

# Working Paper Series

## A COMPREHENSIVE ECONOMIC IMPACT ANALYSIS OF NATURAL GAS EXTRACTION IN THE MARCELLUS SHALE

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### Workforce Development Challenges in the Natural Gas Industry

Jeffrey Jacquet

#### Summary

Thousands of short and long-term jobs will be created as natural gas drilling and hydrofracturing takes place in the Marcellus Shale, presenting both employment opportunities and workforce development challenges. These jobs – found primarily on crews needed during the drilling and completion process – are not for everyone and require a diverse skill set and a rigorous work ethic. In Pennsylvania, the industry has thus far relied on “out-of-town” workers to fill many of these hard-to-fill roles, but over time will replace a portion of these workers with local employees if they are available. A similar pattern is likely to be repeated in New York if shale gas drilling is approved.

The number of workers needed will depend greatly upon the pace and scale of drilling – which has proven highly unpredictable in other areas. In general, local residents will find relatively fewer opportunities for accessible and stable employment in the short term, although opportunities may grow over time.

Local workforce training programs can help to “filter in” local employees that are well-suited to the industry, provide them with a basic orientation to the skills required, and steer these workers towards gas industry occupations that are safe, well-paying, and will keep them in the region for the long term. A concerted effort to match local workers with high quality jobs will

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require investment in workforce education and training programs in community colleges, high schools, and other local educational institutions. Extensive workforce training programs are underway in Pennsylvania, while some smaller initiatives are being investigated in New York State.

## **Keywords**

Natural Gas Industry, Marcellus Shale, Gas Industry Workforce, Workforce Development, New York State, Pennsylvania

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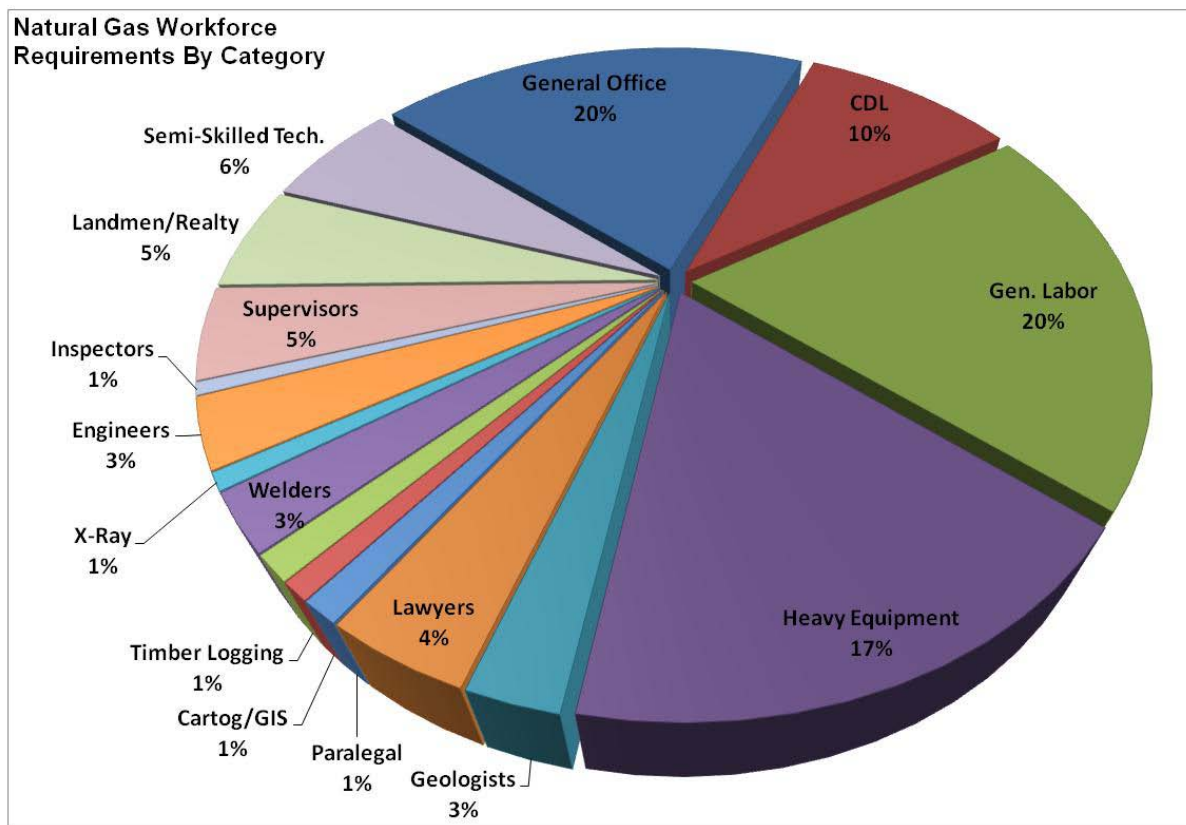
## **What is the issue?**

Fitting local workers with opportunities in the natural gas industry can be challenging as gas industry workforces are diverse, ranging greatly in the education or training required, with little in the way of an established industry training curriculum. While occupations can include advanced positions in engineering and geosciences, the majority of workers work in skilled trades, equipment operation, and general labor. Equally important to workforce development is the wide variation in the location and duration of these occupations: many workers associated with developing the gas wells will only be needed in a particular area while the wells are being drilled, while others related to the long-term production of natural gas will stay at a particular locale for decades.

Development of the Marcellus Shale – and the workforce it requires – is significantly more industrial in nature, labor intensive, and technologically advanced than the shallow natural gas drilling traditionally carried out in New York State and Pennsylvania.

## What Kind of Jobs?

Nearly all jobs in the natural gas industry earn among the highest wages of any industrial sector, with a mean hourly wage of \$34 per hour, typically excellent benefits (USBLS 2010), and dramatically increasing wages among highly skilled positions, including skilled trades such as specialized welding or crane operation, and positions in advanced fields such as engineering and geosciences. Non-experienced roustabouts or construction helpers can start at wages close to \$20 an hour, with many opportunities for overtime (Jacquet 2006).



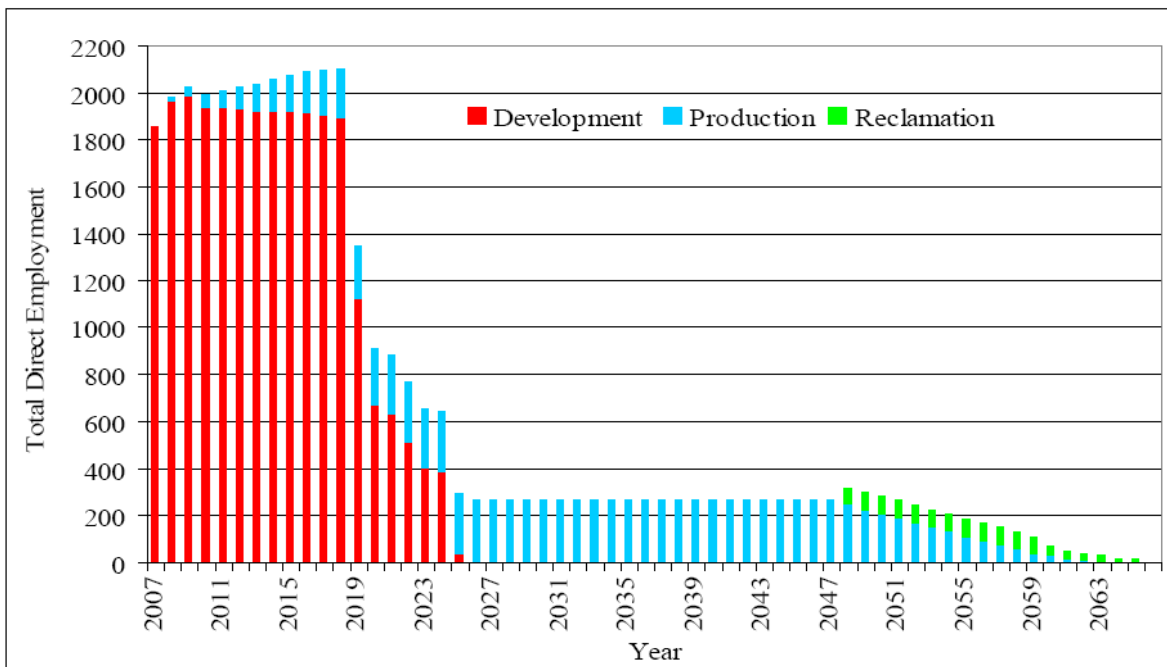
**Figure 1:** This pie chart illustrates the composition of the over 400 occupations needed to drill a single well. It illustrates that most of the workforce is not in salaried occupations requiring advanced training or a college degree. (MSETC/Jacquet 2010)

### Drilling Phase Jobs vs. Production Phase Jobs

It is perhaps more informative to organize the onsite natural gas extraction workforce into two groups: **Drilling Phase Jobs** and **Production Phase Jobs**.

Clearing and constructing a natural gas well site, drilling and casing the well, performing the hydro-fracturing process, and constructing the associated pipeline infrastructure all considered part of the Drilling Phase, and a very labor-intensive process. After this work is performed, however, the number of workers needed to keep producing gas for the remainder of the life of the well -- the Production Phase -- is much smaller.

**Drilling Phase Jobs.** A worker-by-worker tally of the Marcellus Shale industry in Pennsylvania found that *the drilling phase accounted for over 98% of the natural gas industry workforce* engaged at the drilling site (MSETC 2009; 2010).



**Figure 2:** This workforce projection from the Jonah natural gas field in Wyoming demonstrates that the workforce needed for the Drilling (or Development) Phase (red) is much larger than for the Production Phase (blue). The dynamic is very similar in the Marcellus Shale. In 2009, levels of drilling activity in

*the Jonah Field collapsed, due in large part to the economic recession, showing the volatile nature of the drilling phase and the difficulty in making accurate projections (ERG 2008/Jacquet).*

The majority of these jobs include the “roughnecks” who work on drilling rigs, excavation crews, CDL (tractor-trailer) drivers, heavy equipment operators, hydro-fracturing equipment operators, and semi-skilled general laborers.

Because most of the job opportunities occur during the drilling phase of operations, and because drilling activity in a given locale can quickly escalate or decline, natural gas employment conforms to a pattern of “Boom” and “Bust” found in other types of mining and natural resource development activity -- where the population base may expand rapidly over a number of years before shifts in commodity prices, energy company business strategies, or natural resource policies cause extraction activity to collapse, leading new residents and workers to leave the community (Jacquet 2009; Haefele and Morton 2009).

**Production Phase Jobs.** While comprising less than 5% of the total workforce, jobs associated with the Production Phase of operations (i.e. the employees of the energy company operator required to manage gas production from existing wells) -- will remain local and predictable. A 30-year production phase is the typical estimate, although the reality varies by well, location, and market conditions. These production phase jobs will be required even if drilling ceases completely. Occupations associated with the production phase tend to be less labor intensive, more location specific, less hazardous, and more specialized than development phase occupations, while still providing excellent wages and benefits. During the production phase, a local company office typically monitors and maintains production on all existing wells in an area. Many operators' well locations are clustered to the degree that one office location will service all wells for that company in the region. Core jobs at these locations include well operators (or “well tenders”), instrumentation technicians, pipefitting and welding technicians, production engineers, and office staff. Most of these occupations require either experience or vocational education that makes employees well suited for on-the-job training.

The MSETC studies (detailed below) have found that approximately one worker is needed to monitor and maintain 6 wells under production. If thousands of wells are drilled over time,

that eventually adds up to a significant number of long-term local jobs, although a much smaller number of jobs than are involved in the drilling phase, (MSETC 2010).

### **Office Jobs**

A variety of administrative, accounting, public relations, and other business services are needed to support the companies performing drilling phase and production phase work, although in many cases these office-based occupations are found in regional or corporate headquarters, and are not hired in local communities where the drilling takes place. These "white-collar" office jobs in the gas industry tend to be more stable geographically than work that must be performed at a drilling location. Here, the Southwest region of Pennsylvania has an advantage over other Marcellus regions: many of the large natural gas companies have located their regional corporate offices in the greater Pittsburgh area, providing local Pittsburgh workers with opportunities to fill white-collar jobs in these offices. These regional offices constitute a "sub-hub", while the main center of long-term, highly paid employment in the industry remains concentrated at company headquarters located elsewhere, primarily in Texas.

### **The Predictions: How Many Jobs?**

As with many other natural resource-based industries, predicting the future of natural gas drilling activity can be difficult. Commodity prices, technology changes, the discovery of new plays, and other factors can suddenly change the intensity, scope, and location of development. It can quickly become advantageous for an energy company to pull gas drilling operations out of one area, move them to another part of the state, country or the world, or put them on indefinite hold. It is likely that natural gas drilling in the Northeast United States will continue for many years; however, *where*, and *when*, and *how fast*, is much harder to predict (Berman 2010).

### **NYDEC's Development Scenario**

In their Draft Supplemental Generic Environmental Impact Statement (DSGEIS), the New York State Department of Environmental Conservation (NYDEC) estimated that a maximum level of natural gas development is likely to be 500 wells per year (NYDEC 2009). NYDEC does not

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describe how they arrived at that figure, and in only three Pennsylvania counties just south of the New York border (Tioga, Bradford, and Susquehanna counties), energy companies drilled 909 wells in the year 2010 (PADEP 2011).

New York is home not only to the Marcellus Shale, which is likely to be most productive in the central Southern Tier region, but also to the Utica and other gas-bearing shales, which are thought to have a high potential for future development throughout most of Upstate New York.

### **The Considine Studies of Direct, Indirect, and Induced Employment**

In the past two years, a series of studies on the economic impact of Marcellus Shale development have been commissioned by industry groups and performed by economist Tim Considine, in concert with other author-collaborators. Two of these studies (Considine et al 2009, and Considine, Watson, and Blumsack 2010) focus on Pennsylvania, but the third (Considine 2010) includes impacts on New York and West Virginia as well.

In their Pennsylvania analysis, Considine, Watson, and Blumsack (2010) found that 710 Marcellus Shale wells were drilled in Pennsylvania in 2009, and upon performing an input-output analysis using Impact Analysis for Planning (IMPLAN) data of the economic impact of this level of activity, they estimated that some 21,778 direct jobs would be created across all sectors, of which 2,878 would be created in the Mining Sector and 4,989 in the Construction Sector -- two industries most likely to comprise occupations related to the drilling of a natural gas well and associated activities.

In his New York analysis, Considine (2010) assumes that 314 wells will be drilled per year in New York State by 2015, which will generate 1,232 direct jobs in the Mining Sector and 2,154 direct jobs in the Construction Sector, two industrial classifications most likely to comprise the natural gas industry activity. He estimates an additional 4,810 jobs direct jobs will be created in all other sectors in New York, for a total of 8,196 direct jobs. And he estimates a further 7,532 indirect and induced jobs will result throughout all sectors.



The IMPLAN-based input-output model utilized by Considine assumes that most of the industrial, royalty, and wage spending that leads to job creation will occur in the area where the drilling takes place. This assumption may inflate the amount of job creation that is estimated in the model (Kay 2010<sup>1</sup>). In addition, the model assumes most of the jobs created will be “local” in nature. Therefore, it is unclear whether the economic model used in this study has accounted for the transient nature of much of the workforce, or the white-collar work performed at company headquarters located in other parts of the United States.

### **The Broome County Study**

In 2009, the Broome County legislature commissioned an economic impact study from two Texas economists (Weinstein and Clower, 2010) that utilized an IMPLAN-based input-output analysis to predict the economic impact from shale gas development in Broome County, NY. The study assumed two different development scenarios: 2,000 wells are drilled in the county over a 10 year period (or approximately 200 wells per year), and 4,000 wells over ten years (or 400 wells per year). The study found that, under these two scenarios, total direct, indirect, and induced employment could be expected to reach 8,136 and 16,272 "worker person years" respectively -- the equivalent of 813 and 1,627 Full Time Equivalent jobs over the 10 year period, a number much smaller than in the Considine studies. This lower number reflects Weinstein and Clower's stated assumption that most of the employment creation would “leak” from Broome County (that is, occur outside the county), likely from a combination of out-of-town workers performing work locally and jobs that are created and performed elsewhere.

As the range in estimates indicate, it is impossible to accurately predict either the pace and scale of drilling or the number of local jobs that will be created. While the number of jobs created is significant - regardless of the methodology used - workforce development in the natural gas industry faces greater uncertainty than in many other industries.

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<sup>1</sup> As part of this Policy Brief Series, David Kay, an economist at Cornell University, has provided a critique of the assumptions used in these economic models.



## **The MSETC Assessment of Direct Jobs**

The Penn College of Technology's Marcellus Shale Education and Training Center (MSETC) has performed a number of regional workforce needs assessments focused on the Marcellus shale gas industry in Pennsylvania. Recognizing the complexity of the industry's drilling and production workforce, their method was to interview industry officials and contractors and observe operations to "hand-count" the occupations and number of direct workers needed to construct, drill, and complete a single well and move it into production. Their study found approximately 250 different occupations comprised of over 400 different individuals are required to drill a Marcellus Shale well. *However, the vast majority of these individuals and occupations are required for only a few hours or days for each well.* The number of Full Time Equivalent (FTE) workers (an FTE is equal to one worker working full time for a year) for these 410 individuals was about 13 FTE to complete a well (MSETC 2009; 2010).

Using the "maximum" amount of development predicted by the NYDEC -- 500 wells drilled in New York State per year -- this would result in the equivalent of approximately 6,500 full time jobs needed while drilling activity is occurring. It is important to note that these jobs are required only while wells are being drilled; once drilling activity stops, these jobs are no longer needed locally. Many times, drilling activity may pause, or move to another area of the play, or move to another part of the continent, forcing drilling crew workers to follow the work to a new location or find a new source of employment.

The MSETC study also found that for each well drilled the equivalent of 0.18 jobs are created to help maintain gas production for the life of the well. These jobs would be locally required for as long as the well is producing gas, a time frame that is often estimated at between 20 to 30 years, but which will vary from well to well. Since this much smaller portion of the workforce is required locally for the entire length of production, they do compound over time with each and every well drilled. For example, if 500 wells are drilled per year, 90 Production Phase jobs would be needed for a 20-30 year period; after 5 years of drilling, 450 jobs would be required for that amount of time; and so on. Over time, depending on the number of wells ultimately drilled

in the region, jobs associated with the Production Phase can become significant source of “long-term” employment.

## **A Complex and Quickly Changing Workforce**

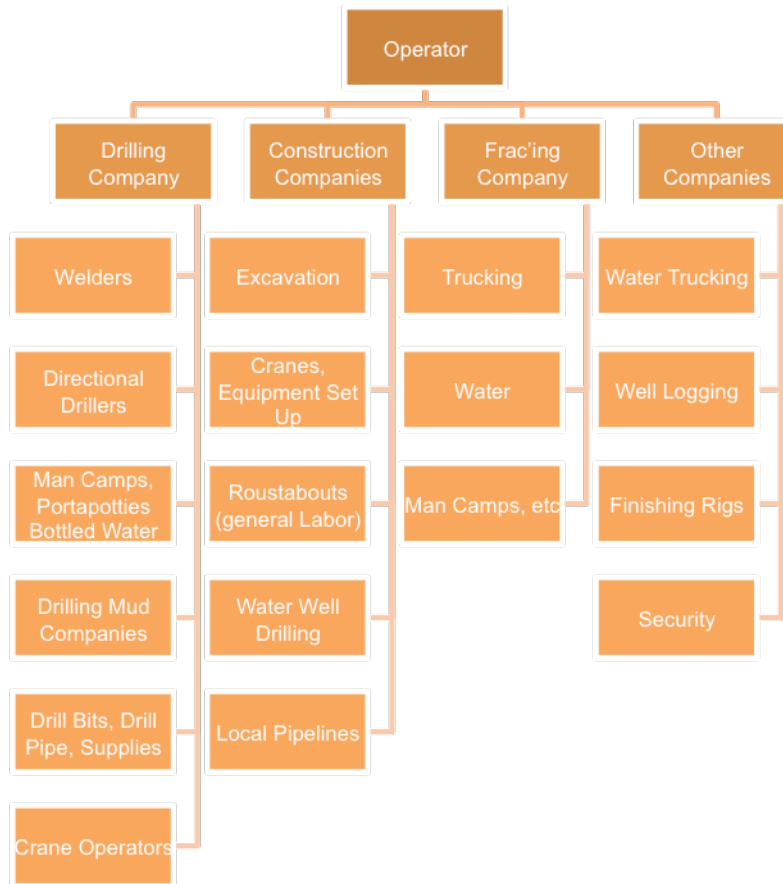
Even if the total amount development activity is well understood, due to the varying work locations, residencies, work schedules, contractors, subcontractors, and development intensities, natural gas workforces are difficult to estimate.

### **A Complex Workforce**

Development of the Marcellus Shale – and the workforce it requires – is significantly more industrial in nature, labor intensive, and technologically advanced than the shallow natural gas drilling traditionally carried out in New York State and Pennsylvania.

Consequently, the energy companies and contractors that perform drilling tasks are typically not local operations, but rather are national or international in scale and scope, and utilize personnel from around the country and around the world to perform these processes.

Further, the industry extensively depends on a wide array of subcontractors, each specializing in a few of the many complex tasks required, leaving the large energy firms that own the leases and the wells (typically called “operators”) to perform the role of a general contractor during the drilling process. For example, the operator may contract out the services of an excavator, a drilling company, a hydro-fracturing company, and a well completion company, and in turn, each of these companies contracts out tasks such as logging, gravel, drilling supplies and services, environmental compliance, water hauling, cementing, etc.



**Figure 3:** An example of the main contractors and subcontractors of the natural gas operator.

The complicated chain of contractors and subcontractors upon which the gas industry relies means that, unlike many other types of mining operations, relatively few people are actually employed “on the ground” by the large energy firms that own the natural gas well.

This system creates a challenge, not only in accounting for a workforce that is spread across a wide array of industrial classifications and geographical areas, but also because it leaves hiring practices and training programs largely uncoordinated among the myriad contractors and subcontractors. Many companies will provide on-the-job training to their workers – either in-house or via private training firms – but the focus of training remains largely company specific and uncoordinated among other firms.

## A Quickly Changing Workforce: Locations, Schedules, and Worker Residency

Since many natural gas industry contractors and subcontractors are accustomed to working at multiple and changing locations throughout North America or the world, and because skilled workers are often needed very quickly, it is commonplace within the natural gas industry to utilize non-local workforces. Industry veterans will typically have worked in locations throughout the United States or the world. For New York or Pennsylvania workers who become well trained in the gas industry, this means that they may eventually be forced to work elsewhere, but will likely retain strong job security if they are willing to do so.

### Shale Gas Plays, Lower 48 States



*Figure 4: Shale plays are emerging throughout the United States, and transferring natural gas workforces from play to play is commonplace and difficult to predict.*

Thus, the industry challenges the general definition of a “worksite”, as employees supporting natural gas development often work in multiple locations within a region, and can develop hundreds of different wells and infrastructure projects. Furthermore, industry employees will sometimes work 12-hour shifts for weeks at a time, and then receive several continuous weeks of leave while an entirely new crew of workers takes their place.

The gas industry consistently battles one of the highest employee turnover problems of any industrial sector (Mallozzi 2010). Reliance on out-of-town workers can prevent local individuals from taking advantage of the high wages and benefits in gas drilling occupations, and the wages earned will leave the host community and be spent in the employee's place of permanent residence. Further, an influx of out-of-town workers can drive up costs to the community, as these workers require additional public and private community services.

However, in general, as development moves forward, the workforce will become somewhat more local to a region. Some employees will decide to fully relocate to the area. Some companies will construct regional offices. As employee turnover occurs, some employers will fill positions with locally-based workers if they are available. In Western states, employment statistics have shown natural gas industry employment increasing in local areas despite declining natural gas activity, reflecting jobs that have become more "local" to the area over time (Headwaters Economics, forthcoming 2011).

In the Marcellus Shale, the industry has thus far relied heavily on an "out-of-town" workforce that will tolerate these requirements and possesses prior experience from working in other natural gas development plays (WTAE 2010). However, in the Southwest region of Pennsylvania, where shale gas development activity has been occurring since 2004, the transition towards local workers has been underway for some time. Companies moving into that area of the Marcellus Shale initially brought an external workforce with them, but are in the process of replacing that workforce with local workers as opportunities arise. Local construction and service firms that serviced shallow gas development in the region have transformed their businesses to take advantage of work in the Marcellus Shale, although out-of-town workers still comprise a large but unknown portion of the total workforce (MSETC 2010; PSCE 2010).

## **Benefits of a Building a Local Workforce**

Over time, however, in order to reduce their workforce costs, businesses within the industry will attempt to use local employees for many drilling phase positions and most of the

production phase positions, if they are available. Local workforce training programs can serve to filter in local employees that are well suited to the industry, provide them with a basic orientation to the skills required, and steer these workers towards gas industry occupations that are safe, well-paying, and will keep them in the region for the long term.

One of the largest factors that influences the total economic impact projected by IMPLAN-based input-output studies is the extent to which wages that are earned locally *are spent locally*. Wages that are spent locally will flow through the local economy, providing economic stimulus to local businesses, in turn, creating more local jobs. This implies that capturing as many jobs as possible for long-term residents will create additional jobs, as they build homes and buy goods and services in the region.

However, the benefit from fostering a local workforce rather than an out-of-town workforce goes beyond the fact that more of their wages are spent locally. Gas development activity can produce strains on local communities as they struggle to provide housing, services, and cultural integration for the hundreds or thousands of workers that may arrive in a drilling area (Jacquet 2009). Providing workers that already have permanent housing, community ties, and are accustomed to local weather and culture can help to reduce this strain.

Local workforces benefit the industry as well. Reduced transportation costs are the most obvious, but as local workers are accustomed to the local area, they may lower rates of attrition, relocation costs, and commuting obstacles.

## **Training Opportunities**

To foster local workforces, several post-secondary educational institutions across the United States have developed training programs or certifications to meet the demand of residents wishing to enter the gas industry. While there is not yet a recognized curriculum standard for most of the drilling and production phase jobs in the industry, the majority of these programs are one-to-two year programs offering an array of introductory classes in areas such as welding, electrical work, and instrumentation, with the content specifically tailored to gas industry applications in some cases. An important component to these programs is typically a “Gas



Industry 101” class that introduces students to the culture, terminology, schedules, and working conditions involved in the drilling industry, and serves to screen out potential employees who find these types of work unappealing.

Marcellus ShaleNet is a Pennsylvania-wide initiative to bring together Workforce Investment Boards (WIBs), their One Stop employment centers, training providers, and industry to build a Marcellus-wide, industry-recognized, uniform training and certification program by aggregating and augmenting existing curricula, and adopting best practices as identified” (WCCC 2010). The initiative has been developed by a consortium of community and technical colleges, anchored by the Penn College of Technology in Williamsport and the Westmoreland County Community College in southwestern PA, but it also includes Broome County Community College in New York and community colleges in West Virginia. The project was recently awarded a nearly \$5 million grant from the U.S. Department of Labor (PCT 2010a).

A challenge faced by the traditional workforce development agencies in Pennsylvania and elsewhere has been differentiating the majority of agency clients looking for traditional kinds of employment from those well-fitted to work in the gas industry. Part of the ShaleNet grant involves implementing a “talent matching system” to identify well-suited individuals, and “when matches are not found, job seekers will be referred to appropriate training programs. [...] The initial focus will be on recruiting and training low-income and dislocated workers, as well as military veterans, for in-demand positions such as derrick operators; rotary drill and service unit operators; roustabouts; welding and brazing operators; and truck drivers. “ (PCT 2010a)

Penn College of Technology in Williamsport has created an industry fundamentals and orientation class called “FIT 4 Natural Gas”, as well as natural gas-specific classes in welding, CDL, and Safety to complement other industrial classes that are available (PCT 2010b). Penn College plans to continue expansion of class offerings, including the use of onsite rig and wellhead equipment. In roughly 2 years, Penn College has graduated about 250 students from these classes, and has reported competitive placement thus far (Brundage, 2011). Over 1,100



students have also graduated from additional safety training, instrument and equipment certifications, and other shorter-term natural gas classes offered at Penn College.

Western Wyoming Community College located in Rock Springs, Wyoming is one example of a community college that provides a two-year certification in “Oil & Gas Technology” and “Natural Gas Compression” that is targeted toward long-term Production Phase employment in the oil and natural gas industry. The classes terminate in either an Associates Degree or one-year certification, with a curriculum that includes electrical, instrumentation, computer information systems, and industrial safety courses among others, and four classes designed specifically for oil and gas production with internships and apprenticeship placement built into the coursework. The program has operated since 2007, graduating an average of 17 students per year. The constructed well pad facilities on campus allow students to experience the job site under actual conditions (WWCC 2010).

*Figure 5: Students perform gas well operator functions on training equipment located on the Western Wyoming Community College Campus in Rock Springs, Wyoming.*

<http://www.wvcc.wy.edu>



In New York, initial steps are underway to provide natural gas focused classes at Broome County Community College (BCCC) and Corning Community Colleges (CCC). BCCC was among the consortium of institutions to receive the ShaleNet grant from the Department of Labor, while Corning Community College is investigating possible credit and non-credit curriculum.

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## Conclusion

A small but significant portion of the jobs associated with natural gas drilling will be local, well paying, and long-term. Significant investments will be needed in local education institutions to provide technical and trade programs to local workers interested in these types of jobs. Examples of workforce training programs exist in other gas producing regions. They provide a basic orientation to the types of jobs available in natural gas drilling and production, the work conditions and equipment involved, and such rudimentary skills as safety practices, welding, and instrumentation. Such an orientation positions local workers as ready and “pre-fitted” for entry-level positions and on-the-job training provided by the gas industry.

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