hours of coursework, of which one-quarter are general education requirements. The majority of the courses are occupation courses, which introduce the electrical utility industry and the fundamentals of power generation and distribution.

The A.A.S. degree in Electrical Utility Technology requires students to complete 102 credit-hours. It builds on the diploma curriculum and requires students to complete general education courses in the natural sciences, social sciences and humanities. These courses are taught at the college level. Most students who choose to switch to the degree program do so during their second year.

Students who graduate from the program are qualified to fill a number of positions in the electrical utility industry: engineering technician or representative, substation maintenance technician or electrician, meter technician or generator technician.

Students in the diploma program are eligible for the state's HOPE Grant program, which covers tuition and expenses, while the HOPE Scholarship program is available to students who have demonstrated academic excellence and want to enter the degree program. Together, these opportunities enable students to prepare themselves to enter the electrical utility workforce at virtually no cost to them.

The EUT program has finished its second academic year. While enrollments had been steady over the first two years at an average of 25 students, enrollment at the beginning of the third year has dramatically increased to 38. According to Lee Allen, Program Director and Lead Instructor, approximately 75 percent of these students are employed and enrolled part time. Occupational courses are offered in the evenings, since many of the instructors are current utility company employees.

Partnership with Industry: The A.A.S. program was born out of collaboration with the Georgia Energy and Industrial Construction Consortium (GEICC). The GEICC is itself a partnership between the State's electrical and natural gas utilities and utility associations, nuclear, oil and gas industries, the industrial construction industry, and the state and federal offices of workforce development, labor and education. This coalition was formed in 2007 to engage the energy industry in a strategic, results-driven plan of action to address the workforce needs of the energy sectors across the state.

At that time, one of the biggest problems utilities were facing was the aging of its line workers. To address this issue, the GEICC worked with three community colleges to develop a line worker apprentice program. Similarly the consortium entered into a partnership with Lanier Tech, with initial funding from the Appalachian Regional Commission, to launch the Electrical Utility Technology A.A.S. degree program. Courses from the line worker apprentice programs are accepted by the EUT program as transfer credit electives.

Though the state of Georgia has many power companies, Georgia Power and Jackson EMC have been the strongest partners with Lanier Tech so far. Their employees serve as program instructors and members of the program's advisory board.

In preparation for the next two years, when the program begins graduating a larger number of students, the EUT program is shifting the composition of its advisory board to include workforce development representatives of power companies. Neil Matheson, the original Program Director, stated that the program's advisory board was composed of "movers and shakers" in the statewide industry who saw the need for training programs and mobilized the resources to launch the EUT program. Now, Matheson sees the need for the people responsible for hiring to be closely involved with the program so they can see the quality of training that students are receiving and provide input to refine the training process.

Directions for the Future: In the near future, Lanier Tech is planning to add curricula in solar photovoltaic and solar thermal technologies. These programs will be offered through the Electronics Technology department of the school's division of industrial technology, and are currently being prepared to undergo the accreditation program. In the meantime, individuals with some knowledge of electricity fundamentals can take a 40-hour course in solar installation that is being offered through the economic development arm of the technical college.

Matheson, who is the Director of the Electronics Technology department, is looking toward developing a program in smart grid technologies.

Finally, the EUT program is ready for replication across the state. The EUT program at Lanier Tech was intended to be a pilot program and is now in the early stages of implementation at Savannah Technical College. The curricula may also expand to schools in other states that fall within the service area of Southern Company, the parent company of Georgia Power, which has been a leader in convening the GEICC.

Reducing Waste in Manufacturing

The Mississippi State University's Industrial Assessment Center (IAC)

Background: The Mississippi State Industrial Assessment Center (IAC) provides plant assessments at no cost to qualifying small and mid-sized manufacturers, defined as those with annual energy costs between $100,000 and $2 million, and is one of 26 U.S Department of Energy sponsored centers in the nation including four in ARC states.

Upon request by a manufacturer, assessment teams from the Mississippi State University IAC, comprised of university faculty and upper-level undergraduate and graduate engineering students, audit a facility's energy and resource usage by evaluating the site's energy-consuming processes, waste generation and handling, and production methods and report opportunities to reduce waste, save energy, and improve productivity. Within 60 days of the site assessment, the IAC team submits a detailed analysis of energy usage, offering recommendations for reducing energy consumption and estimates of costs, performance and payback periods. Two to six months after the assessment, the IAC team will inquire on changes made to the audited facility. The program's success is determined by the facility's implementation rate.

Assisting smaller facilities with needed expertise: In order for a business to meet IAC's requirements for a free assessment it must have a Standard Industrial Classification Code (SIC) of 20-39, be located within 150 miles of MSU, have a maximum of $100 million per year in gross sales and no more than 500 employees. The business must also lack the expertise required to generate an assessment on its own of energy use and conservation.

Mississippi State began its IAC program in 1994 due to industry interest, and the directors saw the program as an opportunity for MSU to participate in community outreach that could have an impact. The goal of the IAC is to complete 25 assessments per year at a rate of two assessments per month.

Mississippi State engineering students gain training and practical experience through the faculty-monitored hands-on evaluation of industrial processes of the sites assessed and the professional and timely delivery of the assessment to management. Full capacity enrollment of the IAC center is 6-7 students.

Students generally are enrolled in the mechanical engineering degree program and are training to be energy managers; however, the program is open to students in all areas of study. Participating students must have a GPA of at least 3.0 to enroll in the program and must have completed Thermodynamics and Heat Transfer courses. Students interested in the program must also be committed to working for at least three semesters for the IAC as it takes at least a semester to properly train for performing an assessment.

Delivering certification: The Department of Energy offers a certificate for participating in the IAC program and MSU provides three technical elective credit hours towards the student's last semester credit requirements. Undergraduate auditors receive $7.50-$9 per hour for working at the IAC. The IAC administrative staff is currently working on a volunteer basis due a decrease in DOE funding; however, the IAC employs one degreed engineer to run operations. Typically the engineer is hired from IAC students entering into graduate school in mechanical engineering. The operations manager is paid around $48,000 per year and is offered up to two courses a semester at no cost, enabling them to potentially complete graduate school debt-free.

Providing services within fiscal constraints: Adequate funding has been the greatest challenge to IAC's offerings to both students and area businesses. The program runs efficiently and meets its assessment goals on $220,000 per year. In the past three or four years, funding has been reduced to $110,000, making it impossible pay administrative costs and difficult to reach the 25 per year assessment goal.

Although funding has been limited, interest in the IAC's offerings has not. The American Recovery and Reinvestment Act (ARRA) requires a company to have completed an ASHRAE Level Two Audit before being considered for ARRA funds. This has increased recent interest in the program because IAC centers offer this type of audit to qualifying companies at no charge.

With reported savings in 1994-2005 of $5 million annually in implemented energy, productivity, and waste management recommendations and an average of $92,000 per year recommended saving for each visited facility, the IAC not only offers great training and hands-on experience for a participating university's students, but also offers a valuable service to area businesses in an effort to promote energy conservation.

Preparing for a New Energy Era in Pennsylvania

Penn Technical College and Pennsylvania Cooperative Extension's Marcellus Shale Education and Training Center

Background: Appalachia has been known as the country's leading producer of coal. In the future, the region could become known as a leading producer of natural gas.

To the unfamiliar ear, the term Marcellus Shale may sound like a man's name, but in reality, it is the key to Pennsylvania's future energy prosperity. The Marcellus Shale is believed to be the country's largest unconventional natural gas deposit, holding an estimated 493 trillion cubic feet of extractable natural gas which is valued at $1.8 trillion. It stretches south and west from New York's Southern Tier region through Pennsylvania, West Virginia, Virginia and Ohio.

While natural gas is a cleaner alternative to other fossil fuels it is a non-renewable resource, so its extraction is not a silver bullet for Appalachia's energy and economic development needs. Nevertheless, drilling of Pennsylvania's portion of the Marcellus Shale is already bringing increased employment and activity to the state as new drilling sites pop up, and the supporting industries that serve them are pressed into action —in this case, railroad shipping, and sand suppliers.

The Marcellus Shale Education and Training Center (MSETC) is a partnership between Penn Technical College and Penn State Cooperative Extension that was launched in October 2008. The purpose of the center is to act as a central resource for workforce development and education for all the actors and communities involved in the burgeoning industry in the state and throughout the Marcellus Shale region.

Understanding the Scale and Scope of Opportunity: The first thing that the MSETC did was to conduct a needs assessment, released in July 2009, that consisted of an in-depth look at the specific jobs that are required in the pre-drilling, drilling and extraction phases of natural gas production, as well as the education and experience that each job requires. The needs assessment team also used a per-well approach to create a picture of how many jobs will be created by the natural gas industry in the next five years.

These estimates give an idea of the scale of the impacts of the natural gas industry. From interviews with operators of existing natural gas wells, MSETC reported that each well drilled involves between 20 and 30 contractors and 410 workers in 150 occupations. Once drilled, each well requires nearly 12 full-time equivalent jobs. Required jobs range from welders to lawyers, though 53 percent of the projected employment falls under the categories of general and semi-skilled labor, commercial drivers and heavy equipment operators.

The total number of jobs created and the workforce development needs of the industry will depend on the number of wells drilled and the pre-drilling and drilling phases that create short-term jobs, not long-term employment. From January to September 2009, the Pennsylvania

Department of Environmental Conservation issued 1,340 drilling permits and operators reported drilling 359 wells.

Coordinating Efforts and Partnering with Industry: Because the promise of Marcellus Shale is so great for Pennsylvania and other affected parts of the Appalachian region, there has been a proliferation of efforts to prepare for and capitalize on natural gas. The danger in this excitement is duplication of efforts and lack of coordination between different industry players. For this reason, a large part of the MSETC's mandate is to act as a central, coordinating body for the Marcellus Shale industry.

Beyond the initial workforce assessment, which is meant to serve as a resource for private industry, educational institutions, workforce development agencies and policymakers, the MSETC convenes an annual workforce forum. The first forum was held in December 2009 in Altoona, Pennsylvania and had 170 attendees; the second forum will be held in December 2010 and between 300 and 400 individuals are expected to attend.

This event brings together workforce developers, educators, and oil and gas exploration, production and service company representatives with the goal of sharing information on issues and industry needs. The first annual event included presentations on myths and realities related to Marcellus Shale, key issues and opportunities for the industry and the secondary and higher education systems, and an example of a successful industry-led workforce development partnership in Texas.

Strong partnership with industry and associations is critical to the MSETC's success in playing a central role in promoting workforce development. To date, the center has developed relationships with a number of individual companies, such as Anazarko and ROC, as well as industry associations and advocacy organizations such as the Pennsylvania Independent Oil and Gas Association (PIOGA) and the Marcellus Shale Coalition. Individual companies have donated between $50,000 and $75,000 worth of equipment to the MSETC for use in classroom training.

In partnership with PIOGA, the MSETC has convened Shalenet. It meets quarterly and is dedicated solely to workforce issues, providing a forum for each institution participating in Marcellus Shale workforce development to receive feedback from industry in order to shape their efforts.

Educating New and Incumbent Workers: In November 2009, Penn College offered its first classes under the auspices of the MSETC. Since then, Penn College has trained 275 incumbent workers from the oil and gas industries and companies that are looking to position themselves for employment in the natural gas industry.

Courses for incumbent workers can be as short as one day while other course may run up to three weeks. Many courses are non-credit and can be customized to meet the needs of individual companies. Courses are offered through the Workforce Development and Continuing Education arm of Penn College of Technology and cover the following topics:

- down-hand welding;

- commercial driver licensing;
- industrial forklift operation and train-the-trainer options;
- instrumentation and controls, including programmable logic controls;
- elementary electronics;
- natural gas measurement;
- basic safety and land orientation; and
- supervisory control and data acquisition (SCADA) computer systems.

Some of these classes are specific to the oil and gas industry, either inherently or in the way they have been designed; examples include the courses in natural gas measurement and the commercial licensing course. Other courses teach skills and instruments that are in demand by the oil and gas industry, such as the instrumentation and controls course.

Several of these classes can lead to certifications that are recognized by the industry, such as two levels of down-hand welding courses and the basic safety course: Welding courses meet standards set by the American Petroleum Institute (API)—specifically the 1104 series for pipeline welding—while the basic safety course follows the PEC/Premier Safety Management SafeLand curricula, which is a well-recognized safety orientation accepted by more than 25 oil and gas operators (and also in compliance with API standards). Upon completion of the safety course, students are entered into an online database so that their knowledge of safety principles can be verified by potential employers. The MSETC also serves as a testing site for API 1104 welding certifications.

The school also has trained approximately 100 new workers for the industry—unemployed, underemployed and displaced workers referred to the center by the state's one-stop career center system, called CareerLink. To respond to the needs of displaced workers, Penn College offers a short-term pre-employment program called "Fit For Natural Gas", which is designed to prepare workers for jobs as roustabouts—a term for entry-level oil field laborer. The program has three phases and is covered over a period of three weeks. The first focuses on soft skills, including communication skills and resume writing; the second, on industry safety; and the third, on oilfield and technical training, including the operation of heavy equipment.

In June 2010, Penn College received a three-year grant from the National Science Foundation to offer courses to high school students. These courses will be offered for college credit and will introduce students to the natural gas industry. The natural gas industry is a promising opportunity for young people in many of the state's rural areas that have recently lacked employment opportunities.

Penn College is well positioned to develop degree programs related to the natural gas industry because of the many courses of study it already offers in related fields. The college now has certificate, diploma and associate's and bachelor's degree programs in welding, an associate's degree program in electronics and computer technology, and certificate and associate's degree programs in diesel and heavy equipment technology, all of which overlap with the workforce needs of the oil and gas industries. Even the school's program in culinary arts is relevant, as increased drilling activity in the state creates a heightened need for catering services.

After making some adjustments to these existing programs, the college is planning to launch a two-year associate's degree program in natural gas measurement and automation. This program would prepare individuals for careers as roughnecks, a term that refers to semi-skilled workers in oil fields who can perform a range of duties related to handling equipment for drilling, pressure control, and pipe connection. Roughneck positions account for the largest share of the projected workforce—19 percent—according to the MSETC workforce assessment needs.

In July 2010, MSETC was awarded a $4.9 million grant from the US Department of Labor, Employment and Training Administration to create ShaleNET.org. ShaleNET.org is a consortium between Penn Tech, Westmoreland County Community College (lead agency), West Virginia Northern Community College, Eastern Gateway Community College in Ohio, and Broome Community College in New York. Their mission is "to design a comprehensive recruitment, training, placement, and retention program" for the natural gas exploration and production industry. In addition to the consortium members, MSETC has added additional key partners to this initiative including 15 Workforce Investment areas serving 69 counties across Pennsylvania, West Virginia, Ohio, and New York (if/when the moratorium is lifted), the Pennsylvania Independent Oil and Gas Association, the Veterans Administration and other education and training resources within the Marcellus Shale footprint.

While much remains to be learned about the actual economic impact of natural gas on the affected Appalachian states, the Marcellus Shale Education and Training Center and its partner institutions have established themselves clearly as early leaders in the shifting energy landscape of the Marcellus Shale region. Their responsiveness and strong partnerships will continue to play a role in ensuring a successful match between the regional workforce and the natural gas industry.

Training for a revived nuclear industry

Tri-County Technical College, Pendleton, South Carolina

Background: The nuclear industry in the United States may see a revival in activity as the US and the globe attempt to reduce greenhouse gas emissions. In addition, the nuclear industry must continue to maintain aging nuclear plants built in the 1960s and 1970s.

The Tri-County Technical College (TCTC), which serves Anderson, Oconee and Pickens counties in the upstate region of South Carolina, offers a comprehensive welding program that has established itself as a strong asset in preparing workers for the region's nuclear power industry and the contractors that provide maintenance services to nuclear plants.

Welding is a profession that is in high demand across the country, but the demand is amplified in South Carolina with the retirement of the generation of workers who staffed the state's nuclear plants when they were constructed and began operations in the 1960s and 1970s. The state is home to three nuclear power plants with a total of seven reactors, three of which make up Duke Energy's Oconee Nuclear Station. The Oconee Nuclear Station, located on Lake Keowee in Oconee County, has a capacity of 2,538 megawatts, and Duke Energy is Oconee County's largest employer, providing employment for 1,700 residents.

In the past five years the welding program at TCTC has doubled in size, and day and evening sessions keep the program's 35 welding stations in constant use. The program is in the planning phase of an expansion into a new welding facility that will allow the program to double in size again, as well as the early phases of developing training specific to the nuclear power industry.

Welding Options from Certificate to Degree: The welding program is housed within TCTC's industrial technology and maintenance program. In a typical semester, the program enrolls approximately 120 students. A handful of these students are enrolled in the program's two certificate programs, but the majority of students are enrolled in the 42-credit diploma program and the 67-credit associate's degree program.

The 9-credit certificate in gas and arc welding and the 13-credit certificate in metal inert gas (MIG) and tungsten inert gas (TIG) welding provide students with sufficient training and a credential for their resume that will help them secure entry-level work in the area's fabrication and repair shops—jobs that typically pay $10 to 12 an hour.

The more popular options are the diploma and degree programs. The diploma program, which enrolls approximately 40 percent of all welding students, requires completion of 42 credits and is set up to be completed over 4 semesters, or about 16 months. Students are required to take an English, math, and psychology course to fulfill general education requirements, and then 12 required courses specific to the welding program. This list of courses includes a computer course; two courses in blueprints; a metallurgy course; and eight welding courses that cover safety, gas, arc and inert welding, testing and quality, and pipefitting.

The degree program, which accounts for approximately 60 percent of all students enrolled in the welding program, awards students an associate of applied science (A.A.S.) degree in general technology, with a major in welding. Compared to the diploma program, the associate's degree requires additional general education courses in math and physics; six general electives, which students can use to take courses in other areas; and eight technical electives, which they can use to complete a minor in another technical area such as industrial electricity or maintenance. Degree students also take two additional welding classes: one in robotic welding, and another in advanced pipe welding.

Approximately 90 percent of course time is spent doing hands-on laboratory work. Teachers demonstrate a welding application, and then students work independently and at their own pace to replicate what they have seen. Repetition is the key to learning, and teachers are available to provide students with feedback and troubleshooting assistance as they continue to refine and eventually master a skill. Each course includes a number of milestones that students must meet, as a way of keeping them on track throughout the course of the semester.

Professional Certifications and Opportunities: The welding program has two certified welding inspectors on staff, and students in the degree and diploma programs are required to complete a number of professional certifications as part of the fulfillment of the requirements for their programs. The certifications are recognized by the American Welding Society. Diploma students complete certifications in structural plate testing and basic pipe, or stick, welding and degree students earn a third certificate in stainless steel, small diameter pipe welding.

The A.A.S. degree program provides the closest fit with what the nuclear power industry is looking for in its hiring because it gives students experience using TIG welding to create small-diameter piping. These jobs can pay upwards of $25 an hour. Though Duke Energy does not have a formal recruiting program at TCTC, students have traditionally found employment there and with other contractors in the area, such as DZ Atlantic. Recently, some students have completed work/co-op rotations at Duke Energy while enrolled at TCTC as a way of gaining professional experience and, in some cases, academic credit.

Duke Energy and other local energy-related companies maintain a presence in the welding program by virtue of an advisory committee that convenes biannually. As a result of the relationship between the welding program and the industry's interest, the college is in the early stages of developing training offerings that would be specific to nuclear power such as more in-depth training in TIG welding for small-diameter piping, and working with different alloys and welding for heavy wall pipes. This coursework would also provide more instruction in the documentation and inspection processes that are specific to nuclear plants. This would give students the advantage of entering the nuclear workforce at a higher level than is currently possible with the general welding degree.

Advanced degrees in mining engineering

Virginia Tech University, Blacksburg, Virginia

Background: Virginia Tech University is one of only three universities in the region offering degrees in mining engineering. The school consistently graduates more than 30 students with bachelor's degrees in mining engineering. Virginia Tech also offers Masters and Doctorate programs in the field.

A focus on career placement: As one of the few universities focused on undergraduate and graduate degrees in mining engineering, the university places a special emphasis on providing high rates of placement for its graduates in the mining industry. The university boasts a hundred percent placement rate of its students. Indeed of all the mining engineers in the nation, an estimated 25 percent are graduates of Virginia Tech University.

Although the mining engineering program began as a program almost exclusively geared towards coal production, it now trains individuals for a variety of mining-related sectors. Twenty-two percent of mining engineering graduates pursue careers in coal related fields with the highest percentage going into aggregate mining.

Interestingly, the past few years has seen a marked increase in coal's share of graduate placements. With the downturn in the construction industry, the need for aggregate mining has dropped dramatically. In the last two graduating classes, nearly 40 percent pursued coal related fields.

The university's high rate of placement comes in part because the university's Mining and Minerals Engineering department is in charge of career placement. While other programs might yield control of the placement program, the mining department operates it completely. Each spring and fall the university hosts recruiters from around the country, many of whom have operations in Appalachia. Not only are students recruited into full time employment but companies offer valuable internships, helping students choose which sector and career within the mining industry to pursue.

The role of research: One unique aspect of the university's engineering program is the housing of two research centers on campus, both of which specialize in advancing mining technology. The Virginia Center for Coal and Energy Research was created by an act of the Commonwealth of Virginia. As the center's name suggests, research focuses on different technical aspects of coal mining as well as assisting Virginia's general energy plans. The Center for Advanced Separation Technologies is a consortium of five universities, including Virginia Tech, that focuses on "the production of clean solid, liquid and gaseous fuels from domestic energy resources in an efficient and environmentally acceptable manner."[10] The Center has received more than $475 million in research funding from the Department of Energy.

[10] Virginia Tech University, http://www.cast.mining.vt.edu/

Even with the impressive research efforts of the university, the focus of the program remains firmly on educating the mining professionals of tomorrow. At the undergraduate level, students are given an introduction into the full range of mining engineering. In addition to standard introduction to geology, undergrads take courses in aspects of coal mining such as mine reclamation and environmental management, resource recovery and underground mine design.

The university's emphasis on the latter is evidenced by the remarkable success of undergraduates at a competition for new engineers. A student team won the Society for Mining, Metallurgy and Exploration (SME) / National Stone, Sand, and Gravel Association (NSSGA) Student Design Competition. In the competition students must design a mine based on specifications given from actual mining companies.

What is clear is that for Virginia Tech graduates there are plenty of good career opportunities.

"The whole mining industry is worried about losing experienced people to retirement," says Dr. Gregory Adel, the Department Chair. "Companies are trying to get young engineers in the door so they can learn from experienced people. We can tell students thinking about mining: 'The path is open for you if you learn the profession, you can climb up the ladder'"

Providing an array of engineering skills and research

West Virginia University, Morgantown

Background: The Petroleum and Natural Gas Engineering Degree (PNGE) at West Virginia University offers training in the fundamentals of science and engineering, along with drilling engineering, production engineering, reservoir engineering, and project design.

West Virginia University PNGE department offers B.S., M.S., and Ph.D. degree options and is fully accredited by the Accreditation Board for Engineering and Technology (ABET, Inc.). Students benefit from local industry interaction through the U.S. Department of Energy's National Energy Technology Laboratory in Morgantown, West Virginia, and gain hands-on experience working on production sites, secondary and enhanced oil recovery projects, compressor stations, gas storage fields, and corporate offices.

Upon completion of the undergraduate degree, graduates of the program will not only have the ability to design experiments and analyze data, design a system, component or process to meet needs of an employer, and work on multi-disciplinary teams, but will also receive the broad education required to evaluate and understand the impact of engineering practices in a global context.

Focus on theory and problem solving: The coursework for the Petroleum and Natural Gas Engineering undergraduate degree combines lessons on theory, application through researching case studies, and project design. This encourages the student to recognize the value of a sound theoretical foundation, experimentation, and engineering judgment when solving petroleum and natural gas engineering problems. Freshman accepted into the College of Mineral Resources are admitted into one of two tracks, Engineering or General Engineering, based on their GPA and ACT and SAT test scores. First year students must complete 6 core courses before choosing a specific discipline. This first year of engineering fundamentals allows the student a full scope of all engineering majors so that they can make a more informed decision when selecting their specific field of study.

Graduating seniors complete a capstone course that combines training from all previous courses. Members of industry in the area are consulted about establishing real-life projects for the students to complete. Those members of industry participating in the development of the project then determine the grade of the graduating senior.

In fall of 2010, 185 undergraduates, excluding freshman, enrolled in the Petroleum and Natural Gas Engineering program. Forty students attended the graduate program, nine of which were at the PhD level. In the spring semester of 2011, 200 undergraduate, excluding freshman, and 43 graduate students were enrolled. As the demand for oil continues to increase, interest and enrollment in the PNGE program continues to increase dramatically. Although enrollment has increased, the resources are not growing at the same rate. It remains a challenge of the department to maintain the high level of academic offerings to accommodate a larger population of students. The PNGE program has very high retention and graduation rates, in part, due to the tutors in the department that ensure students are doing well in their Physics, Calculus, Chemistry, and Engineering courses and to the study labs held 5 days a week in all freshman math and science courses.

The University recruits students at area high schools as well as nationally and internationally through various channels. The College of Mineral Resources enlists a freshman recruiter to travel to area high schools with a presentation of the College's programs and career opportunities available with offered degrees. The program allows students within the common market states to pay in-state tuition to attend the program, so recruitment is not exclusive to the state of West Virginia. Because many alumni have worked in the oil and natural gas industry in other countries, students are recruited outside of the U.S. as well and the program has many international students enrolled. Saudi Aramco, a fully integrated global petroleum enterprise with the largest oil reserves in the world, sponsored 41 of its employees to attend the PNGE program at WVU.

Due to the expertise of its faculty and their diverse educational background, The Petroleum and Natural Gas Engineering Department at WVU is a leader in fluid flow through porous media, reservoir characterization and stimulation by computational intelligence, natural gas storage, multi-phasic flow in pipes, drilling & production engineering, and environmental remediation. Full-time faculty members are attracted through national and international advertising in oil and natural gas magazines

Faculty with industry experience and an industry focus: Most of the faculty has prior industrial experience; however, teaching ability and research potentiality are the highest valued assets of potential faculty members. Instructors must show excellence in teaching, have the ability and drive to market their ideas in research proposals, and participate in the oil and natural gas community. Adjunct faculty members are part-time professors that typically have many years of industrial experience and are hired to teach individual courses and workshops. A Visiting Committee, comprised of representatives of the energy industry, meets annually with faculty, administrators and students to provide feedback on program offerings and to ensure curricula provides proper training to produce skilled and marketable graduates.

The College of Engineering and Mineral Resources works in collaboration with many companies in the area who hire students for summer jobs and for permanent positions. Companies in the industry work with the department's Cooperative Education program, a nationally accredited statewide initiative to support students in their effort to gain meaningful employment. Students apply the knowledge they have received through their coursework in an alternating schedule of 6 months of full-time study and 6 months of paid full-time employment. With the many scholarships available, the summer work and cooperative education opportunities, and the in-state tuition offering for Academic Common Market states, a graduate of the College of Engineering and Mineral Resources has the potential to graduate debt-free.

The Petroleum and Natural Gas Engineering Department aims to effectively produce more fuel from fewer wells, encouraging environmental stewardship among its students. The future initiatives of the program include continued research that promotes easier, more efficient natural gas production in a manner consistent with rules and regulations in place in relation to the natural environment. As Samuel Ameri, Professor and Chair of Petroleum & Natural Gas Engineering Department at West Virginia University, states, the main goal of the program is to “maintain and strengthen our leadership in the development of new extraction technologies and to produce outstanding graduates to manage the oil and gas industry of West Virginia, the nation, and the world.”

A focus on simulation

West Virginia University

Background: The Advanced Virtual Energy Simulation Training and Research Facility (AVESTAR), is a joint program of the Department of Energy's National Energy Technology Laboratory (NETL) and its Regional University Alliance and West Virginia University National Research Center for Coal and Energy's (NRCCE) Advanced Energy Initiative. The simulator's installation will be complete by March and courses will be ready for enrollment by June of 2011.

A focus on simulation: Simulation-based training and research can shorten the time it takes to vet a technology before deploying it. As such, the Department of Energy has teamed with WVU to offer simulation-based training and facilities for research and development of advanced energy systems, such as Integrated Gasification Combined Cycle (IGCC) power generation with Carbon Capture. AVESTAR, Advanced Virtual Energy Simulation Training and Research Facility, is a joint program of the Department of Energy's National Energy Technology Laboratory (NETL) and its Regional University Alliance and West Virginia University National Research Center for Coal and Energy's (NRCCE) Advanced Energy Initiative. An experienced team of energy innovators, including members of NETL, NRCCE, Invensys Operations Management, Fossil Consulting Services, and The Electric Power Research Institute, developed the program.

Due to the aging coal fleet, utilities have been forced to address carbon management and the efficiency of the current plant model. Plants that use coal as utilities are typically designed to operate for 30 years. A large percentage of pulverized coal plants are now approaching 50 years in operation. The Department of Energy and the energy industry are facing the question of how to most effectively meet current demand and carbon management requirements and whether or not new technologies should be implemented. The Department of Energy has studied IGCC as a new clean coal technology and, as West Virginia and Pennsylvania are regionally marketed as the nexus for energy solutions, the organization is supporting the development of the AVESTAR program at West Virginia University.

The facilities feature Dynamic Simulator/Operating Training System (OTS) areas with eight workstations including 16 flat-screened monitors, two instructor workstations, two engineering workstations, and two simulator server computers. The facilities also house two Immersive Training System (ITS) workstations for virtual engines, one operator 3-D visor with head tracking, and projector(s)/screen(s) with 3-D glasses for multiple operators.

Simulator-based training at two facilities, one at NETL Morgantown and the other at WVU NRCCE, will begin in the fall of 2011 and will include programs on Integrated Gasification Combined Cycle (IGCC) Orientation for Engineers and Managers, Introduction to IGCC Operations, IGCC Operator Course, Combined Cycle Operations, Gasification Process Operations, and Principles of IGCC Design and Operation for Engineers.

Building on the support of National Alternative Fuels training consortium (NAFTC) at WVU and the 20 years of experience of the NRECE in providing training for energy professionals, the

AVESTAR program will soon be offering IGCC training. The curriculum has been written and the program designers are in the process of beta testing the courses. The simulator's installation will be complete by March and courses will be ready for enrollment by June of 2011.

Appendix C: Workforce Survey Form

1. Preparing a New Energy Workforce for the Appalachian Region

As you may know, the Appalachian Regional Commission has funded Regional Technology Strategies, Inc. (RTS) to conduct a study on the current and future workforce needs of the energy industry in the ARC region and how post-secondary institutions can meet these needs. As part of this study, it is essential that we learn more about how community and technical colleges in the region are preparing new employees and working with current workers in the energy field. In order to have a complete understanding of the region, it is critical we have your participation. Even if your institution does not have a program specifically aimed at the energy industry, learning more about what foundational training you do offer is extremely important. Please have the person or persons most involved with workforce development training fill out this survey.

The survey should not take more than 15 to 20 minutes to complete. Although individual responses will be kept confidential, we are happy to share any information we get in the aggregate with you if you are interested.

If you have any questions please contact Dan Broun, Director of Special Projects at RTS, 919-93-6699 broun@rtsinc.org
Thank you.

1. Please identify your college. This question will only be used to track which colleges have answered the survey and will not be used in any way to point out deficiencies at your college. This answer will be kept confidential.

2. Please choose the title or area that best describes your function at the college.

- ◯ President
- ◯ Vice President
- ◯ Workforce Development or Workforce Training
- ◯ Academic Affairs
- ◯ Occupational Education
- ◯ Business & Industry or Continuing Education
- ◯ Institutional Development
- ◯ Research

Other (please specify)

2. General enrollment

In this section, please provide approximate enrollment information for your college.

1. Fall 2009 Unduplicated Headcount (credit only)

2. Fall 2009 Unduplicated FTE (credit only)

3. Fall 2009 Unduplicated Headcount Noncredit Courses

4. For the 2008-2009 academic year, how many students:

Completed a certificate program?

Completed a degree program?

Transferred to a baccalaureate institution?

3. Energy-related programs

1. Please indicate if your college offers programs or courses in the following fields:

	Awards of less than 1 year	1-year certificate	2-year AAS Degree	Elective Courses	Noncredit courses	Contract Training	None
Coal mining	☐	☐	☐	☐	☐	☐	☐
Operation of coal powered utility	☐	☐	☐	☐	☐	☐	☐
Other fossil fuels (natural gas, petroleum)	☐	☐	☐	☐	☐	☐	☐
Nuclear power plant operation	☐	☐	☐	☐	☐	☐	☐
Biofuels (biodiesel, algae, ethanol, etc)	☐	☐	☐	☐	☐	☐	☐
Solar (photovoltaic installation, repair)	☐	☐	☐	☐	☐	☐	☐
Solar (photovoltaic manufacturing)	☐	☐	☐	☐	☐	☐	☐
Wind Power (wind turbine installation, repair)	☐	☐	☐	☐	☐	☐	☐
Wind Power (wind turbine manufacturing)	☐	☐	☐	☐	☐	☐	☐
Energy auditor	☐	☐	☐	☐	☐	☐	☐
Energy Efficiency Analysis	☐	☐	☐	☐	☐	☐	☐
Energy Management Systems	☐	☐	☐	☐	☐	☐	☐
Introduction to Energy	☐	☐	☐	☐	☐	☐	☐
Weatherization	☐	☐	☐	☐	☐	☐	☐
Other Alternative Energy (geotherm, etc)	☐	☐	☐	☐	☐	☐	☐

If Other, please specify:

4. Energy related Programs Continued

1. Approximtely how many credit students at your college were enrolled Fall 2009 in the following:

Credit courses with an emphasis on alternative energy (Geothermal, Wind, Solar, Biofuels, Hydrogen, fuel cells)?

Credit courses with an emphasis on energy efficiency?

Credit courses with an emphasis on coal mining or coal technology?

Credit courses with an emphasis on nuclear power?

Credit courses with an emphasis on natural gas?

2. Approximately how many non-credit students were enrolled Fall 2009 in the following?

Courses with an emphasis on alternative energy (Geothermal, Wind, Solar, Biofuels, Hydrogen, fuel cells)?

Courses with an emphasis on energy efficiency?

Courses with an emphasis on coal mining or coal technology?

Courses with an emphasis on nuclear power?

Courses with an emphasis on natural gas?

3. Do you offer courses around entrepreneurship as a component of your energy-focused programs? If so please describe.

5. Non-energy specific programs

1. Approximately how many credit hours are devoted to energy issues such as energy efficiency or energy management in each of the following programs:

	0	1	2	3	4	5	>5	N/A
Construction (residential and commercial)	○	○	○	○	○	○	○	○
Manufacturing	○	○	○	○	○	○	○	○
HVAC	○	○	○	○	○	○	○	○
Electrical Technology	○	○	○	○	○	○	○	○
Automotive Technology	○	○	○	○	○	○	○	○
Electrical Engineering Technology	○	○	○	○	○	○	○	○
Architectural Engineering Technology	○	○	○	○	○	○	○	○
Mechanical Engineering Technology	○	○	○	○	○	○	○	○
Chemical Engineering Technology	○	○	○	○	○	○	○	○
Industrial Mechanics and Maintenance Technology	○	○	○	○	○	○	○	○
Welding	○	○	○	○	○	○	○	○
Other	○	○	○	○	○	○	○	○

2. Do you provide non-credit training and/or customized training to companies in any of the following fields? (Check all that apply)

	Non-credit	Customized Training
Construction (residential and commercial)	☐	☐
Manufacturing	☐	☐
HVAC	☐	☐
Electrical Technology	☐	☐
Automotive Technology	☐	☐
Electrical Engineering Technology	☐	☐
Architectural Engineering Technology	☐	☐
Mechanical Engineering Technology	☐	☐
Chemical Engineering Technology	☐	☐
Industrial Mechanics and Maintenance Technology	☐	☐
Welding	☐	☐

6. Working with Energy Companies

1. For each of the types of energy-related firms below, please indicate the type of customized training your college provides.

	Workplace skills (team building leadership)	General soft skills (word processing, general computer)	Foundational manufacturing skills (blueprint reading, welding)	Field specific skills (information on specific energy technology)	Did Not Provide
Natural gas	☐	☐	☐	☐	☐
Coal mining	☐	☐	☐	☐	☐
Electric utilities	☐	☐	☐	☐	☐
Alternative energy related (wind, solar)	☐	☐	☐	☐	☐
Energy efficiency	☐	☐	☐	☐	☐
Nuclear power	☐	☐	☐	☐	☐

2. If you provided any field- specific customized training to an energy-related firm, please describe the training you offered.

3. Do any students at your college participate in internship or work programs with energy-related firms. If so, please indicate in which energy sector these internships occur.

☐ Coal mining

☐ Electric utilities

☐ Alternative energy related (wind, solar)

☐ Energy efficiency

☐ Nuclear power

☐ Natural gas

4. In interactions with energy-related companies, what do you hear companies saying their greatest workforce or training needs are? (Check all that apply)

- [ ] Basic skills of entry-level workers (work ethic, punctuality, etc)
- [ ] Technical skills of entry-level workers (field-specific training)
- [ ] Basic skills of incumbent mid-skilled workers
- [ ] Technical skills of incumbent mid-skilled workers
- [ ] Skills of management or upper-skilled workers
- [ ] Other (please specify)

8. Thank you very much for your participation

1. RTS may be contacting colleges for more detailed information about their programs. If you are willing to participate in a follow-up interview, please provide your contact information. If you are not the appropriate person to follow up with, please provide their contact information.

Name

Title

College

Phone

E-mail

RTS and ARC thank you very much for your participation. If you have any questions, again please contact Dan Broun at 919-933-6699 or broun@rtsinc.org

Appendix D: Energy Workforce in the ARC Region Advisory Panel

John Carrese
Center Director
Bay Region Center of Excellence
City College of San Francisco
1400 Evans Avenue
San Francisco, CA 94124
Phone: (415) 550-4418
Email: jcarrese@ccsf.edu

Dr. Amy Glasmeier
Head of Department of Urban Studies and Planning
Professor of Geography and Regional Planning
Massachusetts Institute of Technology
77 Massachusetts Ave, Room 7-346
Cambridge, MA 02139
Office: (617) 324-6565
Cell: (814) 777-2184
Email: amyglas@mit.edu

Dr. Michael Karmis,
Stonie Barker Professor, Department of Mining and Minerals Engineering & Director, Virginia Center for Coal and Energy Research (VCCER)
Virginia Tech
Mail code 0411
Blacksburg, VA 24061
Office: 540-231-5273/4078
Cell: 540-239-7057
Email: mkarmis@vt.edu

Dr. Calvin Kent
Vice President of Business and Economic Research
Center for Business and Economic Research
Marshall University
One John Marshall Drive
Huntington, WV 25755
Office: 304/696-2313
Email: kentc@marshall.edu

James F. McKenney
Vice President for Economic Development
American Association of Community Colleges
One Dupont Circle, NW, Suite 410,
Washington, DC 20036
Phone: 202-728-0200 x226
Email: jmckenney@aacc.nche.edu

Appendix E: List of ARC Postsecondary Institutions

Community Colleges by Region

Northern ARC Region

Allegany College of Maryland
Allegany County, Maryland
Average Enrollment: 4,615

Belmont Technical College
Belmont County, Ohio
Average Enrollment: 2,624

Broome Community College
Broome County, New York
Average Enrollment: 8,683

Butler County Community College
Butler County, Pennsylvania
Average Enrollment: 5,598

Columbiana County Vocational School
Columbiana County, Ohio
Average Enrollment: 977

Community College of Allegheny County
Allegheny County, Pennsylvania
Average Enrollment: 28,302

Community College of Beaver County
Beaver County, Pennsylvania
Average Enrollment: 3,399

Corning Community College
Steuben County, New York
Average Enrollment: 7,079

Garrett College
Garrett County, Maryland
Average Enrollment: 939

Hagerstown Community College
Washington County, Maryland
Average Enrollment: 5,348

Jamestown Community College
Chatauqua County, New York
Average Enrollment: 5,867

Jefferson Community College
Jefferson County, Ohio
Average Enrollment: 2,650

Luzerne County Community College
Luzerne County, Pennsylvania
Average Enrollment: 9,478

Pennsylvania Highlands Community College
Cambria County, Pennsylvania
Average Enrollment: 3,462

Tompkins-Cortland Community College
Tompkins County, New York
Average Enrollment: 7,148

Westmoreland County Community College
Westmoreland County, Pennsylvania
Average Enrollment: 9,772

West Virginia Northern Community College
Ohio County, West Virginia
Average Enrollment: 4,715

Zane State College
Muskingum County, Ohio
Average Enrollment: 3,506

North Central ARC Region

Ben Franklin Career Center
Kanawha County, West Virginia
Average Enrollment: 434

Blue Ridge Community and Technical College
Berkeley County, West Virginia
Average Enrollment: 2,707

Carver Career Center
Kanawha County, West Virginia
Average Enrollment: 235

Community and Technical College at West Virginia University Institute of Technology
Fayette County, West Virginia
Average Enrollment: 890

Eastern West Virginia Community and Technical College
Hardy County, West Virginia
Average Enrollment: 927

Garnet Career Center
Kanawha County, West Virginia
Average Enrollment: 175

Hocking College
Athens County, Ohio
Average Enrollment: 8,516

Mercer County Technical Education Center
Mercer County, West Virginia
Average Enrollment: 79

Mountwest Community and Technical College
Cabell / Wayne, WV
Average Enrollment: 3,197

New River Community and Technical College
Raleigh County, West Virginia
Average Enrollment: 2,799

O C Collins Career Center
Lawrence County, Ohio
Average Enrollment: 425

Pierpont Community and Technical College
Marion County, West Virginia
Average Enrollment: 3,469

Potomac State College of West Virginia University
Mineral County, West Virginia
Average Enrollment: 1,735

Southern State Community College
Highland County, Ohio
Average Enrollment: 3,345

Washington State Community College
Washington County, Ohio
Average Enrollment: 3,958

West Virginia State Community and Technical College
Kanawha County, West Virginia
Average Enrollment: 2,118

Central ARC Region

Ashland Community and Technical College
Boyd County, Kentucky
Average Enrollment: 5,582

Big Sandy Community and Technical College
Floyd County, Kentucky
Average Enrollment: 6,688

Hazard Community and Technical College
Perry County, Kentucky
Average Enrollment: 5,662

Mountain Empire Community College
Wise County, Virginia
Average Enrollment: 4,302

Somerset Community College
Pulaski County, Kentucky
Average Enrollment: 8,722

Southeast Kentucky Community and Technical College
Harlan County, Kentucky
Average Enrollment: 6,721

Southern West Virginia Community and Technical College
Logan County, West Virginia
Average Enrollment: 3,314

Southwest Virginia Community College
Tazewell County, Virginia
Average Enrollment: 5,887

Tennessee Technology Center at Jacksboro
Campbell County, Tennessee
Average Enrollment: 342

Tennessee Technology Center at Livingston
Overton County, Tennessee
Average Enrollment: 1,134

Tennessee Technology Center at Oneida-Huntsville
Scott County, Tennessee
Average Enrollment: 401

South Central ARC Region

Asheville-Buncombe Technical Community College
Buncombe County, North Carolina
Average Enrollment: 9,154

Blue Ridge Community College
Surry County, North Carolina
Average Enrollment: 2,830

Caldwell Community College and Technical Institute
Caldwell County, North Carolina
Average Enrollment: 5,258

Southwestern Community College
Jackson County, North Carolina
Average Enrollment: 2,662

Surry Community College
Surry County, North Carolina
Average Enrollment: 4,166

Tennessee Technology Center at Athens
McMinn County, Tennessee
Average Enrollment: 582

Chattanooga State Technical Community College
Hamilton County, Tennessee
Average Enrollment: 10,764

Cleveland State Community College
Bradley County, Tennessee
Average Enrollment: 4,007

Dabney S. Lancaster Community College
Alleghany County, Virginia
Average Enrollment: 2,006

Forsyth Technical Community College
Forsyth County, North Carolina
Average Enrollment: 9,976

Haywood Community College
Haywood County, North Carolina
Average Enrollment: 3,829

Isothermal Community College
Rutherford County, North Carolina
Average Enrollment: 3,180

Mayland Community College
Mitchell County, North Carolina
Average Enrollment: 2,048

McDowell Technical Community College
McDowell County, North Carolina
Average Enrollment: 1,668

Motlow State Community College
Coffee County, Tennessee
Average Enrollment: 5,056

New River Community College
Pulaski County, Virginia
Average Enrollment: 6,558

Tennessee Technology Center at Crossville
Cumberland County, Tennessee
Average Enrollment: 971

Tennessee Technology Center at Elizabethton
Carter County, Tennessee
Average Enrollment: 890

Tennessee Technology Center at Harriman
Roane County, Tennessee
Average Enrollment: 378

Tennessee Technology Center at Hohenwald
Lewis County, Tennessee
Average Enrollment: 757

Tennessee Technology Center at Knoxville
Knox County, Tennessee
Average Enrollment: 1,131

Tennessee Technology Center at McMinnville
Warren County, Tennessee
Average Enrollment: 320

Tennessee Technology Center at Morristown
Hamblen County, Tennessee
Average Enrollment: 1,666

Tri-County Community College
Cherokee County, North Carolina
Average Enrollment: 1,600

Virginia Highlands Community College
Washington County, Virginia
Average Enrollment: 3,427

Walters State Community College
Hamblen County, Tennessee
Average Enrollment: 7,786

Northeast State Technical Community College
Sullivan County, Tennessee
Average Enrollment: 6,829

Patrick Henry Community College
Martinsville County, Virginia
Average Enrollment: 4,303

Pellissippi State Technical Community College
Knox County, Tennessee
Average Enrollment: 11,991

Roane State Community College
Roane County, Tennessee
Average Enrollment: 6,217

Western Piedmont Community College
Burke County, North Carolina
Average Enrollment: 3,876

Wilkes Community College
Wilkes County, North Carolina
Average Enrollment: 3,551

Wytheville Community College
Wythe County, Virginia
Average Enrollment: 4,023

Southern ARC Region

Appalachian Technical College
Pickens County, Georgia
Average Enrollment: 1,748

Bevill State Community College
Walker County, Alabama
Average Enrollment: 5,685

Central Alabama Community College
Tallapoosa County, Alabama
Average Enrollment: 3,058

East Mississippi Community College
Kemper County, Mississippi
Average Enrollment: 5,656

Gadsden State Community College
Etowah County, Alabama
Average Enrollment: 8,049

Lanier Technical College
Hall County, Georgia
Average Enrollment: 5,240

Lawson State Community College-Birmingham Campus
Jefferson County, Alabama
Average Enrollment: 5,066

Marion Military Institute
Marion County, Alabama
Average Enrollment: 361

North Georgia Technical College
Habersham County, Georgia
Average Enrollment: 3,150

Northeast Alabama Community College
De Kalb County, Alabama
Average Enrollment: 3,295

George C Wallace State Community College-Hanceville
Cullman County, Alabama
Average Enrollment: 7,307

Georgia Highlands College
Floyd County, Georgia
Average Enrollment: 6,547

Greenville Technical College
Greenville County, South Carolina
Average Enrollment: 19,346

Itawamba Community College
Itawamba County, Mississippi
Average Enrollment: 6,706

Gwinnett Technical College
Gwinnett County, Georgia
Average Enrollment: 7,221

J F Drake State Technical College
Madison County, Alabama
Average Enrollment: 1,072

J F Ingram State Technical College
Elmore County, Alabama
Average Enrollment: 1,287

Jefferson State Community College
Jefferson County, Alabama
Average Enrollment: 11,911

John C Calhoun State Community College
Limestone County, Alabama
Average Enrollment: 13,053

Northeast Mississippi Community College
Prentiss County, Mississippi
Average Enrollment: 4,044

Northwest Shoals Community College-Muscle Shoals
Colbert County, Alabama
Average Enrollment: 5,185

Northwestern Technical College
Walker County, Georgia
Average Enrollment: 3,652

Shelton State Community College
Tuscaloosa County, Alabama
Average Enrollment: 9,400

Snead State Community College
Marshall County, Alabama
Average Enrollment: 2,999

Southern Union State Community College
Randolph County, Alabama
Average Enrollment: 6,658

Spartanburg Community College
Spartanburg County, South Carolina
Average Enrollment: 6,149

Tri-County Technical College
Anderson County, South Carolina
Average Enrollment: 6,872

West Central Technical College
Haralson County, Georgia
Average Enrollment: 5,307

Universities and 4-Year Colleges by Region

Northern ARC Region

Bloomsburg University of Pennsylvania
Columbia County, Pennsylvania

Average Enrollment: All	10,253
Average Enrollment: Undergraduate	8,945
Average Enrollment: Graduate	1,307

California University of Pennsylvania
Washington County, Pennsylvania

Average Enrollment: All	11,930
Average Enrollment: Undergraduate	9,682
Average Enrollment: Graduate	2,248

Clarion University of Pennsylvania
Clarion County, Pennsylvania

Average Enrollment: All	7,713
Average Enrollment: Undergraduate	6,548
Average Enrollment: Graduate	1,166

East Stroudsburg University of Pennsylvania
Monroe County, Pennsylvania

Average Enrollment: All	8,685
Average Enrollment: Undergraduate	6,571
Average Enrollment: Graduate	2,114

Edinboro University of Pennsylvania
Erie County, Pennsylvania

Average Enrollment: All	8,945
Average Enrollment: Undergraduate	7,320
Average Enrollment: Graduate	1,625

Frostburg State University
Allegany County, Maryland

Average Enrollment: All	5,730
Average Enrollment: Undergraduate	4,770
Average Enrollment: Graduate	960

Pennsylvania State University-Penn State Schuylkill
Schuylkill County, Pennsylvania

Average Enrollment: All	1,055
Average Enrollment: Undergraduate	1,008
Average Enrollment: Graduate	47

Pennsylvania State University-Penn State Shenango
Mercer County, Pennsylvania

Average Enrollment: All	1,084
Average Enrollment: Undergraduate	1,078
Average Enrollment: Graduate	18

Pennsylvania State University-Penn State Worthington Scranton
Lackawanna County, Pennsylvania

Average Enrollment: All	1,668
Average Enrollment: Undergraduate	1,638
Average Enrollment: Graduate	30

Slippery Rock University of Pennsylvania
Butler County, Pennsylvania

Average Enrollment: All	9,508
Average Enrollment: Undergraduate	8,523
Average Enrollment: Graduate	984

SUNY at Binghamton
Broome County, New York

Average Enrollment: All	15,722
Average Enrollment: Undergraduate	12,440
Average Enrollment: Graduate	3,282

SUNY at Fredonia
Chautauqua County, New York

Average Enrollment: All	6,000
Average Enrollment: Undergraduate	5,428
Average Enrollment: Graduate	572

Indiana University of Pennsylvania-Main Campus

Indiana County, Pennsylvania

Average Enrollment: All	16,319
Average Enrollment: Undergraduate	13,071
Average Enrollment: Graduate	3,249

Lock Haven University

Clinton County, Pennsylvania

Average Enrollment: All	6,003
Average Enrollment: Undergraduate	5,546
Average Enrollment: Graduate	456

Mansfield University of Pennsylvania

Tioga County, Pennsylvania

Average Enrollment: All	4,066
Average Enrollment: Undergraduate	3,394
Average Enrollment: Graduate	671

Pennsylvania College of Technology

Lycoming County, Pennsylvania

Average Enrollment: All	7,677
Average Enrollment: Undergraduate	7,677
Average Enrollment: Graduate	-

Pennsylvania State University-Main Campus

Centre County, Pennsylvania

Average Enrollment: All	46,322
Average Enrollment: Undergraduate	38,796
Average Enrollment: Graduate	7,527

Pennsylvania State University-Penn State Altoona

Blair County, Pennsylvania

Average Enrollment: All	4,219
Average Enrollment: Undergraduate	4,211
Average Enrollment: Graduate	8

Pennsylvania State University-Penn State Beaver

Beaver County, Pennsylvania

Average Enrollment: All	910
Average Enrollment: Undergraduate	879
Average Enrollment: Graduate	31

SUNY College at Cortland

Cortland County, New York

Average Enrollment: All	8,222
Average Enrollment: Undergraduate	6,518
Average Enrollment: Graduate	1,704

SUNY College at Oneonta

Otsego County, New York

Average Enrollment: All	6,702
Average Enrollment: Undergraduate	6,432
Average Enrollment: Graduate	270

SUNY College of Agriculture and Technology at Cobleskill

Schoharie County, New York

Average Enrollment: All	2,863
Average Enrollment: Undergraduate	2,863
Average Enrollment: Graduate	-

SUNY College of Technology at Alfred

Allegany County, New York

Average Enrollment: All	3,608
Average Enrollment: Undergraduate	3,608
Average Enrollment: Graduate	-

SUNY College of Technology at Delhi

Delaware County, New York

Average Enrollment: All	2,949
Average Enrollment: Undergraduate	2,949
Average Enrollment: Graduate	-

University of Pittsburgh-Bradford

Bradford County, Pennsylvania

Average Enrollment: All	1,571
Average Enrollment: Undergraduate	1,571
Average Enrollment: Graduate	-

University of Pittsburgh-Greensburg

Westmoreland County, Pennsylvania

Average Enrollment: All	1,894
Average Enrollment: Undergraduate	1,894
Average Enrollment: Graduate	-

Pennsylvania State University-Penn State Dubois

Jefferson County, Pennsylvania

Average Enrollment: All	1,097
Average Enrollment: Undergraduate	1,087
Average Enrollment: Graduate	10

Pennsylvania State University-Penn State Erie-Behrend College

Erie County, Pennsylvania

Average Enrollment: All	4,179
Average Enrollment: Undergraduate	3,982
Average Enrollment: Graduate	197

Pennsylvania State University-Penn State Fayette- Eberly Campus

Fayette County, Pennsylvania

Average Enrollment: All	1,343
Average Enrollment: Undergraduate	1,338
Average Enrollment: Graduate	8

Pennsylvania State University-Penn State Greater Allegheny

Allegheny County, Pennsylvania

Average Enrollment: All	952
Average Enrollment: Undergraduate	952
Average Enrollment: Graduate	-

Pennsylvania State University-Penn State Hazleton

Luzerne County, Pennsylvania

Average Enrollment: All	1,242
Average Enrollment: Undergraduate	1,236
Average Enrollment: Graduate	6

Pennsylvania State University-Penn State New Kensington

Westmoreland County, Pennsylvania

Average Enrollment: All	1,148
Average Enrollment: Undergraduate	1,102
Average Enrollment: Graduate	45

University of Pittsburgh-Johnstown

Cambria County, Pennsylvania

Average Enrollment: All	3,345
Average Enrollment: Undergraduate	3,345
Average Enrollment: Graduate	-

University of Pittsburgh-Pittsburgh Campus

Allegheny County, Pennsylvania

Average Enrollment: All	32,716
Average Enrollment: Undergraduate	21,467
Average Enrollment: Graduate	11,249

University of Pittsburgh-Titusville

Crawford County, Pennsylvania

Average Enrollment: All	603
Average Enrollment: Undergraduate	603
Average Enrollment: Graduate	-

West Liberty State College

Brooke County, West Virginia

Average Enrollment: All	2,638
Average Enrollment: Undergraduate	2,608
Average Enrollment: Graduate	30

Youngstown State University

Mahoning County, Ohio

Average Enrollment: All	16,273
Average Enrollment: Undergraduate	14,171
Average Enrollment: Graduate	2,101

Bluefield State College
Mercer County, West Virginia

Average Enrollment: All	2,255
Average Enrollment: Undergraduate	2,255
Average Enrollment: Graduate	-

Concord University
Mercer County, West Virginia

Average Enrollment: All	3,482
Average Enrollment: Undergraduate	3,235
Average Enrollment: Graduate	247

Fairmont State University
Marion County, West Virginia

Average Enrollment: All	5,121
Average Enrollment: Undergraduate	4,687
Average Enrollment: Graduate	434

Glenville State College
Gilmer County, West Virginia

Average Enrollment: All	1,526
Average Enrollment: Undergraduate	1,526
Average Enrollment: Graduate	-

Marshall University
Cabell / Wayne, WV

Average Enrollment: All	17,559
Average Enrollment: Undergraduate	11,106
Average Enrollment: Graduate	6,453

Ohio University-Main Campus
Athens County, Ohio

Average Enrollment: All	23,368
Average Enrollment: Undergraduate	18,383
Average Enrollment: Graduate	4,985

Shawnee State University
Scioto County, Ohio

Average Enrollment: All	4,654
Average Enrollment: Undergraduate	4,643
Average Enrollment: Graduate	17

Shepherd University
Jefferson County, West Virginia

Average Enrollment: All	4,674
Average Enrollment: Undergraduate	4,498
Average Enrollment: Graduate	176

University of Cincinnati-Clermont College
Clermont County, Ohio

Average Enrollment: All	4,049
Average Enrollment: Undergraduate	4,045
Average Enrollment: Graduate	11

West Virginia State University
Kanawha County, West Virginia

Average Enrollment: All	4,281
Average Enrollment: Undergraduate	4,232
Average Enrollment: Graduate	49

West Virginia University
Monongalia County, West Virginia

Average Enrollment: All	31,346
Average Enrollment: Undergraduate	21,829
Average Enrollment: Graduate	9,518

West Virginia University at Parkersburg
Wood County, West Virginia

Average Enrollment: All	4,968
Average Enrollment: Undergraduate	4,968
Average Enrollment: Graduate	-

West Virginia University Institute of Technology
Fayette / Kanawha, WV

Average Enrollment: All	1,808
Average Enrollment: Undergraduate	1,796
Average Enrollment: Graduate	12

Central ARC Region

Eastern Kentucky University
Madison County, Kentucky

Average Enrollment: All	19,148
Average Enrollment: Undergraduate	16,034
Average Enrollment: Graduate	3,114

The University of Virginia's College at Wise
Wise County, Virginia

Average Enrollment: All	2,368
Average Enrollment: Undergraduate	2,368
Average Enrollment: Graduate	-

Morehead State University
Rowan County, Kentucky

Average Enrollment: All	11,164
Average Enrollment: Undergraduate	8,711
Average Enrollment: Graduate	2,453

South Central ARC Region

Appalachian State University
Watauga County, North Carolina

Average Enrollment: All	17,030
Average Enrollment: Undergraduate	14,854
Average Enrollment: Graduate	2,176

East Tennessee State University
Washington County, Tennessee

Average Enrollment: All	14,873
Average Enrollment: Undergraduate	11,865
Average Enrollment: Graduate	3,007

Radford University
Radford County, Virginia

Average Enrollment: All	10,262
Average Enrollment: Undergraduate	8,737
Average Enrollment: Graduate	1,525

University of North Carolina at Asheville
Buncombe County, North Carolina

Average Enrollment: All	4,252
Average Enrollment: Undergraduate	4,207
Average Enrollment: Graduate	45

University of North Carolina School of the Arts
Forsyth County, North Carolina

Average Enrollment: All	878
Average Enrollment: Undergraduate	762
Average Enrollment: Graduate	117

Western Carolina University
Jackson County, North Carolina

Average Enrollment: All	10,750
Average Enrollment: Undergraduate	8,180
Average Enrollment: Graduate	2,569

Tennessee Technological University

Putnam County, Tennessee

Average Enrollment: All	11,228
Average Enrollment: Undergraduate	8,423
Average Enrollment: Graduate	2,805

The University of Tennessee

Knox County, Tennessee

Average Enrollment: All	32,517
Average Enrollment: Undergraduate	22,990
Average Enrollment: Graduate	9,527

The University of Tennessee at Chattanooga

Hamilton County, Tennessee

Average Enrollment: All	10,596
Average Enrollment: Undergraduate	8,752
Average Enrollment: Graduate	1,843

Winston-Salem State University

Forsyth County, North Carolina

Average Enrollment: All	6,699
Average Enrollment: Undergraduate	6,279
Average Enrollment: Graduate	419

Virginia Military Institute

Rockbridge County, Virginia

Average Enrollment: All	1,504
Average Enrollment: Undergraduate	1,504
Average Enrollment: Graduate	-

Virginia Polytechnic Institute and State University

Montgomery County, Virginia

Average Enrollment: All	30,846
Average Enrollment: Undergraduate	23,098
Average Enrollment: Graduate	7,749

Southern ARC Region

Alabama A & M University

Madison County, Alabama

Average Enrollment: All	6,814
Average Enrollment: Undergraduate	5,419
Average Enrollment: Graduate	1,395

Athens State University

Limestone County, Alabama

Average Enrollment: All	4,124
Average Enrollment: Undergraduate	4,124
Average Enrollment: Graduate	-

Clemson University

Pickens County, South Carolina

Average Enrollment: All	19,654
Average Enrollment: Undergraduate	15,299
Average Enrollment: Graduate	4,356

North Georgia College & State University

Lumpkin County, Georgia

Average Enrollment: All	5,982
Average Enrollment: Undergraduate	4,981
Average Enrollment: Graduate	1,000

The University of Alabama

Tuscaloosa County, Alabama

Average Enrollment: All	26,874
Average Enrollment: Undergraduate	21,477
Average Enrollment: Graduate	5,396

University of Alabama at Birmingham

Jefferson County, Alabama

Average Enrollment: All	19,900
Average Enrollment: Undergraduate	13,391
Average Enrollment: Graduate	6,508

Dalton State College

Whitfield County, Georgia

Average Enrollment: All	5,644
Average Enrollment: Undergraduate	5,644
Average Enrollment: Graduate	-

Gainesville State College

Hall County, Georgia

Average Enrollment: All	10,350
Average Enrollment: Undergraduate	10,350
Average Enrollment: Graduate	-

Georgia Gwinnett College

Gwinnett County, Georgia

Average Enrollment: All	1,022
Average Enrollment: Undergraduate	1,022
Average Enrollment: Graduate	-

Jacksonville State University

Calhoun County, Alabama

Average Enrollment: All	10,942
Average Enrollment: Undergraduate	8,620
Average Enrollment: Graduate	2,322

Mississippi State University

Oktibbeha County, Mississippi

Average Enrollment: All	19,157
Average Enrollment: Undergraduate	14,519
Average Enrollment: Graduate	4,638

Mississippi University for Women

Lowndes County, Mississippi

Average Enrollment: All	2,971
Average Enrollment: Undergraduate	2,749
Average Enrollment: Graduate	222

University of Alabama at Huntsville

Madison County, Alabama

Average Enrollment: All	8,506
Average Enrollment: Undergraduate	6,740
Average Enrollment: Graduate	1,766

University of Montevallo

Shelby County, Alabama

Average Enrollment: All	3,442
Average Enrollment: Undergraduate	2,811
Average Enrollment: Graduate	631

University of North Alabama

Lauderdale County, Alabama

Average Enrollment: All	8,854
Average Enrollment: Undergraduate	7,093
Average Enrollment: Graduate	1,760

University of South Carolina-Upstate

Spartanburg County, South Carolina

Average Enrollment: All	5,615
Average enrollment: Undergraduate	5,389
Average Enrollment: Graduate	226

University of West Georgia

Carroll County, Georgia

Average Enrollment: All	12,441
Average Enrollment: Undergraduate	9,928
Average Enrollment: Graduate	2,513

Appendix F. Data sources and methodology

Identification and analysis of the workforce needs of any region must start with understanding the labor demands of businesses operating in industries within the geographical sector. The demand for labor describes the demand for certain skills and people who have the necessary knowledge and skill sets - either through education, training, and/or experience – to successfully perform a job.

Energy sectors in this report were designed to capture the jobs associated with the production and distribution of energy in the Appalachian Region in an effort to get a full picture of the occupations needed for the energy workforce.

Defining the Industry

The energy sector definition used in this report consists of non-renewable energy typically made from fossil fuel sources (coal, oil, and natural gas), nuclear power and renewable energy—those sectors with energy sources that are naturally and/or quickly replenished such as solar, wind, hydroelectric power, geothermal energy, and biomass. In addition, the study reviews industries that are most often associated with promoting energy efficiency. Finally, it includes the fuel cells sector, a rapidly emerging energy source.

Inherent in the methodology are the energy sectors, and their definitions. The definitions evolved from reviewing relevant literature, engaging in conversations with industry and academics, and examining government definitions. The NAICS codes included in the wind and solar sectors definitions were obtained from the ARC report, "Industry Structure and Company Strategies of Major Domestic and Foreign Wind and Solar Energy Manufacturers: Opportunities for Supply Chain Development in Appalachia."[1] The sector definitions by the Renewable Energy Policy Project, a policy research organization, were the foundation for the remaining renewable energy sectors in this study. Traditional energy definitions from Economic Modeling Specialist, Inc. (EMSI) informed the non-renewable sector definitions. The energy subsector definitions were compared to state targeted cluster definitions (Washington, Colorado, and North Carolina), the Energy Industry Administration (EIA), and industry interviews to confirm and amend the definitions where necessary. Nevertheless we point out that in defining the clean energy economy there is no generally accepted definition. See for example, the Brookings Institution report *Sizing the Clean Economy: A National and Regional Green Jobs Assessment* at http://www.brookings.edu/reports/2011/0713_clean_economy.aspx.

Energy sectors and their associated industries are developed as a means to determine the staffing pattern or occupational mix needed to supply the labor and skills set need to produce goods and services. It is the collection of staffing patterns that will ultimately provide you with the occupational demand information needed to begin analysis of the amount and types of gaps (or surpluses) in your workforce. The study team, however, understands that some regions may (1) define their energy sectors differently and thus result in a vastly different occupational mix, and (2)

---

[1] Susman, Gerald I. and Amy K. Glasmeier. Pennsylvania State University. November 2009. *Industry Structure and Company Strategies of Major Domestic and Foreign Wind and Solar Energy Manufacturers: Opportunities for Supply Chain Development in Appalachia.* District of Columbia: Appalachian Regional Commission www.arc.gov/assets/research_reports/WindandSolarEnergy.pdf

over time these definitions may change as buyer-supplier relationships change or as the taxonomy used to classify industries within a sector evolves. Located in Addendum 2 at the end of this operating manual are steps and resources to help an individual go about identifying a targeted energy sector.

Data for each of the energy subsectors is defined by the North American Industry Classification System (NAICS) taxonomy.

Employment Data:
The data (past and projected employment) used in this report is from EMSI's subscription-based tool that provides labor market information data in a user-friendly application. The data within the system is largely collected and reported by the Bureau of Labor Statistics (BLS). BLS "is the principal Federal agency responsible for measuring labor market activity, working conditions, and price changes in the economy. Its mission is to collect, analyze, and disseminate essential economic information to support public and private decision-making. As an independent statistical agency, BLS serves its diverse user communities by providing products and services that are objective, timely, accurate, and relevant."

EMSI collects information from federal and state sources including the Quarterly Census of Employment and Wages (QCEW), Non-Employer Statistics (NES), County Business Patterns (CBP), Regional Economic Information System (REIS), and BLS's Occupational Employment Statistics and Employment Projections. EMSI uses a proprietary algorithm to estimate the suppressed job numbers (undisclosed by the government to maintain employer privacy) as well as non-payroll employment (not covered in QCEW). The final industry estimates are then benchmarked to the REIS data. Although EMSI uses an algorithm to estimate jobs for all workers using data from BLS, the U.S. Bureau of Economic Analysis, and the U.S. Census Bureau, some of the data is still applicable to the confidentiality rules.

For the purposes of this study and in accordance with ARC reporting guidelines, EMSI data was collected at the county level and aggregated to the various regions within Appalachia. To control data suppression, any employment counts reported as less than ten were changed to five. This estimated mean resulted in some individual NAICS code counts being over estimated and some being underestimated at the county level. Regional levels of employment counts resulted in minimal variation due to the suppressed data control technique employed in this study.

Adjustments to the Employment Data:
The energy subsectors are composed of industries that serve more than one energy subsector and, most often for the newer renewable energy subsectors, may serve industry sectors other than energy related industries. For example, within many of the energy subsectors are businesses that fall into the engineering services industry, but not all the engineering services businesses are providing advice and/or designing structures in the energy subsectors.

To correct the employment counts to include only those employees that were producing products used for energy production and distribution, the industry data was adjusted. The proportion of intermediate demand in each industry for energy production was calculated from the 2002 Bureau of Economic Analysis (BEA) Make and Use tables. The employment counts for each industry in the energy subsectors were multiplied by its proportion of intermediate demand. For NAICS codes that were used in multiple energy subsectors, a ratio of BTUs produced according to the U.S. Department of Energy report of energy usage was also used to make conservative employment estimates. The corrections removed duplication and over counting of employment in the NAICS sectors that are used for other production outcomes.

Next, staffing patterns were determined for each of the NAICS codes used in this report. These staffing counts were converted to staffing pattern ratios. The corrected employment count by NAICS code in each energy subsector for each county was multiplied by the staffing pattern ratios to calculate the number of occupations. The ratio of employment for the staffing pattern was calculated by dividing each entry by the total employment for that NAICS code.

$$\textit{corrected employment count} = \frac{\textit{number in occupation}_x \textit{ in staffing pattern for NAICS}_y}{\textit{total employment in occupations for NAICS}_y} \; X \; \textit{number employed in county in NAICS}_y$$

Employment Projections

The team used EMSI projections as a foundation for the employment projections used in this report. EMSI's basic methodology is to create a projection for the most current year from past QCEW data. To account for the time lag (QCEW data usually lags the publications date by six to nine months) annual percent changes from the most recent CES data is used to bridge the gap between the QCEW data and the present. All data are turned into seasonally adjusted annual averages. Where CES lacks geographic and industry detail, EMSI employs standard disaggregation techniques to distribute jobs at higher-level and industries to lower-level geographies.

EMSI also creates long-term, ten-year industry projections starting from the current year using recent industry trends based on data from local sources, national industry projections produced by the BLS, and state and sub-state regional projections produced by individual states.[2]
EMSI then goes through a series of controls and adjustments to other data sources. The first of these is an adjustment to the BLS staffing patterns. The EMSI projected national growth rates is changed to match the growth rate of the BLS numbers, which acts as a guide to see how the EMSI projections match BLS numbers. Then county and state-level projections are adjusted to state-produced state and sub-state regional projections. County values are controlled to the regional data and state projections, which are controlled to reported state data. Once this is completed, the final state-level numbers are aggregated to determine final national projections. Thus, EMSI data matches state projections very closely but can stray from the national projections.

[2] EMSI's first step in the process is to track recent local trends using a linear regression function. Taking into account the previous base data from 15, 10, and 5 years prior to the base year, a line is plotted as a function of year and employment. This line is dampened (flattened) to curb any wild growth or decline and smooth out the effects of any volatility. Once this is done, state and local government industries (as well as Postal Service) are projected based on the growth or decline of local economies rather than projected through linear regression. Federal government and military, however, are projected through linear regression at the national level and their growth rate is then applied to the states and counties. Then projections for each county are adjusted so that they sum to state- and national-level numbers.

Caveats

The methodology has certain limitations:

1. The definition of each of the energy sub-sectors, as aforementioned, is based on a cluster analysis and thus includes more than those industries that generate or transmit energy. Varying definitions will produce different results.

2. Since the data was collected at the county level some suppression still exists due to confidentiality issues. Thus, aggregation of the data to the regional level is likely to underestimate employment in certain categories.

3. Within a given industry, job estimates may vary because it is difficult to know with accuracy what portion of an industry's employment or output is dedicated to the supply chain or manufacture of components for another industry. For example, a composites manufacturer may be producing materials for wind turbines that are also used in a variety of other products. Estimating apportionment of its output and employment to various downstream products is an imperfect process. Although adjustments were made using the BEA Make and Use tables to help deflate industry employment numbers appropriately, these numbers are only broad estimations.

   Any changes to the underlying data sources, including the BEA Make and Use tables used for employment adjustments, will ultimately affect the employment levels reported in this study.

4. The method of estimating supply and demand of graduates to occupations is based on the ultimate distribution demand. That is, the methodology assumes that the graduates from a given program will distribute themselves across occupations more or less in line with the demand for those occupations. It thus does not account for unemployment, those who go into another field, or those who drop out of the labor force. The study team feels, however, that labor market demand was still the best available basis of estimating how program graduates would be allocated, and goes much farther in attempting this allocation than most other labor market gap analyses. In addition, the methodology does not account for in-migration of already-prepared workers, the rapid relocation of dislocated workers (who may be able to transition quickly with on-the-job training), or for the role of other educational institutions in preparing workers for specific occupations.

In addition there are caveats regarding the comparability of the analyses in this report with other analyses of the energy industries.

1. Readers should be careful when comparing the employment data within this report to other analyses. In particular methodological issues, as noted above, impact the sectors that are included within reports on energy employment within the Appalachian region. The definition used here is based on a cluster analysis approach and thus includes more than those industries that generate or transmit energy. This analysis starts with the supply chain of the various energy sectors and then examines staffing patterns throughout the supply chain. Definitions of the supply chain vary widely between different studies because of

methodological reasons and analytical goals.

2. Definitional issues especially limit the ability to compare reports on economic and employment impacts for new clean renewable energy sectors. The RTS report is a NAICS-based analysis within a cluster and supply chain methodology for wind energy production, generation, services, and other elements of the cluster such as workforce training providers. We rely on definitions developed for the Appalachian Regional Commission in 2009 by Penn State researchers Susman and Glasmeir to define the wind energy cluster (see Appendix A of this report, pp. A-3 – A-4).

   An alternative report by the American Wind Energy Association (AWEA) that reflects fewer jobs is an economic impact analysis of specific projects that are likely to come online based on a 20% Wind Energy scenario (meaning 20% of the energy in the country would be generated by wind energy by 2030). (See http://www.awea.org/_cs_upload/learnabout/publications/5094_1.pdf). Within their report the AWEA uses the JEDI model developed by the US Department of Energy (see http://www.windpoweringamerica.gov/filter_detail.asp?itemid=707). The JEDI model looks at investment in construction and operating wind energy turbines, etc. (see report at http://www1.eere.energy.gov/windandhydro/wind_2030.html) but it does not include all the suppliers to the industry cluster included in the RTS method. The AWEA report references supply chains, but they are effectively looking at the direct, induced and indirect economic effects based on multipliers from the IMPLAN input-output (IO) model. For a comprehensive review on the issues surrounding definitional issues see the Brookings Institute report *Sizing the Clean Economy* published in 2011 and available at http://www.brookings.edu/reports/2011/0713_clean_economy.aspx and the US Department of Energy report *20% Wind Energy by 2030* published in 2008 and available at http://www.nrel.gov/docs/fy08osti/41869.pdf. The Brookings report details the differences between their results and other research sources that sometimes show substantial differences, with Brookings reporting up to three to five times higher employment estimates than other sources in one case (p. 17).

3. In addition, other analyses use different data as the basis for their analyses. For example, other industry studies start with the number of wells and use an average number of full-time-equivalent employees needed to staff those wells. Since estimates about the number of wells expected to be drilled in the future vary quite widely, employment estimates based on those projections will vary considerably as well. These varying definitions, methodologies and data will produce different results.

4. The economic and workforce estimates that drive the results in this and other reports on emerging renewable energy sectors are based on a number of assumptions about state, national and international economic and environmental policies, rates of technological change and adoption in emerging energy sectors and the prices of competing non-renewable energy sources. As a result the estimates vary substantially based on these assumptions.

5. Similarly, the economic and workforce estimates that drive the results in this and other reports on new non-renewable energy sources are based on a number of assumptions about

costs of recovery, the actual size of energy reserves and the environmental impacts of new methods. This is particularly relevant in this report with regard to the ultimate economic and workforce impacts of exploration and production from the Marcellus Shale deposit within Appalachia. For example, the US Geological Survey recently (August 23, 2011) released estimates of undiscovered, technically recoverable natural gas within the Marcellus Shale deposit that are nearly 80 percent lower than previous estimates by the US Energy Information Administration. The report is available here: http://energy.usgs.gov/Miscellaneous/Articles/tabid/98/ID/102/Assessment-of-Undiscovered-Oil-and-Gas-Resources-of-the-Devonian-Marcellus-Shale-of-the-Appalachian-Basin-Province.aspx. These estimates are not reflected within this report.

6. Lastly, Bureau of Labor Statistics projections are based on a careful and vetted methodology and are superior to other ad hoc methods in the vast majority of cases. Still workforce and economic practitioners and policy makers should use all data and analyses at their disposal.

   In cases of extreme economic change BLS estimates can be less reliable. For example, the BLS algorithms may be less effective in adequately reflecting the impacts of events such as Hurricane Katrina or the rapid rise of new oil developments in North Dakota. In these cases, careful analyses based on proven methodologies should be used to supplement BLS analyses, including the projections in this report.

   Within the Appalachian region the increasing exploration and extraction of natural gas from the Marcellus Shale deposit may prove to be such a game-changing event especially in states such as Pennsylvania with significant drilling activity. A relevant report is a very labor intensive analysis recently conducted by the Marcellus Shale Education and Training Center and Penn State examining workforce needs. The report, which can be found at www.msetc.org/docs/NeedsAssessmentwithcoverSW.pdf, is an important source for up-to-date information and projections on workforce issues in Appalachian Pennsylvania and reflects significant annual employment impacts from 8,753 in 2009 to 22,603 in 2013. Our report projects that employment impacts from the broader gas and oil cluster in Pennsylvania are approximately 58,000 in 2009 and 60,000 in 2013. We cannot be sure if the two analyses are inconsistent because we are looking at the broader cluster and some elements of the cluster are in decline. Those declines will offset increases within the narrower natural gas exploration and extraction.

Appendix G: Description of Energy Related Instructional Programs by Classification of Instructional Program (CIP)

NATURAL RESOURCES AND CONSERVATION

03.0509 - Wood Science and Wood Products/Pulp and Paper Technology. A program that focuses on the application of chemical, physical, and engineering principles to the analysis of the properties and behavior of wood and wood products and the development of processes for converting wood into paper and other products. Program includes instruction in wood classification and testing, product development, manufacturing and processing technologies, and the design and development of related equipment and systems.

ENGINEERING

14.0101 - Engineering, General. A program that prepares individuals to apply mathematical and scientific principles to solve a wide variety of practical problems in industry, social organization, public works, and commerce.

14.0701 - Chemical Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems employing chemical processes, such as chemical reactors, kinetic systems, electrochemical systems, energy conservation processes, heat and mass transfer systems, and separation processes; and the applied analysis of chemical problems such as corrosion, particle abrasion, energy loss, pollution, and fluid mechanics.

14.0801 - Civil Engineering, General. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of structural, load-bearing, material moving, transportation, water resource, and material control systems; and environmental safety measures.

14.0802 - Geotechnical Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems for manipulating and controlling surface and subsurface features at/or incorporated into structural sites, including earth and rock moving and stabilization, landfills, structural use and environmental stabilization of wastes and by-products, underground construction, and groundwater and hazardous material containment.

14.0805 - Water Resources Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems for collecting, storing, moving, conserving and controlling surface and groundwater, including water quality control, water cycle management, management of human and industrial water requirements, water delivery, and flood control.

14.0899 - Civil Engineering, Other. Any instructional program in civil engineering not listed above.

14.1001 - Electrical, Electronics and Communications Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of electrical, electronic and related communications systems and their components, including electrical power generation systems; and the analysis of problems such as superconductor, wave propagation, energy storage and retrieval, and reception and amplification.

14.1101 - Engineering Mechanics. A program with a general focus on the application of the mathematical and scientific principles of classical mechanics to the analysis and evaluation of the behavior of structures, forces and materials in engineering problems. Includes instruction in statics, kinetics, dynamics, kinematics, celestial mechanics, stress and failure, and electromagnetism.

14.1201 - Engineering Physics. A program with a focus on the general application of mathematical and scientific principles of physics to the analysis and evaluation of engineering problems. Includes instruction in high and low-temperature phenomena, computational physics, superconductivity, applied thermodynamics, molecular and particle physics applications, and space science research.

14.1301 - Engineering Science. A program with a general focus on the application of various combinations of mathematical and scientific principles to the analysis and evaluation of engineering problems, including applied research in human behavior, statistics, biology, chemistry, the earth and planetary sciences, atmospherics and meteorology, and computer applications.

14.1801 - Materials Engineering. A program that prepares individuals to apply mathematical and materials science principles to the design, development and operational evaluation of materials and related processes used in manufacturing in a wide variety of settings; the synthesis of new industrial materials, including marrying and bonding composites; analysis of materials requirements and specifications; and related problems of system design dependent on materials factors.

14.1901 - Mechanical Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of physical systems used in manufacturing and end-product systems used for specific uses, including machine tools, jigs and other manufacturing equipment; stationary power units and appliances; engines; self-propelled vehicles; housings and containers; hydraulic and electric systems for controlling movement; and the integration of computers and remote control with operating systems.

14.2001 - Metallurgical Engineering. A program that prepares individuals to apply mathematical and metallurgical principles to the design, development and operational evaluation of metal components of structural, load-bearing, power, transmission, and moving systems; and the analysis of engineering problems such as stress, creep, failure, alloy behavior, environmental fluctuations, stability, electromagnetic and thermodynamic characteristics, optimal manufacturing processes, and related design considerations.

14.2101 - Mining and Mineral Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of mineral extraction, processing and refining systems, including open pit and shaft mines, prospecting and site analysis equipment and instruments, environmental and safety systems, mine equipment and facilities, mineral processing and refining methods and systems, and logistics and communications systems.

14.2301 - Nuclear Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems for controlling and manipulating nuclear energy, including nuclear power plant design, fission reactor design, fusion reactor design, reactor control and safety systems design, power transfer systems, containment vessels and structures design; and the analysis of related engineering problems such as fission and fusion processes, human and environmental factors, construction, and operational considerations.

14.2401 - Ocean Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems to monitor, control, manipulate and operate within coastal or ocean environments, such as underwater platforms, flood control systems, dikes, hydroelectric power systems, tide and current control and warning systems, and communications equipment; the planning and design of total systems for working and functioning in water or underwater environments; and the analysis of related engineering problems such as the action of water properties and behavior on physical systems and people, tidal forces, current movements, and wave motion.

14.2501 - Petroleum Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems for locating, extracting, processing and refining crude petroleum and natural gas, including prospecting instruments and equipment, mining and drilling systems, processing and refining systems and facilities, storage facilities, transportation systems, and related environmental and safety systems.

14.2801 - Textile Sciences and Engineering. A program that prepares individuals to apply mathematical and scientific principles to the design, development and operational evaluation of systems to test and manufacture fibers and fiber products, both synthetic and natural; to develop new and improved fibers, textiles and their uses; and to the analysis of related engineering problems such as structural factors, molecular synthesis, chemical manufacturing, weaves, strength and stress, useful life, dyes, and applications to composite systems.

14.3101 - Materials Science. A program that focuses on the general application of mathematical and scientific principles to the analysis and evaluation of the characteristics and behavior of solids, including internal structure, chemical properties, transport and energy flow properties, thermodynamics of solids, stress and failure factors, chemical transformation states and processes, compound materials, and research on industrial applications of specific materials.

14.3501 - Industrial Engineering. A program that prepares individuals to apply scientific and mathematical principles to the design, improvement, and installation of integrated systems of people, material, information, and energy. Includes instruction in applied mathematics, physical sciences, the social sciences, engineering analysis, systems design, computer applications, and forecasting and evaluation methodology.

14.3601 - Manufacturing Engineering. A program that prepares individuals to apply scientific and mathematical principles to the design, development, and implementation of manufacturing systems. Includes instruction in materials science and engineering, manufacturing processes, process engineering, assembly and product engineering, manufacturing systems design, and manufacturing competitiveness.

14.3901 - Geological/Geophysical Engineering. A program that prepares individuals to apply mathematical and geological principles to the analysis and evaluation of engineering problems, including the geological evaluation of construction sites, the analysis of geological forces acting on structures and systems, the analysis of potential natural resource recovery sites, and applied research on geological phenomena.

14.9999 - Engineering, Other. Any instructional program in engineering not listed above.

ENGINEERING TECHNOLOGIES/TECHNICIANS

15.0000 - Engineering Technology, General. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers engaged in a wide variety of projects. Includes instruction in various engineering support functions for research, production, and operations, and applications to specific engineering specialties. (Moved from 15.1101)

15.0303 - Electrical, Electronic and Communications Engineering Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of electrical, electronics and communication engineers. Includes instruction in electrical circuitry, prototype development and testing; systems analysis and testing, systems maintenance, instrument calibration, and report preparation.

15.0399 - Electrical and Electronic Engineering Technologies/Technicians, Other. Any instructional program in electrical and electronic engineering-related technologies not listed above.

15.0403 - Electromechanical Technology/Electromechanical Engineering Technology. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers engaged in developing and testing automated, servo-mechanical, and other electromechanical systems. Includes instruction in prototype testing, manufacturing and operational testing, systems analysis and maintenance procedures, and report preparation.

15.0404 - Instrumentation Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers engaged in developing control and measurement systems and procedures. Includes instruction in instrumentation design and maintenance, calibration, design and production testing and scheduling, automated equipment functions, applications to specific industrial tasks, and report preparation. (Moved from 47.0401)

15.0499 - Electromechanical and Instrumentation and Maintenance Technologies/Technicians, Other. Any instructional program in electromechanical instrumentation and maintenance technologies not listed above.

15.0501 - Heating, Air Conditioning and Refrigeration Technology/Technician (ACH/ACR/ACHR/HRAC/HVAC/AC Technology). A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and using air conditioning, refrigeration, and heating systems. Includes instruction in principles of heating and cooling technology, design and operational testing, inspection and maintenance procedures, installation and operation procedures, and report preparation.

15.0503 - Energy Management and Systems Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing energy-efficient systems or monitoring energy use. Includes instruction in principles of energy conservation, instrumentation calibration, monitoring systems and test procedures, energy loss inspection procedures, energy conservation techniques, and report preparation.

15.0505 - Solar Energy Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing solar-powered energy systems. Includes instruction in solar energy principles, energy storage and transfer technologies, testing and inspection procedures, system maintenance procedures, and report preparation.

15.0506 - Water Quality and Wastewater Treatment Management and Recycling Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and using water storage, waterpower, and wastewater treatment systems. Includes instruction in water storage, power and/or treatment systems and equipment; testing and inspection procedures; system maintenance procedures; and report preparation.

15.0611 - Metallurgical Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and metallurgists engaged in developing and using industrial metals and manufacturing processes. Includes instruction in principles of metallurgy, related manufacturing systems, laboratory techniques, testing and inspection procedures, instrument calibration, system and equipment maintenance and repair, applications to specific processes, and report preparation.

15.0612 - Industrial Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of industrial engineers and managers. Includes instruction in optimization theory, human factors, organizational behavior, industrial processes, industrial planning procedures, computer applications, and report and presentation preparation.

15.0613 - Manufacturing Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills to the identification and resolution of production problems in the manufacture of products. Includes instruction in machine operations, production line operations, engineering analysis, systems analysis, instrumentation, physical controls, automation, computer-aided manufacturing (CAM), manufacturing planning, quality control, and informational infrastructure.

15.0699 - Industrial Production Technologies/Technicians, Other. Any instructional program in industrial production technologies not listed above.

15.0805 - Mechanical Engineering/Mechanical Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers engaged in the design and development phases of a wide variety of projects involving mechanical systems. Includes instruction in principles of mechanics, applications to specific engineering systems, design testing procedures, prototype and operational testing and inspection procedures, manufacturing system-testing procedures, test equipment operation and maintenance, and report preparation.

15.0899 - Mechanical Engineering Related Technologies/Technicians, Other. Any instructional program in mechanical engineering-related technologies not listed above.

15.0901 - Mining Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in the development and operation of mines and related mineral processing facilities. Includes instruction in principles of mineral extraction and related geology, mineral field mapping and site analysis, testing and sampling methods, instrument calibration, assay analysis, test equipment operation and maintenance, mine environment and safety monitoring procedures, mine inspection procedures, and report preparation.

15.0903 - Petroleum Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in the development and operation of oil and natural gas extraction and processing facilities. Includes instruction in principles of petroleum extraction and related geology, petroleum field mapping and site analysis, testing and sampling methods, instrument calibration, laboratory analysis, test equipment operation and maintenance, environment and safety monitoring procedures for oil/gas fields and facilities, facility inspection procedures, and report preparation.

15.0999 - Mining and Petroleum Technologies/Technicians, Other. Any instructional program in mining and petroleum engineering technologies not listed above.

15.1103 - Hydraulics and Fluid Power Technology/Technician. A program that prepares individuals to apply basic engineering principles and technical skills in support of engineers and other professionals engaged in developing and using fluid power and transportation systems. Includes instruction in fluid mechanics and hydraulics principles, fluid power systems, pipeline and pumping systems, design and operational testing, inspection and maintenance procedures, related instrumentation, and report preparation.

15.1199 - Engineering-Related Technologies, Other. Any programs in engineering-related technologies and technicians not listed above.

15.1304 - Civil Drafting and Civil Engineering CAD/CADD. A program that prepares individuals to apply technical knowledge and skills to develop working drawing and electronic simulations in support of civil engineers, geological engineers, and related professionals. Includes instruction in basic civil engineering principles, geological and seismographic mapping, machine drafting, computer-aided drafting (CAD), pipe drafting, survey interpretation, and blueprint reading. (Moved from 48.0103)

15.1305 - Electrical/Electronics Drafting and Electrical/Electronics CAD/CADD. A program that prepares individuals to apply technical knowledge and skills to develop working schematics and representations in support of electrical/electronic engineers, computer engineers, and related professionals. Includes instruction in basic electronics, electrical systems and computer layouts; electrode-mechanical drafting; manufacturing circuitry; computer-aided drafting (CAD); and electrical systems specification interpretation. (Moved from 48.0104)

15.1306 - Mechanical Drafting and Mechanical Drafting CAD/CADD. A program that prepares individuals to apply technical knowledge and skills to develop working drawings and electronic simulations in support of mechanical and industrial engineers, and related professionals. Includes instruction in manufacturing materials and processes, mechanical drafting, electrode-mechanical drafting, basic metallurgy, geometric dimensioning and tolerancing, blueprint reading and technical communication. (Moved from 48.0105)

15.1401 - Nuclear Engineering Technology/Technician. A program that prepares individuals to apply basic engineering, knowledge and technical skills in support of engineer and other professionals operating nuclear facilities and engaged in nuclear applications and safety procedures. Includes instruction in physics, nuclear science, nuclear systems, nuclear plant and systems design, radiological safety, radiological applications, and applicable law and regulations.

PHYSICAL SCIENCES

40.0403 - Atmospheric Physics and Dynamics. A program that focuses on the scientific study of the processes governing the interactions, movement, and behavioral of atmospheric phenomena and related terrestrial and solar phenomena. Includes instruction in cloud and precipitation physics, solar radiation transfer, active and passive remote sensing, atmospheric electricity and acoustics, atmospheric wave phenomena, turbulence and boundary layers, solar wind, geomagnetic storms, coupling, natural plasma, and energization.

40.0501 - Chemistry, General. A general program that focuses on the scientific study of the composition and behavior of matter, including its micro- and macro-structure, the processes of chemical change, and the theoretical description and laboratory simulation of these phenomena.

40.0503 - Inorganic Chemistry. A program that focuses on the scientific study of the elements and their compounds, other than the hydrocarbons and their derivatives. Includes instruction in the characterization and synthesis of non-carbon molecules, including their structure and their bonding, conductivity, and reactive properties; research techniques such as spectroscopy, X-ray diffraction, and photoelectron analysis; and the study of specific compounds, such as transition metals, and compounds composed of inorganic and organic molecules.

40.0508 - Chemical Physics. A program that focuses on the scientific study of structural phenomena combining the disciplines of physical chemistry and atomic/molecular physics. Includes instruction in heterogeneous structures, alignment and surface phenomena, quantum theory, mathematical physics, statistical and classical mechanics, chemical kinetics, liquid crystals and membranes, molecular synthesis and design, and laser physics.

40.0601 - Geology/Earth Science, General. A program that focuses on the scientific study of the earth; the forces acting upon it; and the behavior of the solids, liquids and gases comprising it. Includes instruction in historical geology, geomorphology, and sedimentology, the chemistry of rocks and soils, stratigraphy, mineralogy, petrology, geostatistics, volcanology, glaciology, geophysical principles, and applications to research and industrial problems.

40.0605 - Hydrology and Water Resources Science. A program that focuses on the scientific of study of the occurrence, circulation, distribution, chemical and physical properties, and environmental interaction of surface and subsurface waters, including groundwater. Includes instruction in geophysics, thermodynamics, fluid mechanics, chemical physics, geomorphology, mathematical modeling, hydrologic analysis, continental water processes, global water balance, and environmental science.

40.0606 - Geochemistry and Petrology. A program that focuses on the scientific study of the igneous, metamorphic, and hydrothermal processes within the earth and the mineral, fluid, rock, and ore deposits resulting from them. Includes instruction in mineralogy, crystallography, petrology, volcanology, economic geology, meteoritics, geochemical reactions, deposition, compound transformation, core studies, theoretical geochemistry, computer applications, and laboratory studies.

40.0607 - Oceanography, Chemical and Physical. A program that focuses on the scientific study of the chemical components, mechanisms, structure, and movement of ocean waters and their interaction with terrestrial and atmospheric phenomena. Includes instruction in material inputs and outputs, chemical and biochemical transformations in marine systems, equilibria studies, inorganic and organic ocean chemistry, oceanographic processes, sediment transport, zone processes, circulation, mixing, tidal movements, wave properties, and seawater properties. (Moved from 40.0702)

40.0801 - Physics, General. A general program that focuses on the scientific study of matter and energy, and the formulation and testing of the laws governing the behavior of the matter-energy continuum. Includes instruction in classical and modern physics, electricity and magnetism, thermodynamics, mechanics, wave properties, nuclear processes, relativity and quantum theory, quantitative methods, and laboratory methods.

40.0802 - Atomic/Molecular Physics. A program that focuses on the scientific study of the behavior of matter-energy phenomena at the level of atoms and molecules. Includes instruction in chemical physics, atomic forces and structure, fission reactions, molecular orbital theory, magnetic resonance, molecular bonding, phase equilibria, quantum theory of solids, and applications to the study of specific elements and higher compounds.

40.0804 - Elementary Particle Physics. A program that focuses on the scientific study of the basic constituents of sub-atomic matter and energy, and the forces governing fundamental processes. Includes instruction in quantum theory, field theory, single-particle systems, perturbation and scattering theory, matter-radiation interaction, symmetry, quarks, capture, Schroedinger mechanics, methods for detecting particle emission and absorption, and research equipment operation and maintenance.

40.0806 - Nuclear Physics. A program that focuses on the scientific study of the properties and behavior of atomic nuclei instruction in nuclear reaction theory, quantum mechanics, energy conservation, nuclear fission and fusion, strong and weak atomic forces, nuclear modeling, nuclear decay, nucleon scattering, pairing, photon and electron reactions, statistical methods, and research equipment operation and maintenance.

SCIENCE TECHNOLOGIES/TECHNICIANS

41.0204 - Industrial Radiologic Technology/Technician. A program that prepares individuals to apply scientific principles and technical skills to the operation of industrial and research testing equipment using radioisotopes. Includes instruction in x-ray analysis of materials, nondestructive testing and inspection of materials, and continuous measurement of paper or metal thickness.

41.0205 - Nuclear/Nuclear Power Technology/Technician. A program that prepares individuals to apply scientific principles and technical skills in support of research scientists and operating engineers engaged in the running of nuclear reactors, and in nuclear materials processing and disposal. Includes instruction in basic nuclear physics and nuclear engineering, monitoring and safety procedures, radioactive materials handling and disposal, equipment maintenance and operation, and record keeping.

41.0299 - Nuclear and Industrial Radiologic Technologies/Technicians, Other. Any instructional program in nuclear and industrial radiologic technologies not listed above.

41.0301 - Chemical Technology/Technician. A program that prepares individuals to apply scientific principles and technical skills in support of chemical and biochemical research and industrial operations. Includes instruction in principles of chemistry and biochemistry, technical mathematics, computer applications, radiochemistry, industrial biochemistry, chemical instrumentation, physical chemistry, laboratory research methods, industrial processing methods and equipment, and test equipment operation and maintenance.

CONSTRUCTION TRADES

46.0301 - Electrical and Power Transmission Installation/Installer, General. A program that generally prepares individuals to apply technical knowledge and skills to install indoor and outdoor residential, commercial, and industrial electrical systems, and associated power transmission lines. Includes instruction in electricity, safety procedures, wiring, insulation and grounding, schematic blueprint interpretation, equipment operation and maintenance, and applicable codes and standards.

46.0302 - Electrician. A program that prepares individuals to apply technical knowledge and skills to install, operate, maintain, and repair electric apparatus and systems such as residential, commercial, and industrial electric-power wiring; and DC and AC motors, controls, and electrical distribution panels. Includes instruction in the principles of electronics and electrical systems, wiring, power transmission, safety, industrial and household appliances, job estimation, electrical testing and inspection, and applicable codes and standards.

46.0303 - Lineworker. A program that prepares individuals to apply technical knowledge and skills to install, operate, maintain and repair local, long-distance, and rural electric power cables and communication lines; erect and construct pole and tower lines; and install underground lines and cables. Includes instruction in cable installation and repair, fibre-optic technology, trenching, mobile equipment and crane operation, high-voltage installations, maintenance and inspection, safety, remote communications, and applicable codes and standards.

46.0403 - Building/Home/Construction Inspection/Inspector. A program that prepares individuals to apply industrial, labor, and governmental standards and laws to the oversight of construction projects and the maintenance of completed buildings and other structures. Includes instruction in construction processes and techniques, materials analysis, occupational safety and health, industry standards, building codes and specifications, blueprint interpretation, testing equipment and procedures, communication skills, accident investigation, and documentation.

46.0502 - Pipefitting/Pipefitter and Sprinkler Fitter. A program that prepares individuals to design, install, and test industrial and commercial piping systems and automatic fire and exposure protection systems. Includes instruction in water systems, steam systems, heating and cooling systems, lubricating systems, piping materials, installation tools operation and maintenance, valve installation and repair, technical mathematics, blueprint interpretation, and applicable codes and standards.

46.0503 - Plumbing Technology/Plumber. A program that prepares individuals to practice as licensed plumbers by applying technical knowledge and skills to lay out, assemble, install, and maintain piping fixtures and systems for steam, natural gas, oil, hot water, heating, cooling, drainage, lubricating, sprinkling, and industrial processing systems in home and business environments. Includes instruction in source determination, water distribution, waster removal, pressure adjustment, basic physics, technical mathematics, blueprint reading, pipe installation, pumps, welding and soldering, plumbing inspection, and applicable codes and standards.

46.0504 - Well Drilling/Driller. A program that prepares individuals to apply technical knowledge and skills to set up, maintain, repair, and operate well drilling equipment; locate, drill, construct, and develop water, gas, and oil wells; and test and monitor wells to ensure adequate flow. Includes applications to home, business, and industrial uses.

46.0505 - Blasting/Blaster. A program that prepares individuals to apply technical knowledge and skills in using a variety of explosive materials to aid in the construction process. Includes instruction in safety procedures for storing, handling, placement, charge power determination, drilling, pounding building demolition preparing rocky surfaces for build foundations and demolition of explosives.

MECHANIC AND REPAIR TECHNOLOGIES/TECHNICIANS

47.0101 Electrical/Electronics Equipment Installation and Repair, General. A program that generally prepares individuals to apply technical knowledge and skills to operate, maintain, and repair electrical and electronic equipment. Includes instruction in electrical circuitry, simple gearing, linkages and lubrication of machines and appliances, and the use of testing equipment.

47.0105 - Industrial Electronics Technology/Technician. A program that prepares individuals to apply technical knowledge and skills to assemble, install, operate, maintain, and repair electrical/electronic equipment used in industry and manufacturing. Includes instruction in installing, maintaining and testing various types of equipment.

47.0199 - Electrical/Electronics Maintenance and Repair Technology, Other. Any instructional program in electrical and electronics equipment installation and repair not listed above.

47.0201 - Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (HAC, HACR, HVAC, HVACR). A program that prepares individuals to apply technical knowledge and skills to repair, install, service and maintain the operating condition of heating, air conditioning, and refrigeration systems. Includes instruction in diagnostic techniques, the use of testing equipment and the principles of mechanics, electricity, and electronics as they relate to the repair of heating, air conditioning and refrigeration systems.

47.0302 - Heavy Equipment Maintenance Technology/Technician. A program that prepares individuals to apply technical knowledge and skills in the field maintenance and repair of heavy equipment, and in the general maintenance and overhaul of such equipment. Includes instruction in inspection, maintenance, and repair of tracks, wheels, brakes, operating controls, pneumatic and hydraulic systems, electrical circuitry, engines and in techniques of welding and brazing.

47.0303 - Industrial Mechanics and Maintenance Technology. A program that prepares individuals to apply technical knowledge and skills to repair and maintain industrial machinery and equipment such as cranes, pumps, engines and motors, pneumatic tools, conveyor systems, production machinery, marine deck machinery, and steam propulsion, refinery, and pipeline-distribution systems.

47.0614 - Alternative Fuel Vehicle Technology/Technician. A program that prepares individuals to apply technical knowledge and skills to the maintenance of alternative fuel vehicles and the conversion of standard vehicles to AFV status. Includes instruction in electrical vehicles, liquefied petroleum gas (LPG) vehicles, compressed natural gas, (CNG) vehicles, hybrid fuel technology, electrical and electronic systems, engine performance, diagnosis and repair, and conversion/installation.

PRECISION PRODUCTION

48.0508 - Welding Technology/Welder. A program that prepares individuals to apply technical knowledge and skills to join or cut metal surfaces. Includes instruction in arc welding, resistance welding, brazing and soldering, cutting, high-energy beam welding and cutting, solid state welding, ferrous and non-ferrous materials, oxidation-reduction reactions, welding metallurgy, welding processes and heat treating, structural design, safety, and applicable codes and standards.

48.0801 - Boilermaking/Boilermaker. A program that prepares individuals to apply technical knowledge and skills to fabricate and repair steam boiler components. Includes instruction in principles of steam power, material selection, welding, riveting, sealing materials, pressure testing, pipefitting, and applicable codes and standards.

Appendix H: List of Occupations Used for Gap Analysis

SOC Code	Description
11-3051	Industrial production managers
11-9021	Construction managers
11-9041	Engineering managers
11-9121	Natural sciences managers
15-1011	Computer and information scientists, research
15-1021	Computer programmers
15-1031	Computer software engineers, applications
15-1032	Computer software engineers, systems software
15-1041	Computer support specialists
15-1051	Computer systems analysts
15-1061	Database administrators
15-1071	Network and computer systems administrators
15-1081	Network systems and data communications analysts
15-1099	Computer specialists, all other
17-1011	Architects, except landscape and naval
17-1021	Cartographers and photogrammetrists
17-1022	Surveyors
17-2011	Aerospace engineers
17-2021	Agricultural engineers
17-2041	Chemical engineers
17-2051	Civil engineers
17-2061	Computer hardware engineers
17-2071	Electrical engineers
17-2072	Electronics engineers, except computer
17-2081	Environmental engineers
17-2111	Health and safety engineers, except mining safety engineers and inspectors
17-2112	Industrial engineers
17-2121	Marine engineers and naval architects
17-2131	Materials engineers
17-2141	Mechanical engineers
17-2151	Mining and geological engineers, including mining safety engineers
17-2161	Nuclear engineers
17-2171	Petroleum engineers
17-2199	Engineers, all other
17-3011	Architectural and civil drafters

SOC Code	Description
17-3012	Electrical and electronics drafters
17-3013	Mechanical drafters
17-3019	Drafters, all other
17-3021	Aerospace engineering and operations technicians
17-3022	Civil engineering technicians
17-3023	Electrical and electronic engineering technicians
17-3024	Electro-mechanical technicians
17-3025	Environmental engineering technicians
17-3026	Industrial engineering technicians
17-3027	Mechanical engineering technicians
17-3029	Engineering technicians, except drafters, all other
17-3031	Surveying and mapping technicians
19-1011	Animal scientists
19-1012	Food scientists and technologists
19-1013	Soil and plant Scientists
19-1021	Biochemists and biophysicists
19-1031	Conservation scientists
19-2012	Physicists
19-2021	Atmospheric and space scientists
19-2031	Chemists
19-2032	Materials scientists
19-2041	Environmental scientists and specialists, including health
19-2042	Geoscientists, except hydrologists and geographers
19-2043	Hydrologists
19-2099	Physical scientists, all other
19-4021	Biological technicians
19-4031	Chemical technicians
19-4041	Geological and petroleum technicians
19-4051	Nuclear technicians
19-4091	Environmental science and protection technicians, including health
19-4093	Forest and conservation technicians
27-1021	Commercial and industrial designers
43-5041	Meter readers, utilities
43-9011	Computer operators
47-1011	First-line supervisors/managers of construction trades and extraction workers
47-2011	Boilermakers
47-2021	Brickmasons and blockmasons
47-2022	Stonemasons
47-2031	Carpenters

SOC Code	Description
47-2041	Carpet installers
47-2042	Floor layers, except carpet, wood, and hard tiles
47-2043	Floor sanders and finishers
47-2044	Tile and marble setters
47-2051	Cement masons and concrete finishers
47-2053	Terrazzo workers and finishers
47-2061	Construction laborers
47-2071	Paving, surfacing, and tamping equipment operators
47-2072	Pile-driver operators
47-2073	Operating engineers and other construction equipment operators
47-2081	Drywall and ceiling tile installers
47-2082	Tapers
47-2111	Electricians
47-2121	Glaziers
47-2131	Insulation workers, floor, ceiling, and wall
47-2132	Insulation workers, mechanical
47-2141	Painters, construction and maintenance
47-2142	Paperhangers
47-2151	Pipelayers
47-2152	Plumbers, pipefitters, and steamfitters
47-2161	Plasterers and stucco masons
47-2171	Reinforcing iron and rebar workers
47-2181	Roofers
47-2211	Sheet metal workers
47-2221	Structural iron and steel workers
47-3011	Helpers, brickmasons, blockmasons, stonemasons, and tile and marble setters
47-3012	Helpers, carpenters
47-3013	Helpers, electricians
47-3014	Helpers, painters, paperhangers, plasterers, and stucco masons
47-3015	Helpers, pipelayers, plumbers, pipefitters, and steamfitters
47-3016	Helpers, roofers
47-3019	Helpers, construction trades, all other
47-4011	Construction and building inspectors
47-4021	Elevator installers and repairers
47-4041	Hazardous materials removal workers
47-4099	Construction and related workers, all other
47-5011	Derrick operators, oil and gas
47-5012	Rotary drill operators, oil and gas
47-5013	Service unit operators, oil, gas, and mining

SOC Code	Description
47-5021	Earth drillers, except oil and gas
47-5031	Explosives workers, ordnance handling experts, and blasters
47-5041	Continuous mining machine operators
47-5042	Mine cutting and channeling machine operators
47-5049	Mining machine operators, all other
47-5051	Rock splitters, quarry
47-5061	Roof bolters, mining
47-5071	Roustabouts, oil and gas
47-5081	Helpers, extraction workers
47-5099	Extraction workers, all other
49-1011	First-line supervisors/managers of mechanics, installers, and repairers
49-2092	Electric motor, power tool, and related repairers
49-2093	Electrical and electronics installers and repairers, transportation equipment
49-2094	Electrical and electronics repairers, commercial and industrial equipment
49-2095	Electrical and electronics repairers, powerhouse, substation, and relay
49-3042	Mobile heavy equipment mechanics, except engines
49-9012	Control and valve installers and repairers, except mechanical door
49-9021	Heating, air conditioning, and refrigeration mechanics and installers
49-9041	Industrial machinery mechanics
49-9042	Maintenance and repair workers, general
49-9043	Maintenance workers, machinery
49-9044	Millwrights
49-9045	Refractory materials repairers, except brickmasons
49-9051	Electrical power-line installers and repairers
49-9069	Precision instrument and equipment repairers, all other
49-9092	Commercial divers
49-9095	Manufactured building and mobile home installers
49-9096	Riggers
49-9098	Helpers--Installation, maintenance, and repair workers
49-9099	Installation, maintenance, and repair workers, all other
51-1011	First-line supervisors/managers of production and operating workers
51-2011	Aircraft structure, surfaces, rigging, and systems assemblers
51-2022	Electrical and electronic equipment assemblers
51-2023	Electromechanical equipment assemblers
51-2031	Engine and other machine assemblers
51-2041	Structural metal fabricators and fitters
51-2091	Fiberglass laminators and fabricators
51-2092	Team assemblers
51-2093	Timing device assemblers, adjusters, and calibrators

SOC Code	Description
51-2099	Assemblers and fabricators, all other
51-4011	Computer-controlled machine tool operators, metal and plastic
51-4012	Numerical tool and process control programmers
51-4021	Extruding and drawing machine setters, operators, and tenders, metal and plastic
51-4022	Forging machine setters, operators, and tenders, metal and plastic
51-4023	Rolling machine setters, operators, and tenders, metal and plastic
51-4031	Cutting, punching, and press machine setters, operators, and tenders, metal and plastic
51-4032	Drilling and boring machine tool setters, operators, and tenders, metal and plastic
51-4033	Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic
51-4034	Lathe and turning machine tool setters, operators, and tenders, metal and plastic
51-4035	Milling and planing machine setters, operators, and tenders, metal and plastic
51-4041	Machinists
51-4051	Metal-refining furnace operators and tenders
51-4052	Pourers and casters, metal
51-4061	Model makers, metal and plastic
51-4062	Patternmakers, metal and plastic
51-4071	Foundry mold and coremakers
51-4072	Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic
51-4081	Multiple machine tool setters, operators, and tenders, metal and plastic
51-4111	Tool and die makers
51-4121	Welders, cutters, solderers, and brazers
51-4122	Welding, soldering, and brazing machine setters, operators, and tenders
51-4191	Heat treating equipment setters, operators, and tenders, metal and plastic
51-4192	Lay-out workers, metal and plastic
51-4193	Plating and coating machine setters, operators, and tenders, metal and plastic
51-4194	Tool grinders, filers, and sharpeners
51-4199	Metal workers and plastic workers, all other
51-6063	Textile knitting and weaving machine setters, operators, and tenders
51-6064	Textile winding, twisting, and drawing out machine setters, operators, and tenders
51-6091	Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers
51-8011	Nuclear power reactor operators
51-8012	Power distributors and dispatchers
51-8013	Power plant operators
51-8021	Stationary engineers and boiler operators
51-8031	Water and liquid waste treatment plant and system operators
51-8091	Chemical plant and system operators
51-8092	Gas plant operators
51-8093	Petroleum pump system operators, refinery operators, and gaugers
51-8099	Plant and system operators, all other

SOC Code	Description
51-9011	Chemical equipment operators and tenders
51-9012	Separating, filtering, clarifying, precipitating, and still machine setters, operators, and tenders
51-9021	Crushing, grinding, and polishing machine setters, operators, and tenders
51-9041	Extruding, forming, pressing, and compacting machine setters, operators, and tenders
51-9051	Furnace, kiln, oven, drier, and kettle operators and tenders
51-9061	Inspectors, testers, sorters, samplers, and weighers
51-9141	Semiconductor processors
51-9198	Helpers--Production workers
51-9199	Production workers, all other
53-1021	First-line supervisors/managers of helpers, laborers, and material movers, hand
53-1031	First-line supervisors/managers of transportation and material-moving machine and vehicle operators
53-6041	Traffic technicians
53-7011	Conveyor operators and tenders
53-7021	Crane and tower operators
53-7031	Dredge operators
53-7032	Excavating and loading machine and dragline operators
53-7033	Loading machine operators, underground mining
53-7041	Hoist and winch operators
53-7051	Industrial truck and tractor operators
53-7071	Gas compressor and gas pumping station operators
53-7072	Pump operators, except wellhead pumpers
53-7073	Wellhead pumpers
53-7081	Refuse and recyclable material collectors
53-7111	Shuttle car operators
53-7199	Material moving workers, all other

Appendix I: Workforce Gaps and Surpluses by State

Gap Analysis for ARC Alabama, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-3051	Industrial production managers	**11**	-2	13	**0**	(11)
11-9021	Construction managers	**188**	126	62	**30**	(158)
11-9041	Engineering managers	**29**	14	15	**185**	156
15-1051	Computer systems analysts	**14**	7	6	**352**	339
17-1011	Architects, except landscape and naval	**46**	27	18	**192**	146
17-1022	Surveyors	**28**	14	14	**0**	(28)
17-2051	Civil engineers	**77**	47	30	**0**	(77)
17-2071	Electrical engineers	**42**	16	26	**89**	48
17-2072	Electronics engineers, except computer	**12**	4	7	**90**	78
17-2081	Environmental engineers	**11**	7	5	**43**	32
17-2112	Industrial engineers	**15**	3	12	**2**	(14)
17-2141	Mechanical engineers	**47**	21	26	**22**	(25)
17-2199	Engineers, all other	**24**	12	11	**86**	62
17-3011	Architectural and civil drafters	**42**	24	19	**80**	38
17-3012	Electrical and electronics drafters	**15**	6	9	**151**	136
17-3013	Mechanical drafters	**21**	10	11	**0**	(21)
17-3022	Civil engineering technicians	**21**	13	8	**0**	(21)
17-3023	Electrical and electronic engineering technicians	**15**	4	10	**19**	4
17-3027	Mechanical engineering technicians	**11**	5	6	**50**	39
17-3031	Surveying and mapping technicians	**32**	18	14	**6**	(26)
43-5041	Meter readers, utilities	**10**	-6	16	**3**	(7)
47-1011	First-line supervisors/managers of construction trades and extraction workers	**257**	141	116	**0**	(257)
47-2021	Brickmasons and blockmasons	**18**	9	9	**119**	101
47-2022	Stonemasons	**15**	8	7	**2**	(13)
47-2031	Carpenters	**331**	205	126	**1**	(330)
47-2041	Carpet installers	**12**	6	6	**36**	25
47-2042	Floor layers, except carpet, wood, and hard tiles	**11**	6	5	**0**	(11)
47-2043	Floor sanders and finishers	**12**	6	5	**0**	(12)
47-2044	Tile and marble setters	**17**	8	8	**0**	(17)
47-2051	Cement masons and concrete finishers	**15**	8	7	**2**	(14)
47-2061	Construction laborers	**210**	146	64	**0**	(210)
47-2072	Pile-driver operators	**10**	6	4	**0**	(10)
47-2073	Operating engineers and other construction equipment operators	**50**	16	34	**0**	(50)

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
47-2081	Drywall and ceiling tile installers	**49**	28	21	**3**	(46)
47-2082	Tapers	**19**	11	7	**0**	(19)
47-2111	Electricians	**302**	109	193	**0**	(302)
47-2121	Glaziers	**15**	7	8	**32**	17
47-2131	Insulation workers, floor, ceiling, and wall	**19**	8	11	**0**	(19)
47-2132	Insulation workers, mechanical	**16**	5	12	**0**	(16)
47-2141	Painters, construction and maintenance	**110**	63	46	**0**	(110)
47-2151	Pipelayers	**29**	17	12	**0**	(29)
47-2152	Plumbers, pipefitters, and steamfitters	**237**	144	94	**2**	(236)
47-2161	Plasterers and stucco masons	**12**	6	6	**4**	(8)
47-2181	Roofers	**26**	14	12	**0**	(26)
47-2211	Sheet metal workers	**92**	49	42	**0**	(92)
47-3012	Helpers, carpenters	**17**	9	8	**0**	(17)
47-3013	Helpers, electricians	**68**	26	43	**3**	(65)
47-3015	Helpers, pipelayers, plumbers, pipefitters, and steamfitters	**52**	32	20	**8**	(44)
47-4011	Construction and building inspectors	**24**	15	9	**1**	(23)
47-4021	Elevator installers and repairers	**6**	-5	12	**0**	(6)
49-1011	First-line supervisors/managers of mechanics, installers, and repairers	**30**	5	26	**1**	(29)
49-2095	Electrical and electronics repairers, powerhouse, substation, and relay	**7**	-6	12	**0**	(7)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**156**	103	54	**0**	(156)
49-9041	Industrial machinery mechanics	**6**	-10	16	**111**	105
49-9042	Maintenance and repair workers, general	**20**	-2	22	**28**	8
49-9051	Electrical power-line installers and repairers	**37**	-20	56	**0**	(37)
49-9098	Helpers--Installation, maintenance, and repair workers	**30**	10	20	**0**	(30)
51-1011	First-line supervisors/managers of production and operating workers	**29**	-9	38	**15**	(14)
51-2022	Electrical and electronic equipment assemblers	**5**	-5	10	**0**	(5)
51-2041	Structural metal fabricators and fitters	**28**	9	19	**81**	53
51-2092	Team assemblers	**44**	-9	53	**3**	(41)
51-4011	Computer-controlled machine tool operators, metal and plastic	**10**	-2	12	**0**	(10)
51-4021	Extruding and drawing machine setters, operators, and tenders, metal and plastic	**12**	2	10	**3**	(9)
51-4031	Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	**28**	4	24	**0**	(28)
51-4033	Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic	**11**	-1	12	**0**	(11)
51-4041	Machinists	**27**	-9	36	**2**	(25)
51-4072	Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	**18**	1	17	**9**	(10)
51-4081	Multiple machine tool setters, operators, and tenders, metal and plastic	**10**	-1	11	**0**	(10)

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
51-4121	Welders, cutters, solderers, and brazers	**53**	6	47	**3**	(50)
51-8013	Power plant operators	**21**	-7	28	**104**	83
51-8091	Chemical plant and system operators	**8**	-2	10	**0**	(8)
51-8092	Gas plant operators	**5**	-5	10	**0**	(4)
51-9061	Inspectors, testers, sorters, samplers, and weighers	**21**	-1	22	**0**	(21)
51-9198	Helpers--Production workers	**14**	-5	19	**0**	(14)
53-7032	Excavating and loading machine and dragline operators	**14**	3	11	**0**	(14)
53-7051	Industrial truck and tractor operators	**38**	9	29	**1**	(37)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC Georgia, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-9021	Construction managers	**200**	138	62	**0**	(200)
11-9041	Engineering managers	**16**	9	7	**110**	94
17-1011	Architects, except landscape and naval	**22**	15	7	**0**	(22)
17-1022	Surveyors	**13**	8	5	**0**	(13)
17-2051	Civil engineers	**39**	27	12	**0**	(39)
17-2071	Electrical engineers	**21**	9	12	**0**	(21)
17-2112	Industrial engineers	**11**	4	7	**0**	(11)
17-2141	Mechanical engineers	**27**	15	12	**0**	(27)
17-2199	Engineers, all other	**12**	7	5	**0**	(12)
17-3011	Architectural and civil drafters	**21**	14	7	**0**	(21)
17-3012	Electrical and electronics drafters	**11**	6	5	**147**	136
17-3013	Mechanical drafters	**14**	8	6	**0**	(14)
17-3022	Civil engineering technicians	**10**	7	3	**0**	(10)
17-3031	Surveying and mapping technicians	**16**	10	5	**4**	(12)
47-1011	First-line supervisors/managers of construction trades and extraction workers	**277**	168	109	**0**	(277)
47-2021	Brickmasons and blockmasons	**18**	9	9	**113**	95
47-2022	Stonemasons	**16**	8	8	**0**	(16)
47-2031	Carpenters	**350**	218	132	**0**	(350)
47-2041	Carpet installers	**12**	6	6	**44**	32
47-2042	Floor layers, except carpet, wood, and hard tiles	**11**	6	5	**0**	(11)
47-2043	Floor sanders and finishers	**12**	7	6	**0**	(12)
47-2044	Tile and marble setters	**16**	8	8	**0**	(16)
47-2051	Cement masons and concrete finishers	**15**	8	7	**0**	(15)
47-2061	Construction laborers	**222**	158	64	**0**	(222)
47-2072	Pile-driver operators	**10**	6	4	**0**	(10)
47-2073	Operating engineers and other construction equipment operators	**43**	25	17	**0**	(43)
47-2081	Drywall and ceiling tile installers	**40**	22	19	**0**	(40)
47-2082	Tapers	**18**	10	7	**0**	(18)
47-2111	Electricians	**387**	200	187	**0**	(387)
47-2121	Glaziers	**11**	3	8	**16**	5
47-2131	Insulation workers, floor, ceiling, and wall	**16**	6	10	**0**	(16)
47-2132	Insulation workers, mechanical	**15**	6	10	**0**	(15)
47-2141	Painters, construction and maintenance	**115**	67	47	**0**	(115)
47-2151	Pipelayers	**31**	19	12	**0**	(31)
47-2152	Plumbers, pipefitters, and steamfitters	**296**	204	92	**0**	(296)
47-2161	Plasterers and stucco masons	**10**	5	5	**1**	(9)
47-2181	Roofers	**29**	16	13	**0**	(29)

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
47-2211	Sheet metal workers	**110**	70	39	**0**	(110)
47-3012	Helpers, carpenters	**19**	10	9	**0**	(19)
47-3013	Helpers, electricians	**93**	48	44	**2**	(91)
47-3015	Helpers, pipelayers, plumbers, pipefitters, and steamfitters	**65**	45	20	**4**	(62)
47-4011	Construction and building inspectors	**13**	9	4	**0**	(13)
49-1011	First-line supervisors/managers of mechanics, installers, and repairers	**33**	17	16	**2**	(31)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**199**	145	53	**32**	(167)
49-9042	Maintenance and repair workers, general	**27**	15	12	**207**	180
49-9051	Electrical power-line installers and repairers	**38**	3	35	**0**	(38)
49-9098	Helpers--Installation, maintenance, and repair workers	**31**	15	16	**5**	(26)
51-1011	First-line supervisors/managers of production and operating workers	**30**	10	20	**10**	(20)
51-2022	Electrical and electronic equipment assemblers	**18**	2	16	**39**	21
51-2041	Structural metal fabricators and fitters	**27**	14	12	**0**	(26)
51-2092	Team assemblers	**62**	22	41	**28**	(34)
51-4011	Computer-controlled machine tool operators, metal and plastic	**11**	4	7	**0**	(11)
51-4021	Extruding and drawing machine setters, operators, and tenders, metal and plastic	**13**	4	10	**11**	(2)
51-4031	Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	**23**	8	15	**0**	(23)
51-4041	Machinists	**28**	10	19	**0**	(28)
51-4072	Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	**13**	5	8	**47**	34
51-4121	Welders, cutters, solderers, and brazers	**51**	22	29	**0**	(51)
51-8013	Power plant operators	**13**	0	14	**169**	156
51-9061	Inspectors, testers, sorters, samplers, and weighers	**20**	8	12	**0**	(20)
51-9198	Helpers--Production workers	**16**	7	9	**0**	(16)
53-7032	Excavating and loading machine and dragline operators	**10**	5	5	**0**	(10)
53-7051	Industrial truck and tractor operators	**27**	6	21	**0**	(27)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC Kentucky, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-9021	Construction managers	**54**	40	15	**0**	(54)
47-1011	First-line supervisors/managers of construction trades and extraction workers	**113**	57	56	**77**	(36)
47-2031	Carpenters	**92**	60	33	**249**	156
47-2061	Construction laborers	**65**	47	18	**62**	(3)
47-2073	Operating engineers and other construction equipment operators	**77**	19	59	**0**	(77)
47-2081	Drywall and ceiling tile installers	**16**	11	5	**9**	(7)
47-2111	Electricians	**114**	52	62	**0**	(114)
47-2141	Painters, construction and maintenance	**32**	21	11	**147**	115
47-2152	Plumbers, pipefitters, and steamfitters	**55**	37	18	**0**	(55)
47-2211	Sheet metal workers	**20**	13	7	**0**	(20)
47-3013	Helpers, electricians	**20**	12	8	**0**	(20)
47-3015	Helpers, pipelayers, plumbers, pipefitters, and steamfitters	**12**	8	4	**6**	(6)
47-5013	Service unit operators, oil, gas, and mining	**10**	4	6	**0**	(10)
47-5041	Continuous mining machine operators	**32**	4	28	**1**	(31)
47-5042	Mine cutting and channeling machine operators	**26**	4	22	**3**	(23)
47-5061	Roof bolters, mining	**28**	5	22	**1**	(26)
47-5071	Roustabouts, oil and gas	**10**	4	6	**0**	(10)
47-5081	Helpers, extraction workers	**29**	6	23	**0**	(29)
49-1011	First-line supervisors/managers of mechanics, installers, and repairers	**14**	2	11	**0**	(14)
49-3042	Mobile heavy equipment mechanics, except engines	**16**	3	13	**0**	(16)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**38**	27	11	**0**	(38)
49-9041	Industrial machinery mechanics	**13**	-1	14	**99**	87
49-9042	Maintenance and repair workers, general	**15**	1	14	**66**	51
49-9051	Electrical power-line installers and repairers	**11**	-3	14	**0**	(11)
51-1011	First-line supervisors/managers of production and operating workers	**8**	-4	12	**0**	(8)
51-2092	Team assemblers	**9**	-3	12	**0**	(9)
51-4121	Welders, cutters, solderers, and brazers	**21**	6	15	**0**	(21)
53-7032	Excavating and loading machine and dragline operators	**28**	5	23	**191**	163
53-7071	Gas compressor and gas pumping station operators	**12**	5	8	**1**	(11)
53-7072	Pump operators, except wellhead pumpers	**14**	6	8	**0**	(14)
53-7073	Wellhead pumpers	**20**	8	11	**0**	(20)
53-7111	Shuttle car operators	**24**	2	22	**0**	(24)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC Maryland, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-9021	Construction managers	**15**	10	5	**0**	(15)
47-1011	First-line supervisors/managers of construction trades and extraction workers	**27**	16	11	**27**	(0)
47-2031	Carpenters	**26**	15	11	**0**	(26)
47-2061	Construction laborers	**16**	11	5	**0**	(16)
47-2111	Electricians	**49**	27	22	**0**	(48)
47-2152	Plumbers, pipefitters, and steamfitters	**19**	12	7	**0**	(19)
47-3013	Helpers, electricians	**13**	7	5	**0**	(13)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**13**	9	4	**0**	(13)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC Mississippi, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-9021	Construction managers	**24**	14	11	**0**	(24)
47-1011	First-line supervisors/managers of construction trades and extraction workers	**38**	18	20	**82**	44
47-2031	Carpenters	**45**	22	23	**32**	(13)
47-2061	Construction laborers	**27**	16	11	**0**	(27)
47-2111	Electricians	**52**	22	30	**0**	(52)
47-2141	Painters, construction and maintenance	**15**	7	8	**15**	1
47-2152	Plumbers, pipefitters, and steamfitters	**40**	25	16	**0**	(40)
47-2211	Sheet metal workers	**15**	8	7	**0**	(15)
47-3013	Helpers, electricians	**12**	6	7	**0**	(12)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**27**	17	9	**2**	(25)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC New York, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-9021	Construction managers	**44**	28	15	**0**	(44)
17-2141	Mechanical engineers	**10**	1	9	**0**	(10)
47-1011	First-line supervisors/managers of construction trades and extraction workers	**79**	45	34	**81**	2
47-2031	Carpenters	**85**	51	34	**39**	(46)
47-2061	Construction laborers	**53**	36	17	**123**	69
47-2073	Operating engineers and other construction equipment operators	**12**	7	6	**16**	4
47-2111	Electricians	**53**	12	41	**33**	(20)
47-2141	Painters, construction and maintenance	**26**	15	12	**0**	(26)
47-2152	Plumbers, pipefitters, and steamfitters	**45**	25	21	**10**	(35)
47-2211	Sheet metal workers	**18**	8	10	**0**	(18)
47-3013	Helpers, electricians	**11**	2	9	**29**	18
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**28**	15	13	**0**	(28)
49-9051	Electrical power-line installers and repairers	**7**	-11	19	**0**	(7)
51-1011	First-line supervisors/managers of production and operating workers	**9**	-4	13	**8**	(1)
51-2022	Electrical and electronic equipment assemblers	**12**	-1	14	**4**	(8)
51-2092	Team assemblers	**17**	-9	26	**0**	(17)
51-4041	Machinists	**9**	-5	15	**6**	(4)
51-4121	Welders, cutters, solderers, and brazers	**15**	-1	16	**0**	(15)
53-7071	Gas compressor and gas pumping station operators	**13**	8	5	**11**	(2)
53-7072	Pump operators, except wellhead pumpers	**15**	9	6	**0**	(15)
53-7073	Wellhead pumpers	**21**	13	8	**0**	(21)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC North Carolina, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-9021	Construction managers	**158**	114	43	**0**	(158)
17-2051	Civil engineers	**11**	7	4	**169**	159
47-1011	First-line supervisors/managers of construction trades and extraction workers	**213**	137	77	**4**	(209)
47-2021	Brickmasons and blockmasons	**15**	8	7	**179**	164
47-2022	Stonemasons	**13**	7	6	**7**	(6)
47-2031	Carpenters	**312**	212	100	**4**	(308)
47-2044	Tile and marble setters	**13**	7	6	**13**	0
47-2051	Cement masons and concrete finishers	**12**	7	5	**4**	(9)
47-2061	Construction laborers	**188**	142	47	**0**	(188)
47-2073	Operating engineers and other construction equipment operators	**32**	21	11	**0**	(32)
47-2081	Drywall and ceiling tile installers	**30**	18	12	**0**	(30)
47-2082	Tapers	**13**	8	5	**0**	(13)
47-2111	Electricians	**233**	123	110	**0**	(233)
47-2131	Insulation workers, floor, ceiling, and wall	**10**	4	6	**25**	15
47-2141	Painters, construction and maintenance	**92**	58	33	**0**	(92)
47-2151	Pipelayers	**22**	14	8	**0**	(22)
47-2152	Plumbers, pipefitters, and steamfitters	**149**	97	52	**1**	(148)
47-2181	Roofers	**22**	13	9	**9**	(13)
47-2211	Sheet metal workers	**53**	30	22	**0**	(53)
47-3012	Helpers, carpenters	**21**	13	8	**0**	(21)
47-3013	Helpers, electricians	**54**	29	25	**1**	(53)
47-3015	Helpers, pipelayers, plumbers, pipefitters, and steamfitters	**32**	21	11	**9**	(23)
49-1011	First-line supervisors/managers of mechanics, installers, and repairers	**15**	6	9	**1**	(14)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**100**	69	32	**2**	(98)
49-9042	Maintenance and repair workers, general	**13**	4	9	**102**	89
49-9051	Electrical power-line installers and repairers	**9**	-2	11	**0**	(9)
49-9098	Helpers--Installation, maintenance, and repair workers	**15**	7	9	**0**	(15)
51-1011	First-line supervisors/managers of production and operating workers	**11**	-3	14	**0**	(11)
51-2022	Electrical and electronic equipment assemblers	**8**	-13	21	**3**	(5)
51-2092	Team assemblers	**24**	-17	42	**0**	(24)
51-4031	Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	**8**	-2	10	**0**	(8)
51-4041	Machinists	**17**	3	14	**0**	(17)
51-4121	Welders, cutters, solderers, and brazers	**24**	6	18	**36**	12
51-9061	Inspectors, testers, sorters, samplers, and weighers	**8**	-2	10	**94**	86
53-7051	Industrial truck and tractor operators	**15**	0	15	**0**	(15)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC Ohio, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-3051	Industrial production managers	**10**	3	7	**0**	(10)
11-9021	Construction managers	**-6**	-43	37	**22**	28
17-2071	Electrical engineers	**11**	2	9	**112**	101
43-5041	Meter readers, utilities	**13**	4	10	**33**	20
47-1011	First-line supervisors/managers of construction trades and extraction workers	**30**	-56	85	**0**	(30)
47-2031	Carpenters	**13**	-66	78	**2**	(10)
47-2061	Construction laborers	**-11**	-52	41	**0**	11
47-2073	Operating engineers and other construction equipment operators	**12**	-10	22	**0**	(12)
47-2081	Drywall and ceiling tile installers	**-1**	-12	11	**0**	1
47-2111	Electricians	**61**	-41	102	**0**	(61)
47-2141	Painters, construction and maintenance	**6**	-23	29	**2**	(5)
47-2152	Plumbers, pipefitters, and steamfitters	**15**	-38	53	**0**	(15)
47-2211	Sheet metal workers	**10**	-13	22	**0**	(10)
47-3013	Helpers, electricians	**11**	-10	22	**0**	(11)
47-3015	Helpers, pipelayers, plumbers, pipefitters, and steamfitters	**3**	-8	11	**0**	(3)
49-1011	First-line supervisors/managers of mechanics, installers, and repairers	**17**	3	14	**0**	(17)
49-2095	Electrical and electronics repairers, powerhouse, substation, and relay	**16**	8	8	**0**	(16)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**2**	-28	31	**0**	(2)
49-9041	Industrial machinery mechanics	**18**	9	9	**26**	8
49-9042	Maintenance and repair workers, general	**20**	7	13	**2**	(18)
49-9051	Electrical power-line installers and repairers	**45**	12	33	**0**	(45)
49-9098	Helpers--Installation, maintenance, and repair workers	**10**	-2	11	**0**	(10)
51-1011	First-line supervisors/managers of production and operating workers	**33**	13	19	**0**	(33)
51-2092	Team assemblers	**28**	4	24	**0**	(28)
51-4021	Extruding and drawing machine setters, operators, and tenders, metal and plastic	**21**	13	8	**0**	(21)
51-4031	Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	**17**	5	11	**1**	(16)
51-4041	Machinists	**21**	6	15	**2**	(19)
51-4072	Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	**13**	4	9	**1**	(12)
51-4121	Welders, cutters, solderers, and brazers	**24**	2	22	**0**	(24)
51-8013	Power plant operators	**24**	8	17	**35**	10
51-9061	Inspectors, testers, sorters, samplers, and weighers	**18**	7	11	**0**	(18)
51-9198	Helpers--Production workers	**17**	8	9	**0**	(17)

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
53-7051	Industrial truck and tractor operators	**20**	4	16	**0**	(20)
53-7071	Gas compressor and gas pumping station operators	**7**	-5	12	**0**	(7)
53-7072	Pump operators, except wellhead pumpers	**8**	-6	14	**0**	(8)
53-7073	Wellhead pumpers	**11**	-8	19	**0**	(11)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC Pennsylvania, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-3051	Industrial production managers	**26**	-2	28	**0**	(26)
11-9021	Construction managers	**168**	62	106	**0**	(168)
11-9041	Engineering managers	**23**	2	21	**83**	60
15-1021	Computer programmers	**10**	3	8	**396**	386
15-1041	Computer support specialists	**13**	3	10	**1281**	1268
15-1051	Computer systems analysts	**14**	4	10	**188**	174
17-1011	Architects, except landscape and naval	**21**	2	19	**22**	1
17-1022	Surveyors	**16**	1	15	**118**	102
17-2051	Civil engineers	**37**	5	33	**26**	(11)
17-2071	Electrical engineers	**30**	-4	34	**11**	(19)
17-2072	Electronics engineers, except computer	**12**	-1	12	**265**	253
17-2112	Industrial engineers	**27**	1	26	**147**	121
17-2141	Mechanical engineers	**42**	3	39	**160**	118
17-2151	Mining and geological engineers, including mining safety engineers	**18**	10	9	**183**	165
17-2171	Petroleum engineers	**17**	10	7	**163**	146
17-2199	Engineers, all other	**22**	5	17	**3**	(19)
17-3011	Architectural and civil drafters	**21**	2	19	**5**	(16)
17-3012	Electrical and electronics drafters	**11**	-1	12	**115**	103
17-3013	Mechanical drafters	**19**	3	16	**78**	59
17-3022	Civil engineering technicians	**11**	2	10	**0**	(11)
17-3023	Electrical and electronic engineering technicians	**16**	-2	18	**16**	0
17-3027	Mechanical engineering technicians	**11**	1	9	**77**	66
17-3031	Surveying and mapping technicians	**17**	1	16	**194**	177
19-2031	Chemists	**11**	1	10	**140**	129
19-2041	Environmental scientists and specialists, including health	**22**	10	12	**8**	(14)
19-2042	Geoscientists, except hydrologists and geographers	**23**	12	12	**252**	229
19-2043	Hydrologists	**15**	7	7	**29**	14
19-4031	Chemical technicians	**16**	0	16	**126**	110
43-5041	Meter readers, utilities	**16**	-10	27	**51**	34
47-1011	First-line supervisors/managers of construction trades and extraction workers	**339**	110	230	**27**	(312)
47-2021	Brickmasons and blockmasons	**21**	5	16	**0**	(21)
47-2022	Stonemasons	**17**	4	13	**236**	219
47-2031	Carpenters	**316**	92	224	**3**	(313)
47-2041	Carpet installers	**13**	4	10	**1**	(13)
47-2042	Floor layers, except carpet, wood, and hard tiles	**13**	3	9	**111**	98
47-2043	Floor sanders and finishers	**13**	3	10	**0**	(13)

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
47-2044	Tile and marble setters	**19**	4	15	**0**	(19)
47-2051	Cement masons and concrete finishers	**20**	6	14	**0**	(20)
47-2061	Construction laborers	**194**	79	115	**1**	(194)
47-2072	Pile-driver operators	**11**	3	8	**0**	(11)
47-2073	Operating engineers and other construction equipment operators	**89**	23	66	**1**	(89)
47-2081	Drywall and ceiling tile installers	**51**	19	32	**0**	(51)
47-2082	Tapers	**19**	7	12	**0**	(19)
47-2111	Electricians	**239**	-62	301	**0**	(239)
47-2121	Glaziers	**20**	5	15	**0**	(20)
47-2131	Insulation workers, floor, ceiling, and wall	**22**	5	17	**62**	40
47-2132	Insulation workers, mechanical	**22**	4	18	**0**	(22)
47-2141	Painters, construction and maintenance	**114**	33	81	**0**	(114)
47-2151	Pipelayers	**31**	10	21	**0**	(31)
47-2152	Plumbers, pipefitters, and steamfitters	**268**	107	161	**0**	(268)
47-2161	Plasterers and stucco masons	**13**	4	9	**3**	(10)
47-2181	Roofers	**29**	7	22	**12**	(17)
47-2211	Sheet metal workers	**107**	38	69	**0**	(107)
47-2221	Structural iron and steel workers	**11**	3	8	**0**	(11)
47-3012	Helpers, carpenters	**16**	1	15	**10**	(6)
47-3013	Helpers, electricians	**45**	-20	65	**0**	(45)
47-3015	Helpers, pipelayers, plumbers, pipefitters, and steamfitters	**59**	24	34	**6**	(53)
47-4011	Construction and building inspectors	**14**	3	12	**5**	(9)
47-4021	Elevator installers and repairers	**15**	-3	18	**2**	(13)
47-5011	Derrick operators, oil and gas	**17**	9	8	**2**	(15)
47-5012	Rotary drill operators, oil and gas	**37**	19	18	**1**	(36)
47-5013	Service unit operators, oil, gas, and mining	**35**	19	17	**0**	(35)
47-5021	Earth drillers, except oil and gas	**12**	4	8	**0**	(12)
47-5041	Continuous mining machine operators	**16**	1	15	**8**	(7)
47-5042	Mine cutting and channeling machine operators	**13**	1	12	**0**	(13)
47-5051	Rock splitters, quarry	**12**	7	5	**0**	(12)
47-5061	Roof bolters, mining	**24**	8	16	**0**	(24)
47-5071	Roustabouts, oil and gas	**41**	22	19	**0**	(41)
47-5081	Helpers, extraction workers	**38**	15	23	**0**	(38)
47-5099	Extraction workers, all other	**16**	9	8	**0**	(16)
49-1011	First-line supervisors/managers of mechanics, installers, and repairers	**39**	-2	41	**0**	(39)
49-2095	Electrical and electronics repairers, powerhouse, substation, and relay	**6**	-9	15	**0**	(6)
49-3042	Mobile heavy equipment mechanics, except engines	**16**	4	12	**0**	(16)

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
49-9012	Control and valve installers and repairers, except mechanical door	**8**	-9	17	**0**	(8)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**166**	73	93	**31**	(135)
49-9041	Industrial machinery mechanics	**26**	-5	30	**0**	(26)
49-9042	Maintenance and repair workers, general	**40**	-3	43	**95**	55
49-9044	Millwrights	**12**	-1	13	**5**	(7)
49-9051	Electrical power-line installers and repairers	**45**	-28	73	**1**	(44)
49-9098	Helpers--Installation, maintenance, and repair workers	**40**	6	34	**1**	(39)
51-1011	First-line supervisors/managers of production and operating workers	**67**	-7	74	**5**	(62)
51-2022	Electrical and electronic equipment assemblers	**31**	-17	48	**2**	(29)
51-2023	Electromechanical equipment assemblers	**7**	-4	11	**1**	(7)
51-2041	Structural metal fabricators and fitters	**41**	9	31	**2**	(39)
51-2092	Team assemblers	**99**	-26	125	**5**	(94)
51-2099	Assemblers and fabricators, all other	**14**	0	14	**2**	(12)
51-4011	Computer-controlled machine tool operators, metal and plastic	**46**	12	33	**0**	(46)
51-4012	Numerical tool and process control programmers	**12**	3	9	**0**	(12)
51-4021	Extruding and drawing machine setters, operators, and tenders, metal and plastic	**15**	-16	31	**2**	(13)
51-4023	Rolling machine setters, operators, and tenders, metal and plastic	**10**	-1	11	**2**	(9)
51-4031	Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	**46**	-2	48	**1**	(46)
51-4032	Drilling and boring machine tool setters, operators, and tenders, metal and plastic	**11**	1	10	**7**	(4)
51-4033	Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic	**23**	3	19	**29**	6
51-4034	Lathe and turning machine tool setters, operators, and tenders, metal and plastic	**23**	3	19	**0**	(23)
51-4035	Milling and planing machine setters, operators, and tenders, metal and plastic	**12**	3	9	**2**	(10)
51-4041	Machinists	**140**	52	88	**0**	(139)
51-4072	Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	**24**	-12	37	**0**	(24)
51-4081	Multiple machine tool setters, operators, and tenders, metal and plastic	**21**	-1	22	**8**	(13)
51-4121	Welders, cutters, solderers, and brazers	**120**	24	96	**0**	(120)
51-4122	Welding, soldering, and brazing machine setters, operators, and tenders	**18**	2	16	**2**	(16)
51-8011	Nuclear power reactor operators	**8**	-3	11	**50**	42
51-8013	Power plant operators	**19**	-13	32	**6**	(14)
51-8091	Chemical plant and system operators	**0**	-13	12	**0**	0
51-8092	Gas plant operators	**23**	-3	26	**0**	(23)
51-8093	Petroleum pump system operators, refinery operators, and gaugers	**17**	1	16	**0**	(17)

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
51-9061	Inspectors, testers, sorters, samplers, and weighers	**52**	1	51	**0**	(52)
51-9198	Helpers--Production workers	**35**	-1	36	**0**	(35)
51-9199	Production workers, all other	**10**	-2	12	**9**	(1)
53-1031	First-line supervisors/managers of transportation and material-moving machine and vehicle operators	**12**	2	9	**0**	(12)
53-7021	Crane and tower operators	**11**	2	9	**0**	(11)
53-7032	Excavating and loading machine and dragline operators	**26**	5	21	**0**	(26)
53-7051	Industrial truck and tractor operators	**57**	4	53	**0**	(57)
53-7071	Gas compressor and gas pumping station operators	**52**	24	27	**0**	(52)
53-7072	Pump operators, except wellhead pumpers	**53**	26	27	**0**	(53)
53-7073	Wellhead pumpers	**75**	38	37	**0**	(75)
53-7111	Shuttle car operators	**12**	0	11	**0**	(12)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC South Carolina, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-9021	Construction managers	**59**	34	25	**0**	(59)
17-1011	Architects, except landscape and naval	**13**	8	5	**99**	86
17-2051	Civil engineers	**23**	14	9	**45**	22
17-2071	Electrical engineers	**15**	5	10	**96**	81
17-2141	Mechanical engineers	**19**	8	11	**56**	37
17-3011	Architectural and civil drafters	**13**	7	6	**73**	60
47-1011	First-line supervisors/managers of construction trades and extraction workers	**84**	39	45	**4**	(80)
47-2031	Carpenters	**111**	59	52	**10**	(101)
47-2061	Construction laborers	**69**	43	26	**7**	(63)
47-2073	Operating engineers and other construction equipment operators	**16**	9	7	**0**	(16)
47-2081	Drywall and ceiling tile installers	**12**	5	7	**0**	(12)
47-2111	Electricians	**84**	-4	88	**0**	(84)
47-2141	Painters, construction and maintenance	**36**	17	19	**1**	(34)
47-2152	Plumbers, pipefitters, and steamfitters	**91**	51	40	**0**	(91)
47-2211	Sheet metal workers	**35**	18	17	**0**	(35)
47-3013	Helpers, electricians	**18**	-3	21	**0**	(18)
47-3015	Helpers, pipelayers, plumbers, pipefitters, and steamfitters	**20**	11	9	**0**	(20)
49-1011	First-line supervisors/managers of mechanics, installers, and repairers	**13**	3	10	**0**	(13)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**57**	35	23	**3**	(55)
49-9042	Maintenance and repair workers, general	**12**	4	8	**103**	91
49-9051	Electrical power-line installers and repairers	**20**	3	17	**0**	(20)
49-9098	Helpers--Installation, maintenance, and repair workers	**12**	3	9	**0**	(12)
51-1011	First-line supervisors/managers of production and operating workers	**18**	3	15	**4**	(14)
51-2022	Electrical and electronic equipment assemblers	**19**	6	14	**4**	(15)
51-2041	Structural metal fabricators and fitters	**12**	6	6	**39**	26
51-2092	Team assemblers	**46**	8	38	**0**	(46)
51-4031	Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	**12**	2	9	**0**	(12)
51-4041	Machinists	**17**	0	17	**9**	(8)
51-4121	Welders, cutters, solderers, and brazers	**23**	6	16	**10**	(13)
51-8013	Power plant operators	**10**	1	9	**65**	54
51-9061	Inspectors, testers, sorters, samplers, and weighers	**12**	2	10	**0**	(12)
53-7051	Industrial truck and tractor operators	**17**	6	11	**5**	(12)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC Tennessee, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-3051	Industrial production managers	**11**	2	9	**0**	(11)
11-9021	Construction managers	**222**	148	75	**21**	(201)
11-9041	Engineering managers	**14**	6	9	**168**	153
17-1011	Architects, except landscape and naval	**21**	11	10	**417**	396
17-1022	Surveyors	**13**	6	7	**29**	17
17-2051	Civil engineers	**37**	21	16	**6**	(31)
17-2071	Electrical engineers	**18**	6	13	**96**	78
17-2112	Industrial engineers	**13**	3	10	**56**	43
17-2141	Mechanical engineers	**26**	9	17	**34**	8
17-2199	Engineers, all other	**11**	4	7	**51**	40
17-3011	Architectural and civil drafters	**20**	10	10	**39**	19
17-3012	Electrical and electronics drafters	**11**	5	6	**63**	52
17-3013	Mechanical drafters	**13**	6	7	**0**	(13)
17-3031	Surveying and mapping technicians	**14**	7	7	**14**	0
47-1011	First-line supervisors/managers of construction trades and extraction workers	**306**	174	132	**18**	(289)
47-2021	Brickmasons and blockmasons	**21**	10	11	**48**	26
47-2022	Stonemasons	**19**	9	9	**1**	(17)
47-2031	Carpenters	**428**	259	169	**1**	(427)
47-2041	Carpet installers	**14**	7	7	**0**	(14)
47-2042	Floor layers, except carpet, wood, and hard tiles	**13**	7	6	**0**	(13)
47-2043	Floor sanders and finishers	**15**	8	7	**0**	(15)
47-2044	Tile and marble setters	**19**	9	10	**0**	(19)
47-2051	Cement masons and concrete finishers	**19**	10	9	**1**	(18)
47-2061	Construction laborers	**259**	180	79	**0**	(259)
47-2072	Pile-driver operators	**12**	7	5	**6**	(6)
47-2073	Operating engineers and other construction equipment operators	**51**	31	20	**0**	(51)
47-2081	Drywall and ceiling tile installers	**45**	22	23	**0**	(45)
47-2082	Tapers	**19**	11	9	**0**	(19)
47-2111	Electricians	**351**	173	178	**0**	(351)
47-2121	Glaziers	**13**	4	9	**25**	11
47-2131	Insulation workers, floor, ceiling, and wall	**17**	5	12	**0**	(17)
47-2132	Insulation workers, mechanical	**16**	4	12	**0**	(16)
47-2141	Painters, construction and maintenance	**132**	75	57	**0**	(132)
47-2151	Pipelayers	**32**	19	13	**0**	(32)
47-2152	Plumbers, pipefitters, and steamfitters	**216**	130	85	**0**	(216)
47-2161	Plasterers and stucco masons	**11**	5	6	**0**	(11)

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
47-2181	Roofers	**33**	17	16	**0**	(33)
47-2211	Sheet metal workers	**83**	46	38	**0**	(83)
47-3012	Helpers, carpenters	**26**	14	13	**0**	(26)
47-3013	Helpers, electricians	**81**	40	40	**0**	(81)
47-3015	Helpers, pipelayers, plumbers, pipefitters, and steamfitters	**46**	28	18	**4**	(42)
47-4011	Construction and building inspectors	**13**	7	6	**0**	(13)
47-4021	Elevator installers and repairers	**11**	-2	13	**0**	(11)
49-1011	First-line supervisors/managers of mechanics, installers, and repairers	**24**	10	14	**15**	(9)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**146**	96	50	**0**	(146)
49-9042	Maintenance and repair workers, general	**26**	11	15	**70**	44
49-9051	Electrical power-line installers and repairers	**17**	2	15	**0**	(17)
49-9098	Helpers--Installation, maintenance, and repair workers	**24**	10	15	**0**	(24)
51-1011	First-line supervisors/managers of production and operating workers	**32**	9	23	**27**	(5)
51-2022	Electrical and electronic equipment assemblers	**25**	7	18	**0**	(25)
51-2041	Structural metal fabricators and fitters	**27**	13	14	**17**	(10)
51-2092	Team assemblers	**92**	31	61	**15**	(77)
51-2099	Assemblers and fabricators, all other	**14**	6	8	**0**	(14)
51-4011	Computer-controlled machine tool operators, metal and plastic	**16**	7	9	**0**	(16)
51-4021	Extruding and drawing machine setters, operators, and tenders, metal and plastic	**15**	4	10	**15**	0
51-4031	Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	**28**	9	19	**1**	(27)
51-4041	Machinists	**36**	15	21	**5**	(31)
51-4072	Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	**11**	-1	12	**50**	39
51-4081	Multiple machine tool setters, operators, and tenders, metal and plastic	**11**	3	9	**0**	(11)
51-4121	Welders, cutters, solderers, and brazers	**57**	22	36	**20**	(37)
51-4122	Welding, soldering, and brazing machine setters, operators, and tenders	**12**	5	7	**89**	77
51-9061	Inspectors, testers, sorters, samplers, and weighers	**24**	7	17	**19**	(4)
51-9198	Helpers--Production workers	**16**	3	13	**1**	(15)
53-7032	Excavating and loading machine and dragline operators	**12**	6	6	**0**	(12)
53-7051	Industrial truck and tractor operators	**33**	9	24	**0**	(33)
53-7073	Wellhead pumpers	**12**	7	5	**0**	(12)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC Virginia, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-9021	Construction managers	**44**	31	13	**112**	69
47-1011	First-line supervisors/managers of construction trades and extraction workers	**71**	35	36	**10**	(60)
47-2031	Carpenters	**83**	54	30	**0**	(83)
47-2061	Construction laborers	**54**	39	15	**0**	(54)
47-2073	Operating engineers and other construction equipment operators	**9**	-10	19	**0**	(9)
47-2111	Electricians	**53**	19	34	**5**	(48)
47-2141	Painters, construction and maintenance	**26**	16	10	**0**	(26)
47-2152	Plumbers, pipefitters, and steamfitters	**39**	23	16	**0**	(39)
47-2211	Sheet metal workers	**12**	4	8	**0**	(12)
47-3013	Helpers, electricians	**11**	5	6	**1**	(10)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**25**	15	10	**17**	(8)
51-2022	Electrical and electronic equipment assemblers	**14**	-1	15	**12**	(2)
51-2092	Team assemblers	**-4**	-28	24	**0**	4
51-4121	Welders, cutters, solderers, and brazers	**3**	-13	15	**16**	13
53-7072	Pump operators, except wellhead pumpers	**10**	5	6	**0**	(10)
53-7073	Wellhead pumpers	**14**	7	8	**0**	(14)

Note: Numbers may not add or subtract exactly due to rounding.

Gap Analysis for ARC West Virginia, 2009 - 2013

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
11-3051	Industrial production managers	**7**	-6	12	**29**	22
11-9021	Construction managers	**57**	26	31	**86**	29
17-2051	Civil engineers	**15**	8	7	**73**	58
17-2071	Electrical engineers	**10**	0	10	**49**	39
17-2141	Mechanical engineers	**10**	2	8	**47**	37
17-2151	Mining and geological engineers, including mining safety engineers	**15**	6	9	**5**	(10)
17-2171	Petroleum engineers	**11**	5	6	**13**	2
19-2041	Environmental scientists and specialists, including health	**11**	4	6	**22**	11
19-2042	Geoscientists, except hydrologists and geographers	**14**	6	8	**22**	8
43-5041	Meter readers, utilities	**7**	-6	12	**0**	(7)
47-1011	First-line supervisors/managers of construction trades and extraction workers	**165**	57	109	**25**	(140)
47-2031	Carpenters	**107**	38	69	**0**	(107)
47-2061	Construction laborers	**64**	28	36	**0**	(64)
47-2073	Operating engineers and other construction equipment operators	**89**	11	77	**0**	(89)
47-2081	Drywall and ceiling tile installers	**14**	5	9	**0**	(14)
47-2111	Electricians	**177**	58	119	**7**	(170)
47-2141	Painters, construction and maintenance	**35**	12	23	**0**	(35)
47-2152	Plumbers, pipefitters, and steamfitters	**87**	37	50	**1**	(86)
47-2211	Sheet metal workers	**33**	13	20	**0**	(33)
47-3013	Helpers, electricians	**34**	15	19	**0**	(34)
47-3015	Helpers, pipelayers, plumbers, pipefitters, and steamfitters	**19**	8	10	**0**	(19)
47-5011	Derrick operators, oil and gas	**12**	4	7	**0**	(12)
47-5012	Rotary drill operators, oil and gas	**24**	8	16	**0**	(24)
47-5013	Service unit operators, oil, gas, and mining	**23**	9	15	**2**	(21)
47-5021	Earth drillers, except oil and gas	**11**	3	8	**0**	(11)
47-5041	Continuous mining machine operators	**39**	4	35	**0**	(39)
47-5042	Mine cutting and channeling machine operators	**32**	5	28	**0**	(32)
47-5061	Roof bolters, mining	**38**	8	30	**0**	(38)
47-5071	Roustabouts, oil and gas	**25**	9	16	**3**	(22)
47-5081	Helpers, extraction workers	**45**	10	35	**0**	(45)
47-5099	Extraction workers, all other	**15**	5	9	**0**	(15)
49-1011	First-line supervisors/managers of mechanics, installers, and repairers	**19**	-4	23	**3**	(16)
49-3042	Mobile heavy equipment mechanics, except engines	**20**	3	17	**8**	(12)
49-9021	Heating, air conditioning, and refrigeration mechanics and installers	**55**	28	27	**33**	(22)
49-9041	Industrial machinery mechanics	**11**	-13	23	**10**	(0)

SOC	Description	Annual Openings	Annual New	Annual Replacement	Average Annual Completers	Gap or Surplus
49-9042	Maintenance and repair workers, general	**12**	-12	24	**0**	(12)
49-9051	Electrical power-line installers and repairers	**28**	-10	37	**5**	(22)
49-9098	Helpers--Installation, maintenance, and repair workers	**15**	2	13	**0**	(15)
51-1011	First-line supervisors/managers of production and operating workers	**3**	-23	27	**3**	(1)
51-2092	Team assemblers	**11**	-9	20	**0**	(11)
51-4041	Machinists	**1**	-18	19	**6**	5
51-4121	Welders, cutters, solderers, and brazers	**27**	-3	30	**24**	(3)
51-8013	Power plant operators	**13**	-6	18	**0**	(13)
51-8091	Chemical plant and system operators	**-9**	-26	17	**1**	10
51-8092	Gas plant operators	**8**	-8	16	**0**	(8)
51-8093	Petroleum pump system operators, refinery operators, and gaugers	**6**	-4	10	**0**	(6)
51-9061	Inspectors, testers, sorters, samplers, and weighers	**7**	-8	14	**0**	(7)
51-9198	Helpers--Production workers	**4**	-8	12	**0**	(4)
53-7032	Excavating and loading machine and dragline operators	**33**	4	29	**0**	(33)
53-7051	Industrial truck and tractor operators	**8**	-7	16	**0**	(8)
53-7071	Gas compressor and gas pumping station operators	**30**	6	24	**0**	(30)
53-7072	Pump operators, except wellhead pumpers	**34**	12	22	**0**	(34)
53-7073	Wellhead pumpers	**50**	20	30	**0**	(50)
53-7111	Shuttle car operators	**29**	2	28	**0**	(29)

Note: Numbers may not add or subtract exactly due to rounding.

Appendix J: Occupational Supply and Demand Analysis Operating Instructions

A Methodology Technical Manual prepared for the Appalachian Regional Commission

Operating Instructions

This guide serves as a companion piece to the workforce analysis conducted by Regional Technology Strategies (RTS) to determine occupational gaps—an assessment of how projected labor demand compares to projected labor supply, and where there may be "gaps" between the two. The purpose is to help guide the states' colleges and universities as they prepare workers for future opportunities. This type of analysis enables schools and other educational providers to orient programs and training toward in-demand fields, thus providing future employment opportunities for individuals while also responding to the labor needs of employers in the Appalachian region.

As the conversation about energy continues to shift it is a good idea for colleges and universities to be prepared with tools that can help them to understand workforce supply and demand issues as the economy changes. A critical part of RTS' deliverable, therefore, is this manual that lays out the methodology that RTS developed for this gap analysis and explains how university and college personnel can replicate the analysis in the future. It expands the report from an analysis into a capacity-building tool.

The purpose of this tool is to explain the steps that the RTS team took to collect, analyze, and interpret the data in order to produce the workforce gap analysis presented in the main body of the report. It includes explanations of what approaches are used, what purpose they serve, what data are used, and how the data are manipulated and analyzed in order to produce desired information. The goal of the *Operating Instructions* is to enable educational providers to create ongoing gap analyses of their own—not merely to repeat the calculations involved, but to understand the data and information used, recreate the contextual understanding of the analyses, and perform meaningful reassessments of local, regional, and statewide workforce gaps in years to come.

Overview of the methodology

The study team developed a methodology for this analysis to serve two functions: (1) to provide college and universities detailed and nuanced data on the relationship between educational offerings and labor demand and (2) to serve as a clear, reproducible deliverable in itself that individuals in the ARC region could implement without extensive training. In addition, the manual provides information and analysis that can be used to understand not only the numerical data of the labor market, but the context for these data and the specific roles that educational institutions play in supplying that labor market.

The study methodology serves these different needs by using regional data on occupational projections, regional data on credit enrollments and completions in educational programs, and industry training, surveys of high-level college administration, and interviews with regional employers and industry intermediaries. These data are analyzed to produce a broad economy-wide picture by sector of occupational supply and demand, as well as more detailed analyses of the supply and demand forecast and context of specific energy sectors at the regional level.

Inherent in this methodology are the energy sectors, and their definitions, used in the accompanying ARC Energy Workforce Study. Energy sectors and their associated industries are developed as a means to determine the staffing pattern or occupational mix needed to supply the labor and skills set need to produce goods and services. It is the collection of staffing patterns that will ultimately provide you with the occupational demand information needed to begin analysis of the amount and types of gaps (or surpluses) in your workforce. The study team, however, understands that some regions may (1) define their energy sectors differently and thus result in a vastly different occupational mix, and (2) over time these definitions may change as buyer-supplier relationships change or as the taxonomy used to classify industries within a sector evolves. Located in Addendum 2 at the end of this operating manual are steps and resources to help an individual go about identifying a targeted energy sector.

Note on limitations

The methodology has certain limitations; the first concerns the method of estimating supply and demand. The primary element of this limitation is that the estimated allocation of graduates to occupations is based on the ultimate distribution demand. That is, the methodology assumes that the graduates from a given program will distribute themselves across occupations more or less in line with the demand for those occupations.

It thus does not account for unemployment, those who go into another field, or those who drop out of the labor force. The study team feels, however, that labor market demand was still the best available basis of estimating how program graduates would be allocated, and goes much farther in attempting this allocation than most other labor market gap analyses. In addition, the methodology does not account for in-migration of already-prepared workers, the rapid relocation of dislocated workers (who may be able to transition quickly with on-the-job training), nor for the role of other educational institutions in preparing workers for specific occupations.

Note on data sources

The most resource-effective way the study team found to obtain the data needed for this methodology was through an economic modeling system called EMSI (Economic Modeling Specialists, Inc.), a proprietary database. In order to account for the possibility that an ARC region or community may not have access to EMSI we provide notes on other available sources for the data that we secured through EMSI (see Addendum 1).

Regional Gap Analyses

For this part of the analysis, the methodology aims to demonstrate the relationship between the industry demand for workers in energy occupations and the supply of people prepared by educational providers in the region to meet that demand. The analysis includes the energy occupations, regardless of energy sector, in a region and includes supply and demand from one of the ARC regions—at this level the analysis yields a broad-sweep picture of the relationship between supply and demand, emphasizing breadth over depth of detail.

Why this is important

The primary utility of the broad-sweep regional analysis that includes the top energy occupations in a given region is that it can be used to identify particular areas of need in the target region in the whole energy sector. Thus, a researcher can get a sense of where there might be excessive demand for labor regardless of which energy sector is driving that demand.

The detailed sector-based analysis described below is the one that the study team envisions being used more regularly by local areas that want to plan how to serve the specific sectors that are important in a service area. If that detailed cluster-based analysis were used exclusively, however, researcher would miss changing in-demand energy occupations outside those core sectors. A useful way to combine them would be to conduct the broad-sweep regional analysis in order to check for any “surprises” in the data, and then use the more detailed analysis to drill down in the sectors that appear to be worthy of consideration.

What it doesn’t tell us

Because it includes only high demand energy occupations in the various ARC regions, and because demand for these occupations is total economy-wide demand rather than demand within a particular industry sector, this approach does not focus on providing contextually useful information about specific industry sectors. It rather provides raw data with which to start comparing occupational demand and supply. Also, because the approach used in the RTS study focused on top energy related occupations it misses demand on certain occupations outside the energy sectors, unlike the sector-based approach described below can. For instance, demand cannot be distributed across educational programs, and thus a true gap (or surplus) cannot be calculated.[1] Rather, supply and demand can be compared to get a sense of which occupations and industries may require further analysis.

Steps for creating the Regional Gap Analyses

The goal of the regional gap analysis is to compare the demand and supply side of a large labor market area. A comparison is made between average annual demand and average annual

[1] Because the study team’s mandate was to create a methodology that could be easily learned and used by practitioners at the local district development level, we kept it as a guideline that the steps must be doable by reasonably computer-literate staff putting in a reasonable amount of time. The level of detail offered in the sector-based picture is not included in the regional picture, not because it is technically impossible, but because it would involve many days of data analyzing to produce information that we see as being more useful at the target cluster level. It would be possible for a programmer to use Microsoft Access or any SQL-based database instrument to automate the process we describe here rendering it possible to do the more detailed analysis on any number of occupations, and this option is certainly open to ARC or individual regions. We do not include it here, however, in keeping with our mandate to provide a methodology usable by computer-literate laypeople rather than information technology professionals.

program completers to determine a potential labor pool. The steps involved in assessing training gaps at the larger regional level begin with the demand side of the equation.

The first step is to select the occupations expected to have the highest impact in the economy based on a set of predetermined criteria. The report focused on energy-related occupations projected to have the highest average annual demand (new and replacement jobs) over the 2009 to 2013 time period. For instance, within the ARC Central Region demand for heating, air conditioning, and refrigeration mechanics and installers is expected to grow 23% percent (or 117 jobs) between 2009 and 2013. In addition, the heating, air conditioning, and refrigeration mechanics and installers occupation is expected to replace 56 jobs over the same time period with an average of 43 new and replacement jobs needed on an annual basis.

Example 1.1: Selecting an occupation and calculating average annual demand

SOC	Occupation	# New and Replacement Jobs (2009-2013)	Avg. Annual # New and Replacement Jobs	Educational Level
47-9021	Heating, air conditioning, and refrigeration mechanics and installers	173	43	Long-term OTJ

Each occupation is then matched, using its Standard Occupational Classification (SOC code), to an instructional program(s) whose coursework has a strong relationship with the knowledge and skills needed in that occupation. The SOC to Classification of Instructional Program (CIP) crosswalk table (available at the National Crosswalk Service Center's website (http://www.xwalkcenter.org/index.html) outlines the relationship between occupations and instructional programs.

The crosswalk is a comprehensive list of programs available at educational institutions throughout the country; some of the programs may not apply to the specific educational level or region chosen for analysis. Of the programs that feed the heating, air conditioning, and refrigeration mechanics and installers occupation,[2] only the Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (HAC, HACR, HVAC, HVACR) program was found in the region. Heating, Air Conditioning and Refrigeration Technology/Technician (ACH/ACR/ACHR/HRAC/HVAC/AC Technology) and Solar Energy Technology/Technician programs are not in the region and were dropped from further analysis.

[2] The scenarios in this document should be used as examples only, as they do not reflect actual data given to RTS, Inc.

Example 1.2: Matching instructional programs to the selected occupation

SOC	Occupation	Avg. Annual # New and Replacement Jobs	CIP	Program Title
49-9021	Heating, air conditioning, and refrigeration mechanics & installers	43	15.0501	Heating, Air Conditioning and Refrigeration Technology/Technician (ACH/ACR/ACHR/HRAC/HVAC/AC Technology)*
			15.0501	Heating, Air Conditioning and Refrigeration Technology/Technician (ACH/ACR/ACHR/HRAC/HVAC/AC Technology)*
			15.0505	Solar Energy Technology/Technician*
			47.0201	Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (HAC, HACR, HVAC, HVACR)

*Instructional programs without enrollment or completers.

The next step focuses on the supply side of the equation, which deals with the potential pipeline of students based on skills taught at the post-secondary level. This step sums the total number of program enrollees to determine the potential number of people enrolled in programs related to the selected occupations. This yields a potential pipeline of students seeking skills related to occupations in high demand. Unfortunately, there is no way of knowing whether these students will complete their current field of study, work in the selected occupation, or if a particular program is teaching the skills needed to adequately prepare students for heating, air conditioning and refrigeration mechanics and installers jobs in the Central ARC Region.

Example 1.3: Comparing average annual demand to a potential labor pool

SOC	Occupation	Avg. Annual # New and Replacement Jobs	CIP	Program Title	Avg. Completers
49-9021	Heating, air conditioning, and refrigeration mechanics & installers	43	47.0201	Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (HAC, HACR, HVAC, HVACR)	118

The regional approach provides a framework for more in-depth analysis. The example above does not suggest a gap, but further quantitative and qualitative information should be gathered to determine true workforce needs and whether the lack of a Heating, Air Conditioning and Refrigeration Technology/Technician (ACH/ACR/ACHR/HRAC/HVAC/AC Technology) program or a Solar Energy Technology/Technician results in a lack of available skills in the region.

Note that the above example uses a three-year average for program completions. Using an average of multiple time periods allows for a more complete picture of the number of completions. The average number of completers in a program over a number of consecutive time periods diminishes fluctuations due to short-term economic and policy changes that can affect people's educational attainment goals.

In summary, the steps for conducting a regional analysis are:

- Compile a list of all the energy sector occupations in a region.
- Assess the projected new and replacement jobs estimated to be created for each occupation by end of projected time period.
- Match each of the occupations with the post-secondary programs that could potentially prepare a worker for that occupation.
- Total the completions in all of those programs.
- Compare the completions in the potential feeder programs to the projected needed number of annual new and replacement jobs.

Energy Sector-Based Picture

A picture like the one described above is most useful for gaining a broad perspective on in-demand occupations in the region and the potential for meeting that demand. Most institutions of higher learning and communities already have a sense for which industries and industry sectors are significant in their regions, and thus require a more detailed understanding of how their own offerings and activities relate to probable demand within these significant sectors. This part of the methodology provides educational institutions and communities with a way to develop that more detailed understanding.

For the sector-based picture, occupational demand estimates do not show demand from all industries economy-wide, but only from the industries that make up a particular energy sector. This is one of two primary differences between the sector-based picture and the regional picture. The other is that at this more detailed level, it is possible to distribute demand across post-secondary programs to develop a much more direct comparison between projected supply and projected demand.

Why this is important

Having a sector-specific context for occupational analysis will give the ARC communities and educational institutions a more useful knowledge about the probable future needs of its major private sector stakeholders. In addition, examining supply and demand at a more focused and detailed level allows for a more intricate analysis in which demand can be distributed across programs, allowing for a more direct calculation of gaps and surpluses.

What it doesn't tell us

As detailed and contextual as this analysis is, it cannot answer the question of why certain occupations appear to be showing gaps or surpluses. Neither can it show specifically what employers need and want, beyond the simple numbers of workers they are projected to require. For instance, it makes no reference to skills or other qualities that employers value, and it doesn't account for in-migration of new workers or the out-migration of students who find jobs outside an ARC region.

Steps for creating the Sector-Based Picture

As with the regional analysis, the team compiled a list of all the occupations in the region within a given sector and then filtered that by the level of education and training required. For this example, the gas and oil sector in the ARC Southern region was explored and the civil engineer[3] occupation was chosen. The top occupations were selected based on their projected employment impacts in 2013. Average annual new and replacement[4] jobs were used to estimate annual demand. The team, again, determined which educational programs are feeding the selected occupation(s) and totaled the completions in each program.

Example 2.1: Selecting the occupation and determining demand

SOC	Occupation	# New and Replacement Jobs (2009-2013)	Avg. Annual Demand	Educational Level
17-2051	Civil Engineers	237	59	Bachelor's Degree

Example 2.2: Matching instructional programs to the selected occupation

SOC	Occupation	Avg. Annual Demand	CIP	Program Title
17-2051	Civil Engineers*	59	14.0801	Civil Engineering, General
			14.0899	Civil Engineering, Other

*Civil Engineers matches to 4 instructional programs. For the purposes of this example only two programs were chosen.

Since programs often feed more than one occupation, the study team developed an estimate of the percentage of completers in every program that could enter a given occupation. In this example, the 105 completers of the two programs could go into the three different occupations, as shown below: Engineering Manager, Civil Engineer, or Engineering Teacher, postsecondary. The regional demand for each occupation represents the average annual new and replacement jobs needed in the region for all industries, not just the industries that make up a specific sector.

[3] The information presented in this example does not represent actual employment and completer numbers.
[4] For the cluster-level analysis, replacement jobs were estimated using the rate of replacement jobs in an occupation industry-wide (within the region of analysis) multiplied by the number of jobs in the base year (2006).

Example 2.3-a: Determining industry-wide regional demand for program completers

CIP	Program Title	Avg. # Completers	SOC	Occupation	Regional Demand
14.0801	Civil Engineering, General	55	11-9041	Engineering Manager	162
			17-2051	Civil Engineers	144

Example 2.3-b: Determining industry-wide regional demand for program completers

CIP	Program Title	Avg. # Completers	SOC	Occupation	Regional Demand
14.0899	Civil Engineering, Other	50	11-9041	Engineering Manager	162
			17-2051	Civil Engineers	144
			25-1032	Engineering Teachers, Postsecondary	56

As mentioned above, the team estimated the portion of graduates supplied by a program based on the occupation's percentage of total regional demand - in this example, the general civil engineering program for engineering managers and civil engineering. Within the southern region, 162 civil engineers are needed on an annual basis (including the 59 needed in the gas and oil sector example). Since the general civil engineering program trains for both the engineering manger occupation and the civil engineering occupation, only 47.1 percent (26 completers) of the program's completers are available to become a civil engineer, as shown below.

Example 2.4-a: Distributing demand for the Civil Engineering, General Program

SOC	Occupation	Regional Demand	Portion of Total Demand	Portion of Total Demand (Completers)
11-9041	Engineering Manager	162	52.9%	29
17-2051	Civil Engineer	144	47.1%	26

The "civil engineering, other" program trains for engineering mangers, civil engineers, and postsecondary engineering teachers. Average annual demand for the completers of this program is 50 jobs; however, engineering managers demands almost 45 percent of the completers of the "civil engineering, other program". This leaves 39.8 percent of the 50 completers (or 20 completers) available to become civil engineers.

Example 2.4-b: Distributing demand for the Civil Engineering, Other Program

SOC	Occupation	Regional Demand	Portion of Total Demand	Portion of Total Demand (Completers)
11-9041	Engineering Manager	162	44.8%	22
17-2051	Civil Engineers	144	39.8%	20
25-1032	Engineering Teachers, Postsecondary	56	15.5%	8

The final step is to total the estimated completers from each program that would enter a given occupation, and compare this sum to the total projected demand. The difference between the two is the labor market gap or surplus for that occupation with respect to post-secondary programs. In the example presented above, two programs feed the occupation selected, the result being a gap of 13 people to fill the projected job demand.

Example 2.5: Calculating the Gap

SOC	Occupation	Annual Demand	Completers Allocated	Difference
17-2051	Civil Engineers	59	46	-13

In summary, the cluster-based approach steps are:

- Define the sector(s) for analysis.
- Select top occupations within the selected sector(s).
- Assess the projected new and replacement jobs estimated to be created for each occupation by end of projected time period.
- Match each of the occupations with the post-secondary programs that could potentially prepare a worker for that occupation.
- Allocate educational completers.
- Calculate the gap.

This methodology could also be used with enrollment numbers to get an idea of a potential pipeline of future students. Unfortunately, enrollment does not present as clear a picture at the sector level since the intentions of people who enroll in a curriculum program may not be to obtain an award (certificate, associate, bachelor’s, etc).

Continuing Education/Industry Training

The continuing education and industry training data pushes the gap analysis methodology beyond traditional supply-demand comparisons by including an examination of the more specific non-credit training that educational institutions offer to individuals and companies. These data, however, while they are quantitative and can be analyzed quantitatively, cannot be combined with the other quantitative data, due to the lack of corresponding industry codes and occupational groupings—they must be analyzed separately and either viewed as a separate quantitative analysis or incorporated into the analysis as qualitative information that provides part of the context for the quantitative findings.

Non-credit data is, unfortunately, collected in different ways by the various educational systems in the ARC region. Due to the vast number of colleges and universities in Appalachia, performing this analysis for this study was time and cost prohibitive; however, RTS has performed gap analyses for individual educational systems and has provided the steps below.

Why this is important

Much of what educational institutions provide for their industry stakeholders falls into the categories of continuing education and industry-specific training, especially on the two-year college level. An analysis that does not include some examination of these activities risks underestimating the level of post-secondary focus on and service to specific key economic sectors. Also, these activities often represent more up-to-date responses by educational providers. It can take a considerable amount of time to create and gain approval for new credit programs, but colleges and universities can respond to industry needs comparatively quickly with continuing education or industry-specific training programs. Non-credit data can be used to provide a big picture of which clusters and program areas have the most enrollments and which have the fewest. These data also give a broad-sweep understanding of the types of companies and type of training non-credit and industry training provides, as well as what types of students are benefiting.

What it doesn't tell us

The data in continuing education and industry training programs are generally not tracked at a specific enough level of detail to allow for extensive sector-specific analyses. Neither do they connect to occupational codes in a way that allows for a direct relation between noncredit training and occupational demand. Even if there were, much of non-credit training is geared toward enhancing the skills of people already in the workforce—meaning that the numbers of people trained could not be used to indicate the numbers that are ready to fill new jobs.

Steps to create the analysis of continuing education/industry training

- The following continuing education and industry training data is needed:
  - At least one year of gender and race/ethnicity information, by college, for workforce continuing education enrollments, industry training provided, and self-supporting continuing education courses
  - At least one year of enrollments in workforce continuing education courses by college and by type of training based on the master course list – usually provided at the system office level
  - At least one year of customized industry training projects (with NAICS code, if available). Data should include the number of trainees, expenditures per project, instructional hours and location, if available

- Analysis steps:
  - Race/gender/ethnicity:
    - Combine the data for all program areas and develop percentage breakouts by gender and race/ethnicity
    - Compare the percentages in each category to the proportion of residents in the region fitting those same categories in order to see what segments were over or under-represented compared to state population levels. (Population information available from the US Census Bureau at www.census.gov.)
  - Workforce Continuing Education:
    - Add a column to the data provided by the system office that lists each educational provider's current ARC regional designation.
    - Use spreadsheet filter functions to examine the continuing education classes by region and by program area.
    - Use this information to inform the sector and regional analyses. For the regional level analysis, for example, combined type of training data into broad categories using the educational system's rubric in order to present a high level picture of the program offerings by enrollment. While these data cannot be "crosswalked" as the credit program data can be, it is possible to visually compare the types of training being carried out to occupational demand projections in order to identify matches and mismatches.
  - Industry Training:
    - While the study recommends that NAICS codes be included in all customized industry training projects, we realize that this is information is not always available. NAICS codes can sometimes be found online by searching a company's line of business on the NAICS taxonomy. Try http://www.census.gov/eos/www/naics/ or http://www.naics.com/search.htm .
    - In a spreadsheet, categorize the projects by sector, based on the NAICS codes. In most cases, 2-digit codes can be used to classify companies in order to keep the number of sectors from being onerously high.
    - Sort the projects by number of trainees to identify sectors served by the programs, from highest to lowest.
    - When doing an analysis on a geographically broad area (ex. the total ARC region), organize projects by region as well as sector, in the same manner as for continuing education courses. This will reveal whether there has been customized industry training in the region that is relevant to a particular sector.

Qualitative contextual analysis

The study team included several interviews with private sector members of the various energy sectors (these could be conducted over the phone, one-on-one or in small focus-group size meetings). Public-private, nonprofit, or public sector intermediaries, such as economic development authorities, Chambers of Commerce, or industry associations, can also provide important qualitative information.

Why this is important

The qualitative information served two roles in the analysis: (1) to provide insight into skills needs, not just occupational needs, for each sector; and (2) to shed light on the specific role of the educational providers in meeting the particular sector's needs and providing opportunities for students to prepare for in-demand jobs. The qualitative elements of the analysis provide a reality check and explanatory backup for the results of the quantitative analysis. The quantitative analysis provides an answer to the question of *what* will be happening to occupational supply and demand in a given sector; the qualitative analysis speaks to *why* these changes are taking place and *how* they will come about.

What it doesn't tell us

Qualitative information will be richest and most valuable in the context of substantive, long-standing relationships between colleges/universities and their private sector stakeholders. This means, however, that if the qualitative piece of the analysis were conducted on its own, without being informed by the quantitative analysis, it might not uncover new or surprising information about projected changes in the target industry sectors. The quantitative piece is needed to prompt what questions should be asked of industry, or in some cases even to prompt an educational institution to develop new connections with industries that formerly had not been on its radar screen.

Creating the qualitative analysis

- **Interviews with regional and state-level employers and industry representatives.** The main step to creating the qualitative analysis is to conduct several interviews with employers or other industry stakeholders in the target region who can shed light on the sector occupational and skills needs in the region, and on the ways in which the region's community college help to meet those needs. These interviews can be conducted one-on-one or in focus group-style meetings. The kind of information to be gleaned includes:

- What is the overall industrial makeup of X sector in this region? I.e., what segments are most important here?
    - Is this sector characterized in this region by small businesses, large businesses, branch plants, entrepreneurs, or other?
    - In this region, is this sector declining, expanding, or maintaining? Where do you see it going over the next X years?

- What are this sector‘s most important workforce needs in this region? Which kinds of workers are most important to its competitiveness? Which kinds of workers are hardest to find and keep?
- In a typical establishment in this sector in your region, what specific occupations are in greatest demand? What skills are in greatest demand?
- Which of these occupations require at least some training beyond high school? Which require a two-year degree? Which require an advanced degree, etc?
- Have you hired workers who have gone to nearby schools? If so, how would you rate their quality in terms of having the skills needed to be successful in your company? Are educational programs up-to-date in terms of what they're teaching? [This question should be more general if interviewing an association.]
- How do employers in this sector generally find workers? To what extent do employers in this industry work closely with the local colleges and universities or other workforce institutions to develop their workforce? In particular, do you see skills upgrading for current workers being provided by educational institutions in the area? What, if any, gaps in the type of continuing education courses offered by educational providers do you see?
- If community colleges/universities do not play much of a role in preparing your workforce, why is that? What could community colleges/universities do to be more relevant to your workforce needs?
- How do you see the industry changing in the next five years? (Prompts: for example, new markets, technology changes, aging baby boomers leaving workforce, off-shoring) How do you think this will affect the industry's workforce needs here in this region? What do you think educational providers should do to prepare for these changes?

These basic questions are included to show the range of information that one would need to elicit from industry stakeholders during this process. If you are entering the interview process without already being familiar with some of this information, it would make the process more effective to do some background research first so that you have a preliminary understanding with which to begin the discussion.

Addendum 1: Data Sources

The report is based on data obtained from Economic Modeling Specialists, Inc (EMSI). EMSI is a subscription, web-based data company specializing in labor and economic data. The data provided by EMSI in this report comprises quarterly census employment and wage (QCEW) data augmented with data on self-employment, proprietors, and other members of region's workforce not typically covered under the unemployment insurance law. Thus, the data presents a more complete picture of a region's workforce. Although the report utilizes the data services of EMSI, the methodology can still be applied to free federal and state data sources.

Employment Data

Once the relevant sectors have been identified and the industries within those sectors defined, employment projections can be found at either a particular state's Employment Security Commission or the US Department of Labor, Bureau of Labor Statistics[5] (BLS). Both agencies provide data on covered employment only. Some data may be suppressed due to policies regarding establishment confidentiality. As a supplement to the QCEW data, Non-employer data may be obtained free of charge from the US Census Bureau, Economic Planning and Coordination Division's Non-employer Statistics database. (http://www.census.gov/epcd/nonemployer/).

For each of the chosen industries within a cluster, staffing patterns can be determined based on the National Industry-Occupation Employment Matrix on the Bureau of Labor Statistics website (http://data.bls.gov/oep/nioem/empiohm.jsp). Detailed files on occupations by industry can be accessed through (http://www.bls.gov/emp/empoils.htm). The staffing patterns will give an occupation's percentage of industry employment, which can then be applied to the total industry employment to determine a region's industry needs.

A clearer picture of demand includes not only occupational growth within a cluster but also addresses the need to fill existing jobs. The inclusion of replacement jobs[6] allows for a truer picture of the demand for labor faced by employers on an annual basis. The BLS compiles data on the annual average number of replacement jobs and publishes it through their Occupational Employment, Training, and Earnings program[7] (http://data.bls.gov/oep/noeted/empoptd.jsp). To estimate minimum annual average demand for an occupation, use the Job Openings due to growth and net replacements as a percent of the base year's total employment. This percentage should be applied to the base year of employment at the selected regional level to get an estimate of total demand in the target area.

Crosswalk

A relationship between standard occupational classifications (SOC) and classification of instructional programs (CIP) has been established and is available through the National Crosswalk Service Center, a depository of occupational/educational resources. The most recent

---

[5] BLS data does not allow for the selection of data by economic development or workforce board region. However, county and metropolitan statistical area data is available and can be used to estimate regional employment.
[6] Replacement jobs exist due to workers leaving their jobs to work in another occupation, leaving the labor force because of retirement or other reasons, or death.
[7] The data used in determining replacement jobs is from the total and net separations data gathered through the Current Population Survey.

SOC to CIP crosswalk can be accessed through the National Crosswalk Service Center. For more information regarding the CIP taxonomy visit the National Center for Education Statistics site regarding CIP resources (http://nces.ed.gov/pubs2002/cip2000/).

Addendum 2: Identifying Energy Sectors

Developing a sector definition is important in understanding the relevant industries in particular energy sectors as well as the occupational needs within those industry sectors. Before a staffing pattern can be developed, a complete definition of each target energy sector must be created. Should the energy sectors or how they are defined in the accompanying study not fit your need, we offer the following advice in identifying the appropriate sector(s) to begin your gap analysis.

Identify target sectors. This is a step that can be undertaken in a number of ways. Because any quantitative method can be used to different effect in different types of regions and economic contexts, and because it would be impractical to suggest that every college or university wishing to conduct an occupational gap analysis first undertake a comprehensive regional sector study, the study team does not prescribe a specific method for selecting the industry sectors. Instead, we offer the following guidelines for selecting clusters:

- **Base the selection on existing relationships within the regional economy.** As noted elsewhere, the richest and best source of data is the ongoing relationships between a community's educational providers and the industry stakeholders. Ideally, an analysis such as this one would be the occasion for eliciting specific information from these stakeholders, not for establishing connections with them. If educational providers are in regular communication with employers, these communications will provide a solid understanding of industry trends that will reveal which of the industries in a service area are most critical to the regional economy.
- **Make use of economic and cluster studies.** Studies conducted at the state, regional, and even county and local level can all shed light on changing industry trends. These are useful as a supplement to information gleaned from existing industry connections, as these existing connections may not serve to inform colleges of new economic development such as emerging clusters. The Economic Development Administration maintains excellent regional data and industry cluster mapping tools at: http://www.clustermapping.us/index.html and http://www.statsamerica.org/innovation/
- **Consult with local/regional/state-level economic development authorities and industry representatives.** Connections with these stakeholders can be an effective way to bolster your understanding of new and emerging clusters, to establish contacts in an industry not currently connected to the college, and to get a broader view of a particular cluster or set of industries than the individual members of it can provide.
- **Consult regional sources of data**. When there is staff capacity to do so, examining direct sources of data can be a good way of looking for clues about changing trends in a local or regional economy. The Bureau of Labor Statistics, County Business Patterns, Employment Security Commission data, and Dun and Bradstreet are all sources of data that can be used to create targeted economic information. This can be time-consuming, and easily misleading if data are not interpreted with a great deal of care; for this reason, and because quantitative information is rarely sufficient on its own to fully explain any economic trend or phenomenon, we recommend extreme caution when attempting to analyze economic data in order to understand a local economy and identify target sectors.

Appendix K: NAICS CODES BY ENERGY SECTOR

NAICS	Description	Subsector									
		Coal	Nuclear	Gas & Oil	Hydroelectric	Wind	Solar	Geothermal	Biomass	Fuel Cells	Efficiency
211111	Crude petroleum and natural gas extraction			x							
211112	Natural gas liquid extraction			x							
212111	Bituminous coal and lignite surface mining	x									
212112	Bituminous coal underground mining	x									
212291	Uranium-radium-vanadium ore mining		x								
213111	Drilling oil and gas wells			x							
213112	Support activities for oil and gas operations			x							
213113	Support activities for coal mining	x									
213114	Support activities for metal mining		x								
221111	Hydroelectric power generation				x						
221112	Fossil fuel electric power generation	x		x							
221113	Nuclear electric power generation		x								
221119	Other electric power generation					x	x	x	x		
221121	Electric bulk power transmission and control	x	x		x	x	x	x			
221122	Electric power distribution	x	x		x	x	x	x	x		
221210	Natural gas distribution			x							
221330	Steam and air-conditioning supply							x			
236115	New Single-Family Housing Construction (except Operative Builders)										x
236116	New Multifamily Housing Construction (except Operative Builders)										x
236118	Residential Remodelers										x
237110	Water and sewer system construction				x			x			
237120	Oil and gas pipeline construction			x							
237130	Power and communication system construction	x	x			x	x	x	x		
237990	Other heavy construction		x		x						
238210	Electrical Contractors and Other Wiring Installation Contractors										x
238220	Plumbing, Heating, and Air-Conditioning Contractors										x
238290	Other Building Equipment Contractors										x
238310	Drywall & insulation contractors										x
238390	Other Building Finishing Contractors										x
238990	All Other Specialty Trade Contractors										x

NAICS	Description	Subsector									
		Coal	Nuclear	Gas & Oil	Hydroelectric	Wind	Solar	Geothermal	Biomass	Fuel Cells	Efficiency
314992	Tire Cord and Tire Fabric Mills									X	
321113	Sawmills								x		
322110	Pulp mills								x		
322121	Paper mills								x		
322299	All Other Converted Paper Product Mfg.										x
324110	Petroleum refineries			x							
324199	All other petroleum and coal products mfg.	x		x							
325110	Petrochemical manufacturing			x							
325120	Industrial gas manufacturing			x							
325191	Gum and wood chemical manufacturing								x		
325193	Ethyl alcohol manufacturing								x		
325199	All Other Basic Organic Chemical Manufacturing								x		
325211	Plastics Material and Resin Manufacturing						x				
325510	Paint and Coating Manufacturing						x				
326113	Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing						x				
326199	All Other Plastics Product Manufacturing					x					
327211	Flat Glass Manufacturing						x				
327993	Mineral Wool Manufacturing					x	x		x		
331210	Iron and Steel Pipe and Tube Manufacturing from Purchased Steel							x	x		
331422	Copper Wire (except Mechanical) Drawing						x				
331511	Iron Foundries					x					
332312	Fabricated Structural Metal Manufacturing					x					
332322	Sheet Metal Work Manufacturing					x	x				
332410	Power boiler and heat exchanger manufacturing							x			
332420	Metal tank, heavy gauge, manufacturing							x			
332710	Machine Shops					x					
332911	Industrial Valve Manufacturing	x	x	x	x			x	x		
332991	Ball and Roller Bearing Manufacturing					x					
333120	Construction Machinery Manufacturing	x							x		
333131	Mining machinery and equipment manufacturing	x						x			
333132	Oil and gas field machinery and equipment			x							
333295	Semiconductor Machinery Manufacturing						x				
333411	Air Purification Equipment Manufacturing					?					

NAICS	Description	Subsector									
		Coal	Nuclear	Gas & Oil	Hydroelectric	Wind	Solar	Geothermal	Biomass	Fuel Cells	Efficiency
333412	Industrial and Commercial fans and blowers					x					
333414	Heating equipment, except warm air furnaces						x				
333415	Air-conditioning and Warm Air Heating Equipment and Commericial and Industrial Refrigeration Equipment Manufacturing							x			
333611	Turbine and turbine generator set units mfg.					x					
333612	Speed Changer, Industrial High-Speed Drive, and Gear Manufacturing					x					
333613	Power Transmission Equipment Manufacturing					x					
333911	Pump and Pumping Equipment Manufacturing							x	x		
333912	Air and Gas Compressor Manufacturing							x	x		
333922	Conveyor and Conveying Equipment								x		
333923	Overhead Traveling Crane, Hoist, and Monorail System Manufacturing							x	x		
333995	Fluid Power Cylinder and Actuator Manufacturing								x		
333999	All Other Miscellaneous General Purpose Machinery Manufacturing			x					x		
334413	Semiconductors and related device mfg.						x			X	
334418	Printed Circuits and Electronics Assemblies					x					
334513	Instruments and Related Products Manufacturing for Measuring, Displaying, and Controlling Industrial Process Variables			x	x			x			
334515	Instrument Manufacturing for Measuring and Testing Electrictiy and Electrical Signals	x	x		x	x	x	x	x		
334517	Irradiation Apparatus Manufacturing						x				
334519	Other measuring and controlling device mfg.					x					
335311	Electric power and specialty transformer mfg.	x	x		x				x		
335312	Motor and generator manufacturing					x					
335313	Switchgear and switchboard apparatus mfg.						x				
335314	Relay and industrial control manufacturing	x	x		x						
335911	Storage battery manufacturing						x				
335912	Primary battery manufacturing										x
335929	Other communication and energy wire mfg.	x	x		x						
335931	Current-carrying wiring device manufacturing	x	x		x	x	x	x	x		
335991	Carbon and graphite product manufacturing	x			x						
335999	Miscellaneous electrical equipment mfg.	x	x		x	x	x	x	x	x	
336412	Aircraft Engine and Engine Parts Manufacturing					x					

NAICS	Description	Subsector									
		Coal	Nuclear	Gas & Oil	Hydroelectric	Wind	Solar	Geothermal	Biomass	Fuel Cells	Efficiency
339113	Surgical Appliance and Supplies Manufacturing						x				
423490	Other Professional Equipment ans Supplies Merchant Wholesalers					x	x				
423510	Metal Service Centers and Other Metal Merchant Wholesalers					x					
423520	Coal and other mineral merchant wholesalers	x	x								
423610	Elec. equip. and wiring merchant wholesalers	x	x		x	x	x				
423620	Electrical and Electronic Appliance, Television, and Radio Set Merchant Wholesalers										x
423690	Other electronic parts merchant wholesalers										x
423720	Plumbing equip. merchant wholesalers										x
424710	Petroleum bulk stations and terminals			x							
424720	Other petroleum merchant wholesalers			x							
444110	Home Centers										x
444190	Other Building Material Dealers										x
447110	Gasoline stations with convenience stores			x							
447190	Other gasoline stations			x							
453998	All Other Miscellaneous Store Retailers (except Tobacco Stores)					x	x				
454311	Heating oil dealers			x							
454312	Liquefied petroleum gas, bottled gas, dealers			x							
454319	Other fuel dealers			x					x		
486110	Pipeline transportation of crude oil			x							
486210	Pipeline transportation of natural gas			x							
486910	Refined petroleum product pipeline transport.			x							
486990	All other pipeline transportation	x									
488999	All Other Support Activities for Transportation					x					
517919	All Other Telecommunications					x	x				
523910	Miscellaneous intermediation	x	x	x	x	x	x	x	x		x
523999	Miscellaneous financial investment activities	x	x	x	x	x	x	x	x		x
532412	Other heavy machinery rental and leasing	x	x	x	x	x	x	x	x		
533110	Lessors of nonfinancial intangible assets	x	x	x	x	x	x	x	x		x
541330	Engineering services	x	x	x	x	x	x	x	x		x
541360	Geophysical surveying and mapping services	x	x	x	x			x			
541380	Testing laboratories	x	x	x	x	x	x	x	x		x
541611	Administrative Management and General Management	x	x	x	x	x	x	x	x		x

NAICS	Description	Subsector									
		Coal	Nuclear	Gas & Oil	Hydroelectric	Wind	Solar	Geothermal	Biomass	Fuel Cells	Efficiency
	Consulting Services										
541620	Environmental consulting services	x	x	x	x			x	x		x
541690	Other technical consulting services	x	x	x	x	x	x	x	x		x
541710	Physical, engineering and biological research	x	x	x	x	x	x	x	x		x
541712	Research and Development in physical, engineering, & life sciences (except biotechnology)	x	x	x	x	x	x	x	x		x
541990	All Other Professional, Scientific, and Technical Services	x	x	x	x	x	x	x	x		x
561110	Office Administrative Services					x	x				
561990	All Other Support Services					x	x				