Energy-Sector Workforce Development in West Virginia

Aligning Community College Education and Training with Needed Skills

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Preface

The energy sector is a fundamental component of West Virginia's economy. In the past, West Virginia's energy sector was primarily based on coal mining and combustion for electricity and industrial uses. In recent years, the production of natural gas and natural gas liquids from shale resources and their industrial application have increased demand for workers in these industries of the energy sector. In 2013, the National Energy Technology Laboratory (NETL) asked the RAND Corporation to work closely with the Community and Technical College System of West Virginia (CTCS) to develop a strategy for energy-sector employers and public education and training institutions (such as K–12 public education, state-sponsored career and technical education centers, public education consortia that support students' transition from high school to postsecondary education, and the state's two-year community college system) to collaborate to ensure that the local talent pool is prepared to enter the workforce with the knowledge, skills, and behavioral competencies to fill energy-sector jobs across the state now and in the future.

This report communicates the results of that study. It sets the stage for more in-depth work supporting the development of publicly funded programs to train workers in the energy sector in the West Virginia region but also in other regions enjoying growth in demand for workers from emerging energy industries. The results of this study should be of interest to developers of training programs designed to meet the needs of the energy sector and to firms in the energy sector, which need to plan for their workforce over the long term.

About RAND Environment, Energy, and Economic Development

The research reported here was conducted in the RAND Environment, Energy, and Economic Development Program, which addresses topics relating to environmental quality and regulation, water and energy resources and systems, climate, natural hazards and disasters, and economic development, both domestically and internationally. Program research is supported by government agencies, foundations, and the private sector.

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Questions or comments about this report should be sent to the project leader, Gabriella C. Gonzalez (Gabriella_Gonzalez@rand.org). For more information about the Environment, Energy, and Economic Development Program, see http://www.rand.org/energy or contact the director at eeed@rand.org.

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Summary

Background and Study Objectives

The energy sector is a fundamental component of West Virginia's economy. In the past, West Virginia's energy sector was dominated by coal mining and combustion for electricity and industrial uses. In recent years, however, the production of natural gas and natural gas liquids extracted from shale resources and their industrial application have increased energy-sector demand for workers. According to employment projections from WorkForce West Virginia, the oil and gas extraction industry will experience a 10-percent increase in employment in West Virginia by 2020 when compared with employment in 2010; mining, primarily coal-mining, is predicted to experience a 5 percent fall. Most of the jobs in oil and gas extraction require semi-skilled workers with high school or two-year associate's degrees. Given this potential demand, a clear challenge faced by West Virginia is how to support the system that moves these workers into the energy sector's workforce: the workforce-development pipeline. This pipeline involves recruiting, training, and educating the local talent pool (both young recent high school graduates and adults already in the workforce) to fill the job and skills needs of energy-sector employers, for both the short and long terms.

To address this challenge, the National Energy Technology Laboratory (NETL) asked RAND to work closely with the Community and Technical College System of West Virginia (CTCS) to develop a strategy for energy-sector employers and public education and training providers—including CTCS, the K–12 public education system, and state-

sponsored education consortia that provide technical and career training or support students' transitions from secondary to postsecondary institutions—to collaborate to ensure that the local talent pool is prepared to enter the workforce with the knowledge, skills, and behavioral competencies to fill semiskilled energy-sector jobs across the state now and in the future.

Limitations of Analysis

This study was intended to be a first, exploratory phase that will inform subsequent phases of work to support energy-sector workforce development in West Virginia. The study's focal area of inquiry is education and training opportunities available through public institutions in West Virginia. We therefore briefly describe the education and training provided through private, for-profit institutions and apprenticeship programs developed between industry and unions but do not examine those programs in depth.

A second important limitation is this study's narrow scope. It was out of this study's scope to investigate the education and training required to obtain skills needed for employment in "downstream" industries supported by the energy sector, such as the refining of petroleum crude oil and the processing and purifying of raw natural gas, as well as the marketing and distribution of products derived from crude oil and natural gas. Nor do we include in this study an analysis of indirect jobs that typically build up around newly established energy-sector locales, such as hotels, restaurants, and other hospitality or service-sector businesses, or government or environmental jobs that have grown to monitor or regulate the energy sector. It was also outside of the scope of this study to conduct a thorough labor market analysis of the employers' demands compared with local talent's skills; however, this type of analysis is needed to have an accurate understanding of employers' demands and whether there is a shortage of skilled talent to fill those demands.

Given the narrow scope of this study, the recommendations produced are intended to serve as a launching point for discussions among stakeholders in West Virginia to develop collaboratively a specific implementation plan. It is intended to be a first step in promot-

ing deeper analyses of the issues at hand and conversations about possible solutions. Results from this study should be useful to regional stakeholders and prove valuable as a template for other regions confronted with similar workforce-development challenges. They should also assist NETL and CTCS to understand the scope and scale of the workforce needs of the energy sector, gaps in the regional workforce, existing workforce-development partnerships and initiatives that can be leveraged, lessons learned from other regions' initiatives aimed at developing a capable and adaptable workforce for the energy sector, and suggested paths forward.

Key Findings

To meet these objectives, the study undertook four tasks.

Task 1: Identify key knowledge, skills, and abilities needed for energy-sector jobs in West Virginia. For this task, we analyzed Occupational Information Network (O*NET) data from the U.S. Department of Labor (DOL) Employment and Training Administration (ETA). This data set provides a national- and state-level portrait of the key knowledge, skills, and abilities (KSAs) needed in the energy sector, and specifically for oil and gas occupations, as reported by employers. We examined which KSAs were reported as important for high-employment and high-growth occupations in West Virginia writ large, in the energy sector only in the United States, and in the energy sector only in West Virginia. *We found that, across these three types of occupations, the most important KSAs were basic skills and abilities, such as English language, mathematics, listening, and critical thinking.*

Task 2: Identify gaps between educational and training programs and employers' reported needs. For this task, we first analyzed data from the West Virginia Higher Education Policy Commission to document enrollments in energy sector–related courses, remedial courses, and majors by age of students from 2008 through 2012 in CTCS educational and training programs. *We found that most students enrolled in non–energy-related courses and close to 50 percent of new students in energy-related programs needed to first take remedial*

math courses. This suggests that the young talent pool who could be candidates for semiskilled, high-demand positions in the state's energy sector are not meeting basic skill requirements.

Second, we conducted interviews with key program staff in charge of CTCS curriculum development and programs of study. Interview questions focused on collecting information on program course requirements and curricula and did not ask about personal opinions or perspectives. Interviews were conducted at three community colleges in person; they were conducted by phone for the remaining six community colleges and education partners in the state of West Virginia. We contacted 85 individuals in CTCS or education consortium partners (such as career and technical education providers linking K–12 education and the community colleges) and interviewed roughly half of them. We also interviewed representatives from two unions whose members typically work in the oil and gas sector in West Virginia; a representative from one regional Workforce Investment Board (WIB) located in an area in West Virginia that has a high volume of oil and natural gas job openings; and a small, select sample of energy-sector employers. We contacted 20 employers and interviewed five. *These interviews revealed that while employers noted core skills needed for semiskilled positions within their firms, they reported difficulty in finding local West Virginia talent with the necessary skills to fill these jobs. Education and training providers (within CTCS, the regional WIB, and the two unions) with whom we spoke reported that the alignment between employers' reported workforce needs and course requirements and training for graduates from the energy-related programs needs to be improved: There were few, piecemeal examples of employers collaborating with education providers to develop programs.*

Task 3: Identify reported barriers and perceptions that inhibit students' access to educational and training opportunities in the energy sector. To understand barriers to accessing training programs and perceptions of employment in the energy sector, we conducted focus groups composed of a sample of students enrolled in a purposefully selected set of CTCS energy sector–related training programs. Questions in the focus groups explored students' perspectives on barriers or challenges encountered to entering postsecondary energy sector–

related educational or training programs. These could be institutional challenges (such as need for childcare or transportation constraints) or personal impressions (such as family approval or disapproval of pursuing employment in the energy sector). The findings from the focus groups were not intended to be generalized to other students in higher education but rather were intended to help identify potential barriers that postsecondary education institutions should help students overcome.

We found that students felt that there was little support for job placement or career counseling from CTCS. Internships or apprenticeships were not available through programs or formal arrangements through the institution but depended on the connections of individual instructors to employers.

Task 4: Synthesize promising approaches to improve the energy-sector workforce pipeline. To understand what appropriate strategies West Virginia could adopt to fill gaps in the workforce-development pipeline, we reviewed national and other state partnerships that aim to develop key workforce skills, knowledge, and behavioral competencies. We defined a partnership as any publicly coordinated effort between stakeholders from at least two different areas (e.g., education, industry, local or regional or federal government). We focused on those partnerships that had been evaluated using rigorous program evaluation methodologies or have been highlighted in peer-reviewed journals or books as informative case studies. However, the review was not intended to provide a comprehensive overview of the entire literature on workforce development. Indeed, partnerships for the immediate West Virginia region were limited in number and scope and have not been systematically evaluated to determine their effectiveness. Therefore, we first described the characteristics of regional and high-profile energy partnerships and initiatives identified through Internet searches using several combinations of terms (e.g., *energy partnerships*, *consortium*, *workforce development*, *training*). We then distilled lessons learned and any best practices resulting from this review to suggest ways West Virginian institutions of higher education can fill gaps in their programs or course offerings to meet the needs of energy-sector employers.

We found that there are three key characteristics for successful partnerships between academic institutions and employers:

1. **Bridge services**, which focus on increasing job skills and opportunities for low-skilled workers and are typically provided by community service programs, help to ensure future workers develop the personal effectiveness, academic, and workplace competencies needed to succeed in a wide range of occupations. These competencies focus on KSAs, such as an individual's professionalism, interpersonal skills, teamwork, math and science knowledge, and ability to follow directions.
2. **Employer involvement** is a critical factor for ensuring future workers in the energy sector receive the education required for entry, as well as the training needed to succeed in energy-specific jobs. Without frequent input and participation from local employers, training and education providers are unable to plan and create programs that would develop the KSAs needed to be competitive in the energy sector.
3. **Recognizing and addressing barriers to implementation** is also a key characteristic. Initiatives often face similar challenges such as geographic isolation, lack of reliable transportation for trainees, and securing highly qualified instructors. Higher-paying opportunities to work directly in energy industries were a significant deterrent for those otherwise qualified and interested in becoming instructors.

Suggested Measures to Support Energy-Sector Workforce Development in West Virginia

Using the analyses conducted in this study, we developed a set of recommended action items energy-sector employers, CTCS, and other public regional education and training providers can implement to support a well-aligned and coherent workforce-development pipeline for West Virginia's energy sector. These suggested measures are intended to be used as a springboard for deeper discussion among West Virginia

stakeholders. It is expected that this report will be used in a workshop setting in which these regional partners initiate specific practices to collaboratively develop programming and policies and implementation strategies to ensure that practices are undertaken so that education and training institutions are best prepared to support local talent's training in the energy sector.

We order these suggestions based on ease of implementation—first those that we recommend occurring earlier than others, to address crucial bottlenecks, and those feasibly implemented in the short term, then those that could take a longer time frame to be implemented and would most likely require the involvement of multiple partners.

Measures Regional Stakeholders Can Implement in the Short Term

Develop ongoing partnerships among industry leaders, training providers, and other education providers. A key finding from our interviews with CTCS administrators and student focus groups was that while there were many examples of involvement of industry leaders as advisory board members for programs or colleges, we did not hear of any examples of direct, continued involvement in curriculum development, in providing formal or institutional-based internship opportunities to students, or in active recruitment of program graduates into available jobs. In our review of public-private partnerships deemed successful, the deep and consistent involvement of industry in the development of educational and training programs and in providing opportunities for job seekers upon graduation has been one of the most successful practices of other energy-sector consortia and partnerships. Based on our findings, we recommend the following to stakeholders engaged in preparing West Virginians for jobs in the energy sector:

- Employers in the energy sector should engage with education and training programs to forecast demand for workers, to provide regular input on curricula, to support the acquisition of equipment and supplies used in hands-on training, and to institute formal workplace learning opportunities for students.

- Industry leaders who serve on advisory boards or committees of training institutions and community colleges should have an *active*, continuous role in the development of curricula that meet the industry's needs.
- Employers should establish formalized on-the-job programs that offer hands-on, practical experience for students across the many energy-related CTCS programs. Such joint programs between employers and training institutions facilitate communication regarding the structure and the content of internships or other hands-on experiences for students.

Revise CTCS programs to fit the demands of the energy-sector workplace. At the time of this study, the degree-granting programs in place in CTCS were reportedly not meeting employer needs. Furthermore, students noted the lack of institutionalized processes to help them with hands-on practical application or job placement. To design programs deemed useful by students and to ensure that graduates from programs are competitive candidates on the job market, we recommend the following improvements to programming:

- Integrate technical, occupation-specific training along with workplace readiness and other soft skills through cross-college collaboration with continual input from industry.
- Design the curriculum through industry-college collaboratives, with ongoing review and updates.
- Integrate behavioral competencies and workplace readiness skills into the curriculum.
- Develop hands-on modules within the curriculum so that students practice working with equipment they will find on the job.

Leverage workforce-development training programs already in place in CTCS. CTCS administrators with whom we spoke noted that CTCS workforce-development training programs, which provide non–credit-bearing on-demand certifications, are one possible avenue to improve connections between CTCS and employers. This relationship provides an opportunity for CTCS to tap the adult workforce

already in the labor pool who are in need of a specific credential or degree, who could then be a viable talent pool for degree-granting programs.

Longer-Term Measures That Require Comprehensive Partnerships Among the State's Education and Business Stakeholders

Improve awareness of available energy-sector education and training programs and employment opportunities. At the time of this study, CTCS administrators noted that some of their energy-related programs were only partially filled. One possible reason all spaces were not filled was lack of awareness on the part of students of these programs and the opportunities available in the job market. Improved communications about CTCS and the opportunities that degree and nondegree programs provide could encourage more students to seek training for energy-related jobs. An expanded marketing campaign that includes social media approaches would likely improve knowledge about the benefits of enrollment. Streamlined and strategic communication of technical programs between the career and technical education (CTE) providers and CTCS would also improve recruitment of students with interests and skills in the types of technical programs offered by CTCS.

Institutionalize and formalize internships or cooperative training partnerships, and provide career counseling. In focus groups, students noted that access to internships or job counseling within CTCS programs was inconsistent and depended on the instructor. They noted that while there were opportunities within the classroom for hands-on experiences, there were few opportunities to demonstrate their technical skills to employers. Yet employers value on-the-job experience and note this in job position announcements. Students also noted that the availability and quality of career counseling at CTCS largely depended on the instructors' initiative or personal contacts. Interviews with CTCS administrators corroborated students' perceptions: Career counseling positions were typically not a priority, and, when counselors were available, students sometimes found them inadequate. Improving career counseling, both during students' course

of study and after graduation, when they are actively looking for jobs, would greatly improve the programs.

Make the recruitment and retention of quality instructors a priority for education and training program administrators. CTCS administrators commented that hiring and keeping good instructors for energy-related courses was challenging. Unlike other more established shale plays, West Virginia is not home to a pool of retired workers who can be tapped as instructors. The colleges have had to compete with industry for employees qualified to be instructors. We recommend two measures to make it easier to hire and retain quality instructors for all education and training providers in the state:

- Provide instructors with opportunities for professional development, including time in the workplace at partner employers in the energy sector.
- Reduce the competition between industry and colleges by developing agreements between training institutions and energy-sector employers in the region so that employees can teach in education and training programs. Employers may be willing to offer incentives to employees who teach at CTCS and other education partners, or set up cooperative agreements so that industry can second employees to teach for a semester.

Improve readiness of talent entering postsecondary education and training programs. This study revealed that a key first step to improving the pool of talent entering postsecondary education and training programs is to focus efforts on improving the basic skills of all schoolchildren in the state. To that end, we recommend that the West Virginia State Department of Education work more closely with CTCS and other higher education institutions to reach down to K–12 students to underline the importance of basic mathematics and reading skills in finding jobs in the energy sector. Among all the strategies, this could be the most difficult to plan and implement because it would involve not only strategic public-private partnerships, but also coordination with state-level agencies and departments.

Concluding Remarks: Institutionalize Cross-Communication and Collaboration Across State Institutions

To ensure the successful implementation of the action items suggested in this report, labor, economic, and educational institutions within West Virginia will need to incorporate CTCS's efforts into their own programs and activities. One method to encourage stronger cross-communication and collaboration across state institutions is to leverage the regional education consortia already in place. Another way to encourage collaboration across state institutions is to ask the recently reestablished West Virginia Workforce Planning Council to oversee the implementation of the strategy. The council has been tasked with

> coordinating initiatives, leveraging resources, and planning for the delivery of a comprehensive workforce strategy that ensures an integrated and strategic approach in meeting the educational and training needs of West Virginia's employers and students, and enhancing the economic development efforts of the state. (State of West Virginia, Office of the Governor, 2013)

Tasking the council with the responsibility for aligning the energy sector's workforce-development pipeline with industry needs would make the effort more coherent and create a healthy, useful system for meeting the needs of employers and students, in the context of budgetary and other constraints faced by education providers.

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CHAPTER ONE

Introduction

Semiskilled STEM Occupations and the Energy Sector in West Virginia

There is increasing attention on workforce shortages to fill jobs that require science, technology, engineering, and mathematics (STEM) skills and training (hereafter referred to simply as STEM jobs). STEM jobs constitute 20 percent of all jobs in the U.S. economy (Rothwell, 2013), and projections anticipate that the STEM economy will grow by 17 percent through 2018, with expected job vacancies totaling 2.4 million (Carnevale, Smith, and Melton, 2011). Yet, only 1.5 percent of 25- to 34-year-olds in the workplace have a higher education degree in a STEM-related field, putting the United States in the bottom third of all Organisation for Economic Co-operation and Development (OECD) countries (President's Council on Jobs and Competitiveness, 2011). The gap between employer needs and workforce skills is starkest as more jobs open up in the near term than the current output of graduates is likely to meet, coupled with impending retirements from the baby-boomer generation (Center for Energy Workforce Development [CEWD], 2013) and an increased reliance on technical skills in the workforce (National Research Council, 2013). With an expansion in the STEM economy and the growing demand for workers to fill STEM jobs, business leaders are putting pressure on—and in some cases, providing investments in—schools to recalibrate their curricula to emphasize STEM skills directly required on the job (Tai, 2012), particularly for those jobs specific to the energy sector and within the bur-

geoning oil and natural gas industry (Committee on Emerging Workforce Trends in the U.S. Energy and Mining Industries et al., 2013).

It is estimated that nearly half of all STEM jobs do not require a four-year degree and that one-third of all STEM jobs are in blue-collar occupations (Rothwell, 2013). Among workers with only a high school diploma or an associate's degree, wages for those with STEM jobs are substantially higher than those in other fields (Carnevale, Smith, and Melton, 2011). A report by the Brookings Institution refers to this subbaccalaureate segment of the labor market as the "second STEM" economy, in which workers are considered "semiskilled" or "middle-skilled" (Rothwell, 2013). Semiskilled jobs in the second STEM economy include a diverse array of occupations, such as carpenters, machinists, mechanics, electricians, production workers, computer support specialists, computer systems analysts, and drafters (Landivar, 2013; Rothwell, 2013).

Three major federal efforts occurred in 2014 to address this gap—each emphasizing that public-private partnerships are a potentially promising practice to develop a "job-driven" U.S. workforce and training system. First, President Barack Obama convened the President's Council on Jobs and Competitiveness, composed of 25 leaders from business, labor, and academia, to develop ideas to accelerate job growth and improve the country's long-term position in the global economy. A key recommendation was to promote partnerships between businesses and educational institutions to ensure that training for students and workers meets the demands of the labor market (President's Council on Jobs and Competitiveness, 2014). Second, in July 2014 the White House released a *Job-Driven Checklist* (U.S. Department of Labor et al., 2014) to make the U.S. workforce and training system "more job-driven, integrated and effective to improve job-driven training and education" (White House, 2014). Third, on July 9, 2014, Congress passed (and the President then signed on July 11) the Workforce Innovation and Opportunity Act of 2014 (WIOA) (Pub. L. 113-128). This act reauthorizes the Workforce Investment Act *of 1998* (WIA) (Pub. L. 105-220) and ties federal workforce training money to local and regional employers that will help customize training programs at high schools and community colleges. It also consolidates programs

and provides more local flexibility in how they are run. The aim of this act is to promote workforce-development programs that are directly tied to skills demands. WIOA requires states to develop unified plans across all WIOA-authorized programs and encourages them to incorporate the White House's *Job-Driven Checklist* into their new plans.

Energy-Sector Employment Needs in West Virginia

The need to stem workforce shortages is particularly pronounced in West Virginia, given the burgeoning field of natural gas extraction that exists alongside well-established coal mining and crude-oil extraction industries. In 2011, West Virginia was the fifth-largest producer of energy in the nation, accounting for 5 percent of the nation's total. West Virginia generates more electricity than its population consumes, exporting about 56 percent of its net generation to other states in 2010. However, on a per capita basis, West Virginia is one of the largest consumers in the United States because of consumption by the state's industrial sector. Chemicals, primary metals, and lumber are major manufacturing industries in the state, and they all consume large amounts of electricity. Coal remains the primary source of energy; in 2012 West Virginia produced 12 percent of total U.S. coal production, making the state the second-largest coal producer after Wyoming. Coal-fired electric power plants accounted for 95 percent of West Virginia's net electricity generation in 2013.[1]

In recent years, the production of natural gas and natural gas liquids from shale resources, and their use in industry, has increased greatly. A key source for natural gas in the state is the 6,000-foot-deep Marcellus Shale formation. Proven shale gas reserves in West Virginia have increased substantially since 2007; by 2011, they exceeded 6 trillion cubic feet of natural gas. Shale gas production surpassed the production from all other natural gas wells in the state for the first time in 2011. West Virginia has some of the most liquid-rich natural gas in the Marcellus region, with liquids making up nearly 9 gallons per thousand cubic feet (mcf) of gas in some areas (Braziel, 2011). Many natural gas

[1] All information in this paragraph was taken from the U.S. Energy Information Administration, 2014.

processing plants are being constructed or expanded in north central West Virginia to separate these liquids from dry natural gas (West Virginia Department of Commerce, 2014). West Virginia also has large underground natural gas storage capacity, accounting for about 6 percent of the U.S. total.

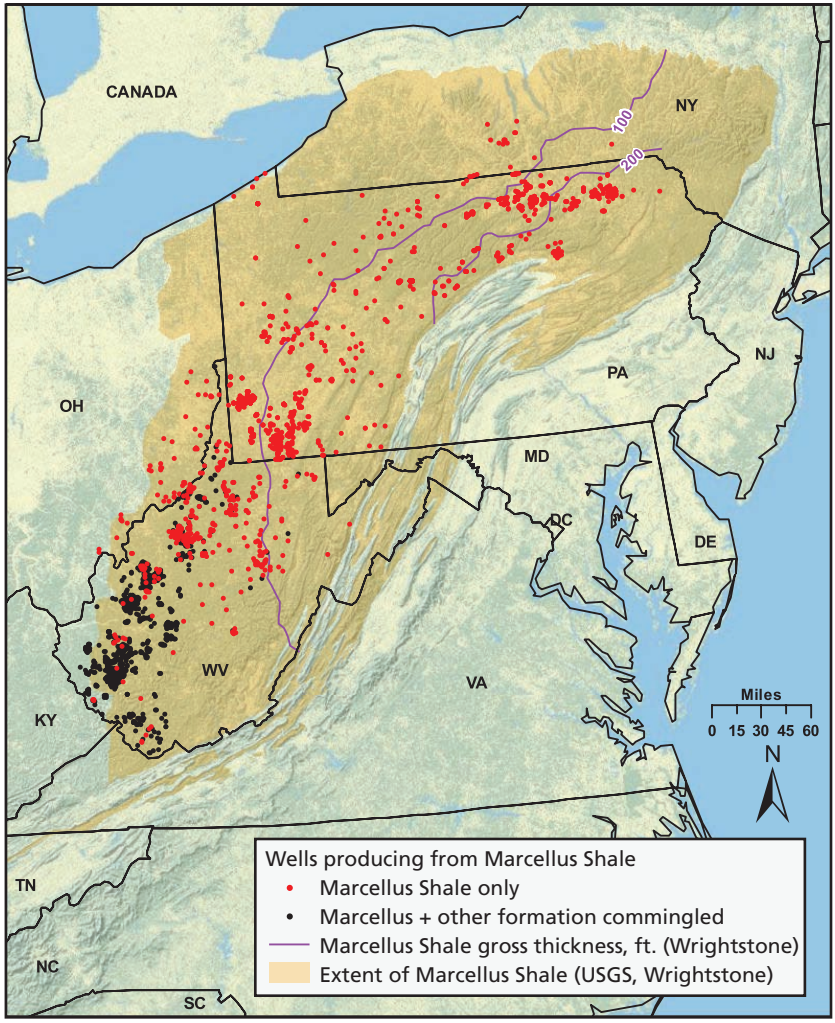
Figure 1.1 shows the extent of the Marcellus Shale formation and the location of major wells in relation to the states of West Virginia, Pennsylvania, and Ohio. We also show New York, which currently has imposed a moratorium on extracting natural gas through hydraulic fracturing ("fracking") but has substantial reserves of shale gas.

The Marcellus Shale gas industry has emerged as the new nexus of entry- and mid-level STEM jobs in Ohio, Pennsylvania, and West Virginia. Employment in the core occupations of the Marcellus Shale gas industry increased 130 percent—more than 15,000 jobs—from 2009 to 2013, with average wages reaching $90,000 per year (Pennsylvania Department of Labor and Industry, 2014). The increase in the production of natural gas in West Virginia has brought about a concomitant rise in the demand for workers in the energy industry. According to employment projections from WorkForce West Virginia,[2] the oil and gas extraction industry in West Virginia will experience a 17-percent increase in employment from 2012 to 2022, while (non–oil and gas extraction) mining will suffer a 16.4-percent decrease, or almost 4,000 positions (as detailed in Table 1.1). Indeed, in 2012, due to low prices for coal and greater demand for natural gas, a number of mines shut down operations, creating a loss of more than 3,000 jobs that year (about 13 percent of the state's mining jobs).[3] To buffer the job loss, the U.S. Department of Labor (DOL) awarded a $1.8 million National Emergency Grant (NEG) to WorkForce West Virginia to provide retraining and reemployment services to dislocated coal miners and displaced homemakers impacted by mass layoffs and coal mine closures (as of

[2] WorkForce West Virginia is a division within the state Department of Commerce. It houses the research, information, and analysis office, which produces monthly reports on civilian labor force, employment, and unemployment using state Labor Market Information data. More information can be found on its website (WorkForce West Virginia, undated[a]).

[3] For figures on the national employment rate of coal mining, see U.S. DOL, Bureau of Labor Statistics (BLS), undated.

Figure 1.1
Map of Marcellus Shale Gas Play



SOURCE: U.S. Energy Information Administration based on data from West Virginia Geological and Economic Survey, Pennsylvania Department of Conservation and Natural Resources, Ohio Division of Geological Survey, New York Department of Environmental Conservation, Virginia Department of Mines, Minerals and Energy, U.S. Geological Survey (USGS), Wrightstone, 2009.
NOTE: Only wells completed after January 1, 2003, are shown. Updated June 1, 2011.

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Table 1.1
Employment Projections for the Mining Industry in West Virginia, 2012–2022

NAICS Code	Industry Title	2012 Employment	Projected 2022 Employment	Growth Rate	Numeric Change	Percentage Change
	Total—all industries	787,112	825,712	0.49	38,600	4.9
210000	Mining (total)	32,782	30,343	–0.74	–2,439	–7.4
211000	Oil and gas extraction	2,272	2,658	1.70	386	17.0
212000	Mining (except oil and gas)	23,552	19,686	–1.64	–3,866	–16.4
213000	Support activities for mining	6,958	7,999	1.5	1,041	15.0

SOURCE: WorkForce West Virginia, undated(b).

NOTE: NAICS (North American Industry Classification System) is the standard code used by federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. It was developed by the Office of Management and Budget and adopted in 1997 (see U.S. Census Bureau, 2014, for more information).

March 1, 2012)—with a $5.6 million extension awarded in 2014 to extend training opportunities to the end of 2016. The grant is intended to help participants find new career paths outside the coal mining industry and long-term reemployment opportunities. The grant provides up to $5,000 per year to be used toward training in an occupation expected to be in high demand. Participants can also be enrolled in a business's on-the-job training (OJT) programs, in which a participant can earn a wage while participating in occupational skills training provided by an employer. In addition, the grant can provide assistance with job search activities and some daily expenses.[4]

Two industries in West Virginia experienced notable gains in employment between 2008 and 2012 due, in part, to the increase in Marcellus Shale natural gas extraction activity: (1) establishments engaged in the construction of oil and gas pipelines, mains, refineries, and storage tanks and (2) establishments engaged in support activities, such as excavation, well surveying, running and cutting casings, and other well work. In the case of the former, employment grew by more than 200 percent from 1,276 in 2008 to 3,941 in 2012. Wages during this period grew by approximately 35 percent from an annual average of $60,329 in 2008 to $81,250 in 2012. In the case of the latter, employment increased by more than 46 percent from 2,782 in 2008 to 4,074 in 2012. Wages increased more than 36 percent from an annual average of $46,615 in 2008 to an annual average of $63,607 in 2012 (WorkForce West Virginia, 2013b).

The new employment opportunities have typically been in occupations that require a semiskilled workforce, i.e., those that require only some training or certification after high school (Kauffman and Fisher, 2012). Table 1.2 lists key occupations in Marcellus Shale–related industries in the third quarter of 2013, as reported by WorkForce West Virginia and the U.S. DOL, BLS. Only two of the 15 key occupations require a bachelor's degree. The remaining occupations require a high school diploma or equivalent, with either some work experience or on-the-job training. For some occupations, a high school diploma

[4] More information about the decline in the West Virginia coal mining and the Workforce West Virginia grant can be found at WorkForce West Virginia, 2012c.

Table 1.2
Key Occupations in Marcellus Shale–Related Industries, 2013

Job Title	Annual Wage ($)	Education	Work Experience	Job Training	Employment	Employment RSE (%)[a]
Petroleum engineer	110,355	Bachelor's degree	—	—	170	19.0
Geoscientist	60,177	Bachelor's degree	—	—	130	11.4
Gas plant operator	63,747	High school diploma or equivalent	—	Long-term OJT	290	20.0
Gas compressor or gas pumping station operator	53,765	Less than high school	—	Moderate-term OJT	340	21.2
Rotary drill operator, oil and gas	53,523	Less than high school	—	Moderate-term OJT	620	25.6
Service unit operator, oil and gas	48,050	Less than high school	—	Moderate-term OJT	1,000	12.7
Plumber, pipefitter, or steamfitter	46,386	High school diploma or equivalent	—	Apprenticeship	2,090	11.7
Operating engineer	44,856	High school diploma or equivalent	—	Moderate-term OJT	6,200	6.6

Table 1.2—Continued

Job Title	Annual Wage ($)	Education	Work Experience	Job Training	Employment	Employment RSE (%)[a]
Derrick operator, oil and gas	44,844	Less than high school	—	Short-term OJT	440	43.4
Industrial machinery mechanic	42,267	High school diploma or equivalent	—	Long-term OJT	2,560	10.0
Welder	39,350	High school diploma or equivalent	Less than 1 year	OJT	2,650	10.7
Wellhead pumper	36,674	Less than high school	Less than 1 year	Moderate-term OJT	880	14.0
Construction laborer	34,724	Less than high school	—	Short-term OJT	8,410	5.1
Truck driver, heavy or tractor-trailer	34,681	High school diploma or equivalent	1 to 5 years	Short-term OJT	11,520	4.5
Roustabout, oil and gas	27,464	Less than high school	—	Moderate-term OJT	1,070	12.4

SOURCE: WorkForce West Virginia, 2013a, Table 2. Employment and relative standard error (RSE) from U.S. Department of Labor, Bureau of Labor Statistics, 2013.

NOTE: — = none required.

[a] The RSE of the employment estimate is a measure of the reliability or precision of the employment estimate. The relative standard error is defined as the ratio of the standard error to the survey estimate. For example, a relative standard error of 10 percent implies that the standard error is one-tenth as large as the survey estimate (U.S. Department of Labor, Bureau of Labor Statistics, 2015).

is unnecessary. Occupations in Table 1.2 are listed in order by highest annual wage.

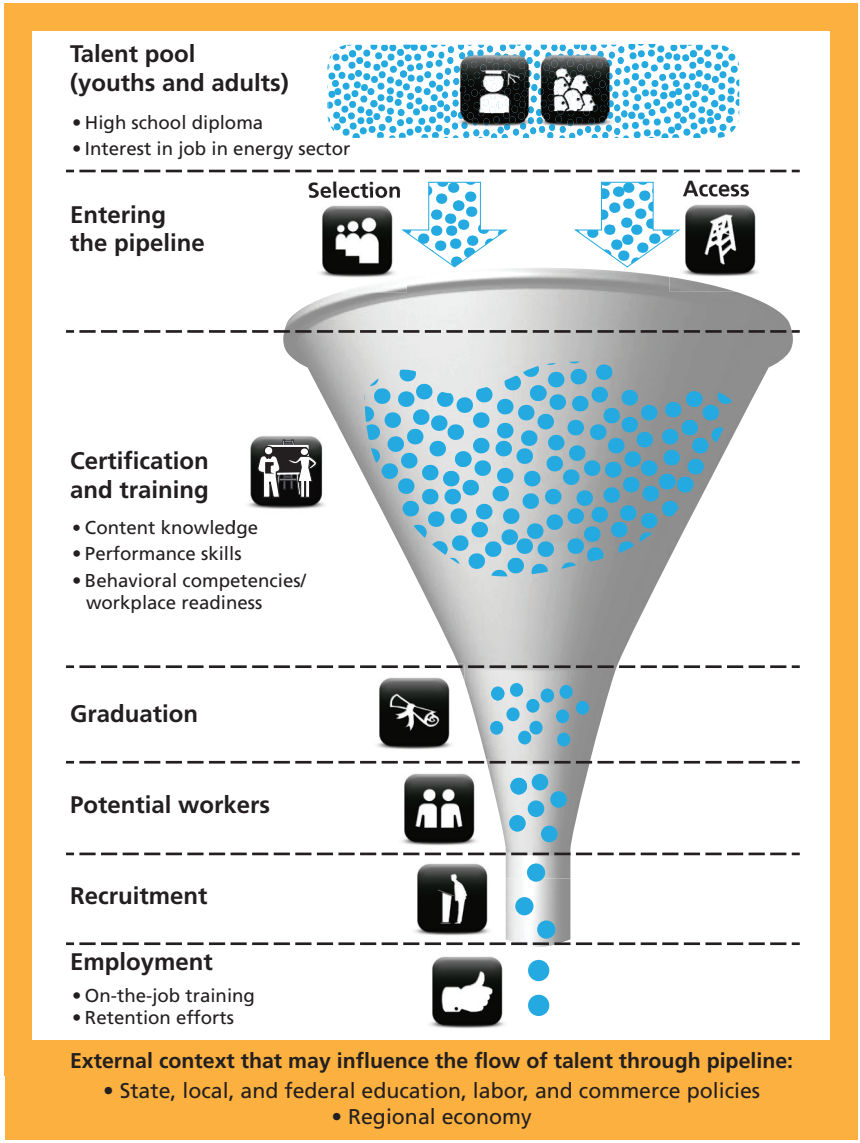
The Workforce-Development Pipeline for the Energy Sector in West Virginia

In light of the growth in potential employment opportunities in semi-skilled jobs in the energy sector, a clear challenge facing West Virginia is how to quickly generate qualified candidates to fill these positions. The state would benefit from developing an effective system for recruiting, training, and educating the local talent pool to fill the job and skills needs of energy-sector employers in the short and long terms. Such a system, an *energy-sector workforce-development pipeline*, consists of three interconnected components: potential talent, education and training providers, and employers.

Figure 1.2 illustrates this pipeline. At the top of the pipeline is the pool of potential applicants for a certification or training program. Potential applicants include youths who have recently graduated from high school or have passed the General Education Development (GED) test for a high school diploma equivalent, adult learners with insufficient credentials, and energy-sector employees who are seeking advancement. Typically, individuals within this pool of potential applicants for a certification or training program flow through the pipeline, gaining admittance to the training courses and educational programs that will provide them with the skills needed to meet the demands in available jobs. Education and training programs can be available in two-year public degree-granting institutions, such as community colleges; at private technical certification programs; by Workforce Investment Boards (WIBs); or through registered apprenticeship programs required for specific certifications or licenses. Two key factors can impede or facilitate the flow of talent through the pipeline: (1) economic activity within the region; and (2) the policy environment created by local, state, and federal education, labor, and commerce policies.

As suggested by the pipeline depicted in Figure 1.2, workforce development is a system of interrelated components within which employment training is just one part of a larger whole. For the system

Figure 1.2
Illustration of the Workforce-Development Pipeline for the Energy Sector



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to function adequately so that talent is prepared appropriately and is therefore employable in the energy sector, and for employers to recruit, hire, and retain workers who meet the skills needs of job opportunities, the components need to operate in a cohesive way. This requires deep employer engagement in all aspects of the pipeline, career advancement opportunities for talent-, industry-, or job-driven education and training, and connectivity across all components (Giloth, 2000).

The workforce-development system for the energy sector in West Virginia faces a number of hurdles to becoming a fully functioning, coherent system due to the following unknowns:

- the number of new jobs likely to be created and the skills needed for those jobs from the upstream, midstream, and downstream parts of the sector in both the near and long terms
- the degree to which the current talent pool has the skills and competencies desired by the energy sector
- whether current training programs are able to meet the energy sector's projected workforce demands
- the extent to which prospective employees are aware of, have access to, and utilize regional training opportunities.

Purpose of This Study

Recognizing the need for a well-aligned workforce-development pipeline in West Virginia to meet the burgeoning oil and natural gas industry's demand for semiskilled STEM workers and the important role community colleges can play in filling shortages in semiskilled jobs, in 2013 the National Energy Technology Laboratory (NETL) asked the RAND Corporation to work closely with the Community and Technical College System of West Virginia (CTCS) to develop a strategy for energy-sector employers and public education and training institutions to collaborate to ensure that the local talent pool is prepared to enter the workforce with the content knowledge, performance skills, abilities, and behavioral competencies to fill semiskilled energy-sector jobs across the state now and in the near future.

Community colleges play an integral role in STEM professional workforce development and offer a way for public education institutions to provide the education and training needed for talent to obtain a job in the energy sector. Workforce development has been one of the key missions of community colleges nearly from their inception in the beginning of the 20th century (Vaughan, 2006), and such colleges are typically the education institution of choice for students wishing to enter the workforce shortly after graduating from high school or to gain more skills if they have been in the labor force (Kane and Rouse, 1999). For most communities, two-year colleges and trade schools are the primary arena for imparting the skills and training needed to succeed in the subbaccalaureate local labor market. This is particularly the case for non–college-bound youths, who often remain in their hometowns after graduation and, thus, typically constitute the labor pool for local employers (Daugherty et al., 2014). While high-skilled STEM jobs that require bachelor's degrees are clustered in select metropolitan areas to which many young workers migrate after finishing college, jobs in the second STEM economy are more geographically dispersed and available in nearly every major metropolitan region (Rothwell, 2013). Students rely on community colleges because of their low tuition and fees, proximity to jobs and family, and open admissions (Mooney and Foley, 2011; Tsapogas, 2004). It was thus important to CTCS that graduates from its associate's degree and workforce-development training programs be prepared for employment in the semiskilled energy sector.

The strategy developed from our analysis provides guidance to public two-year institutions of higher education in terms of programs and supports for students. It also provides recommendations on informing and attracting prospective workers to this sector in West Virginia. In this report, we lay out approaches that CTCS could adopt to ensure that it is offering the appropriate kinds of programming to best fit the needs of its students and employers in the energy sector. The recommended changes should ensure that West Virginians will be prepared to enter the workforce. The report describes the characteristics of high-quality programs, practices that promote access to programs,

and actionable guidelines for successful implementation of programs and practices.

Study Scope and Limitations of Analysis

For the analyses undertaken in this study, we defined the scope of the energy sector broadly to include the industries listed by the National Academy of Sciences (2013) and Kauffman and Fisher (2012): oil, natural gas (including liquefied natural gas [LNG] and natural gas liquids), coal, renewables (e.g., solar and wind), nuclear, electricity transmission and distribution, and intelligent building technologies. Within those industries, we focus on a subset of energy-industry components:

- production/extraction
- equipment manufacturing
- monitoring/controls
- design/engineering/construction (including smart buildings).

We do not investigate the education and training required to meet skills needed for employment in "downstream" industries supported by the energy sector, such as the refining of petroleum crude oil and the processing and purifying of raw natural gas, as well as the marketing and distribution of products derived from crude oil and natural gas. Nor do we include in this study indirect jobs that typically build up around newly established energy-sector locales, such as hotels, restaurants, and other hospitality or service-sector businesses, or government or environmental jobs that have grown to monitor or regulate the energy sector.

This study's analysis focuses on education and training opportunities for semiskilled jobs in the energy sector available through the public education system (K–12, community and technical education opportunities, and community colleges) in West Virginia. While we do include a description of private technical programs within this report, we do not conduct a focused analysis on the quality of the myriad private technical programs available within the state, nor on the training opportunities and apprenticeships available. (Many of the

high-demand occupations in the energy sector in West Virginia require union membership, and unions typically cosponsor, with industry leaders, apprenticeship programs that align with industry standards. For example, the International Brotherhood of Boilermakers represents workers in industrial construction, repair, and maintenance; manufacturing; shipbuilding and marine repair; railroads; and mining and quarrying and offers a national apprenticeship program.)

It was also outside of the scope of this study to conduct a thorough labor market analysis of the employers' demands compared to local talent's skills. In order to conduct such a study, one would need to acquire data from employers in the state on current and projected demand for needed jobs and skills, where core vacancies within their firms are, and data on hiring practices—such as number of applicants per open position. This type of analysis is needed to have an accurate understanding of employers' demands and whether there is a shortage of skilled talent to fill that demand.

Because we defined the parameters of the study in consultation with our colleagues at NETL and CTCS, it was important to focus on the issues deemed most relevant to the public education and training programs within the state. We recognize that the study's narrow scope limits our ability to examine the breadth of potential training opportunities for a wide range of possible occupations related to the energy sector. Given this limitation, this study is intended to be a first, exploratory phase of analysis, which will inform subsequent phases of work to support workforce development for West Virginians. The recommended strategy produced from our analysis is intended to serve as a launching point for discussions among industry leaders and education and training provider stakeholders in West Virginia to collaboratively develop an implementation plan. The strategy should be useful to regional stakeholders and prove valuable as a template for other regions confronted with similar workforce-development challenges.

Analytic Approach

Four tasks informed the development of the strategy. In this section, we describe each task, associated research questions, and the data sources we used to answer the research questions.

Task 1: Identify Key Knowledge, Skills, and Abilities Needed for Energy-Sector Jobs in West Virginia

Two research questions guided this task:

- What types of jobs are available at the time of this study?
- What skill sets do those jobs demand in terms of content knowledge, performance skills, and workforce-readiness skills (behavioral competencies or "soft" skills)?

To answer these questions, we relied on two sources of data. We first reviewed previous work that projects the short-term employment needs of various energy-sector industries in West Virginia. We then analyzed Occupational Information Network (O*NET) data from the U.S. Department of Labor (DOL) Employment and Training Administration (ETA). This data set provides a national- and state-level portrait of the key knowledge, skills, and abilities (KSAs) needed by the energy sector, and specifically oil and gas occupations, as reported by employers.

Task 2: Identify Gaps Between Educational and Training Programs and Employers' Reported Needs

This task answered one research question: To what extent are the educational and training programs offered by CTCS providing the skill sets required by the region's energy sector for its existing and future workforce?

To answer this research question, RAND researchers relied on three sources of data. First we used publicly available documentation about course requirements, content and skills covered in each program, and enrollment to document existing CTCS educational and training programs that focus on employment in the energy sector. Second, we conducted interviews with key CTCS program staff in charge of

curriculum development and programs of study. Interview questions focused on collecting information on program course requirements and curricula and did not ask about personal opinions or perspectives. Interviews were conducted in person at three community colleges and by telephone for the remaining six community colleges and education partners in the state of West Virginia. We contacted 85 individuals in CTCS or education consortia; we interviewed roughly half of them.[5]

We complemented the document review and interviews with CTCS and education providers with interviews with representatives from two unions whose members typically work in the oil and gas sector in West Virginia, a representative from one regional WIB located in an area in West Virginia that has a high volume of oil and natural gas job openings, and a small, purposefully selected sample of energy-sector employers. The sample of employers was selected to be representative of the state's energy-sector employers in aggregate, including type of industrial activity, firm size (number of employees), and geographic location. We contacted 20 employers and interviewed five of them. Interviews inquired about types of jobs and skill sets (content knowledge, performance skills, and workforce-readiness skills) that need to be filled as well as probing about how innovation or shifts within the energy sector might change needed jobs or skill sets of employees.

Task 3: Identify Reported Barriers and Perceptions That Inhibit Students' Access to Educational and Training Opportunities in the Energy Sector

Three research questions guided this task:

- What are the typical or common challenges workforce-development programs experience in attracting students to their programs, and how are these challenges being addressed?

[5] Some individuals referred us to other staff at their institutions whom they felt were better able to answer our questions. Some of these referrals directed us to someone else. Others refused to participate when we contacted them to schedule an interview time; still others did not respond to our attempts to schedule by email or phone. A few declined to participate once we tried to conduct the interview.

- Are current mechanisms aimed at overcoming these challenges reportedly successful?
- What are the barriers experienced or reported by the local talent pool in accessing energy-sector training or programs?

To answer the first two research questions, we relied on information provided in the interviews with key staff employed by institutions of higher education in West Virginia undertaken in task 2. In the interviews, we inquired about reported challenges, what measures the institutions had implemented to offset these challenges, and which measures, if any, had been successful—in the opinion of the interviewee.

To understand the barriers to accessing training programs and perceptions of employment in the energy sector, we conducted focus groups with a sample of students currently in a purposefully selected set of CTCS energy sector–related training programs. Questions during the focus groups explored students' perspectives of barriers or challenges encountered in entering postsecondary education or training programs. These could be institutional challenges (such as the need for childcare or constraints on transportation) or personal issues (such as family approval or disapproval of pursuing employment in the energy sector). The findings from the focus groups were not intended to be generalizable to other students in higher education but rather were intended to help develop hypotheses about potential barriers that postsecondary education institutions will need to help students overcome.

Task 4: Synthesize Promising Approaches to Improve the Energy-Sector Workforce Pipeline

To develop effective strategies that West Virginia may choose to adopt to fill gaps in the workforce-development pipeline, we reviewed several national partnerships that aim to develop key workforce skills, knowledge, and behavioral competencies. We defined a partnership as any publicly coordinated effort between stakeholders from at least two different areas (e.g., education, industry, local/regional/federal government). We first focused on those partnerships evaluated using rigorous program evaluation methodologies or highlighted in peer-reviewed journals or books as informative case studies. However, the review was

not intended to provide a comprehensive overview of the entire literature on workforce development. Indeed, partnerships for the immediate West Virginia region were limited in number and scope and have not been systematically evaluated to determine their effectiveness. Therefore, we first described the characteristics of regional and high-profile energy partnerships and initiatives identified through Internet searches using several combinations of terms (e.g., *energy partnerships*, *consortium*, *workforce development*, *training*). We then distilled lessons and promising practices resulting from this review to offer ways West Virginia's institutions of higher education can fill gaps in their programs or course offerings to meet the demands of energy-sector employers.

Organization of This Report

The remainder of this report summarizes the findings from each task and presents our suggested strategy to support workforce development in the energy sector in West Virginia. Chapter Two provides background information on the educational system and employment in the energy sector in West Virginia. Chapter Three summarizes the analyses and findings from task 1. Chapter Four describes the gaps in alignment of the workforce-development pipeline based on analyses from tasks 2 and 3. Chapter Five summarizes our analysis and findings from task 4. Chapter Six presents our synthesis of the information from the four tasks into a workforce-development strategy for the energy sector. Appendix A provides detailed figures of KSAs rated as "highly important" for employers in West Virginia and the U.S. energy sector, from analyses of O*NET data. Appendix B contains the protocols for the interviews and focus groups conducted in tasks 2 and 3. Appendix C lists the energy-sector training programs available at each CTCS college campus.

CHAPTER TWO

Characteristics of the Energy-Sector Workforce-Development Pipeline: Education, Training, and Employment in West Virginia

This chapter describes each of the three components of the energy-sector workforce-development pipeline in West Virginia: potential talent, education and training providers, and employment opportunities. The chapter provides context for the analyses reported in subsequent chapters. We start with a description of the academic achievements of the potential talent pool in the state. Although the potential talent pool includes recent high school graduates as well as adult workers, this section focuses on the skills youths have acquired in high school. We then describe postsecondary education and training opportunities that aim to prepare the workforce for jobs in the energy sector within West Virginia, including private technical training programs and apprenticeship programs, state-sponsored training opportunities through Workforce Investment Areas, CTCS, early degree pathway initiatives, and opportunities to obtain a bachelor's degree. We conclude with a description of key energy employers and employment figures.

Component 1: Talent Pool in West Virginia

The talent pool of prospective candidates seeking employment in the West Virginia energy sector consists of youth and adults who have an active interest in the energy sector and who have a high school diploma. This section describes the knowledge and skills of the state's youths to determine how well equipped the young talent pool in West Virginia is for potential employment in the energy sector. We describe

on-time graduation rates for high school students (the percentage of ninth-graders who graduate within four years) and recent results from the West Virginia Educational Standards Test 2 (WESTEST2), which is administered to all students in grades 3 through 11.

High School Graduation Rates

On average, the high school graduation rate in West Virginia is close to the national average: Seventy-nine percent of ninth-graders enrolled in West Virginia high schools in the fall of 2008 graduated within four years, by the spring of 2012; 72 percent of economically disadvantaged students graduated on time. The national averages are 80 percent and 72 percent, respectively (Stetser and Stillwell, 2014, Table 2, p. 10). While West Virginia high school students are graduating at rates similar to those of other students across the United States, it is evident from the results on WESTEST2 assessments, described in the following section, that most students are graduating from high school without the requisite skills to be competitive in the energy-sector labor market.

Students' Performance on State Assessments

According to K–12 student performance data released by the West Virginia Department of Education, 46 high schools in West Virginia, or 40 percent, met or exceeded the No Child Left Behind (NCLB) (Pub. L. 107-110, 2002) standards for mathematics and reading as of 2011 (West Virginia Department of Education, undated[b]). This suggests that 60 percent of high schools in West Virginia are not meeting the adequate yearly progress on WESTEST2 assessments, and their students are not making significant progress on the state assessments. In the 2011–2012 school year, fewer than half of the students in West Virginia were deemed proficient or above in mathematics and in reading on the WESTEST2 (48 percent of students in mathematics and 49 percent of students in reading (West Virginia Department of Education, undated[c]).

A closer examination of high school students reveals similar results. Table 2.1 summarizes WESTEST2 assessment results for grades 9, 10, and 11 from the 2012–2013 and 2013–2014 school years, the most recent data available. Overall, fewer than half of tested

Table 2.1
High School Student Performance on the WESTEST2, 2012–2013 and 2013–2014

Grade Level and Subject	Percentage Proficient 2012–2013	Percentage Proficient 2013–2014
9th		
Mathematics (algebra 1)	42	41
Reading/language arts	51	51
Science (physical science)	35	34
Social studies	37	37
10th		
Mathematics (geometry)	42	39
Reading/language arts	50	48
Science (biology)	40	37
Social studies	43	32
11th		
Mathematics	44	42
Reading/language arts	46	43
Science (chemistry)	38	33
Social studies	37	24

SOURCE: West Virginia Education Information System, undated.

high school students in the state of West Virginia were proficient in mathematics, reading, and science. Less than half of high school students were proficient on the mathematics WESTEST2: 41 percent on the test for algebra I, 39 percent on geometry, and 42 percent on eleventh-grade mathematics in 2013–2014. Performance on the Reading/Language Arts assessments is slightly higher than on mathematics in 2013–2014, with about half of students scoring proficient or above (51 percent of ninth-graders, 48 percent of tenth-graders, and 43 percent of eleventh-graders). High school students scored lowest on WESTEST2 science assessments. On the physical science assess-

ment, 34 percent of students scored at or above proficient, 37 percent of tenth-graders on the biology assessment scored at or above proficient, and 33 percent of eleventh-grade students on the chemistry assessment scored at or above proficient.

In comparison, 60 percent of eleventh-grade students in Pennsylvania were scored as proficient in mathematics, 68 percent in reading, and 42 percent in science on the Pennsylvania Standardized Student Assessments in 2011–2012 (the most recent year of data publicly available) (Pennsylvania Department of Education, undated). Although students in the two states are taught using different standards and curricula, and the assessments and the points at which students are deemed proficient also differ, the gaps in mathematics and reading percentage-proficiency between students in the two states are noteworthy. Results from the 2012 Programme for International Student Assessment (PISA), a series of tests in mathematics, reading, and science literacy administered by the Organisation for Economic Co-operation and Development (OECD) to representative samples of 15-year-olds in 65 countries, corroborate the WESTEST2 results. PISA results demonstrate that about 77 percent of students in the United States surpassed Level 2 on the PISA mathematics (OECD, 2014). Level 2 is considered a baseline level of proficiency at which students can interpret and recognize situations in contexts that require no more than direct inference. This is a "baseline level of proficiency at which students begin to demonstrate the skills that will enable them to participate effectively and productively in life" (OECD, 2013, p. 24). Therefore, compared with the average 15-year-old in the United States, it is evident that West Virginia eleventh-graders are not graduating with the necessary mathematics skills to participate productively in life.

Component 2: Education and Training Opportunities

There are many options for secondary and postsecondary education for West Virginians. There are technical training programs for high school students and high school graduates; public or private two-year

degree programs offering certifications, licenses, and associate's degrees; four-year degree programs offering a bachelor's in science; employer-developed on-the-job training programs; and registered apprenticeships that provide required training and experience for union positions. Education and training providers can be either private or public, and some providers offer more than one type of training or degree program. In this section, we describe the core secondary and postsecondary public education and training providers in the state of West Virginia: the career and technical education (CTE) program, technical and training programs offered within CTCS, associate's degree programs available in CTCS, and bachelor's degree programs available in West Virginia institutions of higher education.

Career and Technical Education

The CTE program is a West Virginia State Department of Education initiative that provides individual courses as well as career cluster training at the high school and postsecondary levels. There are six career clusters: (1) Agriculture, Science, and Natural Resources; (2) Arts and Humanities; (3) Business and Marketing; (4) Engineering and Technical; (5) Health Science Education; and (6) Human Services. In West Virginia the Engineering and Technical cluster is the most relevant to the energy sector. Within that cluster is a broad range of concentrations, including electrical technician; energy, power, and engineered systems; hydraulic and pneumatic systems troubleshooting; mining extraction; power equipment systems; and preengineering. Students may either take a single course or graduate high school as "completers," indicating that they completed four courses in a concentration and acquired an industry certification or accreditation. Depending on the course or career cluster in which students are interested, they may participate in CTE at their high school, a county center or multi-county center, or a combination of those locations. During the 2012–2013 school year there were seven multi-county CTE centers, where students are drawn from two or more counties; 23 county CTE centers offering five or more occupational programs in five career clusters; and 25 comprehensive high schools with five or more occupational programs in five career clusters. Eighty-nine high schools offer individual CTE

credit courses (West Virginia Office of Career Technical Education, undated).

When students graduate from high school, those who complete four or more CTE classes in good standing receive a diploma from their school as well as industry accreditation or certification. After graduation, students can choose to (1) enter the workforce, (2) enroll in workforce-education and training classes at public institutions (i.e., at CTE—which are called adult education programs—or at CTCS) or private institutions, (3) enroll in an associate's degree–granting institution (i.e., at CTCS), another public degree-granting institution, or a private two-year degree-granting program, or (4) enroll in a public or private four-year program. Students may move between these options based on interests, academic readiness, cost, or other reasons. For example, a student may opt to enter the workforce immediately after graduation, then after a few years decide to enroll in a technical training program. Others may opt to enroll in a four-year college or university but find that a two-year degree–granting program closer to home is a better fit. The system is very flexible, allowing many West Virginia high school graduates to move in or out of a variety of postsecondary programs.

Technical Training Programs

Technical training programs offer industry-recognized certifications or accreditations, such as novice welding certifications, at the time of program completion. Technical certification programs are offered by private institutions, through the Workforce Development department of CTCS, and through Workforce Investment Areas, registered apprenticeship programs, and CTEs.

The Workforce Investment Act of 1998 (WIA) provides the framework for a national workforce preparation and employment system, which was to be demand driven, thereby supporting the engagement of employers in workforce training and helping companies find the skilled workers they need, as well as customer focused to help individuals access the tools they need to manage their careers. WIA changed the prior system in three ways. First, income level was no longer the sole criterion by which a person could access services. Funds for train-

ing services were therefore distributed through individual training accounts to training providers chosen by the WIA-eligible participant. Second, WIA required a process by which training providers would establish eligibility: They needed to have an established track record of positive outcomes that met or exceeded each state's performance criteria. States had to establish eligible training provider lists and approved training courses. And, third, services were consolidated at the local level in each state into One-Stop Career Centers. One-Stop Career Centers are the entry point for any person seeking job training and employment services throughout the state. The One-Stop Career Center concept replaces the previous system of services in which an individual visited different state agencies at different locations. State governments were tasked to set up WIBs to oversee WIA implementation and develop the workforce system at the local level (Besharov and Cottingham, 2011). In West Virginia, there are seven Workforce Investment Areas, each with its own One-Stop Career Center, called WorkForce West Virginia Centers. Services provided through the WorkForce West Virginia Centers include, but are not limited to, case management services, vocational guidance assistance, assessment, job-development contracts, referrals to job openings, résumé preparation assistance, labor market information, job finding workshops, veteran tax credit eligibility determination, civil services information, and referrals to partners and other agencies. Typically there are several WorkForce West Virginia Centers within each WIA, and the Center provides services to several counties (WorkForce West Virginia Region VI Workforce Investment Board, 2003). Each WIB plans and implements the Workforce Investment Area's system to coordinate the skills local job seekers are obtaining with the skills that local employers want for their businesses. Members of the WIB are individuals from business, education, labor, community-based organizations, economic development, and One-Stop partner agencies.

Registered apprenticeships are another opportunity for training. The National Apprenticeship Act of 1937 (Pub. L. 75-308) directed the Secretary of Labor to establish labor standards for apprentices, effectively creating the registered apprenticeship system. Registered apprenticeship training is distinguished from other types of workplace

training by several factors: (1) participants earn wages from employers during training, (2) programs must meet national standards for registration with the U.S. Department of Labor (or federally recognized state apprenticeship agencies), (3) programs provide on-the-job learning alongside job-related technical instruction in a classroom, (4) on-the-job learning is conducted in the work setting under the direction of one or more of the employer's personnel, and (5) training results in an industry-recognized credential (U.S. Department of Labor, 2008). Nationally, employers, employer associations, and labor management organizations (unions) typically sponsor an apprenticeship program. Sponsors and employers customize apprenticeship training to their needs, within the bounds of federal and state standards, and cover the costs of training, wages paid to apprentices, costs of managing the program, and costs associated with time spent by senior employees to mentor and train apprentices (Reed et al., 2012; Wagner, 2010). Unions have a long history of creating and offering apprenticeships, although participation declined for many years. Now apprenticeships are regaining popularity in the traditional industries of construction, manufacturing, and the skilled trades as employers and workers alike look for reliable skill-enhancement pathways that lead to portable credentials (U.S. Department of Labor, 2008). In West Virginia, apprenticeship opportunities in the energy sector are typically available through unions, from the local affiliates for boilermakers, ironworkers, electricians, laborers, operating engineers, plumbers and pipefitters, and sheet metal workers. On average, programs are three years in duration and apprentices' pay starts at 60 percent of a journeyman pay scale with benefits. Increases are given every six months until training is complete (West Virginia Joint Apprenticeship Programs, undated).

CTEs also offer technical training programs to the community, separate from the programming offered to high school students described previously. In some cases a CTE program will offer technical training in the same skills as CTCS. There are no academic requirements or selection criteria, like ACT or high school performance data, for technical programs.

Associate's Degree Programs

Two-year associate's degree programs are offered through private institutions as well as CTCS. CTCS is composed of nine community and technical colleges (CTCs), located across 27 campuses: Blue Ridge CTC, BridgeValley CTC,[1] Eastern CTC, Mountwest CTC, New River CTC, Pierpont CTC, Southern West Virginia CTC, West Virginia Northern CTC, and West Virginia University (WVU) at Parkersburg. Each college has a catchment area of designated counties within the surrounding geographic region. Although the community colleges offer the same programs of study (business, engineering and technical, general education, health, human studies, humanities, and science), the same areas of concentration within a program of study vary by college. For example, two of the nine colleges offer an associate's degree in electrical engineering technology, while, in the coming years, five colleges will offer mechatronics. Students rarely attend a college far from where they live, and the colleges do not recruit students from regions they do not serve.

EarnMoreWV is an initiative sponsored by CTCS, the West Virginia Development Office, and WorkForce West Virginia. Its goal is to increase public awareness of the growing high-technology manufacturing industry and provide up-to-date information on what degrees and skills are needed for employment in specific high-demand occupations. The EarnMoreWV website maintains an up-to-date posting of high-demand engineering and technical careers (EarnMoreWV, 2012). The website also lists two-year training programs (including associate's degrees and certificate programs) offered by CTCS colleges, which helps guide students on the appropriate path to pursue a technical career of their choice. Appendix C summarizes the programs available at each college campus, as listed on the EarnMoreWV website. As of 2012, all CTCS colleges offered computer and information technology– and systems and security–related programs. Mechatronic programs were offered by seven of the ten CTCs, while Cisco network preferences and computer-aided design and drafting (CADD) engineering technology

[1] The 2013–2014 academic year marked the first year in which Bridgemont CTC and Kanawha Valley CTC merged to become BridgeValley CTC.

programs were offered by six of the ten CTCs. Program offerings fewer in number included automotive, aviation maintenance, blasting, civil engineering, diesel, highway technician, major appliance repair, maritime, mechanical engineering, mine management, survey, and wind energy technologies, which were offered at only one CTC site each.

Although there is a formal application process for some degree-granting programs within CTCS that request information on applicants' academic performance in high school and performance on nationally normed assessments like the ACT or SAT exam, all applicants to a college within CTCS are accepted. Students who enroll in CTCS have opportunities to graduate on an expedited timeline. Performance on entry exams or nationally normed standardized tests may exempt students from general introductory coursework. Students who participate in CTE courses have an opportunity to be exempt from some technical coursework at the community college.

Early Degree Pathway

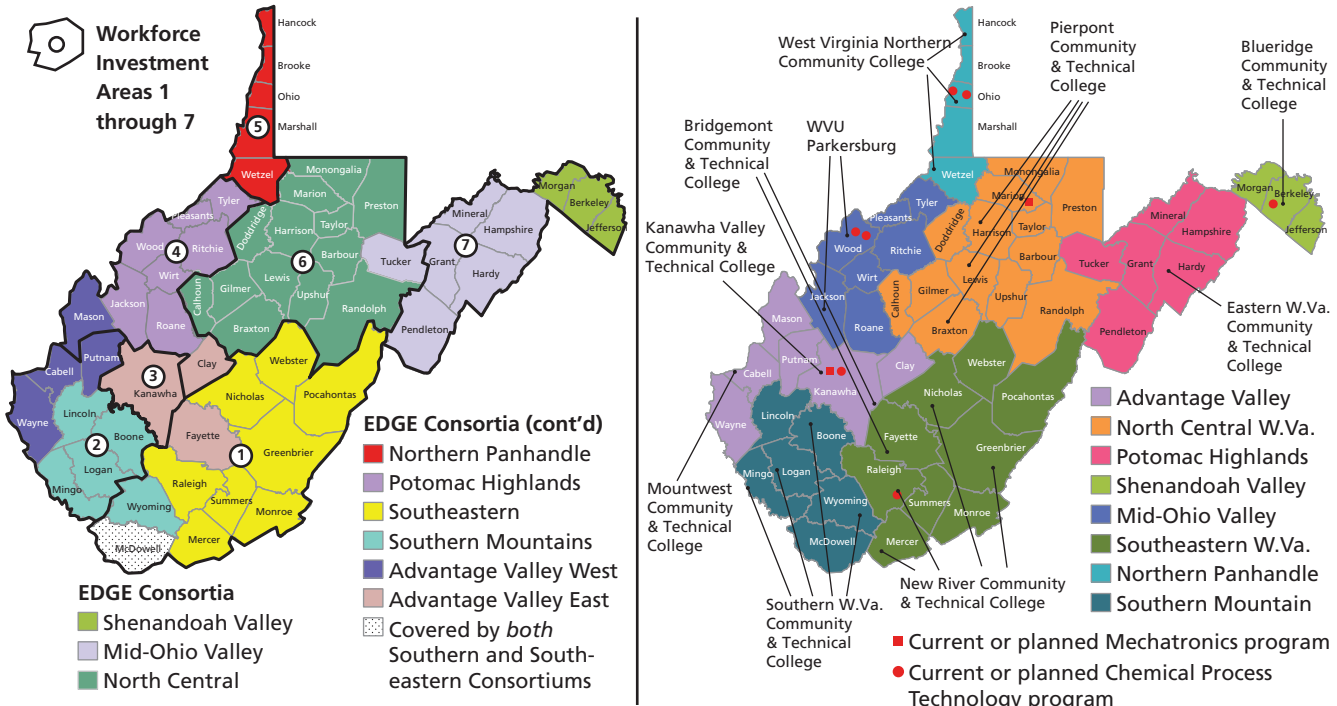
The Earn a Degree–Graduate Early (EDGE) program, a statewide legislative initiative, enables students who demonstrate proficiency in field-specific courses through the CTE to receive credit for the course(s) in CTCS if stakeholders agree that the rigor of CTE and CTCS courses are comparable (West Virginia Code, Chapter 18, Article 13, 2013a). Goals of the West Virginia EDGE initiative are to provide an opportunity for all students to establish a college transcript while in high school, to increase the number of students attending community and technical colleges, and to establish a pathway that allows students to obtain an associate's degree in a shortened time after high school or along with a high school diploma. By allowing students to earn a degree and graduate early, EDGE endeavors to provide incentives for more students to continue their education beyond high school (West Virginia Department of Education, undated[a]). Students demonstrating proficiency in eligible CTE courses by providing a transcript of CTE courses to the CTCs may receive credit for required courses at CTCS. The credit allows students to complete their coursework on an expedited timeline and, therefore, graduate early.

According to discussions with EDGE and CTCS representatives, processes are in place to review a curriculum and determine whether high school and CTCS coursework align. High school staff, including representatives from the CTE, meet as a consortium with representatives of the regional CTCS and employers to review the curriculum of CTE and CTCS courses. If stakeholders determine that the coursework aligns, they agree that students completing the course at the CTE or CTCS possess the same knowledge and skills, or comparable readiness for industry certification. Students completing the course at the CTE and demonstrating proficiency in it therefore can receive credit in CTCS. If the courses do not align, the CTE and CTCS representatives discuss how to adjust their respective courses in order to ensure students who complete the course in high school or in postsecondary programs possess the same skills. Once adjustments occur, students who complete the revised course may receive CTCS credit for the course if they take it at the CTE.

Figure 2.1 illustrates the counties that fall within the catchment areas for EDGE programs, CTCS college campuses, and WIAs to capture the geographic overlap for these three components of the workforce-development pipeline. In most counties, there is one EDGE, CTCS college campus, and WIA that could collaborate with each other to support the educational and employment goals of the talent and the needs of the employers. For example, Lewis County is in WIA 6 and is served by Pierpont Community and Technical College and the North Central EDGE Consortium. However, there are cases in which counties traverse catchment areas. For example, Fayette County is in WIA 1 and is served by New River Community and Technical College and the Advantage Valley East EDGE Consortium; yet, that EDGE covers Kanawha and Clay counties and overlaps with BridgeValley Community and Technical College catchment area, rather than New River Community and Technical College.

Improving geographic coherence is one way in which West Virginia's workforce-development pipeline could be strengthened: The lack of overlap in some counties could mean that talent entering the pipeline is not obtaining adequate or consistent information about resources, educational opportunities, or relevant job openings. Lack of consistent

Figure 2.1
Overview of EDGE, WIA, and CTCS Geographic Catchment Areas



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catchment areas and service areas for EDGE, CTCS campuses, and WIA areas might also result in inadequate attention to certain populations in those counties or confusion on the part of program administrators or job counselors on where to guide talent looking for jobs.

Bachelor's Degree Programs

Bachelor's degrees provided by four-year public and private degree-granting institutions in West Virginia are frequently aligned with the workforce needs of the energy sector. For the energy sector, the most important degrees from these institutions tend to be within science and engineering departments. Public and private four-year institutions are selective. Offers for enrollment depend, in part, on an applicant's performance in high school and on nationally normed assessments like the ACT.

CTCS offers students a two-year associate's degree that could lead to a bachelor's degree if graduates subsequently enroll in a four-year postsecondary institution. These are typically referred to as "2 + 2" programs; students complete the initial two years of coursework at a community college, receive an associate's degree at the end of those two years, and then take the remaining two years of coursework at a four-year college to receive a bachelor's degree. CTCS has strong articulation agreements with public four-year institutions throughout the state of West Virginia. Until West Virginia State Senate Bill 457 passed in 1995, community colleges were part of four-year colleges rather than separate degree-granting institutions. At the time of publication, community colleges were completing the final stages of separating from the public four-year colleges with which they were historically affiliated. The relationships and matriculation agreements between CTCS and public four-year institutions remain strong. Private four-year institutions may opt to give CTCS graduates credit for their coursework, but this is done at the discretion of the accepting private institution.

Component 3: Energy-Sector Employment

In 2013, about 745,000 civilians were employed in West Virginia; the unemployment rate in West Virginia was 6.5 percent, below the national rate of 7.4 percent (U.S. Department of Labor, BLS, 2014).

Employment Trends in the Marcellus Shale Region, 2008 Through 2012

Exploring for new sources of natural gas by oil and gas operators in the Marcellus Shale region has been a booming industry. At the time of this study, state websites advertising job openings have identified positions ranging from drivers, roustabouts, bulldozer and service operators, and mechanic operators, to assistant superintendents for measurement, wastewater inspectors, transmission mechanics, and compression station engineers. Only a handful of these job openings, such as mechanics and engineers, mandate an associate's or bachelor's degree; however, almost all of them set a minimum requirement of a GED or high school diploma. Many employers state a preference for candidates with prior experience in the oil and gas industry (WorkForce West Virginia, 2013b).

Using data from the Quarterly Census of Employment and Wages (QCEW) from the U.S. Bureau of Labor Statistics, this section documents changes in the total number of job openings, number of establishments, and average weekly wages by county in those states in the Marcellus Shale Play area (West Virginia, Ohio, Pennsylvania, and New York) between 2008 and 2012 for industries categorized in the "Oil and Gas Extraction" 2012 NAICS code subsector. These industries

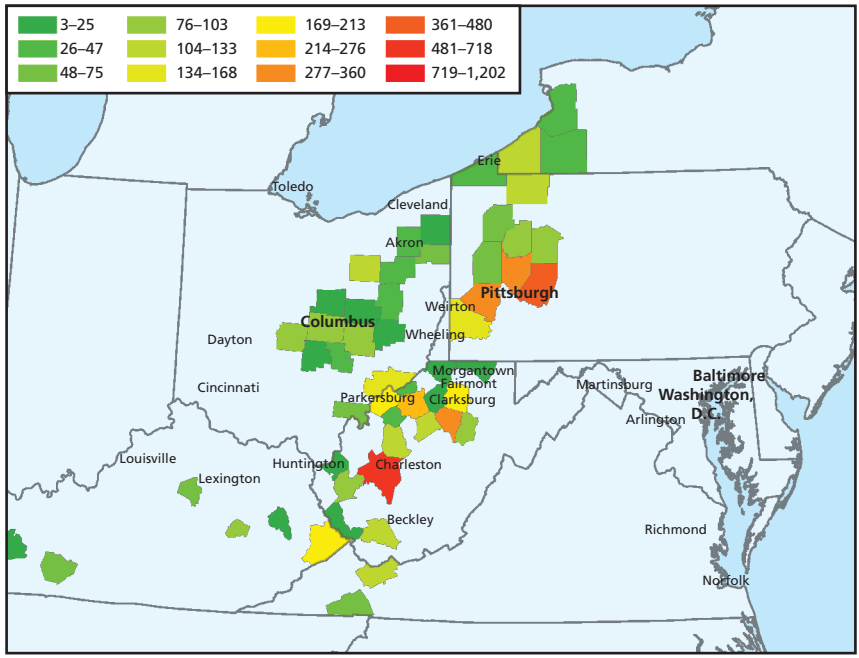
> operate and/or develop oil and gas field properties. Such activities may include exploration for crude petroleum and natural gas; drilling, completing, and equipping wells; operating separators, emulsion breakers, desilting equipment, and field gathering lines for crude petroleum and natural gas; and all other activities in the preparation of oil and gas up to the point of shipment from the producing property. This subsector includes the production of crude petroleum, the mining and extraction of oil from oil shale

and oil sands, and the production of natural gas, sulfur recovery from natural gas, and recovery of hydrocarbon liquids. (U.S. Census Bureau, 2013)

Availability of Jobs in Marcellus Shale Region, 2008 Through 2012

Figures 2.2 and 2.3 show the total number of jobs filled in the oil and gas industry in each county in the Marcellus Shale region at the time of this study (2008 and 2012, respectively). In 2008, employment in oil and gas extraction was prevalent in several counties. West Virginia had the highest number of counties (17) engaged in oil and gas extraction in the region, as well as some of the highest numbers of jobs, with

Figure 2.2
Total Employment for Oil and Gas Extraction in the Marcellus Shale Play Area, by County, 2008



SOURCE: Authors' calculation using QCEW.

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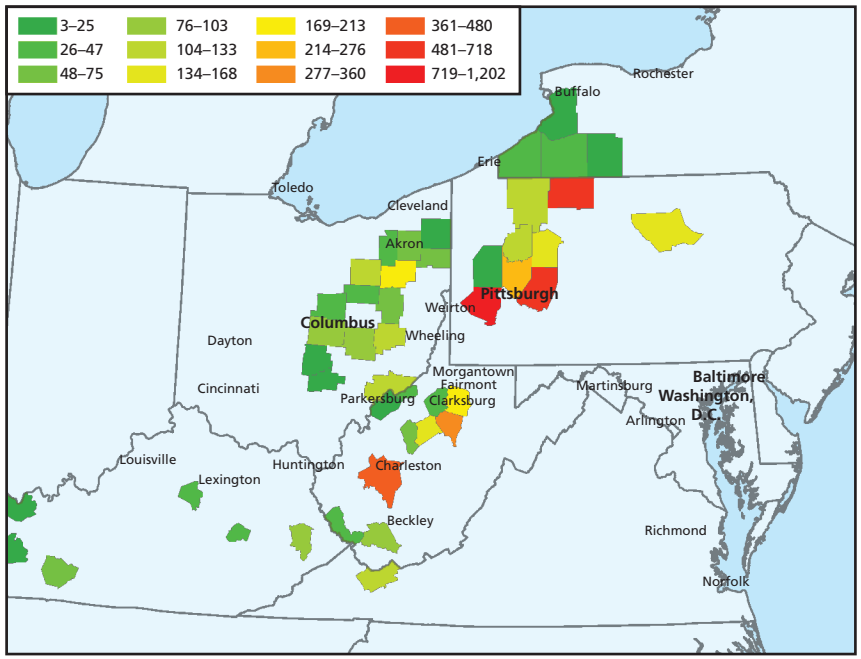
Figure 2.3
Total Employment for Oil and Gas Extraction in the Marcellus Shale Play Area, by County, 2012



SOURCE: Authors' calculation using QCEW.
RAND *RR812-2.3*

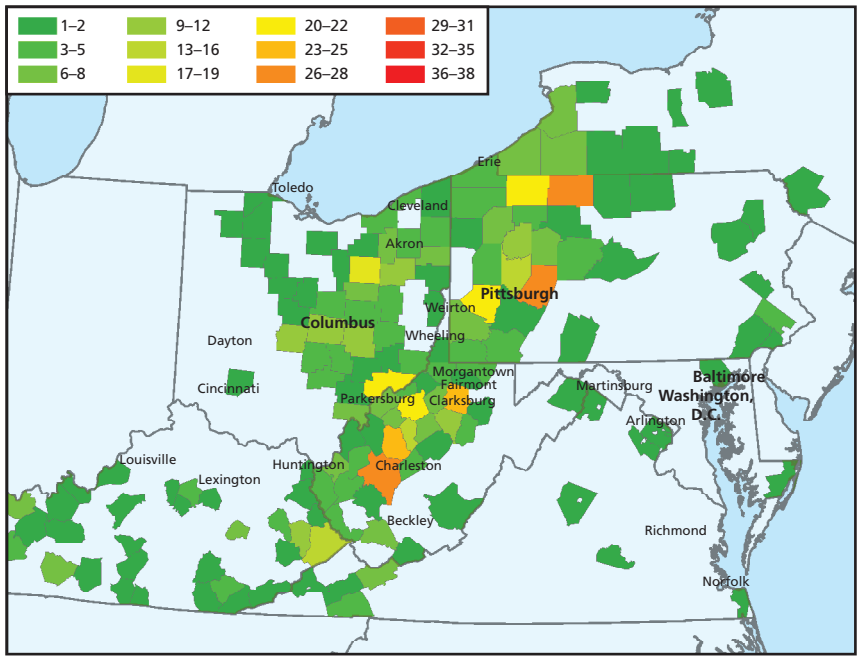
counties offering anywhere between three and 718 jobs. In contrast, the number of jobs in oil and gas extraction in counties in Western Pennsylvania ranged from 48 to 480 jobs in the industry per county. By 2012, the number of counties in West Virginia engaged in oil and gas extraction declined to ten from 17 in 2008. Total employment ranged from 48 to 360 jobs in the industry. In Pennsylvania, by 2012, total employment had shifted: Some counties experienced a decline to three to 25 jobs, while employment in other counties rose to as high as 719 to 1,202 jobs. The industry expanded geographically as oil and gas exploration expanded to new counties.

Number of Oil and Gas Establishments, 2008 Through 2012

Companies or establishments in the oil and gas industry drill and operate oil and gas wells either for themselves or on a contractual basis for other companies. The establishments discussed below also provide support services. However, the U.S. government does not include geophysical surveying and mapping, mine site preparation, and construction of oil/gas pipelines in this category (U.S. Census Bureau, 2013).

Figures 2.4 and 2.5 show the patterns of distribution by county for companies and establishments in the oil and gas extraction subsector located in the region in 2008 and 2012, respectively. It is important to note that the locations on this map are based on the addresses

Figure 2.4
Establishments for Oil and Gas Extraction in the Marcellus Shale Play Area, by County, 2008



SOURCE: Authors' calculation using QCEW.

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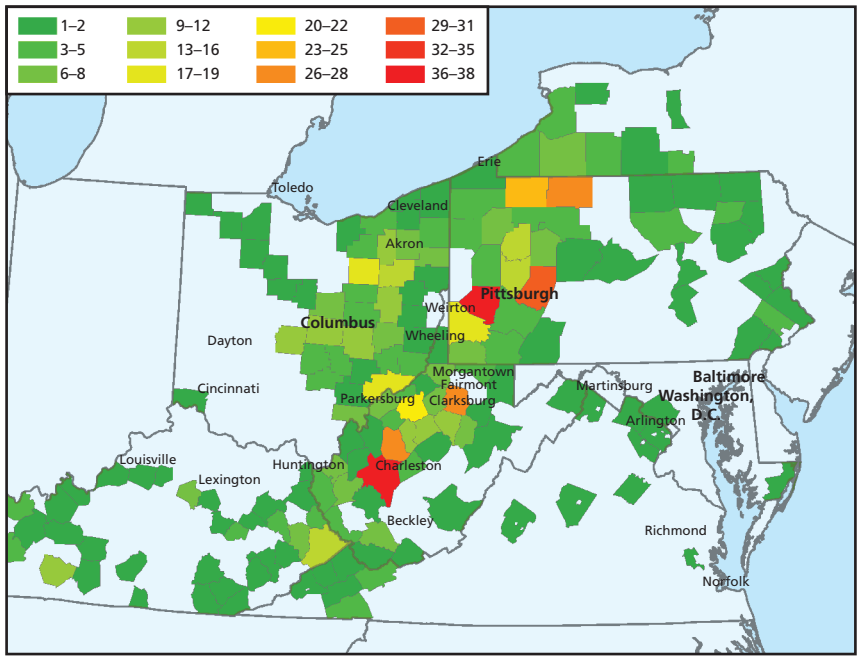
Figure 2.5
Establishments for Oil and Gas Extraction in the Marcellus Shale Play Area, by County, 2012



SOURCE: Authors' calculation using QCEW.
RAND *RR812-2.5*

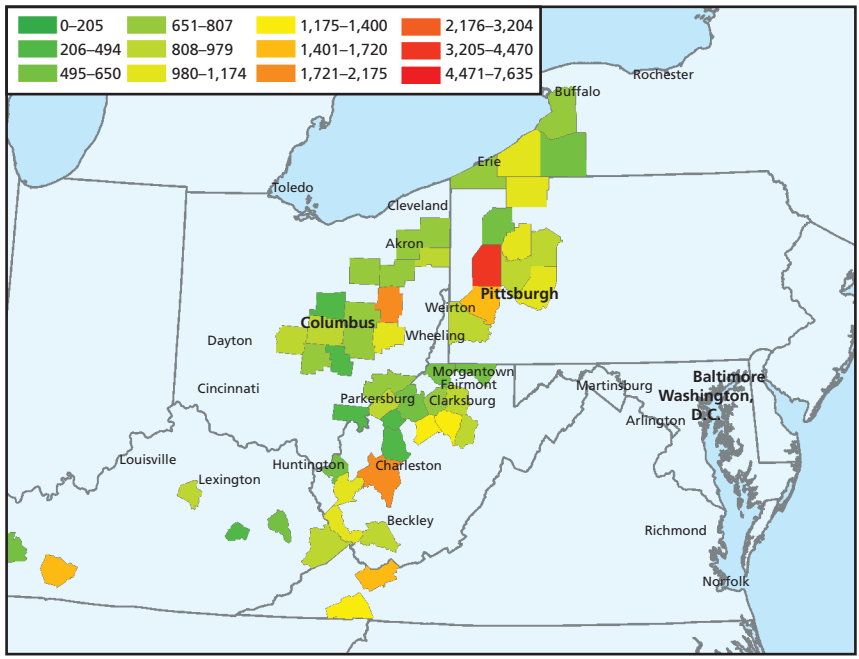
of establishment headquarters and not necessarily where branches or specific oil or natural gas drill sites are located. In September 2008, the number of establishments by county ranged from one to 28, with West Virginia and Pennsylvania having the highest numbers and concentrations. More establishments were sparsely scattered throughout the states of Virginia and Maryland, where the average number of establishments by county in these areas ranged from one to 16. The number of establishments in these regions did not change dramatically over the next four years, as shown in Figure 2.5, which displays data from 2012. The most noteworthy growth occurred in Pittsburgh, Pennsylvania, and Charleston, West Virginia, where an estimated 36 to 38 estab-

lishments were based. Counties surrounding these areas experienced a slight increase in the number of establishments as well.

Average Weekly Wages, 2008 Through 2012

The 2008 statewide average weekly wage in the oil and gas extraction industry in West Virginia was $692.02; it had risen to $763.87 by 2012 (WorkForce West Virginia, undated[b]). The geographical distribution of average weekly wages in the oil and gas extraction industry in 2008 and 2012 are shown in Figures 2.6 and 2.7, respectively. West Virginia's average weekly wages ranged from $495–$605 to $1,721–$2,175, with Charleston County offering the highest wages. In 2008, Ohio's aver-

Figure 2.6
Average Weekly Wages, in Dollars, for Oil and Gas Extraction in the Marcellus Shale Play Area, by County, 2008



SOURCE: Authors' calculation using QCEW.

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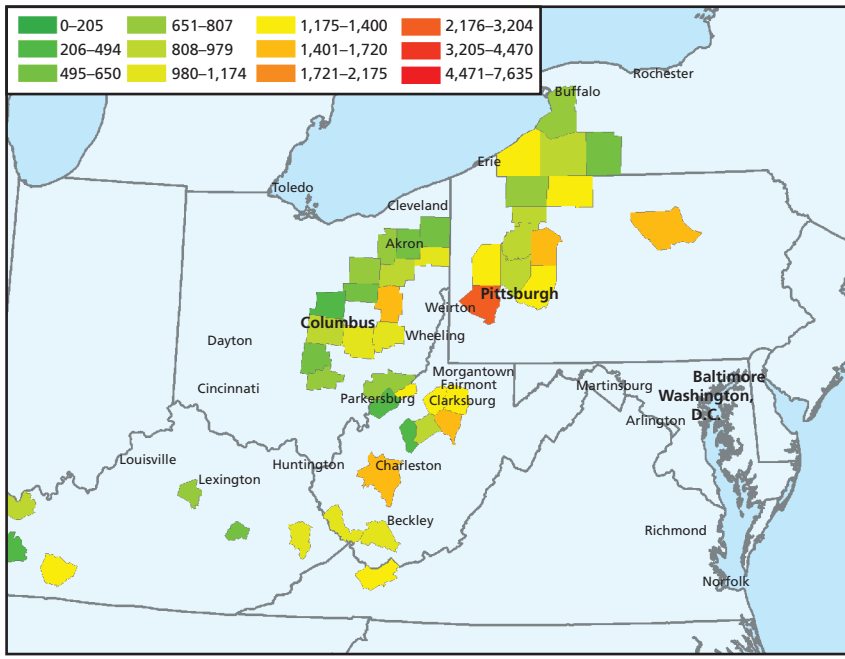
Figure 2.7
Average Weekly Wages, in Dollars, for Oil and Gas Extraction in the Marcellus Shale Play Area, by County, 2012



SOURCE: Authors' calculation using QCEW.

RAND *RR812-2.7*

age weekly wage ranged from $206–$494 to $1,721–$2,175 per week. Pennsylvania's average weekly wages were set as low as $495–$605 and as high as $4,471–$7,635, with regions northwest of Pittsburgh offering the highest wages. With the growth of the oil and gas industry in Western Pennsylvania, average weekly wages rose from 2008 to 2012 to as high as $2,176–$3,204. Although the number of counties involved in the oil and gas industry shrank in West Virginia, the average weekly wages in these counties generally increased from 2008 to 2012, with the exception of Charleston, where rates were $1,401 to $1,720 per week.

The changes from 2008 to 2012 in number of jobs, number of establishments, and average weekly wages in the oil and gas industry suggest that in West Virginia the Marcellus Shale drilling opportunities did not cause a large influx of new businesses into the state, but job opportunities and wages increased. The number of establishments increased slightly, jobs spread across more counties than previously, the number of counties involved in the oil and gas industry shrank, and yet the average weekly wages in these counties generally increased. These findings suggest that the employment component of West Virginia's workforce-development pipeline is relatively open, and there are multiple opportunities for the talent entering the pipeline.

Summary

This chapter provided statistical data and analysis of key components of the energy-sector workforce-development pipeline: potential talent, education and training opportunities, and employment. We found that West Virginia youths have, on average, similar on-time graduation rates as the U.S. national average. However, results from the state assessments suggest that high school students are not graduating with adequate content knowledge or skills, based on the WESTEST2 assessments. Overall, less than half of the high school students taking the WESTEST2 assessment were proficient in the areas tested. We also found a large number of postsecondary educational and training opportunities available to youths and adults interested in pursuing a job in the energy sector. Finally, we analyzed numbers of jobs, weekly wages, and number of establishments engaged in oil and gas extraction from 2008 to 2012 in the Marcellus Shale region by county, using U.S. Quarterly Census of Employment and Wages data on the NAICS subsector "Oil and Gas Extraction." We found that the number of establishments in the region remained about the same between 2008 and 2012. However, the number of jobs available has risen, as have average weekly wages. This descriptive portrait of the state of West Virginia's workforce-development pipeline sets the stage for the analyses sum-

marized in subsequent chapters on the extent to which CTCS is adequately preparing talent to enter the energy-sector workforce.

CHAPTER THREE

Knowledge, Skills, and Abilities Needed for Energy-Sector Occupations Across the United States and in West Virginia

In this chapter, we use occupational employment statistics (OES) data from Bureau of Labor Statistics (BLS)'s Employment and Training Administration from 2006 to 2012 and ETA's O*NET data to characterize occupations relevant to the energy sector in the United States and specifically in West Virginia. We document the skill sets energy-sector jobs demand in terms of content knowledge, performance skills, and workforce-readiness skills, such as behavioral competencies or "soft" skills. We provide a description of the relative importance of the KSAs and education required to meet labor demand (Peterson et al., 1999) under three scenarios.

The O*NET data set provides a national- and state-level portrait of the KSAs needed in all sectors. O*NET contains extensive information about a wide range of occupations (n = 947), which can be linked to NAICS codes. Specific information includes the type of work performed, as well as the required KSAs. A variation of one question was used to gather data about the relevant KSAs for an occupation in the oil and gas sector. For each of 33 knowledge areas, 35 skills, and 52 abilities, subject-matter experts were asked, "How important is [the KSA] to the performance of your current job?" All responses were recorded using a five-point scale ranging from 1 (not important) to 5 (extremely important). KSAs were defined for survey respondents as

- **knowledge**—specific subjects required such as basic math, advanced math, and computer science

- **cross-functional skills**—capacities that facilitate performance across jobs, including technical skills such as installation, operation monitoring, and repair
- **abilities**—specific attributes such as oral comprehension, written expression, and perceptual speed
- **education**—specific requirements such as a high school degree, associate's degree, or bachelor's degree.

Consistent with traditional job analysis methods, the O*NET collects data on worker requirements by conducting surveys using a two-stage process: Information is gathered by identifying "a statistically random sample of businesses expected to employ workers in the targeted occupations" and then using standardized questionnaires to conduct a survey of "a random sample of workers in those occupations within those businesses" (O*NET Resource Center, undated). This information is updated regularly; over 1,300 occupations have been updated in the O*NET since 2003.

This chapter is divided into two sections. In the first section we define and scope the demand for labor by the energy sector and identify energy-sector occupations across the United States that have experienced the highest levels of employment in 2012 and occupations with the highest levels of employment growth from 2006 to 2012. In the second section, we develop three occupation scenarios of KSAs: those associated with (1) all occupations that have reported high growth in West Virginia, (2) occupations that account for large shares of employment or that have experienced rapid growth in the energy sector across the United States, and (3) high-growth occupations in the energy sector in West Virginia.

Identification of Key Occupations and Scope of Region in Scenarios

The analyses in this chapter define the energy sector using the four-digit NAICS codes used by the National Academy of Sciences (2013), which include the following:

- 2111 Oil and gas extraction

- 2121 Coal extraction
- 2131 Support activities for mining
- 2211 Electric power generation, transmission, and distribution
- 2212 Natural gas distribution
- 2371 Utility systems construction
- 3241 Petroleum and coal products manufacturing
- 3331 Equipment manufacturing: mining, oil and gas field machinery
- 486x Pipeline transportation.

The OES use the Standard Occupational Classification (SOC) to classify each occupation, regardless of industry. The total employment levels of each occupation within the energy sector were calculated using national cross-industrial estimates. For each occupation the total number of jobs in the occupation was summed across all of the NAICS industries in the energy sector, to arrive at the level of "energy employment" for the given occupation. Each establishment is classified into one NAICS code, and all jobs within the establishment are considered a part of the employment totals for the given NAICS code.

Key energy occupations were identified in two ways: (1) top eight occupations with the highest levels of energy-sector employment in 2012 and (2) top eight occupations with the highest rates of growth in energy-sector employment between 2006 and 2012 in terms of total jobs filled by the energy sector across the United States. The base year, 2006, was chosen due to the substantial increase in shale gas production that has occurred since that year. Tables 3.1 and 3.2 list these key energy occupations, respectively. Though not all jobs within the occupations were associated specifically with natural gas, most of the occupations cut across several industries and segments of the energy sector.

The employment levels in several shale regions for each of the key occupations were examined to determine whether there were patterns associated with drilling or natural gas or oil production and levels of employment. A shale region is the group of all shale areas covered by the same shale play. A shale area is either a metropolitan area (defined by the Census Bureau) or a nonmetropolitan area (defined by the OES) that includes shale oil or gas reserves being exploited. In all, 14 regions

Table 3.1
Top Eight Occupations in Energy Employment in 2012

Occupation	SOC	Energy Employment 2012	Total Employment 2012
Construction laborer	47-2061	97,700	814,470
Electrical power-line installer and repairer	49-9051	88,100	112,450
First-line supervisor of construction trades and extraction workers	47-1011	57,890	456,640
Roustabout, oil and gas	47-5071	56,790	59,320
Operating engineer and other construction equipment operators	47-2073	55,340	335,160
Service unit operator, oil, gas, and mining	47-5013	54,340	57,180
General and operations manager	11-1021	42,110	1,899,460
Team assembler	51-2092	41,690	1,006,980

SOURCE: BLS, 2012.

were analyzed as parts of the eight shale areas that account for over 90 percent of the shale gas produced nationally. Marcellus Shale play was compared to several shale areas across the nation: Haynesville (Louisiana and Texas), Eagle Ford (Texas), Bakken (North Dakota and Montana), Woodford (Oklahoma), Fayetteville (Arkansas), Barnett (Texas), and Antrim (Michigan). The remaining six shale areas are treated as one region each.

Employment patterns for each of the occupations listed in Tables 3.1 and 3.2 were examined to determine which occupations changed concurrently with natural gas production in a given region. The employment levels refer to the total occupational employment, and not employment solely in the energy sector. We see a number of key trends emerging from Tables 3.1 and 3.2. They include the following:

- **general and operations managers (11-1021)**—Though there was high employment of general and operations managers within the energy sector relative to other occupations, the proportion

Table 3.2
Top Eight Occupations for Energy Employment Growth, 2006 to 2012

Occupation	SOC	Energy Employment 2006	Energy Employment 2012	Energy Employment Change 2006 to 2012
Service unit operator, oil, gas, and mining	47-5013	24,200	54,340	+30,140
Roustabout, oil and gas	47-5071	37,660	56,790	+19,130
Petroleum engineer	17-2171	11,200	28,500	+17,300
Industrial machinery mechanic	49-9041	21,310	35,650	+14,340
Machinist	51-4041	10,330	23,690	+13,360
First-line supervisor of construction trades and extraction workers	47-1011	45,500	57,890	+12,390
Heavy and tractor-trailer truck driver	53-3032	26,820	36,790	+9,970
General and operations manager	11-1021	34,580	42,110	+7,530

SOURCE: BLS, 2015.

of general and operations managers in total employment in the energy sector is low (2 percent of all jobs nationally). Nationally, occupational employment levels did not change much from 2006 to 2009 but have been increasing since 2010. In accordance with national trends, individual shale areas have seen steady and substantial growth in this occupation since 2010.

- **petroleum engineers (17-2171)**—The number of petroleum engineers has more than doubled nationally since 2006; 78 percent of employment has been within the energy sector. The Bakken and Marcellus Shale regions have seen modest growth since 2006; employment in this occupation continues to be concentrated in Texas, Oklahoma, and Louisiana.

- **first-line supervisors of construction trades and extraction workers (47-1011)**—Employment of supervisors of construction/extraction workers is reported nationally; the number employed within the energy sector has increased by more than 25 percent since 2006. However, only 13 percent of the jobs in this category are in the energy sector. In West Virginia, Western Pennsylvania, and Eastern Texas/Western Louisiana (Haynesville Shale), the growth in employment in this occupation has been coincident with substantial increases in shale gas production. However, prior to 2010, in each case employment levels in metropolitan and nonmetropolitan areas were either flat or declining through 2009.
- **service unit operators, oil, gas, and mining (47-5013)**—Employment of service unit operators has more than doubled since 2006; 95 percent of the employment in this category is in the energy sector. Employment and employment growth have been concentrated in Texas, Louisiana, Oklahoma, and North Dakota.
- **roustabouts, oil and gas (47-5071)**—In 2012, the employment level of roustabouts is slightly below the 2008 peak of 63,000 nationally. About 96 percent of all jobs are in the energy sector. Employment is concentrated in Texas, Louisiana, Oklahoma, and North Dakota, but several shale regions have seen substantial growth. From 2006 to 2012, the states of Texas, North Dakota, and Oklahoma added 3,400, 3,400, and 1,400 jobs, respectively, in this occupation. Over this same period roustabout employment grew by 1,000 jobs in Arkansas (Fayetteville Shale), 700 in Pennsylvania, and 400 in West Virginia.
- **construction laborers (47-2061)**—In 2012, there were 814,470 jobs in the construction laborer occupation; 12 percent of them were employed in the energy sector. While this occupation is not growing nationally, some shale regions have seen significant increases in employment levels since 2006. West Virginia and Louisiana each added 1,000 jobs, while North Dakota added 1,700.

Analysis of Knowledge, Skills, Abilities, and Education Required for Energy-Sector Occupations

We identified required KSAs rated as important in O*NET for three occupation scenarios: (1) all occupations that have reported high growth in West Virginia, (2) occupations that account for large shares of employment or that have experienced rapid growth in the energy sector across the United States, and (3) high-growth occupations in the energy sector in West Virginia. Our findings are summarized here. Detailed figures that illustrate the level of importance of each occupation's KSAs for the second and third scenarios are provided in Figures A.1 through A.6 in Appendix A. (The first instance yielded 47 occupations, which were too many occupations to illustrate in a figure, so this illustration is not provided.)

High-Growth Occupations in West Virginia

We first identified the KSAs associated with all high-growth occupations in West Virginia, including occupations outside of the energy industry. We defined a high-growth occupation as any occupation that had shown an increase of at least 100 positions from 2006 to 2012. A total of 47 occupations meeting these criteria were identified.

Education

The most frequent survey responses indicated that a bachelor's degree was often required (28 percent) followed by a high school diploma (27 percent). Other responses indicated that an associate's degree (7 percent), some college (9 percent), or less than a high school diploma (10 percent) was required.

Knowledge

The top five most important knowledge areas determined by ratings of importance across occupations in survey responses were English language, mathematics, customer and personal service, administrative and management, and mechanical.

Skills

The top five most important skill areas determined by ratings of importance across occupations by survey responses were active listening, critical thinking, speaking, reading comprehension, and monitoring. All of these are classified by the O*NET as "basic skills." Several other skills, including cross-functional and systems and resource management skills, also received an average rating of "Important" or higher. These skills include monitoring, judgment and decisionmaking, complex problem-solving, coordination, time management, social perceptiveness, and writing.

Abilities

The top five most important abilities determined by ratings of importance across occupations by survey responses were oral comprehension, problem sensitivity, oral expression, near vision, and deductive reasoning. Several other abilities also received an average rating of "Important" or higher, including written comprehension, inductive reasoning, information ordering, speech clarity and speech recognition, written expression, category flexibility, and selective attention.

Top Employment and High-Growth Energy Occupations Across the United States

We identified the most important KSAs associated with those occupations in the U.S. energy sector that were among the eight highest in terms of energy-sector employment in 2012 and the eight occupations that had enjoyed the most rapid rates of growth in employment between 2006 and 2012 across the U.S. energy sector. Some occupations were found on both lists. The final list consisted of 12 occupations: general and operations managers; petroleum engineers; first-line supervisors of construction trades and extraction workers; construction laborers; operating engineers and other construction equipment operators; service unit operators, oil, gas, and mining; roustabouts, oil and gas; industrial machinery mechanics; electrical power-line installers and repairers; team assemblers; machinists; and heavy and tractor-trailer truck drivers.

Education

The most frequent survey responses indicated that over 56 percent required a high school diploma (42.3 percent) or less (14.2 percent) for their occupations. Approximately 19 percent needed a postsecondary certificate, and about 11 percent needed some college courses or an associate's degree. About 11 percent required a bachelor's degree or higher.

Knowledge

The top five most important knowledge areas determined by ratings of importance across occupations by survey responses were mechanical, mathematics, English language, administrative and management, and public safety and security. These are listed in Figure A.1 in Appendix A. These knowledge areas overlapped considerably with the other two cases. Although customer and personal service was not in the top five knowledge areas for the high-growth energy occupations, it was the sixth–most important knowledge area. One important difference for the high-growth energy occupations is the higher rank of mechanical knowledge. This knowledge area was rated as the most important across the energy occupations and received particularly high ratings for industrial machinery mechanics (49-9041.00) and service unit operators, oil, gas, and mining (47-5013.00). Despite this difference, the remaining knowledge areas were similar in relative importance for both high-growth energy occupations and high-growth occupations in general for the West Virginia shale region.

Skills

The top five most important skill areas determined across occupations by survey responses were critical thinking, active listening, monitoring, operation monitoring, and speaking. Several other skills also received an average rating of "Important" or higher, including reading comprehension, complex problem-solving, judgment and decisionmaking, coordination, social perceptiveness, and time management. Similar to the knowledge areas, the most important skills for the energy occupations overlap considerably with high-growth jobs, in general, for the West Virginia shale region. However, two specific skills, monitoring and operation monitoring, were rated as more important for the

energy occupations. These skills, which are "assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action" and "watching gauges, dials, or other indicators to make sure a machine is working properly," were rated as particularly important for general and operations managers (11-1021.00) and petroleum engineers (17-2171.00) for monitoring; and for industrial machinery mechanics (49-9041.00) and service unit operators, oil, gas, and mining (47-5013.00) for operation monitoring. These are listed in Figure A.2 in Appendix A.

Abilities

The top five most important abilities determined by ratings of importance across occupations by survey responses were problem sensitivity, near vision, oral comprehension, control precision, and multi-limb coordination. Examples of several other abilities that also received an average rating of "Important" or higher included oral expression, information ordering, reasoning (inductive and deductive), manual dexterity, and arm-hand steadiness.

Two abilities included in the top five for energy occupations were not rated as important abilities for general high-growth jobs in the West Virginia shale region. These abilities, control precision and multi-limb coordination, are "the ability to quickly and repeatedly adjust the controls of a machine or a vehicle to exact positions" and "the ability to coordinate two or more limbs (for example, two arms, two legs, or one leg and one arm) while sitting, standing, or lying down," respectively. These abilities were particularly important for operating engineers and other construction equipment operators (47-2073.00) and heavy and tractor-trailer truck drivers (53-3032.00). Abilities are listed in Figure A.3 in Appendix A.

High-Growth Energy Occupations in West Virginia

The third set of occupations we examined were high-growth occupations associated with the energy sector in West Virginia. This included 22 occupations: construction laborers; electrical power-line installers and repairers; first-line supervisors of construction trades and extraction workers; roustabouts, oil and gas; service unit operators, oil, gas,

and mining; general operations managers; team assemblers; customer service representatives; heavy and tractor-trailer truck drivers; office clerks, general; rotary drill operators, oil and gas; helpers-extraction workers; meter readers, utilities; inspectors, testers, sorters, samplers, and weighers; first-line supervisors of office and administrative support workers; construction managers; industrial engineers; geological and petroleum technicians (data tech); geological and petroleum technicians (sample test tech); stock clerks and order fillers; mobile heavy equipment mechanics, except engines; and cost estimators.

Education

The most common survey responses indicated that a high school diploma or GED equivalent or less was required (high school diploma: 39 percent, less than high school diploma: 12 percent). Approximately 17 percent of respondents indicated that a bachelor's degree (14 percent) or higher (3 percent) was needed. A large percentage of responses from a few specific occupations indicated a need for a postsecondary certificate, including electrical power-line installers and repairers (59 percent), mobile heavy equipment mechanics (57 percent), and industrial production managers (24 percent).

Knowledge

The top five most important knowledge areas determined by ratings of importance across occupations by survey responses were in customer and personal service, mathematics, English language, administration and management, and mechanical. These are listed in Figure A.4 in Appendix A.

Skills

The top five most important skill areas determined by ratings of importance across occupations by survey responses were active listening, critical thinking, speaking, monitoring, and reading comprehension. Several other skills also received an average rating of "Important" or higher, including coordination, time management, judgment and decisionmaking, social perceptiveness, and complex problem-solving. These are listed in Figure A.5 in Appendix A.

Abilities

The top five most important abilities determined by ratings of importance across occupations by survey responses were oral comprehension, problem sensitivity, near vision, oral expression, and deductive reasoning. Examples of several other abilities that also received an average rating of "Important" or higher included information ordering, speech clarity and speech recognition, written comprehension, and inductive reasoning. These are listed in Figure A.6 in Appendix A.

Comparing U.S. and West Virginia Important KSAs in Energy-Sector Jobs

A simple comparison across the three cases indicates that only three KSAs are unique among the top five lists: (1) public safety and security knowledge for U.S. energy, (2) operation monitoring for high-growth occupations in the West Virginia shale region, and (3) multilimb coordination for energy occupations in the United States.

Table 3.3 summarizes the top five most important KSAs shared among these cases. Here, the importance of basic skills and abilities, such as English language, mathematics, listening, and critical thinking, is evident across the cases. Education and training programs geared to improving students' skills in these basic areas will be best suited to meet expected growth in demand for energy sector–related employment.

Although averaging ratings across occupations reveals commonalities among KSAs, a more detailed analysis of specific occupations is needed to determine relevant KSAs for building a comprehensive workforce-development program. For example, the most important skill for one of the high-growth energy-related occupations in West Virginia, mobile heavy equipment mechanics (49-3042.00), is troubleshooting, which is the capacity for determining "causes of operating errors and deciding what to do about it." Therefore, programs to develop basic skills and abilities may need to be supplemented by more specific programs focused on high-growth occupations that may require unique skills.

Table 3.3
Comparison of High-Growth West Virginia Occupations, U.S. Energy Occupations, and High-Growth West Virginia Energy Occupations

KSA	High-Growth West Virginia	U.S. Energy	High-Growth West Virginia Energy
Knowledge	1. English language 2. Mathematics 3. Customer and personal service 4. Administrative and management 5. Mechanical	1. Mechanical 2. Mathematics 3. English language 4. Administrative and management 5. Public safety and security	1. Customer and personal service 2. Mathematics 3. English language 4. Administration and management 5. Mechanical
Skills	1. Active listening 2. Critical thinking 3. Speaking 4. Reading comprehension 5. Monitoring	1. Critical thinking 2 Active listening 3. Monitoring 4. Operations monitoring 5. Speaking	1. Active listening 2. Critical thinking 3. Speaking 4. Monitoring 5. Reading comprehension
Abilities	1. Oral comprehension 2. Problem sensitivity 3. Oral expression 4. Near vision 5. Deductive reasoning	1. Problem sensitivity 2. Near vision 3. Oral comprehension 4. Control precision 5. Multilimb coordination	1. Oral comprehension 2. Problem sensitivity 3. Near vision 4. Oral expression 5. Deductive reasoning

Summary

This chapter described the most common and most rapidly growing occupations within the energy sector, in both the United States and West Virginia. We found that while there are occupations within the energy sector that may be relatively concentrated in West Virginia due to the development of the Marcellus Shale gas deposits, other energy occupations are more "general" and do not necessarily correspond to growth in natural gas production. Our analyses also demonstrated that there has been variation in the growth of energy occupations in shale regions, but there are a number of KSAs that were rated as "Impor-

tant" across the U.S. energy sector, and some specific to West Virginia. Therefore, education and training programs geared to improving students' skills in reading comprehension, critical thinking, and active listening, as well as in mathematics and mechanical knowledge, will be best suited to meet expected growth in demand for energy sector–related employment.

CHAPTER FOUR

Community and Technical College System of West Virginia Education and Training Programs

This chapter summarizes our analyses of how well education and training programs available in CTCS are keeping pace with the skills demands of the energy sector in West Virginia, described in the previous chapter. The analyses presented in this chapter describe the educational offerings of CTCS at the time of this study and the perspectives of CTCS students enrolled in energy-related programs. We first summarize the context of the postsecondary education and training provided in the state, with a specific focus on courses and levels of enrollment in energy-related courses of CTCS. We then summarize our analyses of interviews with key officials within CTCS and other educational stakeholders and focus groups with students in energy sector–related programs in CTCS.

Enrollment in Energy-Related and Developmental Courses in CTCS

The West Virginia Higher Education Policy Commission provided data for all courses taken in the spring and fall semesters between 2008 and 2012 for the ten CTCS colleges. These data were snapshots of each semester in which each individual student is at a different point in his or her respective enrollment period. These snapshot data do not document when a student initially enrolled, nor can we calculate a graduation rate. However, the data allow us to track trends in enrollment in individual courses and subject areas by students' characteristics and for each college. In the remainder of this section we provide a descriptive

portrait of enrollment in CTCS, in energy-related courses, in energy-related programs/majors, and in remedial courses (known as developmental courses).

Enrollment in CTCS

West Virginia's total college enrollment in public institutions, including four-year universities and two-year community and technical colleges, consisted of 93,429 students in 2012 (West Virginia Higher Education Policy Commission, undated[a]). About 25,000, or 27 percent of those students, were enrolled in CTCS colleges. Of the students enrolled, about 16,239, or 65 percent of those students, were enrolled in an associate's degree–seeking program, while only 1,809, or less than 1 percent of students, were enrolled in a certificate-seeking program (West Virginia Higher Education Policy Commission, undated[a]).

At the course level, the number of students who enrolled in at least one course from 2008–2009 through 2012–2013 (in two-year intervals) varied across age groups, as demonstrated in Table 4.1. About 12,922 students, a large majority, enrolled in at least one class in 2012–2013 and were between the ages of 18 and 24. The second–most prominent age group of students was those between the ages of 31 and 44, who enrolled in a course at a CTC as a way to further their education and training.

Table 4.1
Number of Students Enrolled in at Least One Course at CTCS in 2008–2009, 2010–2011, and 2012–2013, by Age Category

Age Category	2008–2009	2010–2011	2012–2013
18 to 24	12,082	13,785	12,922
25 to 30	4,033	4,913	4,581
31 to 44	5,542	7,415	6,819
45 to 64	2,848	4,071	4,039
65+	112	146	188

SOURCE: Authors' calculations of data from West Virginia Higher Education Policy Commission, undated(a).

Table 4.2
Average Number of Courses Enrolled in CTCS from 2008–2009, 2010–2011, and 2012–2013, by Age Category

Age Category	2008–2009	2010–2011	2012–2013
18 to 24	6.69	6.28	6.16
25 to 30	5.18	5.35	5.15
31 to 44	4.37	4.78	4.65
45 to 64	3.1	3.55	3.34
65+	2.04	2.25	1.88

SOURCE: Authors' calculations of data from West Virginia Higher Education Policy Commission, undated(a).

Table 4.2 itemizes the average number of courses taken during the same time frame by students' age group. Younger students 18 to 24 years old appeared to enroll in more classes (about six courses) than their older counterparts, who typically enrolled in five or fewer classes per year. Though this pattern of courses by age groups remained consistent between the 2008–2009 and 2012–2013 academic years, younger students (18 to 30 years old) and elderly students (65 years old and older) enrolled in slightly fewer classes in 2012–2013 than they did in 2008–2009. Middle-aged students, however (31 to 64 years old), enrolled in slightly more classes on average in 2012–2013 than they did in 2008–2009.

CTCS Students' Enrollment by Major and in Energy-Related Courses

Table 4.3 presents a list of some of the most commonly studied majors by students from the 2008–2009 to 2012–2013 academic years from the ten CTCS colleges. General business, radiology, and health administration were the three most popular majors chosen by students in 2012–2013, with the number of health administration majors more than doubling since the prior year. Electrical engineering technology, manufacturing engineering technology, and mechanical engineering technology majors, on the other hand, are among some of the least common fields, with only 213 out of 8,654 students pursuing one of them as a major in 2012–2013.

Table 4.3
Majors Chosen by Students at CTCS

Major	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013
Accounting	1,080	1,050	996	887	780
Biology	263	516	527	649	567
Civil engineering	49	46	40	34	33
Computer science	606	732	700	643	593
Criminal justice	347	441	512	586	496
Electrical engineering technology	109	128	171	149	150
General business	976	990	1,064	1,045	1,039
Health administration	65	299	370	389	927
Health management	402	475	542	426	338
Health medical assistance	211	335	429	431	522
Law enforcement	716	799	816	876	631
Legal studies/paralegal	259	309	340	375	330
Manufacturing engineering technology	97	128	121	95	48
Mechanical engineering technology	33	21	22	20	15
Nursing	1,562	1,652	1,334	1,064	896
Radiology	539	849	1,035	1,154	951
Sociology	16	384	287	293	338

SOURCE: Authors' calculations of data from West Virginia Higher Education Policy Commission, undated(a).

Table 4.4 lists the number of enrollees in energy-related courses from the academic years 2008–2009 through 2012–2013, as defined by course records. Note that a course record is an individual student in a course: One student can be enrolled in several courses. Enrollment in Engineering Technologies doubled from 2008–2009 through 2012–2013 from 1,126 course records to 2,355. Engineering enrollment more than doubled as well, but the numbers are relatively small. Enrollment

Table 4.4
Enrollment in Energy-Related Courses for CTCS, 2008–2009 Through 2012–2013

Field of Study	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013
Computer and information sciences and support services	555	678	652	609	691
Engineering technologies and engineering-related fields	1,126	1,323	1,717	2,302	2,355
Mathematics and statistics	5,097	5,149	5,675	5,735	5,437
Physical sciences	948	1,082	1,527	1,386	1,507
Science technologies/technicians	86	730	474	562	636
Construction trades	18	18	41	141	164
Mechanic and repair technologies/ technicians	365	931	794	566	487
Transportation and materials moving	0	2	3	0	14

SOURCE: Authors' calculations of data from West Virginia Higher Education Policy Commission, undated(a).

in Science Technicians and Construction trades has grown substantially over the period; the initial levels of enrollment were quite low. The number of course records in Physical Sciences increased by over 50 percent from 2008–2009 to 2012–2013. Growth in Computer and Information Science and Mathematics has been more modest. Courses in these areas may reflect general education requirements or courses common to many fields.

Enrollment in Developmental Courses

Students enroll in developmental courses where they receive basic instruction on fundamental concepts in mathematics and reading—subjects pertinent to furthering their educational training and which are often prerequisites for regular degree-bearing coursework. Data from fall 2006 of Complete College America state that almost 70 percent of freshmen entering a two-year college require remediation. Tables 4.5 and 4.6 show the percentage of students among different

age groups who enrolled in at least one mathematical and one reading developmental course, respectively, between 2008 and 2012. Although a greater portion (about one-third) of younger students have enrolled in a mathematics developmental courses over the last four years than their older student counterparts, fewer younger students appeared to be enrolling over time. In 2010–2011, there was an increase in the number of middle-aged students, ages 31 to 64, enrolling in at least one mathematics developmental course. Enrollment in reading developmental classes appeared to be less prevalent among all age groups, though young students, ages 18 to 24, made up the greatest portion (15 percent) of enrollees. The percentage of enrollees in at least one reading developmental class between 2008–2009 and 2012–2013 remained relatively consistent across all age groups.

Table 4.7 breaks down the percentage of students enrolled in both mathematics and reading developmental courses by CTCS college. On the whole, in each college more students enrolled in mathematics developmental courses than reading developmental courses from 2008–2009 through 2012–2013, though each college had some variation in patterns for each subject over the course of the four years. For example, Kanawha Valley and Southern consistently had the greatest percentage of students enrolled in both developmental subjects, while Blue Ridge and Bridgemont tended to have lower percentages of stu-

Table 4.5
Percentage of Students Enrolled in at Least One Developmental Course in Mathematics in 2008–2009, 2010–2011, and 2012–2013, by Age Category

Age Category	2008–2009	2010–2011	2012–2013
18 to 24	33	33	30
25 to 30	25	26	21
31 to 44	18	22	18
45 to 64	11	13	12
65+	6	4	4

SOURCE: Authors' calculations of data from West Virginia Higher Education Policy Commission, undated(a).

Table 4.6
Percentage of Students Enrolled in at Least One Developmental Course in Reading in 2008–2009, 2010–2011, and 2012–2013, by Age Category

Age Category	2008–2009	2010–2011	2012–2013
18 to 24	15	15	15
25 to 30	9	11	8
31 to 44	6	8	7
45 to 64	4	5	4
65+	4	3	2

SOURCE: Authors' calculations of data from West Virginia Higher Education Policy Commission, undated(a).

dents enrolling in these classes. It is unclear from the trends displayed in Table 4.7 whether the difference across colleges in percentage of students enrolled in developmental courses is due to variation in the quality of the secondary schooling of each college's enrollees or in the requirements and demands of the courses offered at each college.

Types of Degrees Granted

Table 4.8 lists the number of degrees granted in energy-related programs and non–energy-related programs by CTCS colleges. Substantially more degrees are granted in non–energy-related programs than in energy-related programs. This is particularly evident in the college campuses close to where oil and gas industry jobs tend to be located (as illustrated in Figure 2.5: Kanawha County, which is served by Kanawha Valley CTC, and Lewis County, which is served by Pierpont CTC).

The analysis of West Virginia Higher Education Policy Commission data on enrollment and degrees granted reveals that CTCS is a vital institution for educating West Virginians: Almost 30 percent of students in public higher education are enrolled in a college within CTCS. And most of those students are in degree-granting programs. However, it is also evident that enrollment in the types of programs

Table 4.7
Percentage of Students Enrolled in Developmental Courses in 2008–2009, 2010–2011, and 2012–2013, by CTCS College

	2008–2009		2010–2011		2012–2013	
College	Math	Reading	Math	Reading	Math	Reading
Blue Ridge	11	7	16	8	12	4
Bridgemont	23	10	16	10	11	8
Eastern West Virginia	25	12	36	16	28	12
Kanawha Valley	29	16	32	17	28	11
Mountwest	22	13	18	8	18	11
New River	21	3	21	3	22	5
Pierpont	24	10	28	15	27	15
Southern West Virginia	27	12	31	14	32	16
West Virginia Northern	27	8	27	10	31	9
WVU Parkersburg	22	9	25	13	18	11

SOURCE: Authors' calculations of West Virginia Higher Education Policy Commission data.

Table 4.8
Number of Degrees Granted, 2008 Through 2012, by CTCS College

Institution	Type of Degree Granted	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013
Blue Ridge	Energy related	7	13	20	24	20
	Non–energy related	186	294	356	563	782
Bridgemont	Energy related	44	38	55	41	67
	Non–energy related	115	97	101	75	130
Eastern West Virginia	Energy related	1	6	7	19	42
	Non–energy related	26	45	55	72	66
Kanawha Valley	Energy related	46	45	39	29	34
	Non–energy related	207	252	238	297	367

Table 4.8—Continued

Institution	Type of Degree Granted	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013
Mountwest	Energy related	13	15	40	40	26
	Non–energy related	378	259	336	367	344
New River	Energy related	44	33	37	57	51
	Non–energy related	139	123	103	132	236
Pierpont	Energy related	9	26	26	20	28
	Non–energy related	382	377	289	360	396
Southern	Energy related	35	6	21	16	20
	Non–energy related	288	246	214	227	217
West Virginia Northern	Energy related	6	14	12	11	7
	Non–energy related	363	393	407	412	408
WVU Parkersburg	Energy related	95	136	175	135	75
	Non–energy related	486	571	659	607	695
Total		**2,870**	**2,989**	**3,190**	**3,504**	**4,011**

SOURCE: Authors' calculations of West Virginia Higher Education Policy Commission data.

NOTE: Energy-related programs include applied process technology; applied science; applied technology; chemical and polymer operator technology; chemical process technology; chemical technology; chemistry; civil engineering; diesel mechanics; electric distribution technology; electrical engineering; electricity and instrumentation; electromechanical technology; energy assessment and management; energy assessment and management technology; engineering technology; general engineering; general science (chemistry); general science (physics); general technology; heating, ventilating, air conditioning, and refrigeration technology; mechanical engineering; mining technology; physics; power plant technology; preengineering; refrigeration; safety technology; solar energy technology; survey technology; sustainable building technology; technical studies; welding management technician; welding technology; and wind energy technology.

that would best meet the needs of the energy sector is not sufficient: A large portion of students are in developmental reading and mathematics courses (which do not count toward a degree), the bulk of students are enrolling in non–energy-related programs, and the vast majority

of degrees granted are in non–energy-related fields. While these numbers raise significant concerns about energy programming at CTCS, they do not divulge whether CTCS is not offering the types of courses and programs that students want in the energy field, whether students simply are not prepared to enter energy-related courses and programs, or whether potential enrollees do not know about the programs and courses. The following section of this chapter explores these questions.

Insights on Education and Training in Energy

This section describes findings from interviews with individuals in support positions for the education and training component of the energy-sector workforce-development pipeline in the state of West Virginia. The interviewees included representatives with administrative roles in CTCS, K–12 education, and regional education consortia mandated by state legislation (West Virginia Code, 2013b). Insights from students enrolled in associate's degree programs in applied science or technical fields that could lead to a job within the energy sector are also included. To ensure the anonymity of participants, responses are reported in the aggregate. Table 4.9 lists the response rates for the interview respondents.

The remainder of this chapter summarizes the main themes from the interviews and focus group discussions and describes practices that CTCS administrators reportedly implement to address challenges related to the themes.

Perspectives on Recruitment in CTCS

At the time of this study, CTCS program officials reported that enrollment in energy-related programs (those within the applied science and technical fields) was not at capacity. Interviewees reported that the majority of the programs within the relevant fields enrolled fewer students than the programs could serve; reports suggested some programs operated with vacancies of 50 percent. Analyses of the interviews and focus groups revealed eight commonly reported reasons for the dearth in enrollment in energy-related fields in CTCS: knowledge of CTCS,

Table 4.9
Response Rates for Interviewees

Pool of Interviewees	Number Contacted	Number Participated	Response Rate (%)
Energy sector employers (total)	20	5	25
Education and training stakeholders (total)	81	41	51
CTCS leadership positions (i.e., presidents or deans)	10	4	40
CTCS academic program staff	16	9	56
CTCS nonacademic program staff	14	9	64
CTCS student support services (i.e., advising, student services, career counseling)	23	12	52
Other West Virginia education stakeholders (i.e., EDGE, high school applied technology centers)	18	7	39
Representatives from unions that sponsor energy-related apprenticeship programs	2	2	100
Workforce Investment Area staff	7	1	14

marketing of the program offerings in CTCS, outreach and recruitment of high school students, perceived value of an associate's degree, outreach and recruitment of EDGE students, availability of advanced technical training for EDGE students, knowledge about energy-sector employment opportunities upon graduation, and recruitment of workforce-development trainees to associate's degree programs.

Knowledge of CTCS

Historically, CTCS was affiliated with public West Virginia four-year colleges. Nearly all interviewed participants reported that they believe that West Virginians are familiar with four-year colleges, yet unfamiliar with CTCS colleges because the colleges were still in the process of separating from their four-year partner institutions. Students enrolled

in an energy-related program with whom we spoke reported a similar very strong program available at West Virginia "Tech" that is associated with Bridgemont University, not Tech.

Marketing of CTCS

Interview participants reported limited marketing in their catchment areas. The marketing campaign was described as a few "billboards" on the highway, "signs in the local mall," and "advertisements in the newspaper." Participants perceived that brochures and pamphlets may be available at local business or community areas but were unclear about the extent to which they were available. Participants reported there were few if any advertisements on social media. Interviewees agreed that social media was a key mechanism for promoting the programs and recruiting. One perceived reason for the weakness of the marketing campaign is lack of funds. A robust marketing campaign may reduce perceptions that West Virginians have little knowledge of the CTCS system and programs. Community marketing is perceived as critical for recruiting nontraditional students (i.e., those matriculating from the workforce instead of immediately from high school).

Some interview participants noted promising practices for marketing implemented by their colleagues. To promote a new program, one campus launched an extensive multipage color spread in the regional newspaper. The spread provided information about the program, types of jobs available upon graduation, and salary information for those positions. To accompany the printed campaign, there were advertisements on television about the program and radio commercials. Staff affiliated with another program created an account on a social media site for an event. Attendees of the event joined the site in advance of the event and maintained their social network following the event.

Recruitment of High School Students

High school recruitment generally consists of a one-day visit from a representative of a college to a local high school. The daylong visit may include speaking with students from all grade levels who approach a booth or table located in the cafeteria during lunch. Representatives could also speak to a smaller audience during times prearranged with high school staff. Other recruitment efforts for high school students

included college fairs hosted by high schools or regional consortiums. In general, respondents agreed there was not enough time during the school year for one CTCS staff member to actively engage in "more than two" visits or sustained recruitment activities with students in the many high schools in their service area. Some CTCS service areas include five counties with many high schools. One promising practice is a weeklong grant-funded program in high schools, run by staff from a community college. The program focuses on selecting programs, matriculation readiness, and time as well as study skills. Staff from this site perceived the program was encouraging students to consider selecting and enrolling in an appropriate postsecondary program offered at the college.

Perceived Value of an Associate's Degree

Many participants perceived that for the majority of the students, enrollment in their institution was a "last choice." Nearly all interviewees reported that students accepted at a four-year university would enroll in the four-year program instead of a two-year CTCS program, noting that CTCS students often (1) enrolled in a four-year program first but were unsuccessful, (2) were on a wait list for a four-year program, or (3) were nontraditional students unable to enroll in a four-year institution because of family or financial constraints. Interviewees perceived that families of high school students planning for postsecondary training did not understand the value of receiving an associate's degree instead of immediately entering the workforce. Further, a review of positions posted within the Marcellus Shale section of the WorkForce West Virginia site on February 26, 2013, found that 42 of 45 positions listed GED or high school as the educational background required for the position, two of the 45 positions required an associate's degree, and one required a bachelor's degree (WorkForce West Virginia, 2013a).

Recruitment of EDGE Students

As described in Chapter Two, the purpose of the EDGE program is to allow students to graduate from postsecondary institutions in an expedited time frame. Students enrolled in eligible CTE courses receive credit from CTCS for proficient coursework, eliminating the need to fulfill credit hours by retaking technical courses. Many of the CTE

areas of concentration align with the energy sector; therefore, students interested in energy-sector jobs would be eligible to complete degree-seeking programs on an expedited timeline. Interviewees reported that few students who successfully complete CTE courses enrolled in CTCS. Participants further reported students graduating from high school with industry certification or accreditation rarely enrolled in postsecondary training. The majority of licensed or accredited students immediately entered the workforce because they possessed the skills necessary for entry-level positions in their respective technical fields. One participant estimated that "less than 3 percent of EDGE students enrolled in the CTCS," while another reported "a handful" enrolled in CTCS; another participant observed "declining enrollment of EDGE students in community college." In an attempt to increase the number of CTE students enrolled in CTCS colleges, administrators from CTCS implemented various strategies. For example, program leaders or directors visited local CTEs to speak with students enrolled in courses with concentrations aligned with the leaders' respective programs. The purpose of those conversations was to discuss the benefits of enrolling in degree-seeking programs. Another strategy to recruit students eligible for EDGE credits was to host enrollment days at CTEs. Staff from one college met with each graduating student to identify the appropriate program for the student, then enroll the student in the agreed-upon program. EDGE students received individualized postsecondary counseling from CTCS staff knowledgeable about programs offered at the local site.

Availability of Advanced Technical Training for EDGE Students

Some participants posited that students eligible for EDGE credits did not know or were unsure whether enrollment in a two-year program would provide more advanced technical training, comparable to the training they would receive hands-on in the field. Students did not know whether CTCS programs would provide "levels 3 or 4 or 5" of training in the nationally industry-certified curriculum (EDGE students completed up to level 2 and novice certification at the CTE). Further, they perceived that students interested in fields that required technical certification or accreditation in the energy sector valued

"guaranteed" advanced on-the-job skills training more than an associate's degree because job postings emphasized past experience with the energy sector as well as industry certification over educational background. In a review of positions posted within the energy-sector section of the WorkForce West Virginia website in March 2013, nearly all of the positions listed job experience or industry certifications as requirements for a position, suggesting that employers prioritize technical skills acquired on the job over education level. A few employers confirmed this in their interviews; they reported that while postsecondary degrees are preferable, technical skills provided through OJT or verified through industry accreditation are prioritized when reviewing résumés. Employers with whom we spoke noted that this preference was because their hiring departments were often unsure about the quality of graduates from CTCS. Therefore, years of experience were often used as a proxy in job postings for a specific degree: Hiring departments have more confidence that an employee with previous work experience has workplace competencies and possibly has been trained by a previous employer.

EDGE students may be able to complete a program in an expedited time frame, but EDGE credits exempt them from technical courses that align with their interests instead of the core general education courses in which they may be less interested. For example, a student may be exempt from a level 1 or 2 circuit course required in a concentration because of EDGE credits. The student receives credit for the course but, as reported by some interviewees, these students do not have an opportunity to take a more advanced circuit course that extends their current knowledge and skills with circuits. There may be fewer technical course requirements for EDGE students, but these are in the coursework that many interviewees perceive students in those programs desire most. For technical positions, an applicant with level 3 training or coursework from an industry-certified curriculum could be more attractive than a candidate with level 2 technical training and an associate's degree. In an effort to bolster recruitment and communication about available programs, CTE and CTCS staff in at least one region are mapping the programs offered in the CTE and CTCS. The aim is to clearly communicate to students stream-

lined options in CTCS based on their CTE concentration. The mapping also includes identifying the range of job titles or positions one completing the CTE program may attain, including salary information. Within the next year, the region plans to distribute this map to improve students' knowledge of the benefits of postsecondary training and, in turn, recruit more students. Interviewees involved in this effort also said they planned to modify CTE or CTCS programs if the mapping activity identified gaps between the CTE and CTCS.

Knowledge About Availability of Employment in the Energy Sector

When asked about current high-demand positions in the energy sector, nearly all CTCS respondents identified truck drivers and welders. Interviewees agreed that truck driver is an immediate high need for the energy sector in West Virginia. Review of the WorkForce West Virginia website for available job openings related to the energy sector also suggests that truck drivers are in the greatest demand, as the vast majority of the posted positions were labeled "truck driver." While truck drivers require a West Virginia Commercial Driver's License, preparation for obtaining this license can be gained through adult education programs offered through the CTE or other agencies. CTCS interviewees agreed that one would not or could not enroll in their programs to get a commercial vehicle license. Questions about employment demands in the coming five years elicited responses such as skilled machinists, those who know how to troubleshoot the systems associated with various types of machinery, welders, and "jacks of all trades." Respondents were unclear about how many positions would likely exist or if they were long term, as opposed to a large-scale short-term needs. Respondents shared figures reported in local newspapers or meetings attended with representatives of the energy sector but were unable to be more specific. A few expressed concerns about the accuracy of the projected employment figures. One said there could be "100 to 400 positions in one to two years" that align with concentrations at the college, but "whether those jobs are going to open up" is unknown. The true need was "somewhere between the numbers" of the current employment needs and the projected numbers; the college attempts to closely monitor these employment data.

Many participants noted it was "a challenge to recruit to programs if jobs are not currently available." This was a recruitment challenge because there is an opportunity cost to enrolling in a two-year program perceived to be more risky in a field with promised but not yet available positions. Investments in programs that align with the health sector, for example, are perceived as safer because the health sector is the largest employer in the state of West Virginia. The projections include some growth in new positions and retirement vacancies. Some interviewees noted that projections relying on retirement had been inaccurate in the years surrounding the economic downturn. Individuals whom companies expected to retire did not, reportedly due to financial losses or concerns related to the economic downturn; individuals did not feel secure enough financially to retire. A few interviewees also noted past experiences with inaccurate projections in their region.

CTCS is preparing a workforce based on emerging needs within the energy sector. However, the needs may not exist when graduates of the program are prepared to fill the positions. Some posited that the lack of available jobs at the time of program completion has created some distrust in communities regarding energy-sector job projections. Generally, participants perceived West Virginians were hesitant to enroll in postsecondary programs if jobs related to an area of concentration were not readily available or they had no evidence of progress towards jobs (e.g., activity at a drilling site, word of mouth from a member of the community of signed agreements or development).

Recruitment of Workforce-Development Trainees to Associate's Degree Programs

While nearly all interviewees identified EDGE students as a critical group for targeting recruitment, some also perceived individuals trained in workforce-development programs as another prime recruitment pool. According to interviews, participants in workforce-development training programs are currently employed. These individuals participate in training to maintain mandatory certifications or stay up to date on technologies. Because workforce-development participants are currently employed, a two-year degree-seeking program may provide an opportunity for advancement to middle management

or supervisor positions at a faster rate. At the time of the interviews, participants reported there was no system to share data on individuals enrolled in workforce-development courses and associate's degree programs. The academic and nonacademic programs, as interview participants termed them, operate in silos; there is little collaboration between the two. Participants described the academic and nonacademic departments as if they are independent organizations instead of separate departments within an organization. To target recruitment and encourage collaboration among staff of degree-seeking (academic) and workforce-development (nonacademic) departments, one college is restructuring to place the programs related to the energy sector and workforce development under the purview of a vice president. The college hopes that restructuring will increase the likelihood of collaboration between the workforce development and academic programs related to the energy sector.

Students' Experiences in CTCS

Interviews included questions focusing on the experiences of students once enrolled in CTCS. Questions sought interviewees' perceptions based on their professional capacity and available data for their respective colleges. Participants rarely provided specific figures, instead providing ranges of figures that were often caveated as "best guesses" or estimates based on their experiences. Rarely were specific figures available or readily accessible during interviews. Though there are limitations to the quantitative data, themes about students' experiences in CTCS emerged. The remainder of this section summarizes consistent themes in the reasons students do not persist in degree-seeking programs or experience delays in graduation, and students' experiences in programs.

Enrollment in Developmental Coursework

According to interviewees, "more than 50 percent" or "almost all" students must take developmental, or remedial, mathematics or English courses. When asked in focus groups, current CTCS students reported that more than half of their cohort dropped out of CTCS. Analysis of data from public colleges and universities conducted by Complete Col-

lege America found that 63.6 percent of incoming freshmen in two-year programs required remedial coursework (Complete College America, undated). The purpose of developmental courses is to build the foundational skills required for success in college and the workforce. CTCS administers assessments to all incoming students and uses these data to determine if students must complete developmental coursework before they can begin general education coursework required for graduation. If students are required to enroll in developmental coursework, their academic timeline is delayed: The more developmental courses in which a student is required to enroll, the longer the time to graduation. Participants agreed that, depending on the skills students possessed upon entry to the college, students required one to two years of developmental coursework before enrollment in their degree-seeking coursework (general education or technical).

Interviewees reported a number of challenges surrounding developmental coursework. First, notification of required developmental coursework deterred some students from actively enrolling in CTCS courses. These students dropped out of CTCS after acceptance but before active enrollment in courses. Another group of students enrolled in developmental courses but were either unsuccessful in the courses or had more than one year's worth of developmental coursework to complete before enrollment in a program. Students required to enroll in developmental courses after the first year of developmental coursework were deterred from persisting. Complete College America reported attrition rates of nearly 40 percent for students enrolled in two-year degree-seeking programs after the first year of enrollment.

If success in or number of developmental courses did not deter a student, financial constraints associated with these courses might prevent a student from persisting in CTCS programs. Participants familiar with financial aid restrictions consistently reported that financial aid did not cover the cost of developmental courses. Students must pay or obtain nonfederal loans for developmental courses. For students undeterred by the extended graduation timeline, unplanned costs for developmental courses caused them to cease enrollment in the college.

To combat the delays in program completion related to developmental coursework, CTCS is reportedly launching restructured devel-

opmental courses. Historically, developmental courses are a semester long, and the scope and sequence of the courses build. If assessment data suggest a student requires a skill that is taught late in the scope of a developmental mathematics course, the student must still enroll in the semester-long course. In this case, the student completes coursework below the level of skills the student requires for most of the semester. Following the successful completion of the developmental mathematics course, the student almost always has to enroll in a follow-on course to obtain the level of knowledge needed. Beginning in the 2013–2014 academic year, developmental courses are available in more discrete skill sets. Students may enroll in the course that most closely aligns with their area of deficit. Students are able to progress from one course to another upon successful completion. The traditional semester-long schedule and successive courses no longer exist. Students may complete several skill sets, or the full set of required skills, in a significantly shorter time period. All interviewees who discussed the restructured developmental coursework identified it as a key strategy for improving the likelihood of students persisting in CTCS.

Advising of Enrolled Students

Some staff reported programs require 60 credit hours; the hours include general education and technical coursework. Split across four semesters—fall and spring for year one, then fall and spring for year two—15 credit hours per semester are required for students to graduate in four semesters. According to interviewees, a student is full time when enrolled in 12 credit hours. If a student enrolled in 12 credit hours per semester, a 60-hour program would require five semesters. The fifth semester would not meet the full-time status required to receive federal financial aid. Participants perceived that confusion over how to schedule the required credit hours or the length of program delayed graduation and increased the cost of a program. Interviewees reported that without an alternative to the lengthy course requirements for technical certification, students interested in the energy sector prefer training programs offered by other entities, like adult education programs at the CTE. Students enrolled in adult education programs may obtain industry certifications for employment on an expedited timeline. Fur-

ther, those programs offer courses in the evenings, an appealing schedule for students who must maintain full-time employment while pursuing certifications. Interviewees reported that conversations about the timeline to complete the required credit hours were overwhelming for many students, particularly when students learned developmental coursework also delayed program completion. Students required to complete developmental coursework are given a general academic adviser because they are not enrolled in a chosen associate's degree program until developmental coursework is complete. When students successfully complete these courses and enroll in general education and technical programs, they receive a program adviser affiliated with their degree of study. General advisers share their notes about students' performance on career profiles or matching software with program advisers. The notes may be physical files, electronic files, or a combination of physical and electronic files. Once the handoff of students occurs, general and program advisers must speak by phone or in person to follow up on a student. Interview participants reported there is no data system to view academic performance and other information related to career advising. Some interviewees posited that students enrolled in developmental courses might benefit from advising from program leaders. They perceived that program leaders are better able to encourage students to persist in the developmental courses because they can more specifically speak to the benefits of persistence and what students will experience once enrolled in the program. Program advisers were also better equipped to academically counsel students on developmental coursework; program advisers could direct students to the program that best fit their academic skill set and technical interests. They were able to help a student determine if a nonacademic technical training program would be a better fit, or if the associate's degree program would be better. Advisers could speak to the benefits of acquiring basic technical certification for immediate employment and the longer-term benefits of attaining an associate's degree while employed in the energy sector.

Scheduling of Credit Hours

Nearly all students participating in focus groups reported working full time while enrolled in classes. Students had to support themselves and their families while pursuing their degree. Full-time employment was a requirement for daily survival, whereas a degree served to improve future earnings and job stability. Students reported that former classmates "took time off" because coursework scheduling and demands were too challenging while working full time. This was perceived as particularly true for students who were the primary financial supporters of their families. Though students intended to return after a semester, almost no students reenrolled in coursework. Interviewees agreed few students who dropped out reenrolled in courses. As an intervention to forestall dropping out, leaders and students of a number of CTCS programs reported scheduling courses around students' work schedules. Leaders scheduled technical courses around the general education course schedules in which their students enrolled, as well as around work schedules, in order to create a tight on-campus schedule, so that students could more easily stay in their programs while working full time. Students reported this approach "really helped" and positively affected their ability to stay in their respective associate's degree program. While program leaders aimed to continue this scheduling effort for students, they noted that if programs operated at capacity it could be more difficult to schedule in this customized manner. Other participants suggested that evening classes for general education and technical courses might also alleviate scheduling challenges or employment demands on students.

Spiraling of Scope and Sequence of Technical Courses

Though data were not available to report the proportion of students who drop out of programs after completion of developmental coursework, interview participants reported "some" students, more than a few in each program, dropped out of each program of study. Some staff reported concerns that those students did not have the skills required to obtain employment in the energy sector at the time they discontinued the program but had student loans or financial obligations for the courses they had completed while enrolled in the college. To address

this concern and provide some "encouragement" to remain in college from semester to semester, at least one program reported restructuring the scope and sequence of its technical courses. The aim of the restructuring was to provide all enrolled students with a set of skills related to their program that would make them more employable. If a student stopped going to college after a semester or had to withdraw for a semester for personal reasons, the student could still potentially obtain employment in the field. Students could qualify for positions in the field and highlight employable technical skills desirable to employers. Students could receive short-term benefits from courses in the program, which might encourage them to return to a program after withdrawing for a semester. They might receive some financial benefits from entering the workforce with sought-after skills. Interviewees identified the restructuring as a benefit to students persisting in the program, who could apply for positions in the field because they possessed entry-level skills. Those already employed might qualify for raises or promotions for bettering their technical skill sets, thus realizing short-term financial benefits to offset loans taken out to stay in the program.

Interviewees affiliated with CTCS noted the Workforce Development department provides training and accreditations highly desirable to local employers. Employers contract directly with Workforce Development staff to provide the training. Some training has been customized to an employer's needs, while other training is in certifications, like Occupational Safety and Health Administration certification. Employers relay their immediate needs to Workforce Development, and in a short time Workforce Development meets those needs. Interviewees identified a demand to embed certifications or trainings consistently sought by employers from Workforce Development in associate's degree programs. Embedding the certifications allows students to enter the workforce with specific, sought-after skills and minimizes costs to employers to provide the training. CTCS students would stand out in the applicant pool or be eligible for faster advancement if employed in the energy sector while pursuing their degrees.

Although the required coursework for most programs that closely align with the energy sector is clear, coursework for new programs changes. In interviews and focus groups, individuals involved in new

programs reported that the course requirements often changed from semester to semester. The changing course requirements extended the length of the program; if a required course was not offered in the following semester, or if it was offered only one time per academic year, the timeline to graduation was extended. One student described the changing demands as "very frustrating" and "discouraging." The changing demands reportedly led some students to transfer to a different program or withdraw from CTCS entirely. Individuals recognized that over time the required coursework would be clear but that, in the interim, it was difficult for both faculty and students.

Opportunities for On-the-Job Training

According to interviewees, nearly all programs include an internship or fieldwork elective, but only a few programs embed free internships or paid internships. Participants agreed that internships provide experience employers value. Students perceived internships as an opportunity to apply skills acquired in their technical coursework and build relationships with future employers. The majority of students in focus groups perceived "who you know" was very important in obtaining a job, particularly in larger organizations. One staff member commented that internship opportunities for students enrolled in energy-sector programs were "developed entirely by program staff." Another said, "One professor is working to develop a public service for students to complete assessments for the county" so students could gain hands-on experience while enrolled in that program. Students perceived that relationships with current staff or leaders within an organization cause an equal- or lesser-quality candidate to receive an employment offer. CTCS staff suggested that internships could be implemented to offer students opportunities to practice technical skills in real-life settings, understand the expectations of employers in the sector, receive feedback from professionals other than their professors, and develop a social network, which had been noted by interviewees and focus group participants as critical for finding employment.

Inclusion of Employers in Reviews of Current Programs

Many interviewees reported efforts to review programs more globally than the traditional curriculum review. The purpose of the global

reviews is to determine technical skill sets that students in all programs require. Some interviewees noted that employers want a "jack of all trades," a student with multiple technical skill sets. They reported an employee with a deep skill set in one aspect of a position is no longer desirable. An employee is in high demand if he or she is able to identify the reason a machine is not working, then fix the mechanical and electronic systems errors quickly. Employers are actively engaged in the creation of new programs, but many interviewees reported it was difficult to recruit employers to participate in reviews of current programs. Participants suggested employers are critical partners in improving or streamlining current programs. Employers collaborated to create the Mechatronics and Multicraft programs that offer a diverse set of skills. A similar partnership to guide the review of current programs would be useful. Workforce Development staff are also critical partners in the review process, as they work closely with a variety of employers to provide training to their employees.

Access to Cutting-Edge Equipment

Interviewees from all parts of the education pipeline agreed the cost of technical programs is high. Equipment is needed to provide hands-on training and is expensive. Programs received funds to purchase the equipment and pay for ongoing maintenance. However, the equipment used by employers often changes or is updated. Equipment used by employers two years ago may now be considered "antique." The cost to purchase equipment with updated technical systems and software is high, and funds to continually purchase the equipment used in the field are limited. Employers invested in training programs may regularly donate equipment, but rarely do employers donate the latest models. Stakeholders from the pipeline and students expressed concern that they would not have the latest industry-standard skills for systems needed for employment at the time of program completion. Students expressed concern they would not be viable applicants because they did not have experience working on the electronic systems used by employers; they would graduate with a degree that did not provide the opportunities they enrolled in the program to obtain. The ongoing costs for cutting-edge equipment may be too high for one aspect of the pipeline

alone, but a few interviewees suggested the cost could be more manageable if stakeholders jointly invested in the equipment. If purchased jointly, the equipment to train CTE, Workforce Development, and CTCS students would need to be equally accessible. Sharing equipment may be a logistical challenge if scheduled course times co-occur or transportation time is not factored into a student's schedule. One college acquired cutting-edge technology through a Workforce Development grant and planned to share the equipment with degree-seeking programs, because the cost of acquiring the new technology was prohibitive and associate's degree students needed access to it.

Employment Following Graduation from CTCS

Upon completion of associate's degrees, students in our focus groups planned to seek positions in the energy sector. Interviews asked participants about their knowledge of employment rates after students receive their degrees, employers of students, and how long new employees stayed in positions within the energy sector. Interviewees rarely had access to data related to these questions. They relied on their professional experience and knowledge. Though there were no specific data, across CTCS respondents with whom we spoke provided consistent responses.

Access to Career Counseling

CTCS staff and students agreed the primary providers of career counseling were program staff. Many professors were from industry, leaving to take positions at CTCS. They maintain strong connections with local employers. Professors worked individually with students to share information on available positions and recommend individual students to potential employers. Nearly all program leaders engage in ongoing conversations with employers to discuss the specific knowledge and skills students in their programs acquire, to promote CTCS overall. Interview and focus group participants agreed few energy-sector positions were disseminated through the career counseling office. They perceived employers preferred working directly with program staff because staff better understood the technical needs of positions and the types of students trained through CTCS who meet the employer's needs.

According to some staff, it is "nearly impossible" to get in the door to speak with employers without a specific contact. Interviewees reported that few energy-sector employers or new employers participated in job fairs. Students identified program staff as "critical" in learning about and arranging interviews for positions within the energy sector.

Readiness of the Workforce in the Projected Time Frame

Although the expectation is that an associate's degree requires two years of full-time coursework, most students require more than two years to complete an associate's degree program. Analysis of college completion in West Virginia conducted by Complete College America in 2011 found that 5.2 percent of students enrolled full time in associate's degree–granting programs graduated within two years; 12.6 percent graduated in three years, and 16.7 percent graduated in four years (Complete College America, undated). Interviewees reported students require three to five years to complete an associate's degree. Students participating in focus groups reported three years to four years to complete their respective programs, including developmental courses and changes in program coursework requirements. If employers communicate projected needs within two to three years and expect trained applicants to be available, they may not be prepared in time. This was particularly true for new programs where there were no earlier cohorts entering the workforce in the projected time frame.

Availability of Data on Program Graduates

Many interviewees identified various efforts to understand students' employment after graduation. Some reported fielding a paper or phone survey once a year asking if the student is employed, who the employer is, and whether the student felt prepared for the position. Other staff reported maintaining personal contact with students after graduation and offering ongoing career counseling. Through these personal contacts, often initiated by graduates, staff had information about students' postgraduate employment. Participants agreed there are pockets of data but there is no systematic collection of data. One participant stated, "We don't have a real good feedback system for identifying exactly where students are going" after graduation, but "we are in the process of updating a survey with students who are graduating." In

another interview, a participant produced returned paper copies of a postgraduate survey that had not yet been entered into an electronic form for analysis. The participant also noted the response rate was very low, "very few" of the mailed surveys were returned completed, and a notable number of surveys were returned because of outdated contact information. Generally, estimates of employment rates for students graduating from energy-sector programs ranged from "30 to 50 percent" to "most of our students." Across the board, interviewees agreed employment data from graduates and employers of graduates are critical in guiding future directions of CTCS.

Summary

This chapter summarized our analyses of the education and training available in the CTCS component of the workforce-development pipeline. We first examined the CTCS enrollment in energy sector–related courses and in developmental courses. We then summarized our analyses of perspectives on recruitment, enrollment, and employment of CTCS students in energy-related programs and jobs. Our analyses revealed that a number of energy-sector training opportunities exist in CTCS and through EDGE or CTEs. However, the system appears to be fractured and incoherent. Enrollees in CTCS often require remediation, most likely due to the lack of skills they have when they graduate from a West Virginia high school as revealed in Chapter Two: Twenty percent of new students were enrolled in at least one mathematics-related developmental course (50 percent in energy-sector programs, noted by interviewees) and 9 percent were enrolled in at least one reading-related developmental course at the time of this study. Interview respondents had little information concerning the advantages of a two-year degree or certification in terms of obtaining a job in the energy field. We found that marketing of job opportunities or degree programs in the energy sector to high schools or to the broader community was reportedly weak. State-mandated regional consortia (CTCS, CTE/K–12, EDGE) exist, but the reported effectiveness varies: Colleges do not have an incentive to accept EDGE credits. Because job

postings typically request job experience, rather than a specific degree, incentives for pursuing a two-year degree in the energy sector are not strong. Furthermore, education and training programs were seemingly not well aligned with the job postings available.

These findings suggest that the workforce-development pipeline in West Virginia is fractured and not well aligned: Education and training opportunities available through publicly funded institutions such as CTCS, CTEs, and EDGE are not well connected either to each other or to the training efforts provided through the Workforce Investment Areas' WorkForce West Virginia Centers, though the institutions are making strides to work more collaboratively, according to our study participants. Deeper efforts to align education and training across the different institutions are clearly needed. Further, students with whom we spoke reported few opportunities to obtain OJT or workplace experience while in CTCS programs. If these occur, they are piecemeal and one-off opportunities, rather than integrated as part of a program's curriculum. And students in energy-related degree-granting programs felt that career counseling and support to obtain a job was not adequate; they relied more on personal networks than on CTCS administration to obtain a job. Stronger industry-college connections are clearly needed to support CTCS programming and the employment of its graduates.

CHAPTER FIVE

Promising Practices to Strengthen the Energy-Sector Workforce-Development Pipeline in West Virginia

The challenges noted in the previous chapters highlight the need for stakeholders in West Virginia to develop and implement a strategy to support the workforce-development pipeline. As described in Chapter Two, the talent pool entering the pipeline needs to improve basic skills, content knowledge, and workplace competencies; employers require certain KSAs for jobs in the energy sector in West Virginia, as described in Chapter Three; and, as described in Chapter Four, education and training providers need to more closely align their programming to employers' needs and ensure that any gaps in programming are filled, any redundant programs are uncovered, and graduates from programs are employable.

To support West Virginia education and training, industry, and government stakeholders' efforts to strengthen the state's workforce-development system in the energy sector, this chapter outlines a set of viable tactics that West Virginia could employ. We first review promising practices typically used to support workforce-development systems and then describe example energy-sector public-private partnerships and collaborative efforts. We conclude the chapter with a summary of promising practices most useful for West Virginia's workforce-development system in the energy sector.

Nationally Recognized Promising Practices

A variety of strategies have been developed to promote skill development and sustainable employment for regional workforces. Successful

strategies may incorporate programs in higher education, professional education, and on-the-job training opportunities. Comprehensive workforce development strategies are typically supported by a combination of partnerships among educational institutions (e.g., high schools, community colleges), regional employers, and government agencies (e.g., WIBs). Promoting collaboration among these different stakeholders results in a comprehensive approach to workforce development focused on addressing multiple needs (e.g., labor shortages, unemployment, national energy goals). In this section, we describe practices to support workforce development that have been nationally recognized as promising: sector-based programs and career pathway models (U.S. Department of Labor, undated) and higher education consortia with strong industry ties (Kochan, Finegold, and Osterman, 2012).

Sector-Based Models

Sector-based models are a partnership between public agencies and the economic stakeholders in a targeted industry, cluster of industries, or occupations. The partnership plans and implements customized education and training programs to upgrade the skills of the workforce and improve the economic performance of the region (Harper-Anderson, 2008; Kochan, Finegold, and Osterman, 2012). Sector-based models "seek to develop deep knowledge of the markets, technology, and labor market circumstances of the industry and, through this knowledge, to contribute to both the human resource and also the economic growth and development needs of the industry" (Osterman, 2007, p. 139). Thus, rather than one employer working with an education or training program to fill jobs, sector-based programs involve multiple employers in a region or industry sector that articulate their workforce and skills demands, and numerous education and training institutions—both private and public—working collectively to meet the needs of employers. Because the sector approach targets an entire sector, rather than a single company, a sector-based program may involve the government or public sector to help an entire sector become more competitive. And, typically, sector-based programs involve an *intermediary* with deep knowledge of the industry. The intermediary facilitates partnerships with employers, links employers and potential employees, or encour-

ages employers to develop curriculum, evaluation and assessment tools, or on-the-job experiences for training participants, or to commit to interviewing graduates of training programs (National Network of Sector Partners, 2010; Giloth, 2004). The organizations most likely to act as intermediaries are WIBs and community-based organizations. Other types of organizations play a role in sector-based programs. Examples include community colleges, economic development agencies or community development corporations, employers and employer associations, unions, and research or advocacy organizations (National Network of Sector Partners, 2010).

There is suggestive evidence that sector-based programs are successful in meeting the workforce demands of employers and in improving participants' employment and wages: A qualitative analysis found that sector-based programs were able to achieve their stated goals (Pindus et al., 2004), and a pre-post evaluation of six sector-based programs found gains in participants' hourly wages 24 months after completion of five of the programs (Grote and Roder, 2005). Other studies, including a random-control trial, summarized by National Network of Sector Partners (2010), have demonstrated a number of sector-based programs' potential effectiveness.

Career Pathways Model

The development of career pathways is a second practice that has garnered increased attention, especially at the federal level, as a method to strengthen workforce-development systems. In April 2012, the U.S. Departments of Education, Labor, and Health and Human Services jointly issued a letter promoting the adoption of career pathways as a way to ensure that adults and youths have opportunities to gain industry-recognized credentials and skills that allow them to secure employment and advance up a career ladder. The letter defines career pathways as a "series of connected education and training strategies and support services that enable individuals to secure industry relevant certification and obtain employment within an occupational area and to advance to higher levels of future education and employment in that area" (p. 1). In the 1980s and 1990s, a key goal of a workforce-development system was to build a *job ladder* for the working poor

or underemployed that enabled them to move, as needed, from adult "basic" education to a higher education degree and skills training. People would enter this ladder at the appropriate point and then move up (Osterman, 2007). In contrast, a career pathways model is less structured and hierarchical: It is a partnership composed of multiple education, community, and industry partners that provides youths and adults with multiple opportunities to pursue a career ladder in high-demand industries. Career pathways systems are designed using real-time labor market information and active employer involvement to ensure that training and education programs meet the skill and competency needs of local employers.

Sector-based partnerships served as a platform for the development of career pathway models. Within a career pathways model, industry-recognized credentials that can be "stacked" and are portable across states or regions and support services such as counseling, transportation, child care, and mentoring are provided, thereby integrating service delivery with education and training, with strong linkages to local and regional employers. It is a "customer-centered approach," in which talent can better navigate employment opportunities and customize the education and training needed to obtain a job. Because career pathways systematically link education programs and certifications to the occupational structures in industries, workers can move in and out of education and work to advance their knowledge as well as their careers (Scully-Russ, 2013). The vision for career pathways models is to have a demand-driven education and workforce-development system that aims to be more responsive to the needs of employers and accommodating of the wide variation in the ways adults sequence their education and careers (Jenkins, 2006; Lewis, 2008; Stephens, 2009).

Higher Education Consortia

In addition to sector-based and career pathways models, community colleges have the potential to be the center of workforce-development strategies that rely on collaborative efforts between industry employers and social service providers. By collectively providing social services, developing workplace competencies, and integrating basic skills into degree-bearing coursework, these "higher education consortia"

(Kochan, Finegold, and Osterman, 2012) have demonstrated clear promise in supporting the retention of lower-skilled talent in education and training programs and these students' subsequent completion and employment.

Providing social services. Project QUEST, in San Antonio, Texas, is an example of a workforce-development program situated at a community college that partners with industry and integrates social services. This program trains working adults with high school diplomas and cooperates closely with employers to identify job needs and skills required and then design the training curriculum. Firms then make a good-faith pledge to hire program graduates. The jobs must meet living wage standards. The training is provided by local community colleges and typically lasts one and a half years. It provides some financial support and extensive counseling. Although Project QUEST has not been evaluated using random assignment, two independent pre-post evaluations found very substantial wage gains. One study reported an income increase of between $5,000 and $7,500 a year for QUEST participants (Osterman and Lautsch, 1996); this increase was confirmed by another independent evaluation (Grote and Roder, 2005).

Teaching workplace competencies. In addition to industry-specific technical skills needed to enter the workforce, additional skills are necessary to remain competitive and function effectively within the workplace. These workplace competencies (Wang and King, 2008), or "soft skills" necessary for workforce development, include oral and written communication skills, teamwork skills (e.g., respect for differing opinions and customs), problem-solving and critical-thinking skills, and professionalism (i.e., responsibility, accountability, and integrity) (U.S. Department of Labor, Office of Disability Employment Policy, 2013). Service learning is recognized as a promising mechanism to instill both "soft skills" and work experience (Shuman, Besterfield-Sacre, and McGourty, 2005). Service learning is an instructional approach community college courses can provide which combines classroom instruction and community service (Gottlieb and Robinson, 2006). Research has demonstrated that service learning positively influences many student learning outcomes (Astin et al., 2000), including "soft skills" such as teamwork, civic responsibility, academic development and educa-

tional success, critical thinking, and communication and learning of career skills (Prentice and Robinson, 2010), and is a pedagogy that positively affects the traditionally underserved (Finley and McNair, 2013). It is also a pedagogy that can be incorporated into virtually any technical classroom. Furthermore, service learning provides students the opportunity to engage in experiential learning, a methodology that creates knowledge through real-life work experience (Kolb, 1983).

Restructuring the delivery method or content of developmental education. Community colleges across the United States grapple with the challenges their students who require developmental education typically face: increased time to completion, costs associated with their education, and demoralization (Attewell et al., 2006; Bailey, 2009; Bailey, Jeong, and Cho, 2010; Martorell and McFarlin, 2011; Scott-Clayton and Rodriguez, 2012; Bailey, Jaggars, and Scott-Clayton, 2013; Crisp and Taggart, 2013). Further, there is evidence that developmental education courses do an inadequate job of integrating students into the demands of credit-bearing college coursework (Bahr, 2008; Bahr, 2012; Hodara and Jaggers, 2014). Looking to offset the burdens developmental education could place on students, community colleges have begun to implement a variety of innovative strategies to improve their developmental education courses (Collins, 2009; Jenkins et al., 2009; Edgecombe, 2011; Rutschow and Schneider, 2011). Promising strategies include truncating the length of developmental education by compressing coursework (Jenkins et al., 2010; Cho et al., 2012; Fong and Visher, 2013), providing support services such as tutoring or learning communities alongside the developmental education courses (Edgecombe et al., 2013), augmenting curriculum to include study skills (Ogden et al., 2003; Zeidenberg, Jenkins, and Calcagno, 2007; Urciuoli and Bluestone, 2013), and reforming curricula content (Hodara, 2011). Another promising strategy is to integrate developmental education within credit-bearing courses—also called "mainstreaming" (Hodara and Jaggars, 2014). As an example, Washington state's Integrated Basic Education and Skills Training (I-BEST) program mainstreams developmental education within credit-bearing courses. I-BEST is a nationally recognized model that has been demonstrated in a number of studies to improve students' literacy and work

skills, thereby decreasing their time to completion. I-BEST pairs two instructors in the classroom—one to teach the course content and the other to teach basic skills in reading, math, writing, or English as a second language (if needed). As students progress through the program, they learn basic skills in real-world scenarios. This approach has students concurrently learning "basic" education skills while they are in a college program or within a career pathway. Research has found that I-BEST students outperform similar students enrolled in traditional basic skills programs, including those who enrolled in at least one non–I-BEST workforce course. I-BEST students were more likely than others to continue into credit-bearing coursework, earn credits that count toward a college credential, earn occupational certificates, and make point gains on basic skills tests (Jenkins, Zeidenberg, and Kienzl, 2009).

Example Energy-Sector Public-Private Partnerships

The promising practices summarized in the previous section highlight ways in which public education and training institutions can collaborate effectively with various partners. In this section, we describe established and emerging programs and partnerships specific to energy workforce development within West Virginia and nationally. We describe the characteristics of example regional and high-profile energy partnerships and initiatives identified through Internet searches using several combinations of terms (e.g., *energy partnerships*, *consortium*, *workforce development*, *training*) (see Table 5.1). For the purpose of this review, we defined a partnership as any publicly coordinated effort between stakeholders from at least two different areas (e.g., education, industry, local/regional/federal government).

It is important to note that most of the regional partnerships identified have neither been independently reviewed nor systematically evaluated using rigorous scientific methods. Consequently, we expanded our search to include other workforce-development programs and partnerships outside the West Virginia region. Most of these evaluations were supported by grants provided by ETA. For each evaluation we

Table 5.1
Summary of Partnerships, Target Population, and Goals

Partnership	Target Population	Summary of Goals
ShaleNET	Regional	Train and place regional workers in high-priority jobs in the natural gas industry
West Virginia Oil and Gas Association	Regional	Educate the public about industry and support job creation
National Alternative Fuels Training Consortium	National	Develop training curriculum; provide training and education on alternative fuels
Energy Providers Coalition for Education	National	Serve as resource to online education programs to prepare for energy jobs
Eagle Ford Consortium	Regional	Increase communication and collaboration for various initiatives including training, education, and workforce-development analyses
Center for Energy Workforce Development	National	Provide workforce-planning analyses and strategic guidance on workforce-development issues
High Plains Technology Center	Regional	Provide skill training and education for specific jobs as floor hands or derrick hands
Joyce Foundation Shifting Gears Initiative	Regional	Provide bridge program instruction to increase job opportunities
American Petroleum Institute	National	Provide economic analyses and educational opportunities through conferences and workshops

describe the program, its objectives, primary activities, target population, documented results, and any lessons learned.

West Virginia Regional Partnerships

Partnerships for the immediate West Virginia region were limited in number and scope and have not been systematically evaluated to determine their effectiveness. Therefore, this section provides a brief description rather than an evaluation of three partnerships focused on

energy workforce development found within the West Virginia region: (1) ShaleNET, (2) West Virginia Gas and Oil Association, and (3) the National Alternative Fuels Training Consortium.

ShaleNET is the only example we could find of a notable collaborative effort in the region. It includes Westmoreland County Community College and Pennsylvania College of Technology, West Virginia Northern Community College, and Stark Community College (Ohio). Founded in 2010 and funded by a $4.9 million grant from ETA, ShaleNET's intent is to "design a comprehensive recruitment, training, placement, and retention program for high priority occupations in the natural gas drilling and production industry" (ShaleNET, undated). In addition to specific colleges that provide training, ShaleNET's website lists as partners the Allegheny Conference on Community Development and the Pennsylvania Independent Oil and Gas Association (PIOGA).

ShaleNET leverages its partnerships by providing a talent match service through which interested jobseekers can find job opportunities and potentially even be paired up with a training provider to receive free training. The organization also holds meetings that bring together educators and industry representatives to share information about workforce-development initiatives. It is unclear what specific action items might result from one of these meetings. ShaleNET holds an annual "Workforce Forum" that aims to inform educators and students about new jobs in unconventional natural gas areas while providing a forum for networking with members from industry and the government.

Chartered in 1915, West Virginia Oil and Gas Association (WVONGA) is one of the state's oldest trade associations, with over 200 member companies. It provides services including exploration, drilling, transmission, and legal and technical support. The organization's goals include educating the public about the industry, furthering safe and responsible development in the region by working with regulatory and legislative entities, expanding the role of natural gas in the region, and creating jobs. It is unclear to what extent the WVONGA umbrella has specifically contributed to increased job creation in the region, but member companies employ thousands of people across the

state and have invested $10 billion in West Virginia. WVONGA has made great strides in raising public awareness of shale gas and associated industries through two forums: EnergizeWV, a nonprofit alliance that disseminates information about the natural gas industry, and *Inside Shale*, a weekly radio show about the natural gas industry.

The National Alternative Fuels Training Consortium (NAFTC) is an example of a partnership between an educational institution in West Virginia and several other stakeholders including fuel providers, manufacturing companies, government agencies, and professional associations. Established in 1992 under a contract with the U.S. Environmental Protection Agency, the NAFTC was created by WVU to help address a shortage of technicians skilled in alternative fuel vehicles. The programs offered by NAFTC are modeled after a train-the-trainer design with specific goals to develop instructors at various levels to provide curriculum supporting the development of alternative fuel vehicles. As of 2012, NAFTC had provided over 1,500 workshops and events to over 600,000 participants across the country. Although not a comprehensive evaluation, specific programs under the NAFTC have undergone a merit and peer review through the U.S. Department of Energy. For example, the NAFTC's Clean Cities Learning Program, which is focused on raising awareness of alternative fuel technologies, was evaluated in 2012 as part of DOE's Annual Merit and Peer Evaluation Meeting. This included evaluations by five reviewers who found that the program is consistent with DOE's objectives and has done well to establish a wide network of partnerships with various stakeholders (e.g., community colleges, industry partners) (U.S. Department of Energy, 2012).

ShaleNET, WVONGA, and NAFTC were the only examples of established partnerships focused on the West Virginia region we found at the time of this study. Consequently, we broadened our search to include examples of other regional or national partnerships and initiatives in the United States to identify successful practices from outside West Virginia.

Other Regional and National Partnerships

Although other partnerships generally shared similar objectives to improve the workforce for the energy sector, specific goals varied across programs. We identified four types of goals pursued by these programs: (1) image building, (2) information sharing, (3) training and education, and (4) public policy. Some programs pursued several goals, whereas others focused on only one of these goals (see Table 5.1). Also similar to partnerships within the West Virginia region, most of these partnerships have not been rigorously evaluated. That is, when program evaluations have been conducted, they are largely descriptive, with data summarizing enrollment and completion rates of students and trainees. More research needs to be conducted to determine the specific initiative and/or features of specific programs that will benefit West Virginia's goals to develop its workforce. Nonetheless, the qualitative findings and lessons learned from these partnerships are still useful.

High Plains Technology Center (HPTC)

The HPTC was established in 1982 to provide skill training and education for residents of northwest Oklahoma. HPTC's geographic region includes the areas connecting four states in Oklahoma, Kansas, Texas, and Arkansas. In 2007, the HPTC received two High Growth Job Training Initiative (HGJTI) grants[1] totaling $4 million awarded by ETA to address employment challenges in the upstream oil and gas industry.

Partnering with postsecondary schools, local workforce investment boards, and employers, the HPTC developed programs to provide 40 hours of training (classroom and hands-on) to prepare workers as either floor hands or derrick hands. The overall training goal was to prepare approximately 1,300 trainees. HPTC far exceeded that goal: It enrolled 2,162 people and had close to a 100-percent completion rate. HPTC estimated that about 75 percent of its trainees who had previously been unemployed were placed in jobs.

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[1] More than 160 grants were awarded by ETA to programs and partnerships across the United States to provide industry-focused job training.

Despite the success of HPTC, several challenges were noted. The large geographic region served by HPTC was a challenge for partnering organizations, trainees, and instructors. Retention of instructors, particularly those who had experience as floor hands and derrick hands, was difficult as other job opportunities with higher wages were available to them.

Important factors in the success of the program include the following:

- The area's regional employers were key partners in developing and supporting the initiative.
- Approximately 30 oil and gas companies were involved in designing and planning the HPTC initiative.
- Representatives from these companies served on advisory committees, which provided feedback and guidance on the curriculum used for each training initiative.

This participation was critical to ensure that trainees were receiving instruction on the KSAs most relevant for the target jobs and organizations. Some of these organizations also provided HPTC with equipment and tools for training. Industry, trade associations, and local economic development agencies also supported the HPTC by advertising the initiative to the area's organizations. The industry and trade associations were an important source of information regarding job vacancies in the area.

Joyce Foundation Shifting Gears Initiative

The Shifting Gears Initiative, funded by the Joyce Foundation, is another grant program primarily focused on training and education. Launched in 2007, the initiative was designed to support education and training in six states: Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin. Shifting Gears initially selected ten community college sites to provide bridge program instruction to improve job opportunities and to support organizations in three industries: health; manufacturing; and transportation, distribution, and logistics. Although the goals and objectives were specific to each community college site, the bridge programs were required to include contextualized instruction

(to ensure that basic skills, such as reading, are connected to job- or industry-specific knowledge); career development; and transition services, which provide information to students about further education (e.g., degrees) and job training programs (e.g., apprenticeships).

Evaluations of these bridge programs found that the percentage of students completing the bridge program ranged between 33 and 100 percent. Program completion was found to be partially explained by

> 1) the percentage of students receiving career orientation more than once; 2) the percentage of students receiving admissions and financial aid assistance at least once; 3) the percentage of students receiving advising at least once; 4) the percentage of students receiving transportation assistance at least once; and 5) the frequency of student meetings with an assigned transition coordinator. (Bragg et al., 2010, p. 17)

The percentages of students placed in jobs or who continued their employment varied considerably between programs (50–89 percent).[2]

Center for Energy Workforce Development

The Center for Energy Workforce Development (CEWD), founded in 2006, was created as a nonprofit consortium to help develop strategies to address anticipated labor shortages and broader energy workforce-development issues. The primary goal of CEWD is to serve as a central location for sharing information about the energy workforce and fostering partnerships among companies, unions, industry associations, and educational institutions. According to its website, the strategic goals for 2013 included

> career awareness—build awareness of the need for a skilled energy workforce, b) workforce development/education—implement short and long term education solutions to build a pipeline of skilled workers, c) workforce planning—identify critical workforce needs and measuring the success of workforce development initiatives. (Center for Energy Workforce Development, 2013)

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[2] Additional information about Shifting Gears can be found at Joyce Foundation, undated.

Members of CEWD have access to a range of resources, including monthly newsletters, webinars, annual member summits, regional meetings, and virtual networking. CEWD also supports workforce planning by conducting annual member surveys and developing workforce forecasts and reports.

CEWD has supported the development of over 25 state consortia. However, West Virginia was not listed among those states having an existing or planned state consortium with CEWD. State consortia are structured to develop a range of goals and objectives, including career awareness, workforce planning, and marketing the services provided by the state consortium. The effectiveness of these consortia is not yet known. However, the objectives are consistent with successful practices to connect organizations, industry, and educational institutions to ensure the next-generation workforce will be prepared to meet occupational demands.

The Energy Providers Coalition for Education

The Energy Providers Coalition for Education (EPCE) was founded in 2000 to serve as a central location for finding online education for energy jobs. EPCE partners with educational institutions, which then provide the education. Currently, five institutions have been selected to partner with EPCE: Bismarck State College, Clemson University, Excelsior College, Worcester Polytechnic Institute, and the Virtual High School (VHS) Collaborative. Each of these institutions provides online education to support a range of student goals. Some programs provide individual courses; others provide education leading to certificates and bachelor's and master's degrees.

A key component of the EPCE model is that industry representatives (e.g., utility companies) meet twice a year to discuss workforce challenges with the educational institutions. The industry organizations are encouraged to provide feedback to EPCE and the educational institutions to ensure that the curriculum is meeting the industry's

needs. The curriculum is reviewed to facilitate matching the instructional goals to job responsibilities.[3]

The Eagle Ford Consortium

The Eagle Ford Consortium (EFC) was created to meet four primary objectives emphasizing (1) communication with the local community, (2) coordinating efforts to support dislocated and underemployed workers, (3) securing resources to improve opportunities for the local workforce, and (4) facilitating economic development within the Eagle Ford Shale region. To meet these objectives, the consortium created five subcommittees, which focus on education and workforce, infrastructure and natural resources, community and economic development, industry, and community investment. The education and workforce subcommittee includes representatives from educational institutions, workforce-development agencies, and recruitment organizations. Some of the educational partner institutions include Del Mar College, Laredo Community College, Texas A&M–Corpus Christi, and the University of Texas at San Antonio.

The consortium issues reports focused on workforce-development issues for specific regions. For example, the EFC Workforce and Education Development Workgroup prepared a summary of its findings on workforce issues and immediate needs for five workforce-development areas (i.e., Alamo, Golden Crescent, Coastal Bend, Middle Rio, and South Texas). This overview highlights barriers to employment (e.g., motivation to work 70-hour weeks, drug screenings) as well as the employers' desires to have a readily available applicant pool that can be accessed as needed. One of the immediate needs identified was having real-time information on the number of organizations, jobs, and unfilled positions. The workgroup also considered the industry's long-term needs and emphasized the importance of partnering with educational institutions and industry organizations to develop a strategic plan for growth.

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[3] Additional information about EPCE can be found at Energy Providers Coalition for Education, undated.

The American Petroleum Institute

The American Petroleum Institute (API) is a national trade association in operation since 1919. It is the oldest partnership included in our review. The API's mission is to "influence public policy in support of a strong, viable U.S. oil and natural gas industry to meet the energy needs of consumers in an efficient, environmentally responsible manner" (American Petroleum Institute, 2014). In support of this mission, API engages in a wide range of activities related to workforce development. Some relevant activities include economic analyses, seminars, workshops, and conferences. API also operates its own educational institution (API University), which offers a variety of technical, professional, and safety courses. The purpose of these courses is to help people meet regulations and standards established by the energy industry. Certification programs are also offered for several career fields including pressure vessels inspector, piping inspector, refractory personnel, and tank entry supervisor. API not only provides courses that lead directly to employment but also provides educational and instructional material for teachers and students from kindergarten through eighth grade.

API has partnered with Wood Mackenzie and IHS Global Insight to conduct studies on specific topics related to workforce development. One such report by IHS, published in 2012, examined the employment outlook for African Americans and Latinos in the upstream oil and gas industry for 2010 to 2030.

Summary of Promising Practices to Strengthen the Pipeline of Workers and Support Their Employability in West Virginia's Energy Sector

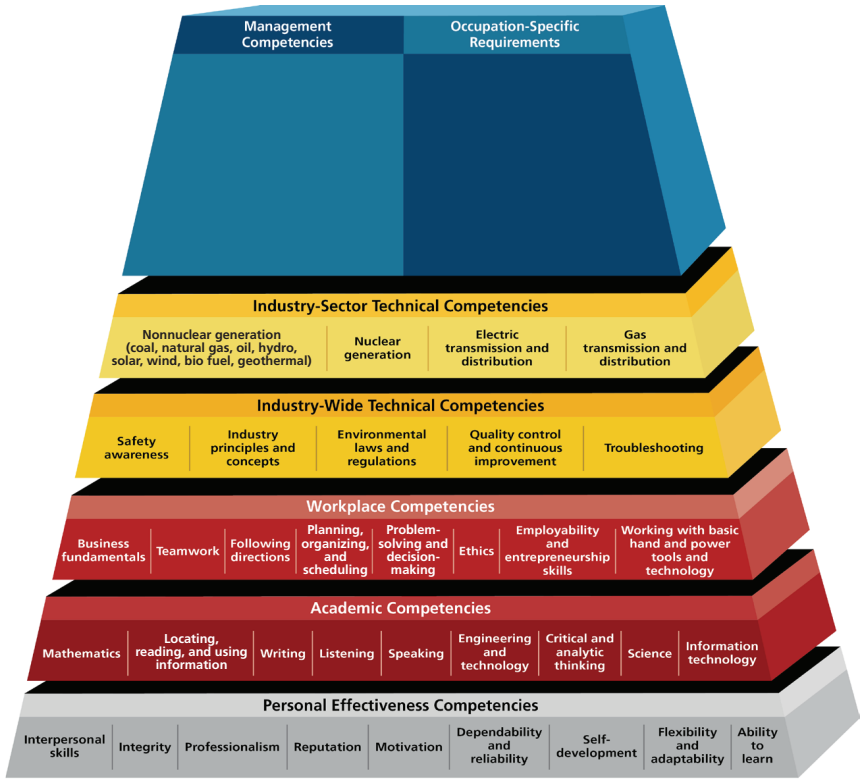
Based on our review, three key themes emerged:

1. **Employer involvement is critical to ensuring that future workers receive the technical knowledge and skills needed to meet future occupational demands.** Without frequent input and participation from local employers, training and edu-

cation establishments (e.g., community colleges, private training firms) are unable to plan and develop programs that result in the KSAs needed to be competitive in the energy sector.

2. **Combining input from employers with bridge services provides the opportunity for comprehensive training to (a) surmount general employment barriers (e.g., poor attendance) and (b) develop the technical skills that serve as a foundation for building a career in the energy industry.** Bridge services, which focus on increasing job skills and opportunities for low-skilled workers, and employer involvement are critical factors for ensuring that future workers in the energy sector receive the education required for entry into the industry as well as the training needed to succeed in energy-sector jobs. Bridge services typically provided by community service programs help to ensure that future workers develop the personal effectiveness and academic and workplace competencies needed to succeed in a wide range of occupations (Alssid, Goldberg, and Klerk, 2011). These competencies focus on broad KSAs such as an individual's professionalism, interpersonal skills, teamwork, mathematics and science knowledge, and ability to follow directions (Figure 5.1).
3. **Recognize potential structural barriers to program usage and quality of programming.** Workforce-development programs and initiatives often face similar challenges. Geographic restrictions are a major barrier to employment, education, and training opportunities in many regions of the United States. Accessibility of training, in particular, was identified as an important factor affecting the success of the workforce-development initiatives reviewed. Geographic isolation and lack of reliable transportation are factors that must be considered when targeting a specific population for training and development. Workforce-development programs and initiatives also identified challenges in securing highly qualified instructors. Higher-paying opportunities to work directly in the energy industry are a significant deterrent for those otherwise qualified and interested in becoming instructors.

Figure 5.1
Department of Labor Employment and Training Administration Competency Model for the Energy Sector



SOURCE: CareerOneStop, undated.

RAND *RR812-5.1*

Summary

A few notable partnerships designed to raise awareness and enhance training, education, and job opportunities have been established in the West Virginia region. However, the full impact of these partnerships has yet to be systematically evaluated. Consequently, we reviewed several other regional and national partnerships to determine lessons learned and factors associated with successful programs and partnerships. As in the West Virginia region, comprehensive evaluations of

other regional and national partnerships still need to be conducted. However, our review of lessons learned and the summary evaluations, focused mostly on enrollment and completion rates of students and trainees, indicated three key themes. First, employer involvement plays an important role in connecting students and trainees with job and career opportunities and helping to facilitate a successful transition to work by ensuring educational programs are providing relevant skills and training. Second, bridge programs help to address common barriers to employment through internships and on-the-job training. And third, successful programs must address challenges like instructor retention and geography, which can limit training opportunities for individuals living in isolated areas.

CHAPTER SIX

Summary of Findings and Recommendations to Improve the Workforce-Development Pipeline to Meet West Virginia's Energy-Sector Needs

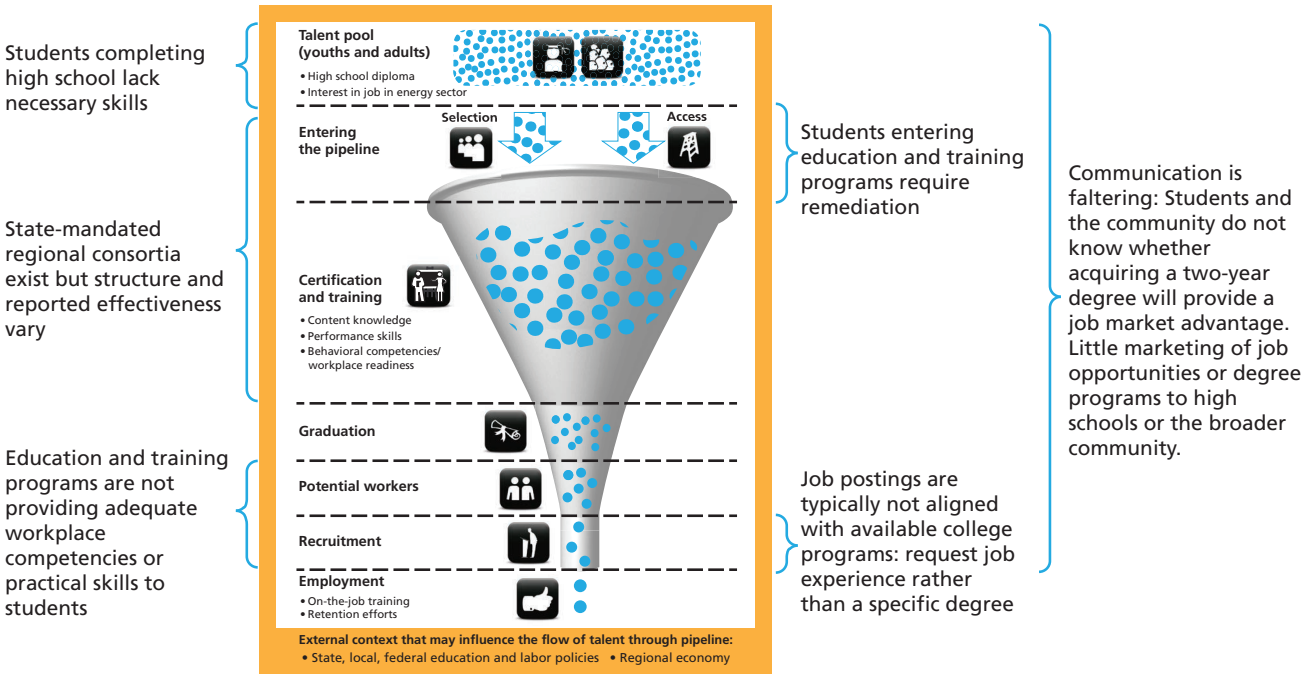
The Workforce-Development Pipeline for West Virginia's Energy Sector

The analyses undertaken in this study revealed that a number of energy-sector training opportunities exist in West Virginia through CTCS, EDGE or CTEs. However, the system appears to be fractured and incoherent, as illustrated in Figure 6.1.

In the first two components of the workforce-development pipeline (talent and access/selection), and as described in Chapter Two, only a portion of talent is eligible for training and postsecondary education opportunities: Seventy-nine percent of ninth-graders enrolled in West Virginia high schools in the fall of 2008 graduated within four years, by the spring of 2012; 72 percent of economically disadvantaged students graduated on time. Few are graduating with the needed skills to be employable in the energy sector; results on WESTEST2 state assessments reveal that 46 high schools, or 40 percent, met or exceeded the NCLB standards for mathematics and reading; 48 percent of students were proficient or above in mathematics, and 49 percent of students were proficient or above in reading on the WESTEST2. Our analyses further revealed that enrollees in CTCS often require remediation: Twenty percent of new students were enrolled in at least one mathematics-related developmental course (50 percent in energy-sector programs, noted by interviewees) and 9 percent were enrolled in at least one reading-related developmental course at the time of this study.

In the middle components of the pipeline (certification and training, graduation, and recruitment), our analyses revealed a fractured

Figure 6.1
Illustration of the State of the Workforce-Development Pipeline of West Virginia's Energy Sector



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and not well-aligned system. Interviewees reported little information existed to communicate the advantages of a two-year degree or certification, or the types of job available in the energy field. Further, state-mandated regional consortia exist, but the reported effectiveness varies; colleges do not have an incentive to accept EDGE credits. Because job postings typically request job experience, rather than a specific degree, incentives for pursuing a two-year degree in the energy sector are not strong. Furthermore, education and training programs were seemingly not well aligned with the job postings available. We also found evidence for the need to improve the development of workplace competencies and hands-on training, which could be accomplished through deeper connections between education providers and employers (i.e., through curriculum development, internships, and stronger career counseling).

Drawing on the analyses within this report, this chapter outlines a strategy to improve the alignment of West Virginia's energy-sector workforce-development pipeline. The pipeline needs to ensure that the talent pool has the necessary skills to be successful in the energy-sector labor market across the state—for youths just graduating from high school, adult workers currently looking to switch professions, or displaced coal mine workers in need of employment.

The strategy includes suggested practices and action items to ameliorate barriers to accessing training opportunities and to promote education and training providers' abilities to successfully train talent in the skills needed in the energy sector in West Virginia. We order these suggestions based on ease of implementation—those that we recommend adopting earlier than others to address crucial bottlenecks, or that can be feasibly implemented in the short term, followed by those that could take a longer time frame to be implemented and that will most likely require the involvement of multiple partners.

Suggested Measures Regional Stakeholders Can Implement in the Short Term

Develop sustained permanent partnerships among industry leaders, training providers, and other education providers. WIOA

requires all states to create state- and local-level workforce-development boards that must include the development and adoption of career pathways practices as part of their strategic plans. As the nation's largest source of occupational training (Osterman, 2007), community colleges are the core public institution for education and skills training and a central component of any workforce-development system (Alssid, Goldberg, and Schneider, 2011). Therefore, CTCS could be the central purveyor, or intermediary, for energy-sector career pathways, structuring and linking education and training offered by its own programs with employment and training available through WIBs, private training institutions, or registered apprenticeships, and coordinating also with social service providers (Alssid et al., 2002).

Yet community colleges cannot be expected to shoulder the responsibility for this entire system alone. As described in Chapter Five, whether through sector-based partnerships, career pathways models, or via higher-education consortia, employer engagement in all aspects of the workforce pipeline is crucial to developing a ready workforce. In the study reported here, interviews with key CTCS administrators and focus groups with students showed limited involvement by employers and industry leaders in the development and planning of educational and training programs. While there were ample examples of involvement of industry leaders as advisory board members of a program or a college, we did not hear of examples of direct, continued involvement in curriculum development, providing formalized or institutionalized internship opportunities to students, or actively recruiting program graduates for available jobs. Interviewees reported that employers are most involved in the development of new programs that meet a specific need. All respondents agreed the contributions of employers were critical to steering the development and fit of a workforce to industry needs.

Our review of promising practices found that a key characteristic of partnerships that successfully trained workers to fill labor demands was a deep commitment and involvement by industry in the development of educational programs and in providing opportunities for job seekers upon graduation. Employers are needed in the review process of current programs to confirm or suggest improvements in pro-

ducing a workforce with the skills employers need. Communication from employers in the region about the importance of training offered through the education pipeline, particularly surrounding an associate's degree, would also be helpful in recruiting students to CTCS.

We therefore recommend the following:

- Employers in the energy sector should engage with education and training programming in forecasting demand, providing regular input on curricula, supporting the acquisition of equipment and supplies used in hands-on training, and instituting formalized workplace learning opportunities for students.
- Industry leaders should serve on advisory boards or committees of training institutions and community colleges so as to have an active role in the development of curricula that meet their needs.
- Employers should establish formalized internship programs that offer hands-on, practical experience for students across several energy-related CTCS programs. Having such a joint program between employers and training institutions will facilitate ongoing conversations, because employers and educational institutions will need to communicate regarding the structure and the content of the internships.
- To better engage employers, CTCS, EDGE, and the Workforce Investment Areas need to work more effectively with each other, especially to develop comprehensive industry-specific career pathways, as required by WIOA.

Develop CTCS programs that suit the needs of the energy-sector workplace, yet provide a broad range of skills to students. At the time of this study, interviewees felt the degree-granting programs in place in CTCS were not meeting employer needs. Students did not see institutionalized processes to help with job placement other than the personal contacts of instructors. To better design programs so that graduates are competitive on the job market, we recommend the following improvements to programming:

- Integrate technical, occupation-specific training along with workplace readiness and other soft skills through cross-college collaboration with continual input from industry.
- Design curriculum through industry-college collaboratives, which include continual review and updates.
- Integrate behavioral competencies and workplace-readiness skills in the curriculum; for example, by using service-learning pedagogical approaches.
- Develop hands-on modules within the curriculum so that students get practice working with equipment they will find on the job.

Incorporating soft skills in a program's curriculum will help prepare graduates for on-the-job demands. Integrating technical training that conveys specific content knowledge along with work readiness and basic skills training allows students to obtain the wide range of content and skills necessary to be competent yet agile employees.

Provide services to address potential barriers to talent's entrance into, and completion of, education and training programs. CTCS students are facing a number of structural barriers to entering and staying in programs. We heard in focus groups with students that many worked full time and had families they were supporting while they were studying. As described in Chapter Five, the education and training programs that produced the most successful workers were those that made long-term, substantial investments in their participants. For example, Project QUEST provides intensive financial assistance, counseling, and social support. Indeed, the career pathway models required by WIOA incorporate partnerships with community-based organizations and social service providers to engage with and help students in need. We therefore recommend that CTCS provide stronger career counseling and reach out to local social service providers and community-based organizations to help its student population with child care, transportation, financial literacy, and other potential issues students may encounter that could inhibit their entrance or graduation.

Consider modifying developmental education delivery and content. According to interviews with CTCS administrators, approximately 50 percent of incoming students in energy-related degree-granting programs need to enroll in non–credit bearing developmental mathematics and reading courses. While necessary in order to bring students' skills up to par so they can perform adequately once in required courses, the extra course work can be demoralizing to students and cause extra financial burdens, thereby contributing to a student's likelihood to drop out.

To alleviate this serious issue, we recommend that CTCS modify its developmental education coursework to integrate innovative practices being implemented in other community college systems facing similar issues. Example innovative approaches in delivery and content of developmental education that could be used as models for CTCS were summarized in Chapter Five. These include truncating the length of developmental education by compressing coursework, providing support services such as tutoring or learning communities alongside the development education courses, augmenting the curriculum to include study skills, reforming curricula content, and "mainstreaming" (integrating basic skills instruction and degree-bearing coursework). Prior to implementing any modifications to CTCS developmental education's content and delivery, administrators will need to carefully consider the possible costs versus the benefits. For example, administrators will need to determine the number of additional instructors required if developmental education is mainstreamed into credit-bearing courses, if developmental education courses are accelerated, or if study skills are added to curricula.

Leverage workforce-development training programs already in place. CTCS administrators with whom we spoke noted that CTCS workforce-development training programs, which grant non–credit bearing on-demand certifications, provide a possible avenue to improve connections between CTCS and employers. According to our interviewees, by design the workforce-development training program works hand-in-hand with employers to develop specific as-needed training and certification programs for employees. Employers currently have a stronger connection to workforce-development program administrators than to those in degree-granting programs because the workforce-

development program fills immediate skills needs as opposed to long-term workforce needs. This relationship provides an opportunity to tap the adult workforce already in the labor pool but in need of credentials or a degree.

Longer-Term Measures That Require Comprehensive Partnerships Among the State's Education and Business Stakeholders

Improve awareness of energy-sector employment opportunities and available education and training programs. At the time of this study, CTCS administrators noted that some of the energy-related programs were only partially filled. This could be because potential talent lack the skills required to enter an energy sector–related program in CTCS. Another reason is lack of awareness or misperceptions about the availability of jobs in the energy sector. Interviews with key stakeholders and focus groups with currently enrolled CTCS students indicated that many talented, potentially interested people are unaware of the employment and training opportunities available in the energy sector. For example, interviewees noted that students eligible for EDGE credits did not know or were unsure whether enrollment in a two-year program would provide more advanced technical training comparable to the training they would receive hands-on in the field. If students were aware of programs, there is a sense that potential talent has been hesitant to enroll in postsecondary education or training programs because of a lack of trust in energy-sector job projections. Therefore, few people are enrolling in these programs because they do not know whether jobs will be available when they graduate. Students with whom we spoke in focus groups perceived that for the majority of the students enrolled in their program, it was a "last choice."

Improved communications about CTCS, the array of education and training programs available, and the job opportunities that degree and nondegree programs open for graduates are needed. An expanded marketing campaign that includes social media approaches would improve knowledge of the benefits of enrollment. Streamlined and

strategic communication about technical programs between the CTE and CTCS would improve recruitment of EDGE students—students with established interests and skills in the types of technical programs offered by CTCS.

Expand and improve opportunities for on-the-job training and career counseling. Students in focus groups noted that access to internships or job counseling within CTCS programs seemed to depend on one's instructor. They noted that while there are opportunities within the classroom for hands-on-experience, there are few opportunities to demonstrate technical skills to employers. Yet, employers value on-the-job experience and note this in job position announcements. We recommend the following measures:

- Include formalized internships, cooperatives, or apprenticeships with partner employers to provide on-the-job training as a way to enhance the practicality and usefulness of education programs.

Students also noted that the availability and quality of career counseling at CTCS largely depends on instructors' initiative or personal outreach. Interviews with CTCS administrators corroborated students' perceptions: Career counseling is typically not a priority. When counselors have been hired, students perceive them to be inadequate. Students and administrators voiced the following complaints:

- Career counselors reportedly did not have sufficient time to develop ongoing, substantive relationships with energy-sector employers, especially if there were no local employer office or clear contact from the employers.
- Job fairs in some areas rarely include a range of energy-sector employers; new companies rarely participate.
- Career counselors provide services to the main campus and all of the satellite campuses for their region, diminishing opportunities for sustained contacts with students in programs not on the main campus.
- The clarity of alignment of employers' job postings with college programs varies; all require a few years of experience with a mini-

mum high school diploma/GED, yet current programs do not integrate OJT or internships.
- Counselors may not know what companies are considering coming to the area to speak.

However, a key promising practice in workforce-development programs is intensive counseling to students, such as in Project QUEST. We therefore recommend that CTCS improve and institutionalize career counseling, both during the course of study as well as at the end of a program when students are actively looking for a job.

Make the recruitment and retention of quality instructors a priority for education and training program administrators. Hiring and retaining good instructors for energy-related courses are major challenges. Unlike other more established natural gas fields, West Virginia is not home to a pool of retired workers who can be tapped as instructors. The colleges have had to compete with industry for employees. We recommend two approaches to ameliorate the challenge of hiring and retaining quality instructors:

- Institute ongoing professional development for current instructors, including time in the workplace at partner employers in the energy sector.
- Develop agreements between training institutions and energy-sector employers in the region so that employees can teach in education and training programs. This could be as simple as offering incentives to employees who teach at CTCS on their own time, or institutionalizing cooperative agreements so that industry seconds employees to teach for a semester.

Improve readiness of talent entering postsecondary education and training programs. West Virginia high school students' graduation rates are on par with national averages, but only about half of high school students are "meeting the standards" on state achievement tests. Thus, most high school students are not graduating with the needed skills to enter CTCS energy-related courses; in fact, almost half of the students entering energy-related programs need to first complete mathematics remedial courses (which do not count toward program credit).

Further, analyses of O*NET data revealed that the key KSAs rated as most important in the West Virginia energy-sector high-employment occupations were basic mathematics and reading comprehension skills. Those analyses revealed that a key first step to improving the pool of talent entering postsecondary education and training programs is to focus efforts on improving these basic skills of all schoolchildren in the state. To that end, we recommend that the West Virginia State Department of Education work more closely with CTCS and other higher-education institutions to not only seek to improve instruction in these areas but also reach down to K–12 students to teach the importance of basic mathematics and reading skills in finding jobs, especially in the energy sector.

Institutionalize cross-communication and collaboration across state institutions to support implementation of action items. To ensure the successful implementation of the action items suggested in this report, state labor, economic, and educational institutions will need to incorporate CTCS's efforts into their own procedures. One method to encourage stronger cross-communication and collaboration across state institutions is to leverage the regional education consortia (e.g., EDGE) already in place. Interviewees noted that the regional consortia use their meetings to improve the alignment of and communication surrounding the education pipeline. Strategies implemented by these consortia may provide a model for systematic alignment across the state. Though many of the stakeholders in the pipeline participate, expanding the meetings to include more employers and representatives of the Workforce Development department of CTCS could strengthen the collaboration.

Another way is to institutionalize collaboration across state institutions by tasking the newly reestablished West Virginia Workforce Planning Council with overseeing the implementation of the strategy. The council was reestablished by executive order of the governor in 2013. Council members include representatives from primary and secondary education, postsecondary education, the executive director of WorkForce West Virginia, and the director of the West Virginia Development Office. The council is tasked with

> coordinating initiatives, leveraging resources, and planning for the delivery of a comprehensive workforce strategy that ensures an integrated and strategic approach in meeting the educational and training needs of West Virginia's employers and students, and enhancing the economic development efforts of the state. (State of West Virginia, Office of the Governor, 2013)

Tasking an objective entity like the council with the responsibility of supporting the energy sector's workforce-development pipeline should result in well-thought-out decisions on employment and workforce policies and a healthy system that best meets employers', students', and education providers' needs.

APPENDIX A

Knowledge, Skill, and Ability Requirements for High-Growth Energy-Sector Jobs in the United States and West Virginia

This appendix lists energy-sector employers' ratings of the importance of specific knowledge, skills, and abilities for high-growth jobs in their fields, using the U.S. Department of Labor's Education and Training O*NET data set. The figures provided in this appendix are described in Chapter Three of the report. The ratings are color-coded as dark green (highest rating of importance) through pale peach (lowest rating of importance).

Figure A.1
Knowledge Requirements of High-Growth Energy Jobs in the United States

Knowledge Area	General and Operations Managers	Petroleum Engineers	First-Line Supervisors of Construction Trades and Extraction Workers	Construction Laborers	Operating Engineers and Other Construction Equipment Operators	Service Unit Operators, Oil, Gas, and Mining	Roustabouts, Oil and Gas	Industrial Machinery Mechanics	Electrical Power-Line Installers and Repairers	Team Assemblers	Machinists	Heavy and Tractor-Trailer Truck Drivers	Average
Mechanical	2.61	2.89	3.7	3.57	3.48	3.97	3.07	4.54	3.43	2.23	3.78	3.55	3.40
Mathematics	3.56	4.25	3.5	3.26	2.75	2.82	2.8	3.58	2.84	2.17	4.04	2.22	3.15
English Language	3.34	3.33	3.66	3.2	2.41	3.3	2.76	3.3	2.85	2.53	3.27	2.94	3.07
Administration and Management	4.33	3.56	3.79	3.45	2.97	2.92	2.45	2.55	2.57	1.76	2.14	3.02	2.96
Public Safety and Security	2.92	2.83	3.71	3.35	2.92	3.23	3.21	2.97	2.41	2.01	1.98	3.65	2.93
Customer and Personal Service	3.98	1.8	3.84	3.21	2.5	3.72	2.52	1.99	3.36	2.24	2.17	3.31	2.89
Engineering and Technology	2.5	4.78	2.85	2.63	2.58	2.8	2.23	3.53	2.31	2.16	2.84	2.28	2.79
Production and Processing	2.98	2.45	3.93	2.94	2.39	2.21	2.59	3.18	1.36	3.86	3.4	2.05	2.78
Building and Construction	2.92	1.99	3.88	4.09	3.62	1.79	2.72	3.01	2.18	1.27	1.96	2.65	2.67
Education and Training	2.84	2.48	3.45	3.21	2.45	2.23	2.48	2.88	2.68	2.21	2.37	2.18	2.62
Transportation	2.83	2.06	2.98	2.88	2.54	2.94	2.68	2.08	2.4	1.52	1.76	3.98	2.55
Design	2.97	2.9	2.86	2.53	2.67	1.7	1.98	3.37	2.32	1.7	3.04	2.59	2.55
Computers and Electronics	3.41	3.8	2.67	1.76	1.82	2.3	1.59	2.7	2.22	1.83	2.66	2.61	2.45
Personnel and Human Resources	4	2.39	3.3	2.83	2.05	1.91	1.99	1.77	2.17	1.91	1.82	2.93	2.42
Physics	1.84	3.93	2.25	2.37	2.26	2.35	2.36	2.67	2.99	1.47	2.12	1.56	2.35
Law and Government	2.88	2.69	2.81	2.73	2.07	2.17	2.12	2.35	2.13	1.06	1.53	2.76	2.28
Clerical	3.2	2.6	2.94	1.95	1.93	1.72	1.8	2.22	2.22	1.73	1.82	2.86	2.25
Economics and Accounting	3.68	3.49	2.66	2.39	2.05	1.58	1.37	1.77	1.54	1.45	1.58	1.83	2.12
Chemistry	1.92	3.33	2.26	2.33	1.77	2.16	2.47	2.53	1.85	1.45	1.67	1.6	2.11
Telecommunications	2.28	2.15	2.3	2.41	1.58	1.95	1.87	2.06	2.79	1.27	1.49	2.27	2.04
Psychology	2.91	1.9	2.25	2.17	1.74	1.99	1.74	1.95	2.26	1.29	1.71	1.8	1.98
Sales and Marketing	3.18	2.11	2.49	1.96	1.6	1.76	1.58	1.43	1.06	1.36	1.57	2.81	1.91
Communications and Media	2.32	2.03	2.2	2.67	1.53	1.53	1.72	1.88	1.91	1.64	1.56	1.81	1.90
Geography	2.09	2.82	1.9	2.27	1.77	1.66	2.08	1.42	1.88	1.02	1.32	2.25	1.87
Foreign Language	1.41	1.43	1.89	2.54	1.39	1.89	2.4	1.64	1.42	1.59	1.45	1.9	1.75
Sociology and Anthropology	1.86	1.42	1.45	1.65	1.27	1.51	1.92	1.66	1.59	1.3	1.37	1.43	1.54
Biology	1.46	1.61	1.54	1.97	1.17	1.36	2.04	1.79	1.37	1	1.28	1.61	1.52
Medicine and Dentistry	1.27	1.16	1.62	1.54	1.17	1.48	1.92	1.46	1.92	1.01	1.37	2.19	1.51
Philosophy and Theology	1.24	1.71	1.41	1.39	1.18	1.35	1.63	1.67	1.62	1.46	1.31	1.72	1.47
Therapy and Counseling	1.36	1.32	1.71	1.51	1.23	1.47	1.83	1.38	1.81	1.02	1.39	1.54	1.46
Food Production	1.05	1	1.24	1.68	1.05	1.2	1.42	1.35	1.05	2.17	1.38	2.57	1.43
History and Archeology	1.1	1.47	1.27	1.52	1.42	1.15	1.59	1.23	1.09	1.01	1.29	1.39	1.29
Fine Arts	1.05	1.02	1.27	1.31	1.05	1.13	1.26	1.08	1.04	1	1.29	1.49	1.17

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Figure A.2
Skill Requirements of High-Growth Energy Jobs in the United States

Skill	General and Operations Managers	Petroleum Engineers	First-Line Supervisors of Construction Trades and Extraction Workers	Construction Laborers	Operating Engineers and Other Construction Equipment Operators	Service Unit Operators, Oil, Gas, and Mining	Roustabouts, Oil and Gas	Industrial Machinery Mechanics	Electrical Power-Line Installers and Repairers	Team Assemblers	Machinists	Heavy and Tractor-Trailer Truck Drivers	Average
Critical Thinking	3.88	3.88	3.75	2.88	2.88	3.62	3.12	3.5	3.38	3	3.12	3	3.33
Active Listening	4	4	3.88	3.12	2.75	3.5	2.88	3.25	3.62	3	3	3	3.33
Monitoring	3.75	3.75	3.38	2.62	3.25	3.5	3.25	3.5	3.5	3.12	3	3.12	3.31
Operation Monitoring	2.88	3	2.88	3	3.38	3.88	3	4	3.38	2.88	3.25	3.62	3.26
Speaking	4	4	3.62	3	2.75	3.12	2.62	2.88	3.25	3	2.88	3	3.18
Coordination	3.62	3.62	3.88	3	3	3	2.88	2.62	3.25	3.12	3	2.75	3.15
Reading Comprehension	4	4.12	3.5	3	2.62	3.12	2.12	3	3	2.88	3	3	3.11
Operation and Control	2.12	2.12	2.88	2.88	4	3.5	2.88	3.75	3.25	2.62	3.12	4	3.09
Judgment and Decisionmaking	3.5	3.62	3.12	2.38	2.75	3.12	3	3.38	3.25	2.75	2.88	3.12	3.07
Time Management	3.5	3.62	3.5	2.62	2.75	3	2.62	3	3.25	3	2.88	3.12	3.07
Complex Problem Solving	3.5	3.88	3.12	2.88	2.62	3.12	2.62	3.25	3.25	2.75	2.88	2.75	3.05
Social Perceptiveness	3.62	3.5	3.38	3	2.62	3.25	2.62	2.88	2.88	2.75	2.75	2.88	3.01
Quality Control Analysis	2.38	2.62	3.12	2.25	2.88	3.12	3	3.88	3.25	3.12	2.88	2.75	2.94
Active Learning	3.5	3.5	3.12	2.38	2.88	2.88	2.75	3	3	2.38	2.75	2.5	2.89
Management of Personnel Resources	3.38	3.38	3.5	2.25	2.38	3	2.5	2.62	3	2.88	2	2.12	2.75
Troubleshooting	1.88	2	2.38	2.25	3	3.12	3	4	3.38	2	2.75	3.12	2.74
Writing	3.38	3.88	3	2.38	2	2.75	1.88	2.88	2.75	2.5	2.75	2.62	2.73
Instructing	3.12	3.12	3.12	2.5	2.38	2.75	2.25	2.88	2.75	2.5	2.62	2.75	2.73
Persuasion	3.38	2.88	3.25	2.12	2.38	2.88	2.12	2.38	2.75	2.38	2.5	2.25	2.61
Learning Strategies	2.75	2.75	2.88	2.25	2.38	2.88	2.25	2.75	2.88	2.25	2.38	2.5	2.58
Repairing	1	1.12	2.12	2.25	2.88	2.88	2.88	4.38	3.25	1.88	2.62	3	2.52
Equipment Maintenance	1	1	2.38	2.25	3	3	2.75	4.12	3	2.12	2.62	2.88	2.51
Service Orientation	3.12	2.75	3	2.25	2	2.88	2	2.38	2.75	2	2.12	2.75	2.50
Negotiation	3.5	3.12	3	2.12	1.88	3	2	2.12	2.38	1.88	2.5	2.38	2.49
Systems Evaluation	3.12	3.5	2.88	1.62	1.88	2.62	2	2.75	2.62	2	2.62	2.25	2.49
Systems Analysis	3.12	3.62	2.88	1.5	2	2.5	2	2.75	2.75	2	2.5	2.12	2.48
Equipment Selection	1.25	1.5	3	2.5	2.38	2.5	2.5	3.5	2.5	1.75	2.88	2.12	2.37
Mathematics	2.25	3.12	2.75	1.75	2	2.5	2	2.38	2	2	2.62	2.25	2.30
Management of Material Resources	3.12	2.75	2.38	1.5	2	2	1.88	1.88	1.62	1.75	1.62	2	2.04
Operations Analysis	3.25	1.75	2.75	1.62	1.88	1.62	1.12	2.12	2	1.38	2.12	1.88	1.96
Management of Financial Resources	2.88	2.75	2	1.38	1.62	1.88	1.62	1.88	1.38	1.5	1.38	1.88	1.85
Technology Design	1.62	2.38	1.88	1.5	1.5	1.25	1.75	2.38	2	1.25	2.25	1.38	1.76
Science	1.62	3.38	2	1.62	1.5	1.5	1.25	2	1.88	1	1.5	1.12	1.70
Installation	1.12	1.5	1.12	1.88	1.25	1.88	1.38	2.5	2.5	1	2.5	1.62	1.69
Programming	1.38	1.75	1.25	1	1.38	1.75	1	2.12	1.38	1.5	1.62	1	1.43

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Figure A.3
Ability Requirements of High-Growth Energy Jobs in the United States

Ability	General and Operations Managers	Petroleum Engineers	First-Line Supervisors of Construction Trades and Extraction Workers	Construction Laborers	Operating Engineers and Other Construction Equipment Operators	Service Unit Operators, Oil, Gas, and Mining	Roustabouts, Oil and Gas	Industrial Machinery Mechanics	Electrical Power-Line Installers and Repairers	Team Assemblers	Machinists	Heavy and Tractor-Trailer Truck Drivers	Average
Problem Sensitivity	3.88	4	3.88	3	3.38	3.88	3.62	3.63	4	3.38	3.25	3.75	3.64
Near Vision	3.38	3.62	3.75	3.25	3.75	3.5	3.5	3.75	4	3.25	3.38	3.88	3.58
Oral Comprehension	4	4.12	4	3.38	3.12	3.38	3	3.13	3.88	3.25	3.12	3	3.45
Control Precision	2.25	2	3	3.38	4.12	3.75	3.38	3.88	3.62	3	3.5	4.12	3.33
Multilimb Coordination	2.38	1.75	3	3.5	4	3.75	3.62	3.63	4	2.88	3.38	4	3.32
Oral Expression	4	4.12	3.88	3	3.12	3.38	2.88	2.88	3.38	3	3.12	3	3.31
Information Ordering	3.5	3.88	3.75	3	2.88	3.13	2.75	3.63	3.62	3.12	3.25	3.25	3.31
Deductive Reasoning	3.62	3.75	3.5	3	3	3.25	3	3.38	3.62	3.12	3.12	3.12	3.29
Inductive Reasoning	3.38	4	3.5	3	2.88	3.5	3	3	3.5	2.88	3.12	3	3.23
Manual Dexterity	2.38	1.25	3	3.75	3.38	3.25	3.62	3.88	3.62	3.62	3.62	3.12	3.21
Speech Recognition	3.62	3.75	3.25	3	2.75	3.38	3	3.13	3.25	3	3	3.12	3.19
Arm-Hand Steadiness	2.38	1.25	3	3.62	3.25	3.63	3.12	3.75	4	3.12	3.62	3.38	3.18
Far Vision	2.62	3	3.12	3.12	3.5	3.25	3.25	3.38	3	2.75	2.75	4.12	3.16
Written Comprehension	3.88	4.25	3.38	3	2.62	3.13	2.12	3	3	3	3.12	3	3.13
Selective Attention	3.12	3.38	3.12	3	3	3.5	2.75	3.25	3	2.88	3.25	3.25	3.13
Speech Clarity	3.75	3.75	3.12	3	2.75	3.38	2.75	2.88	3.25	2.88	2.88	3	3.12
Finger Dexterity	2.62	2.62	2.88	3	2.88	2.75	3	3.75	3.5	3.38	3.5	3	3.07
Category Flexibility	3	3.62	3.12	2.88	2.75	3.13	2.88	2.88	3.12	2.88	3	3	3.02
Visualization	2.75	3.25	3.25	2.62	2.88	3.13	2.75	3.38	3	2.62	3.25	3	2.99
Depth Perception	1.88	2.25	2.5	3	4	3.5	3	3.25	3	2.38	2.88	3.88	2.96
Written Expression	3.88	4	3.38	2.38	2.38	3	1.88	2.88	3	2.88	2.75	2.88	2.94
Perceptual Speed	2.5	2.88	3	2.38	3	3.38	3	3.25	3	2.75	2.88	2.88	2.91
Reaction Time	1.88	1	2.38	2.62	3.25	3.5	3	4	3.12	2.5	3.25	3.75	2.85
Flexibility of Closure	2.75	3.25	2.75	2.25	2.62	3.13	3	3.25	3	2.38	2.62	2.75	2.81
Visual Color Discrimination	2.25	2.62	3	2.75	2.5	3.25	2.75	3.25	3.12	2.62	2.62	3	2.81
Time Sharing	2.62	3.12	3	2.75	3	2.88	2.5	2.63	2.88	2.5	2.62	3	2.79
Hearing Sensitivity	2.25	2.5	2.88	2.25	2.75	3.5	2.88	3.63	2.5	2.25	2.62	3.12	2.76
Auditory Attention	2.38	2.38	2.88	2.5	2.88	3.13	3	3.38	2.5	2.25	2.62	3	2.74
Static Strength	2	1	2.25	3.5	2.75	3	3.25	3.25	3.12	2.62	2.62	3.12	2.71
Rate Control	1.88	1	2	2.75	3.38	2.88	3	3.13	3	2.5	3	3.62	2.68
Trunk Strength	2.12	1.38	2	3.12	2.25	2.88	3.25	3.38	2.88	2.5	2.75	2.88	2.62
Fluency of Ideas	3.25	3.5	3	2.25	2.12	2.5	2.12	2.88	2.75	2	2.75	2	2.59
Response Orientation	1.88	1	2.25	2.75	3	2.88	2.75	2.88	2.62	2.12	2.75	3.88	2.56
Originality	3.25	3.25	3	2.12	2.12	2.5	2.12	2.63	2.62	2	2.5	2.12	2.52
Extent Flexibility	1	1	2	3	2.5	3.13	3.25	3.25	2.88	2.5	2.75	2.88	2.51
Speed of Closure	2.12	2.75	2.25	2	2.12	2.88	2.12	3	2.5	2	2.5	2.75	2.42
Mathematical Reasoning	2.75	3.38	2.88	2	2	2.63	1.88	2.38	2.25	1.88	2.75	2.12	2.41
Stamina	1.88	1	2	3.12	2	2.75	3	2.88	2.88	2.25	2.38	2.75	2.41
Number Facility	2.5	3.12	2.88	1.88	2	2.63	2	2.38	2.25	2	2.62	2.5	2.40
Gross Body Coordination	1.88	1	2	2.62	2	2.88	2.88	3.13	2.62	2	2.38	2.75	2.35
Spatial Orientation	1.75	1.38	2.12	2.12	2.62	2.63	2	2.38	2.62	1.88	2.25	3.62	2.28
Gross Body Equilibrium	1	1	2	2.62	1.88	3.25	2.88	3	3.12	1.88	2.12	2.62	2.28
Memorization	2.25	2.62	2.25	2	2	2.5	2	2.75	2.25	2	2.5	2.12	2.27
Speed of Limb Movement	1.88	1	2	2.12	2.25	2.75	2.62	3	2	2	2.38	2.62	2.22
Dynamic Strength	1	1	2	3	2	2.75	2.62	2.5	2.38	2.25	2.38	2.62	2.21
Glare Sensitivity	1.62	1	2	2	2.38	2.5	2.12	2.5	2.62	1.88	1.75	3	2.11
Sound Localization	1.88	1.25	2	2	2.25	2.5	2.25	2.75	1.88	1.75	1.88	2.88	2.11
Wrist-Finger Speed	1	1	2	1.88	2	2.75	2.38	2.75	2	2.12	2.75	2.5	2.09
Peripheral Vision	1.88	1.12	2	2	2.12	2.38	2	2	2	1.88	1.62	3.25	2.02
Night Vision	1.88	1.12	2	2	1.88	2.38	2	2.13	2	1.75	1.62	3.12	1.99
Explosive Strength	1	1	1.25	1.75	1.25	1.13	1.62	1.25	1.25	1	1.38	1.12	1.25
Dynamic Flexibility	1	1	1.12	1.75	1	1	1.5	1.13	1.38	1	1.5	1.12	1.21

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Figure A.4
Knowledge Requirements of High-Growth Occupations Employed by Energy in the West Virginia Shale Region

Knowledge Area	Construction Laborers	Electrical Power-Line Installers and Repairers	First-Line Supervisors of Construction Trades and Extraction Workers	Roustabouts, Oil and Gas	Service Unit Operators, Oil, Gas, and Mining	General and Operations Managers	Team Assemblers	Customer Service Representatives	Heavy and Tractor-Trailer Truck Drivers	Office Clerks, General	Rotary Drill Operators, Oil and Gas	Helpers--Extraction Workers	Meter Readers, Utilities	Inspectors, Testers, Sorters, Samplers, and Weighers	First-Line Supervisors of Office and Administrative Support Workers	Construction Managers	Industrial Engineers	Helpers--Production Workers	Industrial Production Managers	Geo. and Petroleum Technicians (Data Tech)	Geological and Petroleum Technicians (Sample Test Tech)	Stock Clerks and Order Fillers	Mobile Heavy Equipment Mechanics, Except Engines	Cost Estimators	Average
Customer and Personal Service	3.21	3.36	3.84	2.52	3.72	3.98	2.24	4.08	3.31	4.05	2.40	2.35	3.05	2.46	4.15	3.94	3.22	1.50	3.09	3.10	3.14	3.72	3.65	2.86	3.21
Mathematics	3.26	2.84	3.50	2.80	2.82	3.56	2.17	2.30	2.22	2.92	3.76	2.19	2.47	3.23	3.51	3.47	4.08	2.51	3.70	3.88	3.82	3.10	3.12	4.43	3.15
English Language	3.20	2.85	3.66	2.76	3.30	3.34	2.53	3.58	2.94	3.74	2.61	2.65	2.54	3.14	3.76	3.66	3.70	2.85	2.78	3.47	2.97	3.08	2.78	3.64	3.15
Administration and Management	3.45	2.57	3.79	2.45	2.92	4.33	1.76	2.25	3.02	2.49	3.33	2.58	2.41	2.09	3.89	4.19	3.45	2.00	3.66	3.16	2.64	3.02	2.48	3.29	2.97
Mechanical	3.57	3.43	3.70	3.07	3.97	2.61	2.23	1.38	3.55	1.20	3.87	3.04	2.03	2.33	1.39	3.31	3.95	2.07	3.94	2.39	3.46	1.64	4.85	2.75	2.91
Public Safety and Security	3.35	2.41	3.71	3.21	3.23	2.92	2.01	2.01	3.65	2.56	2.84	3.09	3.04	2.24	2.72	3.50	2.72	2.49	2.66	2.93	2.49	2.60	2.65	2.39	2.81
Production and Processing	2.94	1.36	3.93	2.59	2.21	2.98	3.86	1.43	2.05	1.20	2.74	2.72	1.87	3.40	2.29	2.81	4.37	2.23	4.80	2.20	3.16	1.81	2.48	3.14	2.69
Education and Training	3.21	2.68	3.45	2.48	2.23	2.84	2.21	1.87	2.18	2.27	3.20	2.76	2.37	2.54	3.47	2.50	3.40	1.89	3.23	2.28	2.77	2.28	2.81	2.36	2.64
Computers and Electronics	1.76	2.22	2.67	1.59	2.30	3.41	1.83	2.39	2.61	2.96	1.69	2.11	2.51	2.57	3.21	2.97	3.47	1.41	2.45	4.10	3.40	2.33	3.35	3.32	2.61
Clerical	1.95	2.22	2.94	1.80	1.72	3.20	1.73	3.60	2.86	4.51	2.33	1.66	1.71	2.32	3.42	2.88	2.89	2.04	2.75	2.68	3.67	2.14	2.46	2.64	2.59
Engineering and Technology	2.63	2.31	2.85	2.23	2.80	2.50	2.16	1.28	2.28	1.16	2.62	2.63	1.43	2.03	1.57	3.94	4.42	1.40	2.91	3.93	2.91	1.20	3.33	3.82	2.51
Personnel and Human Resources	2.83	2.17	3.30	1.99	1.91	4.00	1.91	1.68	2.93	2.61	3.08	1.98	1.62	1.64	3.29	3.25	2.18	1.36	2.87	1.95	2.14	2.09	1.88	2.04	2.36
Transportation	2.88	2.40	2.98	2.68	2.94	2.83	1.52	1.56	3.98	1.44	2.74	2.43	2.45	1.67	1.78	2.34	2.33	1.45	2.11	2.26	2.57	1.80	2.67	2.32	2.34
Design	2.53	2.32	2.86	1.98	1.70	2.97	1.70	1.44	2.59	1.03	1.60	1.96	1.62	2.35	1.53	3.66	3.81	2.07	3.09	2.92	2.42	1.09	2.71	3.21	2.30
Law and Government	2.73	2.13	2.81	2.12	2.17	2.88	1.06	2.13	2.76	2.40	2.06	3.14	1.57	1.49	2.63	3.16	1.93	1.33	2.21	2.82	2.55	1.81	1.78	2.57	2.26
Building and Construction	4.09	2.18	3.88	2.72	1.79	2.92	1.27	1.54	2.65	1.03	2.17	2.50	1.40	1.30	1.27	4.75	2.06	1.34	1.93	1.97	1.98	1.25	2.47	3.04	2.23
Physics	2.37	2.99	2.25	2.36	2.35	1.84	1.47	1.27	1.56	1.05	2.38	2.05	1.39	1.70	1.22	2.31	2.87	1.42	2.25	3.52	3.02	1.33	2.57	2.25	2.07
Economics and Accounting	2.39	1.54	2.66	1.37	1.58	3.68	1.45	2.04	1.83	1.87	1.64	1.62	1.65	1.27	3.04	3.06	2.17	1.30	2.00	1.88	1.98	2.09	1.83	3.50	2.06
Chemistry	2.33	1.85	2.26	2.47	2.16	1.92	1.45	1.09	1.60	1.07	2.75	1.81	1.60	1.80	1.35	1.94	2.62	1.65	2.48	2.52	3.93	1.53	2.28	1.82	2.01
Sales and Marketing	1.96	1.06	2.49	1.58	1.76	3.18	1.36	2.08	2.81	1.50	1.62	1.57	1.13	1.47	2.48	2.62	2.05	1.17	2.05	2.68	2.44	2.38	2.14	1.86	1.98
Communications and Media	2.67	1.91	2.20	1.72	1.53	2.32	1.64	2.18	1.81	2.05	2.14	1.74	1.67	1.65	2.68	2.09	2.15	1.29	2.01	1.85	2.16	1.76	1.81	2.04	1.96
Telecommunications	2.41	2.79	2.30	1.87	1.95	2.28	1.27	1.98	2.27	1.81	1.61	2.26	1.58	1.34	2.14	1.69	1.94	1.21	1.81	2.12	1.89	1.72	2.15	2.18	1.94
Psychology	2.17	2.26	2.25	1.74	1.99	2.91	1.29	1.76	1.80	1.67	2.53	1.67	1.27	1.46	2.65	2.31	2.13	1.46	2.45	1.44	2.24	1.92	1.64	1.50	1.94
Geography	2.27	1.88	1.90	2.08	1.66	2.09	1.02	1.52	2.25	1.51	2.02	1.58	1.81	1.20	1.62	1.62	1.54	1.01	1.44	3.32	3.07	1.57	1.56	1.82	1.81
Foreign Language	2.54	1.42	1.89	2.40	1.89	1.41	1.59	1.58	1.90	1.71	1.36	1.32	1.16	1.25	1.58	1.44	1.15	1.39	1.45	1.54	1.93	1.33	1.37	1.43	1.58
Sociology and Anthropology	1.65	1.59	1.45	1.92	1.51	1.86	1.30	1.22	1.43	1.70	1.09	1.27	1.14	1.23	2.03	1.50	1.83	1.34	1.78	1.46	1.37	1.37	1.11	1.50	1.49
Medicine and Dentistry	1.54	1.92	1.62	1.92	1.48	1.27	1.01	1.15	2.19	1.24	2.00	1.48	1.18	1.08	1.48	1.34	1.18	1.09	1.70	1.30	1.74	1.44	1.36	1.11	1.45
Therapy and Counseling	1.51	1.81	1.71	1.83	1.47	1.36	1.02	1.28	1.54	1.76	1.76	1.45	1.04	1.12	1.93	1.44	1.17	1.12	1.83	1.10	1.21	1.39	1.30	1.07	1.43
Biology	1.97	1.37	1.54	2.04	1.36	1.46	1.00	1.12	1.61	1.04	1.35	1.36	1.08	1.20	1.25	1.31	1.37	1.21	1.51	1.58	2.25	1.08	1.40	1.25	1.40
Philosophy and Theology	1.39	1.62	1.41	1.63	1.35	1.24	1.46	1.31	1.72	1.59	1.24	1.22	1.12	1.17	1.81	1.28	1.39	1.15	1.21	1.14	1.42	1.14	1.09	1.11	1.34
Food Production	1.68	1.05	1.24	1.42	1.20	1.05	2.17	1.11	2.57	1.05	1.01	1.05	1.00	1.03	1.17	1.16	1.02	1.40	1.46	1.16	1.16	1.47	1.34	1.21	1.30
History and Archeology	1.52	1.09	1.27	1.59	1.15	1.10	1.01	1.14	1.39	1.10	1.20	1.23	1.04	1.12	1.47	1.28	1.11	1.03	1.25	2.09	1.55	1.07	1.10	1.29	1.26
Fine Arts	1.31	1.04	1.27	1.26	1.13	1.05	1.00	1.16	1.49	1.10	1.01	1.15	1.03	1.07	1.35	1.12	1.03	1.00	1.03	1.06	1.35	1.00	1.00	1.14	1.13

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Figure A.5
Skill Requirements of High-Growth Occupations Employed by Energy in the West Virginia Shale Region

Skill	Construction Laborers	Electrical Power-Line Installers and Repairers	First-Line Supervisors of Construction Trades and Extraction Workers	Roustabouts, Oil and Gas	Service Unit Operators, Oil, Gas, and Mining	General and Operations Managers	Team Assemblers	Customer Service Representatives	Heavy and Tractor-Trailer Truck Drivers	Office Clerks, General	Rotary Drill Operators, Oil and Gas	Helpers--Extraction Workers	Meter Readers, Utilities	Inspectors, Testers, Sorters, Samplers, and Weighers	First-Line Supervisors of Office and Administrative Support Workers	Construction Managers	Industrial Engineers	Helpers--Production Workers	Industrial Production Managers	Geo. and Petroleum Technicians (Data Tech)	Geological and Petroleum Technicians (Sample Test Tech)	Stock Clerks and Order Fillers	Mobile Heavy Equipment Mechanics, Except Engines	Cost Estimators	Average
Active Listening	3.12	3.62	3.88	2.88	3.50	4.00	3.00	3.88	3.00	3.62	3.38	3.12	3.12	3.38	4.38	3.75	3.75	2.88	3.75	3.50	3.38	3.50	3.00	3.62	3.46
Critical Thinking	2.88	3.38	3.75	3.12	3.62	3.88	3.00	3.38	3.00	3.00	3.62	3.38	2.75	3.12	3.88	3.75	3.75	2.88	4.00	3.50	3.62	2.62	3.38	3.75	3.38
Speaking	3.00	3.25	3.62	2.62	3.12	4.00	3.00	3.88	3.00	3.62	3.25	2.75	3.12	3.12	4.12	3.75	3.62	2.75	3.75	3.38	3.25	3.62	3.00	3.75	3.35
Monitoring	2.62	3.50	3.38	3.25	3.50	3.75	3.12	3.00	3.12	2.88	3.50	3.62	2.88	3.12	3.75	3.62	3.50	2.75	4.00	2.88	3.50	2.75	3.12	3.00	3.25
Reading Comprehension	3.00	3.00	3.50	2.12	3.12	4.00	2.88	3.50	3.00	3.62	3.12	2.75	2.88	3.12	3.75	3.50	4.00	2.75	3.50	3.62	3.50	2.38	3.00	3.50	3.21
Coordination	3.00	3.25	3.88	2.88	3.00	3.62	3.12	3.25	2.75	2.88	3.25	2.88	2.75	3.00	4.00	3.62	3.25	2.25	4.00	3.00	2.88	3.00	2.75	3.12	3.14
Time Management	2.62	3.25	3.50	2.62	3.00	3.50	3.00	3.12	3.12	3.25	2.88	2.75	3.12	2.75	3.75	3.88	3.25	2.50	3.88	3.12	3.25	3.00	2.88	3.12	3.13
Judgment and Decisionmaking	2.38	3.25	3.12	3.00	3.12	3.50	2.75	2.88	3.12	2.75	3.12	2.88	3.25	3.00	3.75	3.50	3.38	2.38	3.50	2.88	3.38	2.88	3.00	3.62	3.10
Social Perceptiveness	3.00	2.88	3.38	2.62	3.25	3.62	2.75	3.25	2.88	3.25	2.88	2.88	2.88	2.75	4.00	3.38	3.12	2.75	3.25	3.00	2.88	3.25	2.88	3.12	3.08
Complex Problem Solving	2.88	3.25	3.12	2.62	3.12	3.50	2.75	2.88	2.75	2.62	3.12	3.12	2.88	2.75	3.38	3.62	3.75	2.38	3.50	2.88	3.38	2.88	3.12	3.38	3.07
Writing	2.38	2.75	3.00	1.88	2.75	3.38	2.50	3.38	2.62	3.25	3.00	2.38	2.88	2.88	3.62	3.38	3.75	2.00	3.12	3.25	3.25	2.00	2.50	3.25	2.88
Active Learning	2.38	3.00	3.12	2.75	2.88	3.50	2.38	3.00	2.50	2.50	2.88	2.88	2.62	2.38	3.62	3.50	3.25	2.00	3.62	2.50	3.12	2.75	2.88	3.12	2.88
Operation Monitoring	3.00	3.38	2.88	3.00	3.88	2.88	2.88	2.00	3.62	2.25	3.62	3.62	3.25	3.00	2.25	2.88	2.38	2.38	2.88	2.50	3.12	1.25	3.75	2.12	2.87
Management of Personnel Resources	2.25	3.00	3.50	2.50	3.00	3.38	2.88	2.38	2.12	2.38	2.88	2.75	2.38	2.00	3.88	3.75	3.00	2.12	3.88	2.38	2.88	2.12	2.75	2.62	2.78
Persuasion	2.12	2.75	3.25	2.12	2.88	3.38	2.38	3.50	2.25	2.62	2.88	2.25	2.50	2.25	3.50	3.38	2.88	1.88	3.38	2.75	2.62	2.62	2.50	3.12	2.74
Service Orientation	2.25	2.75	3.00	2.00	2.88	3.12	2.00	3.75	2.75	3.12	2.38	2.50	3.00	1.88	3.50	2.88	2.75	1.75	2.88	2.25	2.75	3.38	2.88	2.38	2.70
Instructing	2.50	2.75	3.12	2.25	2.75	3.12	2.50	2.75	2.75	2.75	3.38	2.75	2.50	2.00	3.50	2.88	3.12	2.00	3.38	2.25	2.50	2.12	2.50	2.50	2.69
Quality Control Analysis	2.25	3.25	3.12	3.00	3.12	2.38	3.12	1.00	2.75	1.25	3.00	3.25	2.88	3.50	3.00	3.00	2.12	2.25	3.25	2.00	2.88	1.62	3.50	1.50	2.62
Negotiation	2.12	2.38	3.00	2.00	3.00	3.50	1.88	3.12	2.38	2.62	2.88	2.38	2.38	1.88	3.75	3.62	2.75	1.88	3.38	2.00	2.50	2.25	2.25	2.88	2.62
Learning Strategies	2.25	2.88	2.88	2.25	2.88	2.75	2.25	2.50	2.50	2.38	3.00	2.75	2.50	2.00	3.50	2.75	2.88	2.00	3.50	2.12	2.88	1.62	2.38	2.50	2.58
Mathematics	1.75	2.00	2.75	2.00	2.50	2.25	2.00	2.25	2.25	2.38	2.38	2.50	2.50	2.50	2.75	3.12	3.25	2.12	3.12	2.38	3.38	2.88	2.50	3.88	2.56
Operation and Control	2.88	3.25	2.88	2.88	3.50	2.12	2.62	1.00	4.00	1.38	3.62	3.38	2.88	2.62	1.12	2.12	2.12	2.38	2.62	2.50	2.62	1.50	3.50	1.25	2.53
Systems Analysis	1.50	2.75	2.88	2.00	2.50	3.12	2.00	2.38	2.12	2.00	2.12	2.38	2.25	2.12	3.12	3.38	3.12	1.88	3.38	2.50	2.88	1.62	2.50	3.25	2.49
Systems Evaluation	1.62	2.62	2.88	2.00	2.62	3.12	2.00	2.12	2.25	1.88	2.12	2.25	2.12	2.38	3.00	3.12	3.00	1.88	3.25	2.25	2.75	1.50	2.38	2.38	2.42
Troubleshooting	2.25	3.38	2.38	3.00	3.12	1.88	2.00	1.00	3.12	1.12	3.00	3.38	2.50	1.88	1.88	2.38	2.00	2.00	2.12	2.00	3.00	1.12	4.00	1.00	2.31
Management of Material Resources	1.50	1.62	2.38	1.88	2.00	3.12	1.75	1.00	2.00	2.12	1.62	2.38	2.00	1.75	2.50	3.12	2.62	1.50	3.25	1.88	2.38	1.88	2.62	2.88	2.16
Equipment Maintenance	2.25	3.00	2.38	2.75	3.00	1.00	2.12	1.00	2.88	1.00	3.00	3.38	2.50	1.38	1.00	1.00	1.00	2.00	1.38	1.12	2.88	1.12	3.88	1.00	2.00
Repairing	2.25	3.25	2.12	2.88	2.88	1.00	1.88	1.00	3.00	1.00	3.00	3.38	2.50	1.38	1.00	1.00	1.00	2.00	1.38	1.12	2.88	1.00	3.88	1.00	1.99
Management of Financial Resources	1.38	1.38	2.00	1.62	1.88	2.88	1.50	1.25	1.88	1.88	1.25	1.88	2.12	1.62	2.50	3.50	2.38	1.50	3.25	1.50	1.88	1.12	2.12	3.50	1.99
Operations Analysis	1.62	2.00	2.75	1.12	1.62	3.25	1.38	1.75	1.88	1.12	1.75	1.00	1.62	1.88	2.50	3.50	2.12	1.62	2.88	2.00	2.12	1.75	1.88	2.50	1.98
Equipment Selection	2.50	2.50	3.00	2.50	2.50	1.25	1.75	1.00	2.12	1.12	2.62	3.00	2.25	1.50	1.00	1.38	1.25	1.88	1.75	1.50	3.00	1.00	3.25	1.00	1.94
Science	1.62	1.88	2.00	1.25	1.50	1.62	1.00	1.12	1.12	1.00	1.25	1.12	1.12	1.75	1.38	2.38	1.88	1.25	1.62	3.00	3.25	1.00	2.25	1.62	1.62
Technology Design	1.50	2.00	1.88	1.75	1.25	1.62	1.25	1.50	1.38	1.38	1.38	1.88	1.50	1.38	1.38	1.88	2.12	1.50	1.88	1.75	1.62	1.12	2.12	1.75	1.62
Programming	1.00	1.38	1.25	1.00	1.75	1.38	1.50	1.50	1.00	1.38	1.00	1.00	1.88	1.50	1.75	1.62	1.75	1.00	1.75	1.50	2.12	1.12	1.62	1.88	1.44
Installation	1.88	2.50	1.12	1.38	1.88	1.12	1.00	1.00	1.62	1.00	1.12	1.00	1.12	1.25	1.00	1.00	1.00	1.12	1.00	1.12	1.25	1.00	2.38	1.00	1.29

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Figure A.6
Ability Requirements of High-Growth Occupations Employed by Energy in the West Virginia Shale Region

Ability	Construction Laborers	Electrical Power-Line Installers and Repairers	First-Line Supervisors of Construction Trades and Extraction Workers	Roustabouts, Oil and Gas	Service Unit Operators, Oil, Gas, and Mining	General and Operations Managers	Team Assemblers	Customer Service Representatives	Heavy and Tractor-Trailer Truck Drivers	Office Clerks, General	Rotary Drill Operators, Oil and Gas	Helpers--Extraction Workers	Meter Readers, Utilities	Inspectors, Testers, Sorters, Samplers, and Weighers	First-Line Supervisors of Office and Administrative Support Workers	Construction Managers	Industrial Engineers	Helpers--Production Workers	Industrial Production Managers	Geo. and Petroleum Technicians (Data Tech)	Geological and Petroleum Technicians (Sample Test Tech)	Stock Clerks and Order Fillers	Mobile Heavy Equipment Mechanics, Except Engines	Cost Estimators	Average
Oral Comprehension	3.38	3.88	4.00	3.00	3.38	4.00	3.25	4.12	3.00	3.75	3.63	3.13	3.25	3.75	4.25	4.00	4.12	3.00	3.88	3.75	3.50	3.50	3.00	3.75	3.59
Problem Sensitivity	3.00	4.00	3.88	3.62	3.88	3.88	3.38	3.50	3.75	3.12	4.00	3.75	3.25	3.38	4.00	4.00	4.00	3.13	4.00	3.13	3.75	3.00	3.62	3.12	3.59
Near Vision	3.25	4.00	3.75	3.50	3.50	3.38	3.25	3.50	3.88	3.38	3.88	3.75	3.50	3.50	3.75	3.50	3.75	3.50	3.25	3.38	3.63	3.00	3.88	3.25	3.54
Oral Expression	3.00	3.38	3.88	2.88	3.38	4.00	3.00	4.00	3.00	3.75	3.63	2.88	3.25	3.75	4.25	3.88	4.00	3.00	3.88	3.75	3.25	3.75	3.00	3.75	3.51
Deductive Reasoning	3.00	3.62	3.50	3.00	3.25	3.62	3.12	3.38	3.12	3.12	3.38	3.13	2.88	3.25	3.63	3.75	3.75	3.00	3.88	3.00	3.63	3.00	3.25	3.62	3.33
Information Ordering	3.00	3.62	3.75	2.75	3.13	3.50	3.12	3.25	3.25	3.12	3.63	3.13	3.25	3.12	3.50	3.62	3.62	2.75	3.62	3.38	3.63	3.25	3.25	3.38	3.32
Speech Clarity	3.00	3.25	3.12	2.75	3.38	3.75	2.88	4.00	3.00	3.62	3.13	3.00	3.25	3.00	4.13	3.75	3.25	2.88	3.75	3.38	3.00	3.63	3.00	3.62	3.31
Speech Recognition	3.00	3.25	3.25	3.00	3.38	3.62	3.00	3.88	3.12	3.50	3.13	3.00	3.38	3.00	4.13	3.38	3.25	2.88	3.62	3.38	3.13	3.25	3.12	3.50	3.30
Written Comprehension	3.00	3.00	3.38	2.12	3.13	3.88	3.00	3.50	3.00	3.62	3.13	2.75	3.13	3.38	3.75	3.88	4.12	2.63	3.62	3.88	3.75	2.63	3.00	3.62	3.29
Inductive Reasoning	3.00	3.50	3.50	3.00	3.50	3.38	2.88	3.25	3.00	3.00	3.38	3.13	2.88	3.12	3.63	3.50	3.75	2.88	3.62	3.13	3.75	2.75	3.12	3.62	3.26
Selective Attention	3.00	3.00	3.12	2.75	3.50	3.12	2.88	3.00	3.25	3.00	3.38	3.38	2.75	3.12	3.38	3.25	3.62	2.88	3.00	2.88	3.13	2.50	3.00	3.12	3.08
Category Flexibility	2.88	3.12	3.12	2.88	3.13	3.00	2.88	2.88	3.00	3.12	3.13	2.88	2.75	3.12	3.38	3.25	3.38	2.75	3.25	3.13	3.50	3.38	2.88	3.12	3.08
Written Expression	2.38	3.00	3.38	1.88	3.00	3.88	2.88	3.62	2.88	3.50	3.25	2.50	3.00	2.88	3.63	3.50	3.88	2.25	3.25	3.63	3.25	2.25	2.50	3.38	3.06
Far Vision	3.12	3.00	3.12	3.25	3.25	2.62	2.75	2.38	4.12	2.50	2.75	3.75	2.88	3.00	3.25	3.62	3.00	2.50	2.88	2.63	3.38	2.38	3.12	2.62	2.99
Finger Dexterity	3.00	3.50	2.88	3.00	2.75	2.62	3.38	2.88	3.00	2.88	3.50	3.50	3.00	2.88	2.75	2.50	2.62	2.88	2.50	2.75	3.00	1.75	3.88	2.50	2.91
Flexibility of Closure	2.25	3.00	2.75	3.00	3.13	2.75	2.38	2.75	2.75	2.75	3.00	3.13	2.88	3.38	3.00	3.25	3.25	2.38	3.00	3.00	3.63	1.75	2.88	2.75	2.87
Perceptual Speed	2.38	3.00	3.00	3.00	3.38	2.50	2.75	2.25	2.88	2.62	3.13	3.25	3.00	3.12	2.88	3.12	2.88	2.63	3.12	2.25	3.25	2.38	3.00	2.75	2.86
Visualization	2.62	3.00	3.25	2.75	3.13	2.75	2.62	2.00	3.00	2.12	3.00	3.38	2.38	2.62	2.75	3.38	3.25	2.63	2.88	2.63	3.13	2.50	3.50	2.62	2.83
Multilimb Coordination	3.50	4.00	3.00	3.62	3.75	2.38	2.88	1.00	4.00	2.00	3.75	3.75	3.38	2.38	1.00	2.12	2.38	3.00	2.25	2.38	2.88	2.75	3.88	1.12	2.80
Arm-Hand Steadiness	3.62	4.00	3.00	3.12	3.63	2.38	3.12	2.00	3.38	2.38	3.75	3.63	2.88	2.88	1.00	1.12	2.25	3.25	2.12	2.38	3.00	2.50	3.88	1.25	2.77
Control Precision	3.38	3.62	3.00	3.38	3.75	2.25	3.00	1.88	4.12	2.12	4.00	3.63	3.25	2.38	1.13	2.12	2.38	3.13	2.00	2.00	3.13	1.50	4.00	1.12	2.76
Manual Dexterity	3.75	3.62	3.00	3.62	3.25	2.38	3.62	1.62	3.12	2.38	3.75	3.75	3.13	2.88	1.00	1.12	1.25	3.00	2.00	1.75	3.00	2.63	4.00	1.12	2.70
Visual Color Discrimination	2.75	3.12	3.00	2.75	3.25	2.25	2.62	2.12	3.00	2.25	2.88	3.13	2.63	2.88	2.25	3.00	2.75	2.50	2.50	2.50	2.88	1.75	3.25	2.12	2.67
Mathematical Reasoning	2.00	2.25	2.88	1.88	2.63	2.75	1.88	2.50	2.12	2.62	2.50	2.25	2.63	2.62	3.00	3.38	3.38	2.00	3.25	2.50	3.38	2.63	2.62	4.00	2.65
Time Sharing	2.75	2.88	3.00	2.50	2.88	2.62	2.50	2.38	3.00	2.62	2.88	2.88	2.38	2.38	3.00	2.88	3.12	2.25	2.62	2.13	2.50	2.63	2.62	2.25	2.65
Number Facility	1.88	2.25	2.88	2.00	2.63	2.50	2.00	2.38	2.50	2.75	2.63	2.38	2.75	2.38	2.75	3.38	3.00	2.13	3.25	2.50	3.25	2.63	2.50	4.12	2.64
Fluency of Ideas	2.25	2.75	3.00	2.12	2.50	3.25	2.00	2.62	2.00	2.50	2.50	2.75	2.38	2.38	3.38	3.00	3.12	1.88	3.50	2.38	2.88	2.38	2.62	3.12	2.64
Originality	2.12	2.62	3.00	2.12	2.50	3.25	2.00	2.75	2.12	2.25	2.50	2.75	2.63	2.12	3.38	2.88	3.12	1.88	3.25	2.38	3.13	2.50	2.62	2.88	2.61
Auditory Attention	2.50	2.50	2.88	3.00	3.13	2.38	2.25	2.12	3.00	2.00	3.13	3.00	2.50	2.75	2.88	2.75	2.62	2.50	2.62	2.38	2.50	2.00	3.00	2.00	2.60
Depth Perception	3.00	3.00	2.50	3.00	3.50	1.88	2.38	1.00	3.88	1.25	2.88	3.50	3.00	2.00	2.13	2.62	2.38	2.63	2.00	2.38	3.00	1.88	3.12	1.88	2.53
Hearing Sensitivity	2.25	2.50	2.88	2.88	3.50	2.25	2.25	2.00	3.12	2.12	2.75	3.38	2.38	2.00	2.63	2.38	2.75	2.75	2.25	2.50	2.50	1.13	3.38	2.00	2.52
Trunk Strength	3.12	2.88	2.00	3.25	2.88	2.12	2.50	1.12	2.88	1.38	2.75	3.38	3.13	2.38	1.13	1.88	1.88	3.38	2.12	2.25	2.50	3.50	3.12	1.12	2.44
Speed of Closure	2.00	2.50	2.25	2.12	2.88	2.12	2.00	2.38	2.75	2.25	2.50	2.75	2.50	2.25	2.88	2.62	2.25	1.88	2.75	1.88	2.63	1.63	2.75	2.50	2.38
Reaction Time	2.62	3.12	2.38	3.00	3.50	1.88	2.50	1.00	3.75	1.12	3.13	3.63	2.63	2.25	1.00	2.12	2.25	2.50	2.25	1.63	2.50	1.25	3.50	1.12	2.36
Static Strength	3.50	3.12	2.25	3.25	3.00	2.00	2.62	1.00	3.12	1.88	2.88	3.50	2.63	2.00	1.00	1.00	1.00	2.88	1.88	1.88	2.75	3.00	3.25	1.12	2.35
Memorization	2.00	2.25	2.25	2.00	2.50	2.25	2.00	2.50	2.12	2.38	2.25	2.75	2.38	2.00	2.88	2.50	2.38	1.63	2.50	2.00	2.63	2.25	2.75	2.38	2.31
Rate Control	2.75	3.00	2.00	3.00	2.88	1.88	2.50	1.00	3.62	1.12	3.38	3.25	2.50	2.12	1.00	1.00	2.12	2.13	2.00	1.63	2.75	1.13	3.25	1.00	2.21
Extent Flexibility	3.00	2.88	2.00	3.25	3.13	1.00	2.50	1.00	2.88	1.00	2.63	3.13	3.00	2.00	1.00	1.00	1.00	2.88	1.88	1.75	2.00	2.75	3.62	1.00	2.18
Response Orientation	2.75	2.62	2.25	2.75	2.88	1.88	2.12	1.00	3.88	1.12	2.63	3.00	2.63	2.00	1.00	1.12	2.12	2.13	2.00	1.75	2.38	1.25	3.12	1.12	2.15
Stamina	3.12	2.88	2.00	3.00	2.75	1.88	2.25	1.00	2.75	1.12	2.38	3.13	2.63	2.00	1.00	1.00	1.00	2.63	2.00	1.75	2.25	2.63	2.62	1.12	2.12
Gross Body Coordination	2.62	2.62	2.00	2.88	2.88	1.88	2.00	1.00	2.75	1.12	2.63	3.25	3.00	1.88	1.00	1.25	1.00	2.38	2.00	1.75	2.13	2.50	3.00	1.12	2.11
Gross Body Equilibrium	2.62	3.12	2.00	2.88	3.25	1.00	1.88	1.00	2.62	1.12	2.75	3.00	2.25	1.75	1.00	1.75	1.00	2.00	1.75	1.63	2.13	1.88	2.75	1.12	2.01
Dynamic Strength	3.00	2.38	2.00	2.62	2.75	1.00	2.25	1.00	2.62	1.12	2.50	2.88	1.88	2.00	1.00	1.00	1.00	2.13	1.88	1.75	2.00	2.00	2.62	1.00	1.93
Speed of Limb Movement	2.12	2.00	2.00	2.62	2.75	1.88	2.00	1.00	2.62	1.12	2.00	2.75	3.00	1.88	1.00	1.00	1.25	1.88	2.00	1.25	2.50	2.00	2.62	1.00	1.93
Spatial Orientation	2.12	2.62	2.12	2.00	2.63	1.75	1.88	1.00	3.62	1.00	2.25	3.00	2.63	1.00	1.13	2.00	1.25	1.75	1.25	1.13	2.13	2.00	2.50	1.12	1.91
Wrist-Finger Speed	1.88	2.00	2.00	2.38	2.75	1.00	2.12	1.12	2.50	1.25	1.88	2.38	2.00	2.00	1.00	1.12	2.00	2.00	1.88	1.63	2.13	1.50	2.50	1.12	1.84
Glare Sensitivity	2.00	2.62	2.00	2.12	2.50	1.62	1.88	1.00	3.00	1.12	2.13	2.63	2.50	1.00	1.00	2.00	1.00	1.75	1.12	1.00	2.00	1.75	2.62	1.12	1.81
Peripheral Vision	2.00	2.00	2.00	2.00	2.38	1.88	1.88	1.00	3.25	1.00	1.88	2.38	2.25	1.12	1.00	1.00	1.00	1.63	1.00	1.00	2.13	1.38	2.12	1.00	1.68
Sound Localization	2.00	1.88	2.00	2.25	2.50	1.88	1.75	1.00	2.88	1.00	1.75	2.38	2.13	1.12	1.00	1.12	1.00	1.63	1.00	1.00	2.13	1.13	2.38	1.00	1.66
Night Vision	2.00	2.00	2.00	2.00	2.38	1.88	1.75	1.00	3.12	1.00	2.13	2.13	2.00	1.12	1.00	1.12	1.00	1.63	1.00	1.00	1.88	1.13	2.12	1.12	1.65
Explosive Strength	1.75	1.25	1.25	1.62	1.13	1.00	1.00	1.00	1.12	1.00	1.13	1.38	1.00	1.00	1.00	1.00	1.00	1.38	1.00	1.00	1.13	1.00	1.50	1.00	1.15
Dynamic Flexibility	1.75	1.38	1.12	1.50	1.00	1.00	1.00	1.00	1.12	1.00	1.00	1.13	1.00	1.00	1.00	1.00	1.00	1.13	1.00	1.00	1.13	1.38	1.12	1.00	1.12

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APPENDIX B

Interview and Focus Group Data Collection Protocols

Education and Training Provider Interview Protocol

Background of Participant

- Can you start by telling me a little bit about your education and training?
- Please briefly describe your position and responsibilities here at X institution (probe for teaching and administrative).
  - How long have you been in your current position?
  - Is this a full-time position?
    - If no, what other positions do you hold?
- What positions did you hold prior to your current position?
  - When did you hold these positions?

Description of Programs Offered at Institution

- Can you please describe the organization of courses or program offerings that are related to STEM (science, technology, engineering, and mathematics)-related careers?
- What programs do you offer?
- What courses of study do you offer within the programs?
- [If we did not obtain a listing prior to the interview] Do you have a current list of programs and courses of study offered at your institution?

- Which of these are focused specifically on skills needed for a job in the energy sector here in West Virginia?

Program and Curriculum Design

- What program or course of study was most recently created?
  - When was this program/course of study launched or rolled out?
  - What process did the institution use to determine the program or course of study should be added?
    - Data, CTCS leadership team, local need expressed by sector, interviews with employers or students, etc.
    - Centralized decision or local decision?
  - Who participated on the program or course of study design team?
- How many programs has the institution added in the last five years? Which ones?
  - To your best knowledge in your professional capacity, what led the institution to create the programs?
- What program or course of study was most recently discontinued?
  - When was it discontinued?
  - What process did the institution use to determine the program or course of study should be discontinued?
    - Data, CTCS leadership team, local need expressed by sector, interviews with employers or students, etc.
    - Centralized decision or local decision?
  - Who participated in the program or course of study decision-making team?
- How many programs has the institution discontinued in the last five years? Which ones?
  - To your best knowledge in your professional capacity, what led the institution to discontinue the program?
- What is the process for the design of curriculum of new programs or courses of study?
  - Who provides input? Is the curriculum designed by the teacher of the course?

  - Are there standards or other standardized documents that are used to guide the development of the curriculum?
  - If the program or course of study will be offered in multiple institutions, do institutions collaborate on program or curriculum design?
- How often is the curriculum of current programs or courses of study reviewed for relevancy?
  - What process is used to review the curriculum?
    - Who reviews the curriculum?
    - Is the curriculum of a program or course of study modified because of the review? If so, how?
  - If the program or course of study is offered in multiple institutions, do institutions collaborate on program or curriculum review?

Collaboration

- In your professional experience, to what extent do professors within the program collaborate?
  - How often?
  - In what ways?
- To what extent to professors collaborate across programs?
- How often do you collaborate with employers from the healthcare sector?
- In what ways do you collaborate?
- How often do you collaborate with employers from the energy sector?
- In what ways do you collaborate?
- How often do you collaborate with employers from the construction or development sector?
  - In what ways do you collaborate?
- How often do you collaborate with employers from the retail sector?
  - In what ways do you collaborate?

- How often do you collaborate with employers from the gaming sector?
  - In what ways do you collaborate?
- How often do you collaborate with high school career and technical centers?
  - In what ways do you collaborate with the high school CTEs?
  - How are your programs aligned?
  - How do they differ?
- How do you collaborate with high schools?
  - To your knowledge, is there a K-20 initiative in the state of West Virginia?
- How often do you collaborate with the other members of the CTEs?

Current Subscription of Programs

- Which programs are most highly subscribed? Within the programs, which areas of study are most highly subscribed?
  - What do students enrolled in these programs receive when they complete the program (i.e. certification/licensure in trade, associate's degree)?
- How long have the highly subscribed programs existed?
- Has there been a trend in the popularity of these programs?
  - Increase in popularity over the last five years, decreased interest in other programs?
  - Have there been targeted efforts to increase the popularity of these programs? If so, please describe those efforts.
- In your professional capacity, how have applicants learned about these programs?
  - High school guidance counselor
  - High school career and technical centers
  - Advertisements on television

Selection of Instructional Staff

- How does your institution select instructors for the courses it offers?
  - What is the process for selection (e.g., an application, selection committee, interview?)
  - What are the eligibility requirements?
    - Experience in the field/career?
    - Teaching experience?
    - Degree?
  - Are the selection process and eligibility requirements the same across programs, or do they differ? (Probe specifically for differences between energy sector–relevant program instructors and other program instructors.)
- What is the average tenure of instructors in the institution?
- Are instructors employed full time or do they hold other full or part time positions? In what sectors are they employed?

Student Recruitment and Selection Process

- As you understand it, how does the institution recruit students?
  - Collaborate with local high schools and CTEs?
  - Advertisements on TV, radio, or billboards
  - Brochures sent home
  - College or training fairs
  - Word of mouth
  - Partnerships with unemployment centers
- From where in the state does the institution recruit students?
  - Convenience sample, neighboring counties
  - Attend college and career fairs throughout the state
- As you understand it, does the institution target recruitment of certain students?
  - Out of the workforce for two years or more
  - High school students
  - Recent high school graduates employed in low-skilled positions

- In your professional capacity, what other institutions are considered competing for the targeted student population?
  - Adult training center
  - Private training centers
  - Other community colleges

Description of Applicants

- To the best of your knowledge in your professional capacity, how would you describe the prior academic performance of applicants? Of enrolling students?
- Do you have any statistics or documentation of applicants' or enrolling students' results for the following:
  - Proportion of students with high school diplomas versus GED
  - Average score or proficiency level on West Virginia state assessments
  - Average score on ACT or SAT
  - Average score on Work Keys
- To the best of your knowledge in your professional capacity, what percentage of applicants participated in CTE programs during their high school careers?
- To the best of your knowledge in your professional capacity, what technical skills do applicants have? Why do students need these technical skills? How did you arrive at this understanding?
- To the best of your knowledge in your professional capacity, to what extent does location of your institution affect the number of applicants? How did you arrive at this understanding?
- What proportion of applicants is accepted to your institution?
- Do you have statistics or documentation that you can share with the following information:
  - Which counties do applicant, admitted, and enrolled students come from?
  - Average age or other demographic information of applicant, admitted, and enrolled students?
  - Proportion of applicant, admitted, and enrolled students that:

- Have recently graduated from high school (in the last two years)
- Adults that have been out of the workforce for an extended period of time
- Adults current in the workforce, and looking to improve their skills improve skills for a career ladder position
- Adults currently in the workforce, and looking to change their careers?

Description of Admitted Students

- Nearly all of community college applications state that applicants' prior test scores will be used to counsel students once they are accepted into the program. Could you please describe how you understand the institution uses the scores?
  - Who provides counsel?
  - When does counseling occur?
  - Does counseling address students' career interests or goals?
  - Are students ever counseled into or out of programs?
- In your professional capacity, how would you describe the academic skills of accepted students? How did you arrive at this understanding?
- In your professional capacity, how would you describe the technical skills of accepted students? How did you arrive at this understanding?
- In your professional capacity, how would you describe the career readiness skills, or "soft"/ life skills, of accepted students?
  - Teamwork, study skills, time management, communication skills
  - How did you arrive at this understanding?
- In your professional capacity, how would you describe attendance of students? Are there attendance policies?
- From your professional experiences, are there tracks for students that enter programs with higher levels of academic or technical skills?

- From your professional experiences, how do students select their course of study once they are accepted to a program?
- Do students receive a program of study adviser?
  - If yes, how often do they meet with the adviser? Are there recommendations about how to advise students?
- Are there career or job placement counselors offered by the institution?
  - As you understand it, what is the role of the counselors?
  - What is the uptake of students enrolled in programs?
  - How familiar are these counselors with labor needs and data?
- What proportion of students complete their programs?
  - If they exit the program, why do they leave? Do they enroll in another program within the institution? Do they enter the workforce and, if so, what sector and type of job?
- What proportion of graduates is hired within three months of graduation?
  - What proportion is hired before the end of the program?
- What sectors do graduates enter?
  - As you understand it, how do they find their positions? Do professors invite sectors to their classes to discuss job opportunities?
  - Are there career fairs that students are encouraged to attend?
  - What proportion of students move away from the catchment area of the community college after graduation?
- What feedback have graduates provided about their readiness for the workforce? How did your institution acquire this feedback?
- What feedback have employers of graduates provided about the readiness of graduates for the workforce? How did your institution acquire this feedback?
- What proportion of graduates return for ongoing or advanced training?

Perceptions of Energy Sector and Workforce Needs

- In your professional capacity, what types of jobs would the energy sector consider **high demand**? What has informed your perceptions of these as high-demand positions?
  - What skills might an applicant need for these positions (i.e., certifications, licensure, degrees)? How did you arrive at this understanding?
  - What proportion of these positions are on a career ladder, where steps to career advancement are clear?
  - In your professional capacity, do the programs at this institution provide students with the skills required for these positions?
- What programs or areas of study at your institution would provide students the skills needed for **high-demand** jobs in the energy sector?
  - How many students are enrolled in these programs?
  - Other than the energy sector, what other sectors might students in these programs be prepared to enter? Are these sectors ones students are familiar with?
- In your professional capacity, what other types of semi-skilled jobs are available in the energy sector? What has informed your understanding of these as available positions for semi-skilled laborers?
  - What skills might an applicant need for these positions (i.e., certifications, licensure, degrees)? How do you get your information?
  - What proportion of these positions are on a career ladder, where steps to career advancement are clear?
  - In your professional capacity, do the programs at the institution provide students with the technical skills required for these positions?
- What programs or areas of study at your institution would provide students the skills needed for **high-demand** jobs in the energy sector?
  - How many students are enrolled in these programs?

  - Other than the energy sector, what other sectors might students in these programs be prepared to enter? Are these sectors ones students are familiar with?
- In your professional capacity, what are the perceptions of enrolled students of the energy sector? How do these perceptions compare to other sectors like healthcare, retail, or construction? What formed your impressions?
- As you understand it, are there screening procedures for employment in the energy sector? Do these screening procedures differ from semi-skilled positions in other sectors? What has informed your professional understanding of the screening procedures? To the best of your knowledge, to what extent have screening procedures affected students' employment in the energy sector?
- From your professional experiences, are students aware of the screening procedures used by employers in the energy sector? How do students receive this information?

Energy Sector Employer Interview Protocol

Background Questions

- Please briefly describe your position and responsibilities here at _____ company.
- Can you describe what this business/company does/produces and how it relates to the energy sector in West Virginia?

Job Openings and Trends in Workforce Needs

- Since this company opened in/moved to/started conducing work in West Virginia, how many people have you hired?
  - In which job categories?
- In your professional capacity, which jobs are most critical to fill now? And in the coming years? (Probe on overlap between critical and hard-to-fill jobs.)

  - How do you know this? What information do you rely on to inform your knowledge?
  - In your professional capacity, which skills are necessary for an employee to have for these critical jobs?
- In your professional capacity, which are your hardest-to-fill jobs? Which ones of those are semi-skilled?
  - How do you know this? What information do you rely on to inform your knowledge?
  - In your professional capacity, which skills are necessary for an employee to have for these hard-to-fill jobs?
  - Why do you think these particular jobs are so hard to fill?
- What strategies do you employ to find out what jobs need to be filled? Why? Has it been effective?

Requirements and Skills

We would like to discuss the required skills for the jobs that fall within the semiskilled range. Please answer in your professional capacity.

- Do you have any statistics or documentation that you can share with us about the following (if no documentation provided prior to meeting):
  - Number of employees that work for your company in West Virginia, by job type, by education background
  - Which jobs categories fall within the "semiskilled range"? That is, which jobs have a minimum requirement of a high school degree or an associate's degree, but not a bachelor's degree?
  - What are the eligibility requirements for someone to be employed in *each* of these semiskilled job categories? (*Note to interviewer:* Be sure to retrieve information for each job category.)
    - Required minimum degrees or certifications (if any)
    - Required minimum years of experience (if any)
    - Required recertification timeframes for key skills (if any)
- What content knowledge do desired workers need to have for semi-skilled jobs at this firm?

- What performance skills do desired workers need to have for these semi-skilled jobs at this firm?
- What workforce readiness skills (e.g., soft skills, employability skills) do desired workers need to have for these semi-skilled jobs at this firm?
- What is the process for determining the eligibility requirements for each of these jobs?
  - Do you look at other employers' requirements?
  - Do you have a committee to decide these requirements? If so, who is on this committee?
  - Any other determination process(es)?
- You have this job posting on your web site (note to interviewer: if in person, show printout of job posting; if over the phone, describe the posting title, number, and description).
  - Can you walk us through the eligibility requirements (e.g., years of experience or degree) of this job posting?
  - Can you define or explain industry specific terms for us? Are these standard across the industry?
  - What will the employee be doing on the job—what is expected of the employee?
  - What is the process for creating a job posting? (Probe for whether this is done via committee and who involved: whether managers create the job positing, an employee in Human Resources, someone on the ground in West Virginia or at a head office in a different state.)
    - How is the job description created?
    - How are the eligibility requirements listed on this job posting determined?
    - What is the vetting process for received applications?

Recruitment Process

- Through what methods do you recruit applicants in-state? And out-of-state?

- Where do you post advertisements for job openings? (Probe: national job boards, local job boards? Which ones?)
  - Which web sites or job boards do you receive the most applicants from? (Which ones are the most successful in linking job seekers to apply to this company?)
- Do you recruit applicants from specific training programs or educational institutions here in West Virginia? Outside of West Virginia?
  - If so, why those specific programs (e.g., does the firm have a history working with a particular program or institution)?
- Does your firm keep track of which educational or training programs have applicants with the needed skills and competencies? In West Virginia or in another state?
  - How does your firm gather this information?
- Does your company collaborate with or communicate with any educational, certification, or training programs?
  - Does your company have a relationship with CTCS or any CTEs in the state or across the region? If so, please describe this relationship: when it started, the motivation for starting the relationship, and what are the characteristics for this relationship?

Hiring Process and Characteristics of Hired Applicants

- Can you describe your firm's hiring process for semi-skilled jobs?
  - What type of initial screening do you undertake (e.g., drug test, aptitude tests, application, interview)?
  - Do you communicate this screening process to potential applicants? When (i.e., on the job posting, during an interview, etc.)?
- What are known green flags or red flags you look for when screening an applicant?
- What fields of an application have a minimum standard that can be verified?
- What fields when fulfilled are an automatic push to consider hiring?

- Do you have statistics or documentation on the characteristics of applicants who are hired at this firm that you can share with us (de-identified)? Such as:
  - Percentage of applicants who are hired?
  - Percentage of applicants who are from in-state? From out of state?
  - Percentages of applicants by educational or training institutions?
  - Average performance on any screening assessments you apply?

Perceptions of Pool of Talent in West Virginia

- In your professional capacity, how would you describe the quality of current applicants from West Virginia? (*Note to interviewer: allow interviewee to define "quality."*)
  - Have you observed any differences between old hires (a few years ago) and new hires (this year) from WV?
  - How do you know this? What information do you rely on to inform your knowledge?
- In your professional capacity, how do WV applicants compare to out-of-state applicants for this WV facility? How do WV applicants compare to applicants at other company locations in other parts of the country?
  - How do you know this? What information do you rely on to inform your knowledge?
- In your professional capacity, if applicants from outside West Virginia are more sought after for certain job positions, what characteristics do those applicants have?
  - Do those applicants come from specific training programs?
  - Do those applicants have different skills or qualities?

Human Capital Development

- Does the company provide on-the-job training for new hires (or practicum, internship or mentorship opportunities for possible applicants) to build desired skills in workers? Do you have a list of these opportunities you can share with us?
- Are there any opportunities for your employees to become training providers or instructors at educational or training programs?
- Do you keep any statistics or documentation of retention that you can share?
  - Do employees from WV differ from out-of-state employees in their retention rates?
  - Any other differences within workforce in retention rates that your firm has documented?

Focus Groups with Students in Energy-Related CTCS Program Discussion Protocol

Background of Participants

- I'd like to go around the room. Can you please introduce yourself and state which degree program (or certification, or training program) you are enrolled in?

Decisionmaking Factors for Enrolling in WVCTC Degree Program

- What made you decide to enroll in this particular degree program at CTCS?
  - Mid-career transition?
  - Out of workforce, looking for a new career field?
- What other career fields have you considered? Or have you already been employed in?
- Did anyone here consider pursuing other careers or enrolling in a different degree program? What factors did you consider when

making a decision to enter this one rather than any other degree program?
  - Probe for *structural* factors: child care, transportation, timing of classes, working hours constraints
  - Probe for *personal* factors: family members' occupational or educational expectations, individual's occupational or educational expectations, perceptions of what jobs are like in energy/health sector, social status or prestige associated with a job in the energy/health sector.

Barriers and Facilitators to Attending Courses

- What are some things that make it difficult for you to attend classes?
- Anything that makes it easier?

Hiring and Employment

- What kind of job do you hope to get once you graduate from this program?
  - What kind of skills or knowledge are you hoping to acquire with this degree?
- How have you received information about the type of job you can get after you finish here?
  - Have you had the opportunity to meet with potential employers (like at a job fair)?
  - Seen a job posting that listed this degree as a requirement?
  - Word of mouth (from family or friends already employed in this sector)?
- To your knowledge, what are some of the mandatory procedures someone may have to go through when they apply for a job in the energy/health sector?
  - Aptitude tests?
  - Drug tests?
  - Interviews?

Concluding Questions

- In closing, is there anything else anyone would like to add about any of the topics we touched on today?
- Any advice you'd like to give CTCS or employers in the region that would make it easier for you to find a job?

APPENDIX C

Technical Programs Offered by the Community and Technical College System of West Virginia and Enrollment by Major for Each College

Table C.1 lists the engineering and technical programs available at each CTCS college at the time of this study (2012–2013).

Table C.2 provides an overview of the different majors that students pursued at the ten colleges from the academic years 2008–2009 through 2012–2013. Radiology was identified to be the program most widely followed; the ten community colleges attracted 951 students to this major in 2012–2013, almost double the number of students who had studied it four years earlier. Computer Science was offered at eight different colleges, while Biology and Health (Medical Assistance) programs were offered at seven different colleges. On the other hand, technology- and engineering-related degrees tended to be offered by only a few colleges: both Civil Engineering and Mechanical Engineering Technology were available at only one college each, Manufacturing Engineering Technology was available at two colleges, and Electrical Engineering Technology was offered at four colleges.

Table C.1
Engineering and Technical Programs Available at Each CTCS College at the Time of This Study, 2012–2013

Engineering or Technical Program	Blueridge	Bridgemont	Eastern West Virginia	Kanawha Valley	Mountwest	New River	Pierpont	Southern West Virginia	West Virginia Northern	WVU Parkersburg
Air Conditioning, Refrigeration & Heating Technology									X	X
Animation & Game Developer/ Simulating, Gaming & Application Development		X			X	X				
Applied Technology	X	X		X						
Automotive Technology			X							
Aviation					X		X			
Aviation Maintenance Technology							X			
Blasting Technology		X								
Cisco Network Professional	X	X			X		X		X	X

Table C.1—Continued

Engineering or Technical Program	Blueridge	Bridgemont	Eastern West Virginia	Kanawha Valley	Mountwest	New River	Pierpont	Southern West Virginia	West Virginia Northern	WVU Parkersburg
Chemical Process Technology/Applied Process Technology				X						X
Civil Engineering Technology		X								
Computer Application Specialist	X		X							
Computer Maintenance & Networking/ Computer Repair & Operating Systems	X	X		X						X
Computer Network Engineering Technology	X	X		X						X
Computer Science						X				X
Computer/ Information Technology	X	X	X	X	X	X	X	X	X	X
Diesel Technology		X								

Table C.1—Continued

Engineering or Technical Program	Blueridge	Bridgemont	Eastern West Virginia	Kanawha Valley	Mountwest	New River	Pierpont	Southern West Virginia	West Virginia Northern	WVU Parkersburg
Drafting & Design (CADD) Engineering Technology	X	X		X			X	X		X
Electrical Distribution Engineering Technology	X						X			
Electrical Engineering Technology		X						X		X
Electromechanical Technology/ Electromechanical Instrumentation Technology		X	X							X
Electronics Technology					X					X
Engineering Technology										X
Engineering Transfer/Pre-Engineering				X						X

Table C.1—Continued

Engineering or Technical Program	Blueridge	Bridgemont	Eastern West Virginia	Kanawha Valley	Mountwest	New River	Pierpont	Southern West Virginia	West Virginia Northern	WVU Parkersburg
Highway Technician		X								
Industrial Maintenance Technology			X						X	X
Information Technology/ Systems/Security	X	X	X	X	X	X	X	X	X	X
Machinist Technology			X		X	X				X
Major Appliance Repair									X	
Manufacturing Technology		X			X					
Maritime					X					
Mechanical Engineering Technology		X								
Mechatronics	X	X	X			X	X		x	X
Mine Management								X		

Table C.1—Continued

Engineering or Technical Program	Blueridge	Bridgemont	Eastern West Virginia	Kanawha Valley	Mountwest	New River	Pierpont	Southern West Virginia	West Virginia Northern	WVU Parkersburg
Mine Inspection					X			X		
Painting & Allied Trades					X					
Power Plant Technology				X			X		X	
Pre-Press Technology/Press Technology	X	X								
Prepress Technicians & Workers										
Survey Technology								X		
Weatherization Technology/ Sustainable Building Technology		X		X		X				
Welding Technology		X			X	X				X
Wind Energy Technology			X							

SOURCE: EarnMoreWV, 2012.

Table C.2
Number of Students per Major at CTCS, by College, 2008–2009 Through 2012–2013

Major	Institution	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013
Accounting	Blue Ridge	159	184	206	234	244
	Eastern West Virginia	80	98	80	74	83
	Kanawha Valley	119	93	115	106	80
	Southern West Virginia	194	148	151	140	158
	WVU Parkersburg	528	527	444	333	215
Biology	Bridgemont	0	1	1	1	0
	Eastern West Virginia	0	1	1	14	33
	Kanawha Valley	0	2	0	0	1
	Mountwest	3	6	12	11	8
	New River	259	503	510	618	519
	Southern West Virginia	0	0	0	1	2
	WVU Parkersburg	1	3	3	4	4
Civil engineering	Bridgemont	49	46	40	34	33
Computer science	Blue Ridge	129	187	170	128	119
	Bridgemont	42	47	34	34	30
	Eastern West Virginia	0	10	24	31	32
	Mountwest	156	184	183	170	151
	New River	10	10	11	8	2
	Southern West Virginia	28	20	37	31	46
	WVU Parkersburg	136	172	132	127	116
	West Virginia Northern	105	102	109	114	97

Table C.2—Continued

Major	Institution	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013
Criminal justice	Blue Ridge	96	131	183	204	171
	Kanawha Valley	0	0	0	6	0
	Mountwest	0	0	24	98	51
	Southern West Virginia	78	94	97	87	87
	WVU Parkersburg	173	216	208	191	187
Electrical engineering technology	Bridgemont	58	57	70	63	59
	Kanawha Valley	0	1	1	0	0
	Mountwest	23	36	46	29	28
	Southern West Virginia	28	34	54	57	63
General business	Bridgemont	41	21	39	38	42
	Mountwest	213	186	178	153	166
	New River	224	287	291	293	249
	Pierpont	302	324	276	225	219
	WVU Parkersburg	0	0	114	155	222
	West Virginia Northern	196	172	166	181	141
Health administration	Kanawha Valley	65	88	95	103	609
	Mountwest	0	211	275	286	318
Health management	Pierpont	402	475	542	426	338
Health (medical assistance)	Blue Ridge	35	88	142	159	170
	Bridgemont	0	20	32	24	27
	Kanawha Valley	0	1	1	0	0
	Mountwest	84	110	92	85	87
	New River	82	107	135	143	201
	Southern West Virginia	0	0	0	0	15
	West Virginia Northern	10	9	27	20	22

Table C.2—Continued

Major	Institution	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013
Law enforcement	Kanawha Valley	106	65	46	63	58
	Mountwest	311	415	404	410	182
	New River	34	36	45	55	55
	Pierpont	151	158	171	180	200
	West Virginia Northern	114	125	150	168	136
Legal studies/ paralegal	Blue Ridge	45	49	50	58	54
	Kanawha Valley	12	21	39	49	49
	Mountwest	97	104	96	91	68
	New River	37	41	52	66	52
	Pierpont	36	33	37	54	65
	West Virginia Northern	32	61	66	57	42
Manufacturing engineering technology	Bridgemont	1	7	4	3	0
	WVU Parkersburg	96	121	117	92	48
Mechanical engineering technology	Bridgemont	33	21	22	20	15
Nursing	Blue Ridge	313	356	243	181	125
	Eastern West Virginia	19	1	20	19	20
	Kanawha Valley	199	204	240	233	215
	Southern West Virginia	198	147	141	128	132
	WVU Parkersburg	585	713	478	271	204
	West Virginia Northern	248	231	212	232	200

Table C.2—Continued

Major	Institution	2008–2009	2009–2010	2010–2011	2011–2012	2012–2013
Radiology	Blue Ridge	8	6	5	6	10
	Bridgemont	58	201	194	227	212
	Eastern West Virginia	20	13	10	7	11
	Kanawha Valley	17	6	2	2	67
	Mountwest	108	367	459	569	421
	New River	95	136	212	236	133
	Pierpont	163	49	69	65	64
	Southern West Virginia	34	13	12	7	7
	WVU Parkersburg	24	39	47	30	23
	West Virginia Northern	12	19	25	5	3
Sociology	WVU Parkersburg	16	384	287	293	338

SOURCE: Authors' calculations of data from West Virginia Higher Education Policy Commission, undated(a), undated (b).

Abbreviations

API	American Petroleum Institute
BLS	Bureau of Labor Statistics
CADD	computer-aided design and drafting
CEWD	Center for Energy Workforce Development
CTC	Community and Technical College
CTCS	Community and Technical College System of West Virginia
CTE	career and technical education
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
EDGE	Earn a Degree–Graduate Early
EFC	Eagle Ford Consortium
EPCE	Energy Providers Coalition for Education
ETA	Employment and Training Administration
GED	General Education Development
HGJTI	High Growth Job Training Initiative
HPTC	High Plains Technology Center
I-BEST	Integrated Basic Education and Skills Training
KSA	knowledge, skill, or ability
LNG	liquefied natural gas
mcf	1,000 cubic feet

NAFTC	National Alternative Fuels Training Consortium
NAICS	North American Industry Classification System
NCLB	No Child Left Behind
NETL	National Energy Technology Laboratory
O*NET	Occupational Information Network
OECD	Organisation for Economic Co-operation and Development
OES	occupational employment statistics
PIOGA	Pennsylvania Independent Oil and Gas Association
PISA	Programme for International Student Assessment
QCEW	Quarterly Census of Employment and Wages
RSE	relative standard error
SOC	Standard Occupation Classification
STEM	science, technology, engineering, and mathematics
VHS	Virtual High School
WESTEST2	West Virginia Educational Standards Test 2
WIA	Workforce Investment Act of 1998
WIB	Workforce Investment Board
WIOA	Workforce Innovation and Opportunity Act of 2014
WVONGA	West Virginia Oil and Gas Association
WVU	West Virginia University

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In the past, West Virginia's energy sector was primarily based on mining and combusting coal for industry or electricity. In recent years, the production and industrial application of natural gas and natural gas liquids from shale resources have increased demand for workers in the energy sector. In 2013, the National Energy Technology Laboratory (NETL) asked RAND to work closely with the Community and Technical College System of West Virginia (CTCS) to develop a strategy for energy-sector employers and education and training institutions to collaborate to ensure that the local talent pool is prepared to enter the workforce with the competencies to fill energy-sector jobs now and in the future. To develop that strategy we examined data from the Occupational Information Network (O*NET) and interviewed energy-sector employers in West Virginia to determine the key knowledge areas, skills, and abilities required of energy-sector employees across the country and within West Virginia. We then analyzed data from the West Virginia Higher Education Policy Commission, interviews with representatives of academic and training providers within CTCS, apprenticeship programs, a regional Workforce Investment Board (WIB), and CTCS students enrolled in energy-related programs to determine whether education and training is aligned with the sector's needs and what may impede such alignment. We conducted a national review of promising practices from training provider–employer partnerships across the United States. Based on this analysis, we developed ten recommended action items CTCS and other regional stakeholders can implement to support a well-aligned and coherent energy-sector workforce-development pipeline.

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