

# **The Economic Impact of the Natural Gas Industry and the Marcellus Shale Development in West Virginia in 2009**

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# Introduction

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Natural gas is a colorless, odorless, and tasteless fuel that is used by households, manufacturers, industries, and electricity producers across the United States. Natural gas is developed from either conventional or unconventional reservoirs, with the most recently developed unconventional natural gas reservoir being the Marcellus Shale play. The Marcellus Shale play stretches across an area of 95,000 square miles from southern New York across Pennsylvania, into western Maryland, West Virginia, and eastern Ohio. While formed in the Appalachian Basin over 300 million years ago, the Marcellus Shale play has recently become an economically viable source of natural gas due to technological advances in horizontal drilling and hydraulic fracturing as well as relatively high natural gas prices.

Since 2002, drilling and development operations in the Marcellus Shale play have become an important component of the natural gas industry in West Virginia. The Marcellus Shale formation in West Virginia is found throughout most of the state and over 500 permits for shale development were issued in the state in 2009. The development of the Marcellus Shale play has led to a significant amount of job creation in the state's natural gas industry and has also raised the wage level for the industry. Drilling operations in the shale play have increased the amount of state tax collections received from the industry but have also raised new policy questions.

In order to quantify the economic importance of the natural gas industry and the Marcellus Shale play in West Virginia, this report analyzes the industry and presents results from an economic impact in calendar year 2009. In addition, the report outlines key policy questions, including some of the tax, legal, and environmental issues that must be addressed as the industry matures in the state. For example, in addition to its economic impact, the natural gas industry contributes a significant amount of revenue to the West Virginia government. In 2009, the natural gas industry paid \$65.9 million in state severance taxes and the oil and natural gas industry paid approximately \$88.4 million in property taxes to the state.

The economic impact of the natural gas industry is substantial. In 2009 the oil and natural gas industry in West Virginia employed 9,869 individuals and paid over \$551.9 million in wages. The economic activities of the industry in 2009 generated a business volume impact of over \$12 billion in the state's economy and created approximately 24,400 jobs. The economic impact of the Marcellus Shale development in the state in 2009 was calculated to be \$2.35 billion of business volume and accounted for the generation of 7,600 jobs. Marcellus Shale is believed to hold trillions of cubic feet of natural gas thus the development of the shale is expected to continue to have a significant economic impact on the state in the future. This report examines these impacts for 2010 to 2015 in addition to the legal, regulatory, and environmental considerations mentioned above.

# 1. Natural Gas

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## 1.1. Definition and Utilization

Natural gas is a colorless, odorless, and tasteless gas used to produce electricity, steel, glass, paper, clothing, and a variety of other products.<sup>1</sup> In the United States (US), more than half of the homes use natural gas as their main heating fuel. The major consumers of natural gas in the US in 2009 included<sup>2</sup>:

- Electric power sector at 6.9 trillion cubic feet<sup>3</sup> (Tcf) or 30% of US consumption
- Industrial sector at 6.1 Tcf or 27% of US consumption
- Residential sector at 4.8 Tcf or 21% of US consumption
- Commercial sector at 3.1 Tcf or 14% of US consumption

The remaining US consumers of natural gas in 2009 included oil and gas industry operations, vehicle fuel, and pipeline fuel.

## 1.2. Process of Obtaining Natural Gas

The process of finding, developing, and preparing natural gas for consumption is quite extensive and complex. Seismic surveys use echoes to determine the location of natural gas on land and off-shore. Once an area has been deemed promising from a geological perspective, the drilling process begins. As natural gas is found within the deposits of rock formations through the drilling process, it is transported by pipelines to the ultimate consumer (Figure 1).

Transporting natural gas and making it viable for consumers involves many steps. Raw natural gas is gathered in low pressure pipelines and moved from the wellhead to a processing plant or the interconnection with a larger mainline pipeline. Natural gas liquids and impurities, such as liquid hydrocarbons and non-hydrocarbon gases, are separated from the natural gas stream near the site of the well or at processing plants. Natural gas is then transported from the producing area to market areas through wide-diameter, high-pressure interstate and intrastate pipelines. Compressor stations are strategically located throughout the transmission pipeline system to keep the natural gas flowing forward. In low demand times during the year, natural gas is stored in facilities created from depleted oil, natural gas, or aquifer reservoirs or salt caverns. When demand for natural gas increases, such as in the winter months, stored natural gas is delivered

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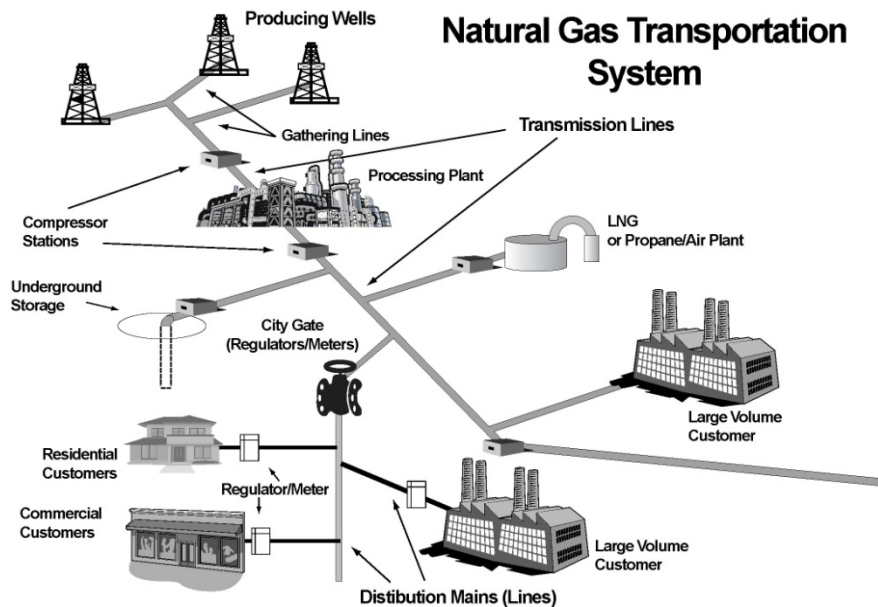
<sup>1</sup> Natural gas consists of hydrocarbon gases including methane, ethane, propane, butane, carbon dioxide, oxygen, nitrogen, hydrogen sulphide and rare gases.

<sup>2</sup> Source: *Modern Shale Gas Development in the United States: A Primer*. (2009) U S Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory

<sup>3</sup> A trillion cubic feet (Tcf) is one billion Mcf (1,000 cubic feet) and is enough natural gas to heat 15 million homes for one year, generate 100 billion kilowatt hours of electricity or fuel 12 million natural gas-fired vehicles for one year.

back into the mainline pipeline system. Distribution companies take natural gas from the high-pressure mainline system, reduce the pressure to levels suitable for residential and commercial use, and transports it through smaller pipelines called mains. Natural gas is then directly routed to homes and industrial facilities through very small pipelines called services.

**Figure 1: The Natural Gas Industry Process**



Source: Chesapeake Energy (<http://www.chk.com/media/corpmmediakits/gastransportation2.pdf>)

While natural gas is being transported or stored throughout the US for consumers, it is also being liquefied to be stored and transported to other countries. Liquefied natural gas is natural gas that has been cooled to  $-260^{\circ}\text{F}$ . It is approximately 600 times smaller by volume than the gaseous form and can be loaded onto tankers to be transported outside of the country. Liquefied natural gas, once transported, is returned to a gaseous form for use by residential, commercial, and industrial consumers.

### 1.3. Natural Gas Industry Breakdown

As illustrated, from extraction and drilling to distribution to support services, the natural gas industry<sup>4</sup> is quite complex and multifaceted. For that reason, the natural gas industry in the United States is classified into several NAICS<sup>5</sup> codes<sup>6</sup>:

<sup>4</sup> Note that the oil industry is included in the analysis of the natural gas industry due to the aggregation of the publically available data.

<sup>5</sup> The North American Industry Classification System (NAICS) classifies establishments by their primary type of activity. Further information regarding NAICS can be found at <http://www.naics.com>.

<sup>6</sup> Complete definitions of each sector can be found in Appendix A.

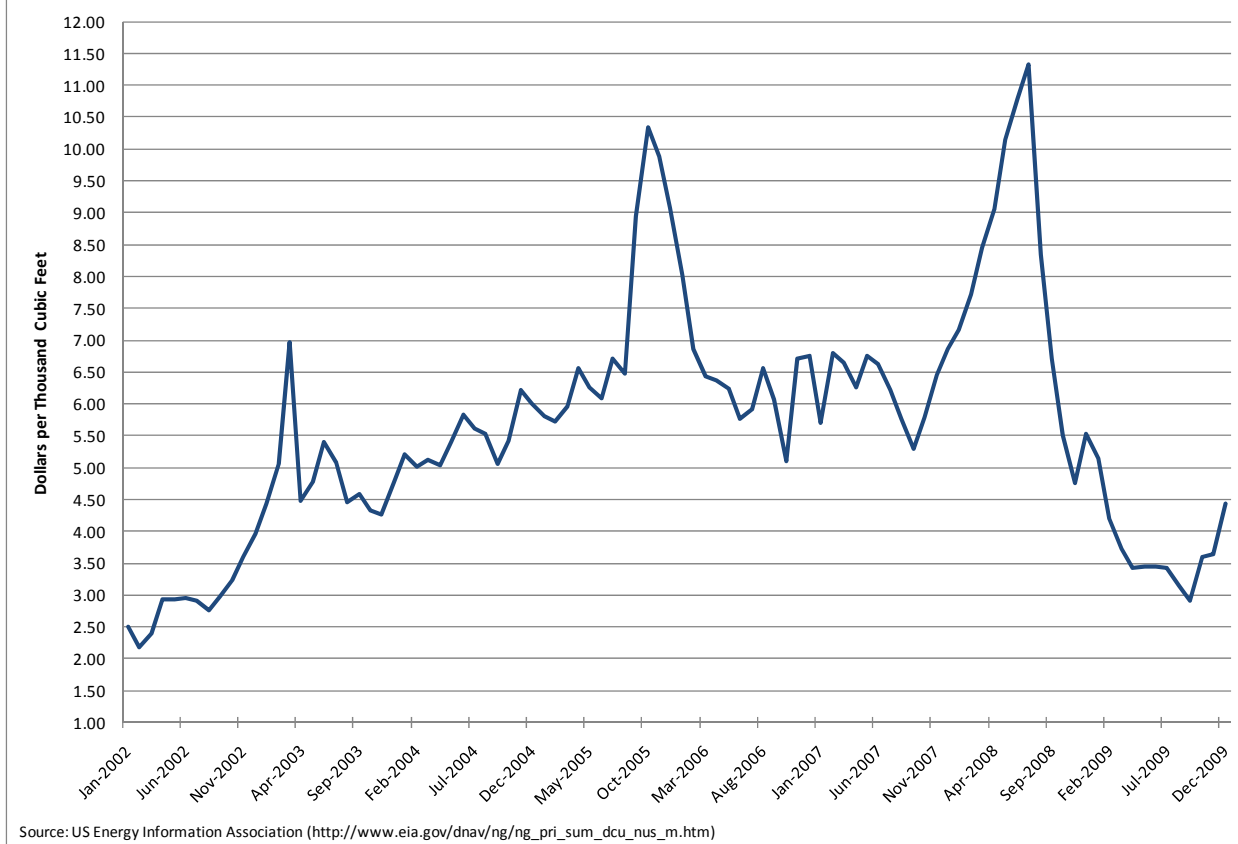
- NAICS 211: Oil and gas extraction
- NAICS 213111: Drilling oil and gas wells
- NAICS 213112: Support activities for oil and gas operations
- NAICS 221210: Natural gas distribution
- NAICS 237120: Oil and gas pipeline and related structures construction
- NAICS 333132: Oil and gas field machinery and equipment manufacturing
- NAICS 486210: Pipeline transportation of natural gas

These NAICS categories capture all aspects of the natural gas extraction, processing and transportation system.

#### **1.4. Natural Gas Prices**

Critical to natural gas exploration and development efforts in the US is the wellhead price for natural gas. According to the US Energy Information Association (EIA), the wellhead price is the value of the natural gas at the mouth of the well and is considered to be the sales price for the gas. From January 2002 to December 2009, monthly natural gas wellhead prices have ranged from \$2.19 per thousand cubic feet to \$11.32 (Figure 2). Wellhead prices for natural gas spiked in the early months of 2003 and 2006 and again in July 2008, reaching a high of \$11.32. This increase followed the pattern of oil prices rather than the typical seasonal price affects that the natural gas industry typically encounters. Since the spike in July 2008, natural gas prices have fallen dramatically. By September 2009, wellhead prices had fallen to \$2.92 per thousand cubic feet, a decline of over 74 percent.

**Figure 2: US Natural Gas Wellhead Prices 2002-2009**



## 1.5 Natural Gas Industry in West Virginia

### 1.5.A. History of Natural Gas in West Virginia

Natural gas has been an essential natural resource for West Virginia. Early settlers first discovered natural gas in “burning springs” on the Kanawha River just north of Charleston, West Virginia. The natural gas industry was developed many years after this discovery as an outgrowth of the state’s salt industry. While drilling for salt, developers would frequently hit oil or natural gas. In 1841, William Tompkins was the first to use natural gas found while drilling for salt as a fuel in the salt manufacturing process. Once the value and usefulness of natural gas were realized, drillers began to drill deeper into the earth and utilize the natural gas in West Virginia. By the 1860’s, the natural gas industry had been developed and towns sprung up near drilling operations in the state using natural gas to produce home and street lighting. From 1906 to 1917, West Virginia was the leader in natural gas exploration and development in the United States.

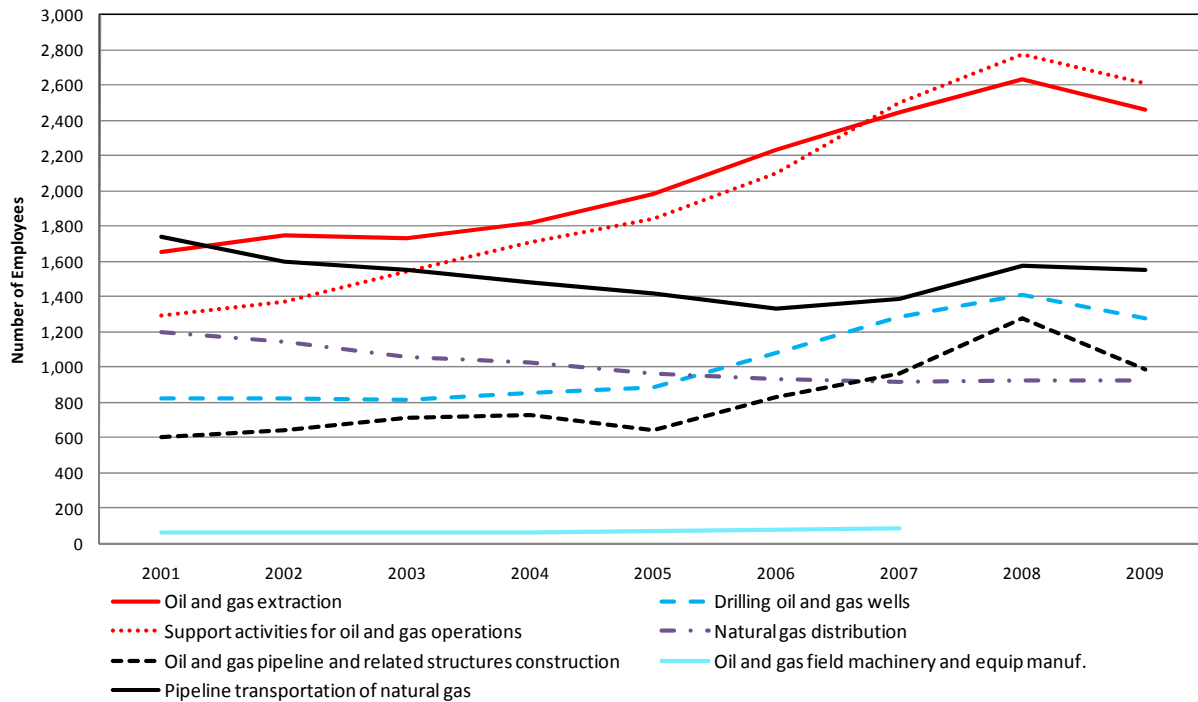
### 1.5.B. Oil and Natural Gas Industry Employment and Wages in West Virginia

The number of individuals employed by the oil and natural gas industry varies across states including across the states most affected by the development of the Marcellus Shale: New York, Pennsylvania, and West Virginia. As shown in Table 1, for 2008, Pennsylvania employed 14,466

individuals in the oil and natural gas industry, which was 37 percent more than employed in West Virginia and 155 percent more than in New York. In 2008, the majority of oil and natural gas employees in New York worked in the natural gas distribution and oil and gas pipeline and related structures construction sectors. The natural gas distribution sector also employed the largest number of individuals in the oil and natural gas industry in Pennsylvania. Unlike New York and Pennsylvania, over 51 percent of oil and natural gas employees in West Virginia were employed in the oil and gas extraction and support activities for oil and gas operations sectors in 2008.

<b>Table 1: Oil and Natural Gas Employment by Sector New York, Pennsylvania, and West Virginia 2008</b>			
<b>NAICS Sector</b>	<b>New York</b>	<b>Pennsylvania</b>	<b>West Virginia</b>
211: Oil and gas extraction	289	2,457	2,629
213111: Drilling oil and gas wells	382	2,280	1,410
213112: Support activities for oil and gas operations	ND	3,127	2,773
221210: Natural gas distribution	3,475	4,051	923
237120: Oil and gas pipeline and related structures construction	1,530	2,206	1,276
333132: Oil and gas field machinery and equipment manufacturing	ND	345	ND
486210: Pipeline transportation of natural gas	ND	ND	1,571
<b>TOTAL</b>	<b>5,676</b>	<b>14,466</b>	<b>10,582</b>
ND: not disclosed			
Source: US Census Bureau <i>County Business Patterns</i>			

**Figure 3: Natural Gas Industry Employment in West Virginia  
2001-2009**



Note: Data for the oil and gas field machinery and equip. manuf. sector was not available for 2008 and 2009.  
Source: Workforce West Virginia (<http://www.workforcewv.org/LMI/cntyform2.cfm?SelectCnty=West%20Virginia>)

Employment in the West Virginia natural gas industry has risen over time (Figure 3). From 2001 to 2009, total oil and natural gas employment, which is the summation of the employment in all natural gas NAICS sectors, increased by 34 percent. The main contributor in the increase in total employment in the industry was increased employment in the support activities for the oil and gas operations sector. This sector, which employs the most natural gas employees at over 2,600 in 2009, increased employment from 2001 by 102 percent. Other sectors including the oil and gas extraction, drilling oil and gas wells, and oil and gas pipeline and related structures construction sectors increased employment levels by more than 49 percent each. The driving force behind this increased employment was the development of the Marcellus Shale in the state. Two natural gas sectors experienced a decline in employment during this time span: natural gas distribution employment fell by 23 percent while pipeline transportation of natural gas employment declined by 11 percent.

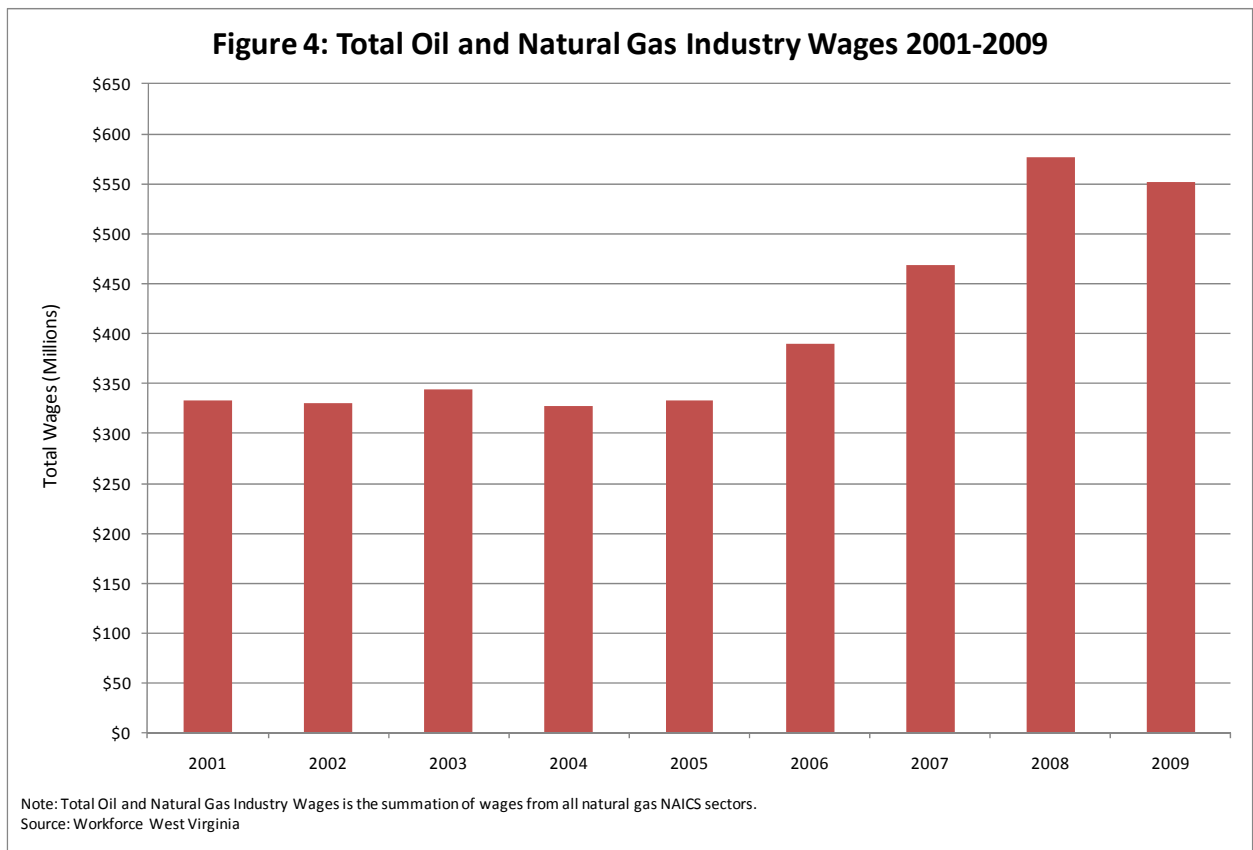
While total oil and natural gas employment in West Virginia has been increasing, it has accounted for a small percentage of total state employment. From 2001 to 2009, the oil and natural gas industry has accounted for 1 to 1.5 percent of total employment in the state.

Employment levels and annual wages coincide in the oil and natural gas industry in the Marcellus Shale area. In 2008, Pennsylvania's oil and natural gas industry not only employed the most individuals of the state most affected by the Marcellus Shale development but also paid the most in wages. As shown in Table 2, total annual wages paid to the oil and natural gas industry

in 2008 equaled over \$1 billion in Pennsylvania and just over \$500 million in both New York and West Virginia.

<b>Table 2: Oil and Natural Gas Annual Wages by Sector</b>			
<b>New York, Pennsylvania, and West Virginia 2008</b>			
<b>(thousands 2008\$)</b>			
<b>NAICS Sector</b>	<b>New York</b>	<b>Pennsylvania</b>	<b>West Virginia</b>
211: Oil and gas extraction	\$21,432	\$188,890	\$205,591
213111: Drilling oil and gas wells	\$32,692	\$120,115	\$89,764
213112: Support activities for oil and gas operations	\$10,015	\$202,143	\$104,564
221210: Natural gas distribution	\$308,945	\$332,990	\$59,300
237120: Oil and gas pipeline and related structures construction	\$178,872	\$137,685	\$108,610
333132: Oil and gas field machinery and equipment manufacturing	ND	\$21,043	ND
486210: Pipeline transportation of natural gas	ND	\$63,574	ND
<b>TOTAL</b>	<b>\$551,956</b>	<b>\$1,066,440</b>	<b>\$567,829</b>
ND: not disclosed			
Source: US Census Bureau <i>County Business Patterns</i>			

Mirroring increase in total employment, total wages in the natural gas industry have risen from 2001 to 2009 (Figure 4). The largest increases in wages occurred in the oil and gas extraction sector, the support activities for oil and gas operations sector, and the oil and gas pipeline and related structures construction sector.



## 1.6. Economic Impact of the Oil and Natural Gas Industry in 2009

### 1.6.A. Economic Impact Overview

To determine the economic significance of the oil and natural gas development in West Virginia, the economic impact of the natural gas industry was quantified for 2009. The economic impacts were estimated through the IMPLAN® input-output modeling system<sup>7</sup>. This analysis quantified the direct, indirect, induced, and total economic impacts<sup>8</sup> that occurred as a result of the natural gas development within the state in 2009. Expenditures by the oil and natural gas industry in 2009 such as operating expenses (payroll, fringe, benefits, supplies, etc.) represent the direct economic impacts. Indirect economic impacts are the economic activities such as sales and wages that result from purchases from suppliers of the industry. For example, a natural gas developer may purchase supplies such as pens and notepads from an office supply store. The office supply store, in turn, purchases manufactured goods, utility services, and pays employee wages, among other expenditures. The continued backward linkages from businesses buying from their suppliers and so on result in a continued re-spending of these funds. The induced economic impact of the oil and natural gas industry represents the expenditures by households of the income they received associated with the direct and indirect impacts. For example, rig hands earn wages, a portion of which they spend locally on the consumption of goods and services. The economic multipliers associated with the indirect and induced economic impacts are a clear indication of the strong economic linkage between the oil and natural gas industry and the rest of the West Virginia economy. The sum of the direct, indirect, and induced economic impacts is the total economic impact of the industry.

The economic impacts of the oil and natural gas industry focus on indicators such as employment, business volume, employee compensation, and selected state taxes. These taxes include personal income, corporate net income, business franchise, and sales and use taxes resulting from the economic activity generated by the industry.

### 1.6.B. Economic Impact Methodology

The economic impact of the oil and natural gas industry in West Virginia in 2009 was estimated using the IMPLAN® input-output modeling system and industry employment and wage data from WorkForce West Virginia<sup>9</sup>. Employment of full and part time employees and subsequent wages of those employees in 2009 were collected for the 7 oil and natural gas NAICS industry sectors. These sectors include:

- NAICS 211: Oil and gas extraction
- NAICS 213111: Drilling oil and gas wells
- NAICS 213112: Support activities for oil and gas operations
- NAICS 221210: Natural gas distribution
- NAICS 237120: Oil and gas pipeline and related structures construction
- NAICS 333132: Oil and gas field machinery and equipment manufacturing
- NAICS 486210: Pipeline transportation of natural gas

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<sup>7</sup> More information regarding the IMPLAN input-output modeling system can be found at <http://www.implan.com>.

<sup>8</sup> Appendix B defines the economic impact terms used throughout this report.

<sup>9</sup> WorkForce West Virginia information and data is available at <http://www.workforcewv.org>.

### 1.6.C. Economic Impact Results

In 2009, the West Virginia oil and natural gas industry directly employed approximately 9,900 individuals and paid over \$550 million in wages. This economic activity led to a significant economic impact in the state's economy for 2009. In fact, the natural gas industry had a \$12 billion economic impact in business volume and \$3.1 billion impact in total value added. The industry generated approximately 24,400 jobs and \$1.1 billion in employee compensation. The oil and natural gas industry directly paid \$65.9 million in severance taxes to the state in 2009 and its economic activity generated another \$44.5 million in other state taxes.

<b>Table 3: Economic Impact of the Oil and Natural Gas Industry in West Virginia 2009</b>			
	<b>Direct</b>	<b>Indirect &amp; Induced</b>	<b>Total</b>
Business Volume (millions 2009\$)	\$4,512.5	\$7,491.2	\$12,003.7
Employee Compensation (millions 2009\$)	\$584.1	\$499.3	\$1,083.4
Employment (jobs)	9,900	14,500	24,400
Total Value Added (millions 2009\$)	\$1,969.1	\$1,153.7	\$3,122.8
Severance Taxes (millions 2009\$)			\$65.9
Assorted Other State Taxes <sup>1</sup> (millions 2009\$)			\$44.5

1: Assorted Other State Taxes include personal, corporate net income, business franchise, sales and use taxes  
 Note: Rows may not equal due to rounding.

A breakdown of the total employment impact of the oil and natural gas industry in 2009 shows that 30 percent of the 24,400 jobs generated were in the mining industry (Table 4). This industry includes coal mining as well as oil and natural gas extraction. Ten other industries were impacted by at least 1,000 jobs due to the oil and natural gas industry.

**Table 4: Economic Impact of the Oil and Natural Gas Industry  
by Major Industry in West Virginia 2009  
Employment (Jobs)**

	<b>Direct</b>	<b>Indirect &amp; Induced</b>	<b>Total</b>
Agriculture, Forestry, Fish & Hunting	0	320	320
Mining	6,300	1,030	7,330
Utilities	900	150	1,050
Construction	1,000	900	1,900
Manufacturing	60	550	610
Wholesale & Retail Trade	0	2,500	2,500
Transportation & Warehousing	1,500	560	2,060
Information, Finance, Insurance, Real Estate, & Rental	0	1,300	1,300
Professional- Scientific and Tech Services	0	1,500	1,500
Mgmt of Companies, Administrative & Waste Services.	0	1,100	1,100
Educational, Health, & Social Services	0	1,900	1,900
Arts, Entertainment, Recreation, Accommodation, & Food Services	0	1,500	1,500
Other Services	0	1,000	1,000
Government	0	150	150
<b>Total</b>	<b>9,900</b>	<b>14,500</b>	<b>24,400</b>

Note: Rows may not equal due to rounding.

#### *1.6.D. Non-Quantifiable Economic Impacts*

As in any economic impact analysis, the economic impact of the natural gas industry and the Marcellus Shale play in West Virginia is not comprehensive. Non-quantifiable economic impacts of the industry and development include:

- *Community Involvement and Development*  
The natural gas industry not only employs individuals living within West Virginia but also practices corporate social responsibility by continuing to improve and develop local communities in which they operate. The natural gas industry partners with local schools, service departments, associations, clubs, and charitable organizations throughout the state. These activities were not quantified within the scope of this report.
- *Payments to Landowners*  
The level of royalty payments made to mineral rights owners and right of way payments made to landowners within the state were not captured within this report. Bonuses for lease agreements as well as royalty payments are also not captured within this impact due to lack to sufficient data.
- *Additional Opportunities Due to Natural Gas Exploration*  
After natural gas is extracted it is processed to remove almost all materials before it is used as a fuel. The byproducts of this processing include: ethane, propane, butanes, pentanes, carbon dioxide, helium, nitrogen, and other higher molecular hydrocarbons. These byproducts can be used as raw materials and/or final products. For instance, ethane is a petrochemical feedstock for ethylene production and is used as a fuel and a

refrigerant. Propane can be sold as a fuel for heating homes and cooking on barbecues as well as a feed stock for the production of base petrochemicals in steam cracking. The economic impact of the uses of these byproducts of natural gas has not been captured in this report but could be considerable for the state's economy. New industries, such as chemical and plastic manufacturing, could be attracted to the area due to the vast supply of these natural gas byproducts.

## 2. Unconventional Natural Gas Development

### 2.1. Natural Gas Reservoirs

**Figure 5: United States Shale Reservoirs**



Source: Energy Information Administration based on data from various published studies  
Updated: May 28, 2009

Natural gas in the US is developed from two types of underground reservoirs: conventional reservoirs and unconventional reservoirs. Natural gas wells drilled into conventional reservoirs produce from carbonates and sands, such as dolomites and limestones, which contain the natural gas in inter-connected pore spaces. Natural gas development using unconventional reservoirs involve wells in low permeability or tight formations such as tight sands and carbonates, coal, and shale. Due to the low permeability of the unconventional reservoirs, it is typically necessary to stimulate the reservoir through processes such as hydraulic fracturing<sup>10</sup> in order to create additional permeability. Tight sands and carbonates gas is produced from reservoirs where natural gas is formed outside the reservoir and migrates over time into the reservoir. Natural gas production of tight gas involves horizontally drilled wells and hydraulic fracturing. Unconventional reservoirs producing coal bed natural gas are found within coal seams and

<sup>10</sup> Hydraulic fracturing is the process of injecting fracturing fluids into a target formation at a force exceeding the parting pressure of the rock formation which induces a network of fractures through which oil or natural gas can flow.

frequently produce water as well as natural gas. Coal bed natural gas wells are typically shallow and can be restricted due to being a source of drinking water. Shale gas wells produce natural gas from low permeability shale formations. Developments of the shale gas involve wells drilled either vertically or horizontally and most use hydraulic fracturing. Shale gas wells are similar to other conventional and unconventional wells in terms of depth, production rate, and drilling. Shale gas reservoirs can be found throughout the US, as shown in Figure 5. The most common US shales include: Barnett, Fayetteville, Haynesville, Devonian, and Marcellus.

## **2.2. Economic Impact of Unconventional Natural Gas Development**

The economic impact of the development of unconventional natural gas reservoirs throughout the US has been estimated to be substantial to state and local economies. Recent studies have estimated the total economic impacts of the development and exploration in the Haynesville, Barnett, Fayetteville and Marcellus shales. Loren C. Scott and Associates estimated that the Haynesville Shale extraction activities in Louisiana generated approximately \$10.6 billion in new business sales in 2009 in the state's economy. Analysis of the Haynesville Shale impact was completed using the RIMS II model and concluded that the shale extraction activities created \$5.7 billion in household earnings in 2009. The Perryman Group estimated that the activities in the Barnett Shale in the Fort Worth, Texas area in 2008 generated 111,131 permanent jobs. The impact of the Barnett Shale development on the entire Texas economy in 2008 was estimated at \$13.7 billion in annual output. Economic impacts of the Barnett Shale for Fort Worth and the state of Texas were estimated using a customized economic impact model developed by the Perryman Group. Annual total employment of 11,000 individuals from 2008 to 2012 was estimated to be the result of the Fayetteville Shale development in Arkansas by the University of Arkansas. Using the IMPLAN® input-output modeling system and a survey of developers, the Center for Business and Economic Research at the University of Arkansas estimated a total economic output impact of development activities in the Fayetteville Shale development from 2008 to 2012 of \$17.9 billion.

Estimates of the economic impact of most recently developed unconventional natural gas reservoirs (i.e. Marcellus Shale) have also been calculated. Considine (2010)<sup>11</sup> used IMPLAN® and data from a survey of operators in Pennsylvania to calculate the economic impact of Marcellus Shale development in Pennsylvania and West Virginia in 2009. Considine concluded that this development created over 57,000 jobs in Pennsylvania and West Virginia in 2009. Considine also estimated the economic impact of Marcellus Shale development in New York, Pennsylvania, and West Virginia in 2020. His analysis shows a total employment impact in 2020 at between 101,000 and 283,000 jobs.

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<sup>11</sup> Further information regarding the economic impact methodologies used in this report can be found at <http://www.api.org/policy/exploration/hydraulicfracturing/upload/API%20Economic%20Impacts%20Marcellus%20Shale.pdf>.

## 2.3. Marcellus Shale Development

**Figure 6: Marcellus Shale**

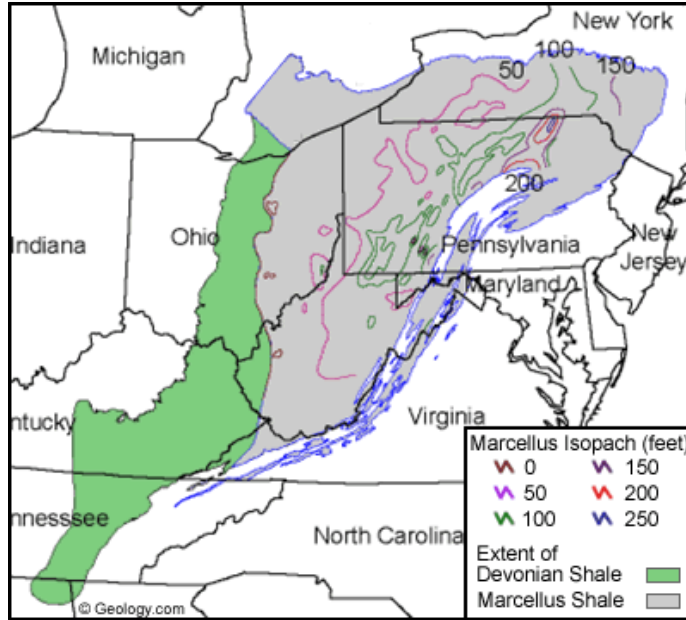


Marcellus Shale is a sedimentary rock formation which developed over 350 million years ago in present day eastern United States (Figure 6). It forms the bottom section of a thick series of Devonian age sedimentary rocks in the Appalachian Basin.

### *2.3.A. Geographical Distribution of Marcellus Shale*

The Marcellus Shale underlies an area of 95,000 square miles from southern New York across Pennsylvania, and into western Maryland, West Virginia and eastern Ohio. The Marcellus Shale formation is wedge-shaped as it is thicker in the east and thins to the west (Figure 7). The thicker sections of the Marcellus Shale are composed of sandstone, siltstone, and shale while the thinner sections consist of finer grained organic rich black shale interblended with organic lean gray shale.

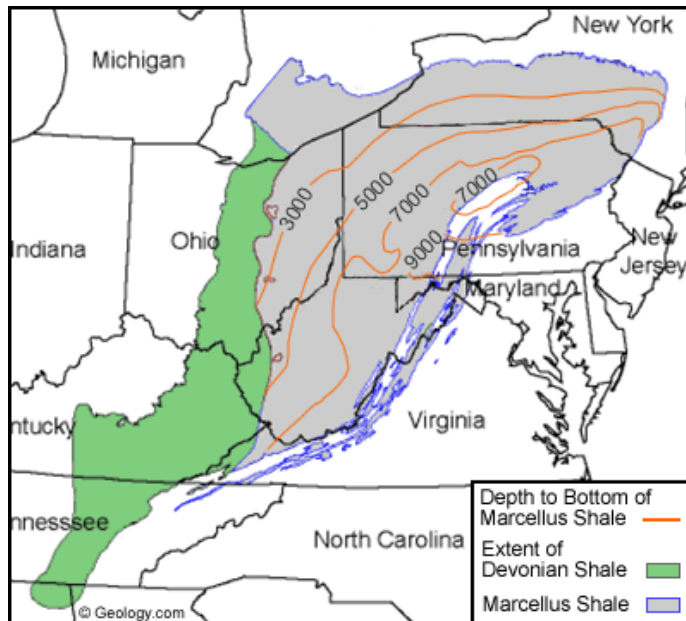
**Figure 7: Marcellus Shale Thickness**



Source: <http://www.Geology.com>

The estimated depth of production for the Marcellus Shale gas is between 3,000 and 9,000 feet as shown in Figure 8.

**Figure 8: Marcellus Shale Depth**

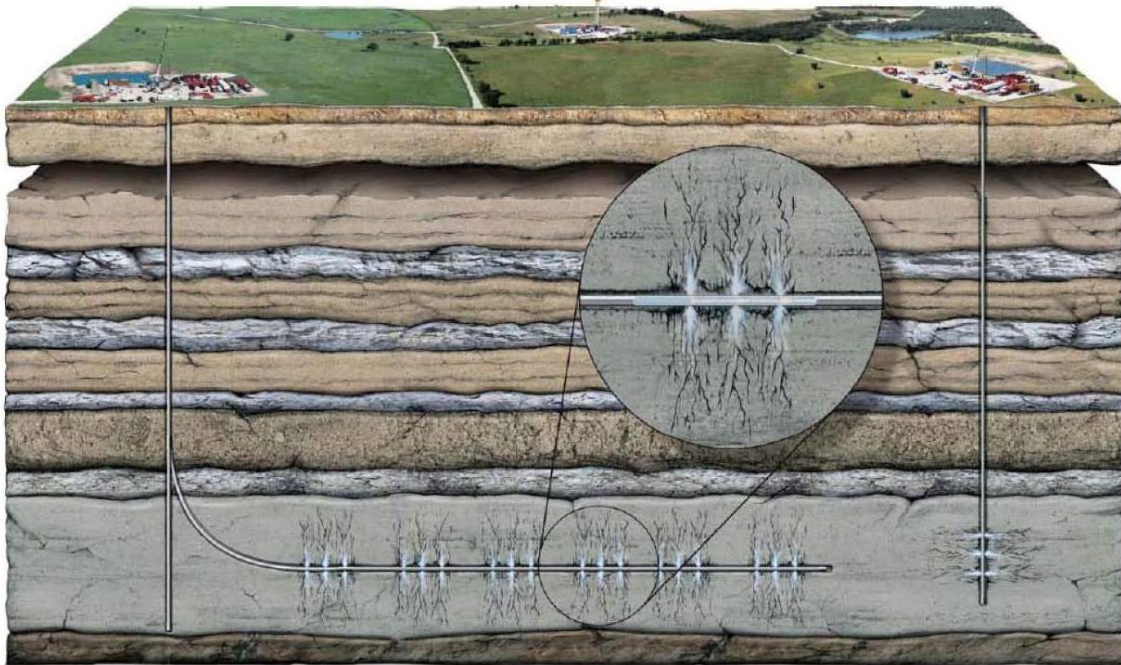


Source: <http://www.Geology.com>

### 2.3.B. Development of the Marcellus Shale

Drilling and developing the Marcellus Shale is an extensive process. As in any natural gas development process, the first step in developing the Marcellus Shale is determining the existence of natural gas in an area through seismic surveys. Geologists and engineers send vibrations underground which are reflected back to a listening device on the surface. Different formations reflect these vibrations at different speeds and allow operators to generate a cross section of the formations present in an area. Operators also determine through water level and flow analysis if an area has a sufficient water source for all aspects of the drilling process including hydraulic fracturing. Once an area is determined to have natural gas in the Marcellus Shale formation, the company must obtain a lease for the area in which Marcellus Shale development is planned. A lease establishes a partnership between the mineral rights owner(s) and the company that plans to drill and produce the natural gas. This lease places all risks and costs of drilling and production on the company or operators while providing the mineral rights owner(s) with royalty payments based on the well's production revenue. Once an area is secured for Marcellus Shale natural gas development, a drill site or pad site for multiple wells is created. Site preparation involves clearing and leveling of an area on the leased land large enough for operations coupled with construction of a location road from the main road to the drill site. Drilling for natural gas in the Marcellus Shale begins once the drilling rig and other necessary equipment are on the prepared location site. The depth of Marcellus Shale wells drilled varies with location and can range from 3,000 to 9,000 feet. All drilling begins with a vertical hole and as the well depth comes near the Marcellus Shale formation horizontal drilling techniques can be used (Figure 9). Horizontal drilling into the potential productive zone (i.e. Marcellus Shale) can maximize the recovery of natural gas reserves.

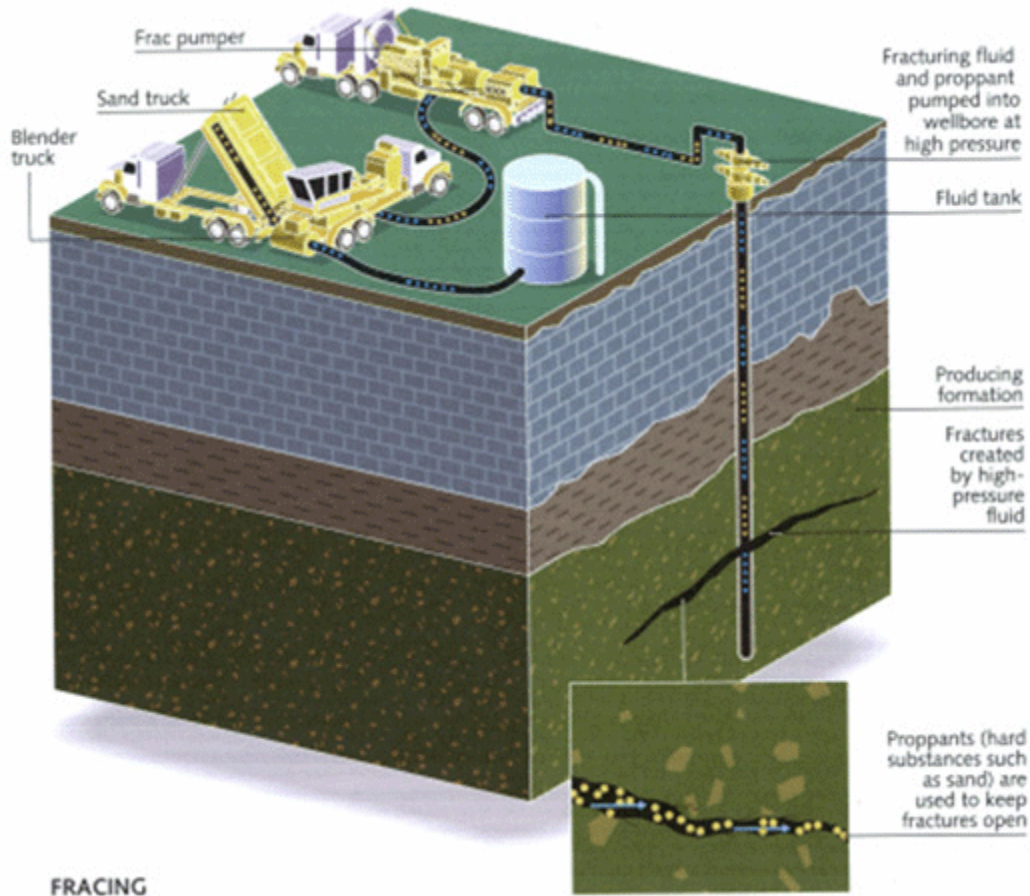
**Figure 9: Horizontal versus Vertical Marcellus Shale Wells**



Source: Independent Oil and Gas Association of Pennsylvania's Drilling and Developing the Marcellus Shale

Once total depth is reached the hydraulic fracturing process<sup>12</sup> begins (Figure 10). Hydraulic fracturing, more commonly known as fracing, is a process of injecting fracturing fluids into the formation penetrated through the vertical or horizontal drilling process. Fracturing fluids consist of 99 percent water, sand and other additives and are forced into the Marcellus Shale formation which induces a network of fractures. These fractures allow the natural gas to flow into the well and be collected at the surface. After the fracing process is complete a wellhead is placed on the top of the wellsite to control and regulate the flow of natural gas into the pipeline.

**Figure 10: Hydraulic Fracturing Process**



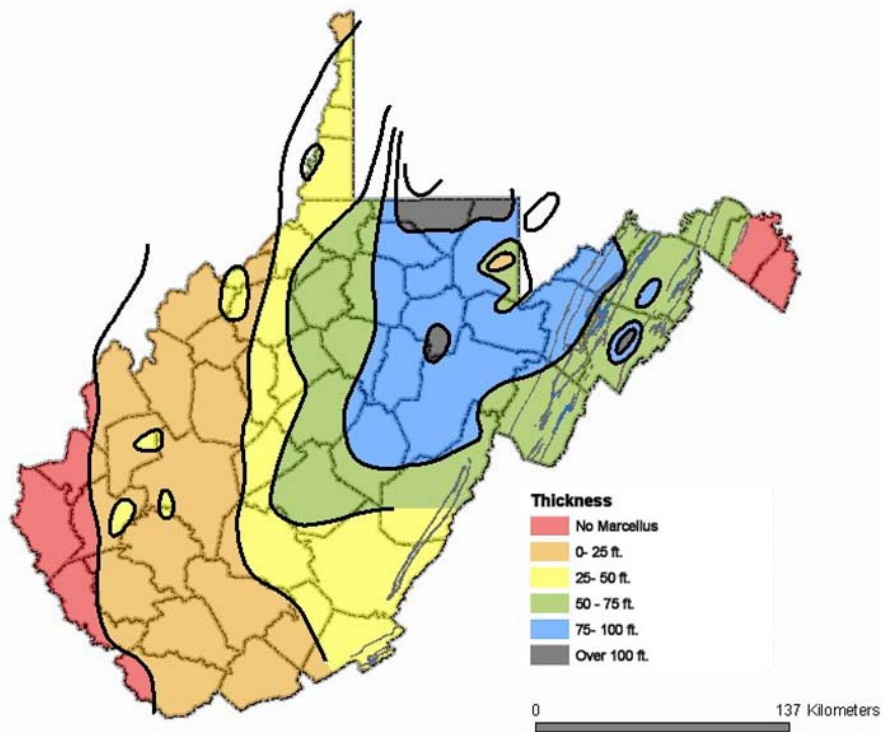
Source: STW Resources (<http://www.stwresrouces.com>)

<sup>12</sup> Hydraulic fracturing is also known as fracing or fracking.

### 2.3.D. Marcellus Shale in West Virginia

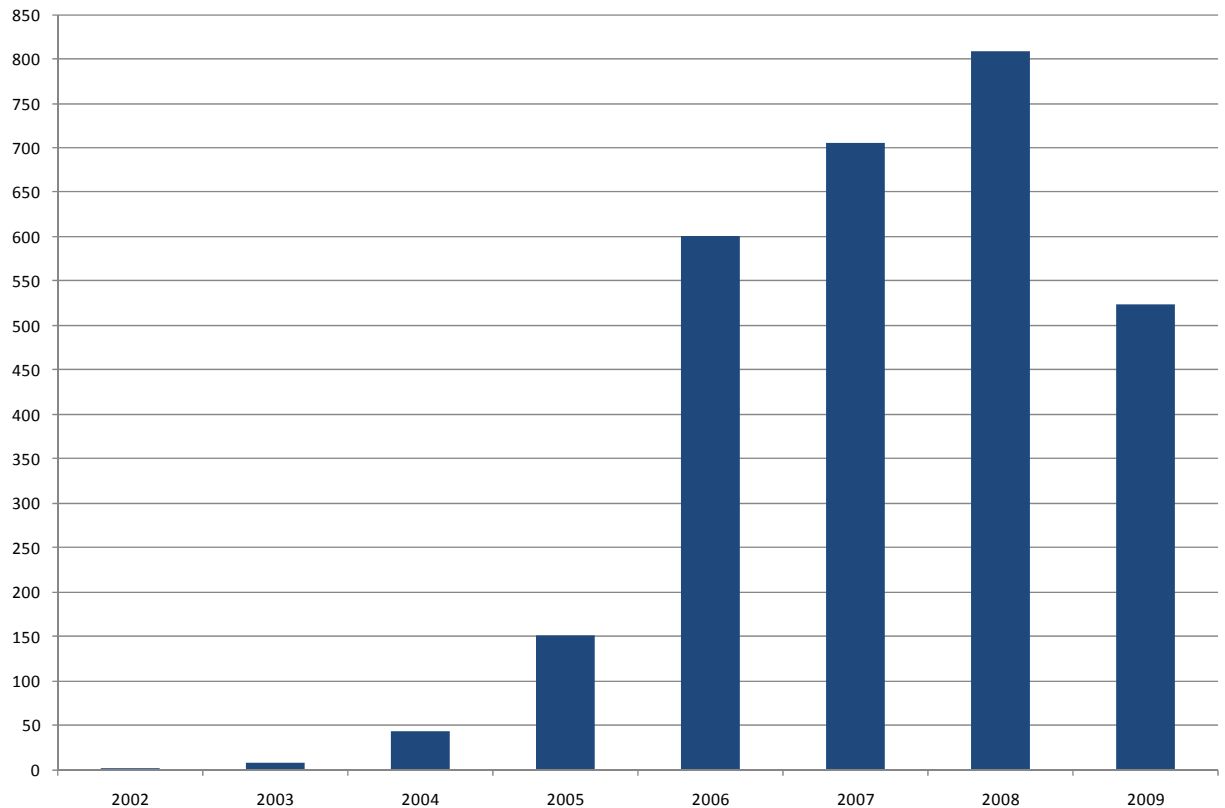
Marcellus Shale can be found from southern New York through Pennsylvania, western Maryland, eastern Ohio and West Virginia. The Marcellus Shale formation in West Virginia is found throughout a majority of the state, as shown in Figure 11. While located throughout, the thickness of the Marcellus Shale formation varies greatly across the state. A majority of the shale is between 0 to 75 feet thick. Marcellus Shale in the north central region of the state is the thickest at over 75 feet. In fact, in parts of Barbour, Monongalia, and Preston counties the Marcellus Shale is over 100 feet thick.

**Figure 11: Marcellus Shale Thickness in West Virginia**



Source: West Virginia Geological and Economic Survey (<http://ims.wvgs.wvnet.edu/index.html#ogmaps>)

**Figure 12: Number of West Virginia Marcellus Shale Permits 2002-2009**

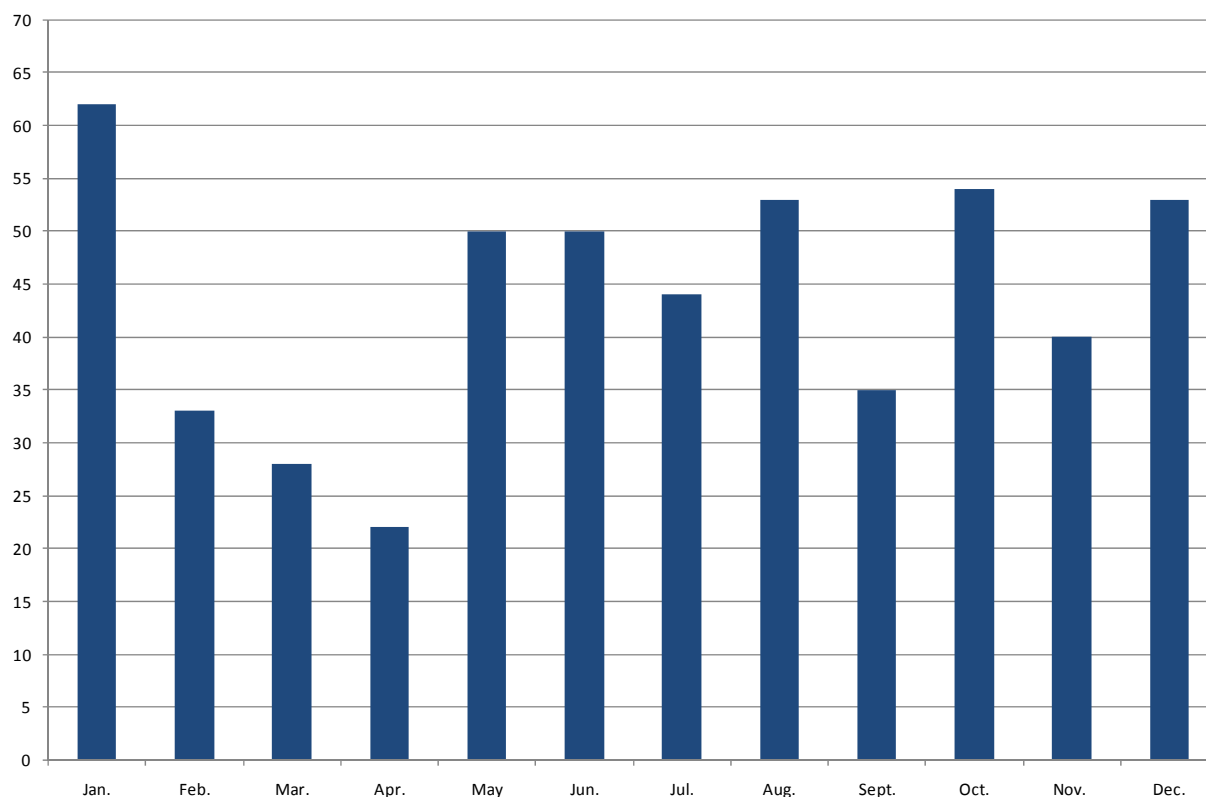


Source: West Virginia Geological and Economic Survey (<http://www.wvgs.wvnet.edu/www/datastat/devshales.htm>)

Marcellus Shale is believed to hold trillions of cubic feet of natural gas and recent advances in drilling technology and increased natural gas prices have made exploring Marcellus Shale economical. With formations throughout the state, permits for Marcellus Shale wells in West Virginia have been on the rise (Figure 12). In 2002, only one Marcellus Shale permit was issued by the West Virginia Department of Environmental Protection (WV DEP). By 2008, Marcellus Shale permits increased to over 800 permits. With lower natural gas prices and the economy in a recession, Marcellus Shale permits in 2009 declined 54 percent.

In relation to other Marcellus Shale development states, West Virginia lead the pack in the number of Marcellus Shale permits issued from 2002 to 2008. The Pennsylvania Department of Environmental Protection reports that from 2005 to 2008 the state issued only 708 Marcellus Shale well permits. In the state of New York, the Department of Environmental Conservation reported that for 2008, 744 oil and natural gas permits were issued. For 2009, however, the development of the Marcellus Shale increased substantially while permits allotted in New York fell as they did in West Virginia. In fact, for 2009, Pennsylvania issued 1,984 Marcellus Shale well permits while New York and West Virginia issued approximately 550 permits each.

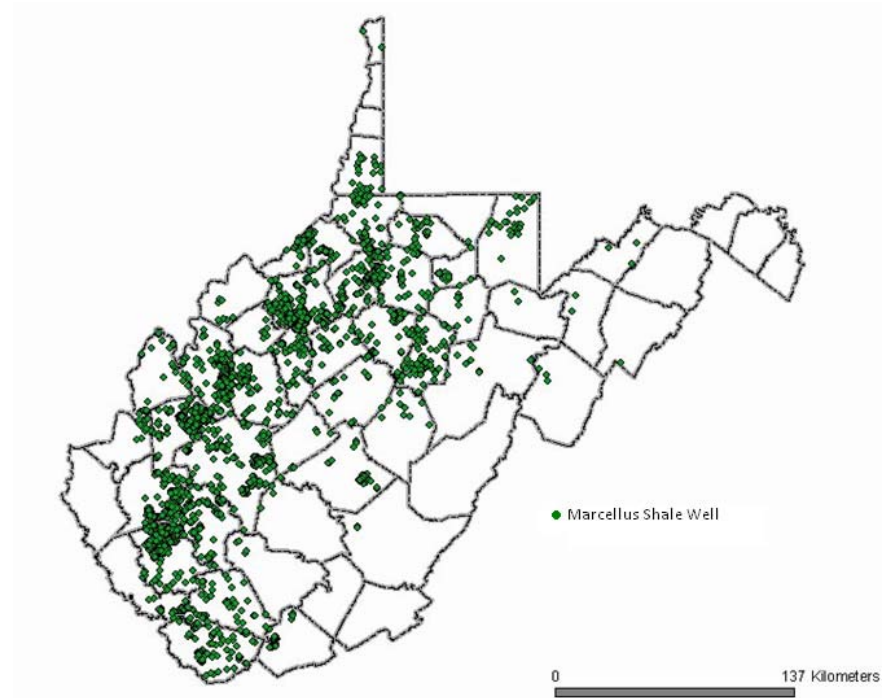
**Figure 13: West Virginia Marcellus Shale Permits by Month 2009**



Source: West Virginia Geological and Economic Survey (<http://www.wvgs.wvnet.edu/www/datastat/devshales.htm>)

Marcellus Shale permits have varied from year to year in West Virginia but also vary significantly throughout the year (Figure 13). For 2009, the WV DEP issued the most permits in the very first month of the year with permits issued at the lowest levels in the next three months: February, March, and April. From May till December, permits remained relatively steady at 35 to 55 per month.

**Figure 14: Marcellus Shale Natural Gas Wells in West Virginia**



Source: West Virginia Geological and Economic Survey

The over 2,800 Marcellus Shale permits issued for Marcellus Shale development in West Virginia since 2002 has led to drilling in 45 of the 55 counties in the state (Figure 14). The majority of the Marcellus Shale drilling in the state has been located in areas where the shale is between 0 and 75 feet thick. The first Marcellus Shale development in the state was in Kanawha County where the first well was permitted in 2002.

## 2.4. Economic Impact of the Marcellus Shale Development in West Virginia

### 2.4.A. Economic Impact Overview

To determine the economic significance of the development of the Marcellus Shale in West Virginia, economic impacts were similarly estimated through the IMPLAN® input-output modeling system<sup>13</sup>. This analysis quantified the direct, indirect, induced, and total economic impacts<sup>14</sup> that occurred as a result of the Marcellus Shale development within the state in 2009. Expenditures by the Marcellus Shale developers in 2009 such as operating expenses (payroll, fringe, benefits, supplies, etc.) represent the direct economic impacts. Indirect economic impacts are the economic activities such as sales and wages that result from purchases from suppliers of the industry. For example, a Marcellus Shale developer may purchase supplies such as pens and notepads from an office supply store. The office supply store, in turn, purchases manufactured goods, utility services, and pays employee wages, among other expenditures. The continued backward linkages from businesses buying from their suppliers and so on result in a continued re-spending of these funds. The induced economic impact of the natural gas industry represents the expenditures by households of the income they received associated with the direct and indirect impacts. For example, rig hands earn wages, a portion of which they spend locally on the consumption of goods and services. The economic multipliers associated with the indirect and induced economic impacts are a clear indication of the strong economic linkage between the natural gas industry and the rest of the West Virginia economy. The sum of the direct, indirect, and induced economic impacts is the total economic impact of the industry.

The economic impacts of the Marcellus Shale development will focus on the indicators such as employment, business volume, employee compensation, and selected state taxes. These taxes include personal income, corporate net income, business franchise, sales and use taxes resulting from the economic activity generated from the industry.

### 2.4.B. Economic Impact Methodology

The economic impact of the Marcellus Shale development in West Virginia in 2009 was estimated using the IMPLAN® input-output modeling system and 2009 data collected from the industry. A survey<sup>15</sup> was distributed to industry representatives (i.e. operators) asking information regarding their company's involvement in the Marcellus Shale development in West Virginia in 2009.

West Virginia operators indicated that on average 139 acres were leased per well for Marcellus Shale development at a cost of \$914 per acre. This average acre price estimate from the industry falls in-line with lease estimates touted on landowner websites, such as GoMarcellusShale.com and the Natural Gas Forum for Landowners, in which landowners indicate that they have been receiving between \$300 and \$2,500 per acre depending on the area in the state in which their land was located. Prior to drilling, operators on average spent \$300,000 per well in location setup according to survey responses. Drilling for natural gas in the Marcellus Shale for 2009 in West

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<sup>13</sup> More information regarding the IMPLAN input-output modeling system can be found at <http://www.implan.com>.

<sup>14</sup> Appendix B defines the economic impact terms used throughout this report.

<sup>15</sup> The survey can be found in Appendix C.

Virginia cost, on average, \$1.5 million per well. Well completion expenditures for 2009 were on average \$2 million per well drilling into the Marcellus Shale in West Virginia.

Survey responses by the natural gas industry in West Virginia for 2009 regarding Marcellus Shale development activities provided a basis for which total expenditures were estimated. Total expenditures for the 383<sup>16</sup> Marcellus Shale wells drilled in West Virginia in 2009 were estimated at \$1.5 billion<sup>17</sup>. Drilling and well completion expenditures accounted for approximately 87 percent of total expenditures.

#### *2.4.D. Economic Impact of the Marcellus Shale Development*

The total estimated impact of the Marcellus Shale development on the West Virginia economy in 2009 was noteworthy. As shown in Table 5, Marcellus Shale development generated \$2.35 billion in business volume and approximately \$1.16 billion in total value added in the West Virginia economy. In 2009, the economic activities associated with the Marcellus Shale development created approximately 7,600 jobs and \$297.9 million in employee compensation in the state. Assorted state taxes associated with Marcellus Shale development totaled \$14.5 million. These taxes included sales, use, personal income, corporate net income, and business franchise taxes in the state.

<b>Table 5: Economic Impact of Marcellus Shale Development in West Virginia 2009</b>			
	<b>Direct</b>	<b>Indirect &amp; Induced</b>	<b>Total</b>
Business Volume (millions 2009\$)	\$1,500.0	\$850.0	\$2,350.0
Employee Compensation (millions 2009\$)	\$145.2	\$152.7	\$297.9
Employment (jobs)	3,600	4,000	7,600
Total Value Added (millions 2009\$)	\$839.0	\$317.7	\$1,156.7
Assorted Other State Taxes <sup>1</sup> (millions 2009\$)			\$14.5
1: Assorted Other State Taxes include personal, corporate net income, business franchise, sales and use taxes			
Note: Rows may not equal due to rounding.			

Total employment, employee compensation, and total value added impacts of the Marcellus Shale development on the West Virginia economy in 2009 had the most effect on the mining and construction industries as shown in Table 6, 7, and 8.

<sup>16</sup> Source: West Virginia Geological and Economic Survey (<http://www.wvgs.wvnet.edu/www/datastat/devshales.htm>)

<sup>17</sup> Note that the economic impact of the Marcellus Shale in West Virginia did not include expenditures for bonuses to landowners, exploration, pipeline, processing, royalties or severance taxes. Data for these expenditures were not available but if added would increase the economic impact on the state.

**Table 6: Economic Impact of Marcellus Development  
by Major Industry in West Virginia 2009  
Employment (Jobs)**

	<b>Direct</b>	<b>Indirect &amp; Induced</b>	<b>Total</b>
Ag., Forestry, Fish & Hunting	0	100	100
Mining	2,500	140	2,640
Utilities	0	60	60
Construction	850	350	1,200
Manufacturing	0	200	200
Wholesale & Retail Trade	60	800	860
Transportation & Warehousing	0	150	150
Information, Finance, Insurance, Real Estate, & Rental	10	400	410
Professional- Scientific and Tech Services	0	450	450
Mgmt of Companies, Administrative & Waste Svc.	0	250	250
Educational, Health, & Social Services	80	650	730
Arts, Entertainment, Recreation, Accommodation, & Food Services	40	400	440
Other Services	20	300	320
Government	0	40	40
<b>Total</b>	<b>3,600</b>	<b>4,000</b>	<b>7,600</b>

Note: Rows may not equal due to rounding.

**Table 7: Economic Impact of Marcellus Development  
by Major Industry in West Virginia 2009  
Employee Compensation (millions 2009\$)**

	<b>Direct</b>	<b>Indirect &amp; Induced</b>	<b>Total</b>
Ag., Forestry, Fish & Hunting	\$0.0	\$0.4	\$0.4
Mining	\$104.7	\$5.5	\$110.2
Utilities	\$0.0	\$5.9	\$5.9
Construction	\$34.4	\$19.3	\$53.7
Manufacturing	\$0.0	\$12.4	\$12.4
Wholesale & Retail Trade	\$1.5	\$24.2	\$25.7
Transportation & Warehousing	\$0.0	\$6.8	\$6.8
Information, Finance, Insurance, Real Estate, & Rental	\$0.3	\$11.4	\$11.7
Professional- Scientific and Tech Services	\$0.0	\$17.2	\$17.2
Mgmt of Companies, Administrative & Waste Svc.	\$0.0	\$12.4	\$12.4
Educational, Health, & Social Services	\$2.6	\$23.0	\$25.6
Arts, Entertainment, Recreation, Accommodation, & Food Services	\$0.6	\$6.8	\$7.4
Other Services	\$0.3	\$4.3	\$4.7
Government	\$0.0	\$2.5	\$2.5
<b>Total</b>	<b>\$145.2</b>	<b>\$152.7</b>	<b>\$297.9</b>

Note: Rows may not equal due to rounding.

**Table 8: Economic Impact of Marcellus Development  
by Major Industry in West Virginia 2009  
Total Value Added (millions 2009\$)**

	<b>Direct</b>	<b>Indirect &amp; Induced</b>	<b>Total</b>
Ag., Forestry, Fish & Hunting	\$0.0	\$1.7	\$1.7
Mining	\$781.7	\$29.7	\$811.4
Utilities	\$0.0	\$19.6	\$19.6
Construction	\$44.6	\$22.0	\$66.6
Manufacturing	\$0.0	\$22.9	\$22.9
Wholesale & Retail Trade	\$2.8	\$41.0	\$43.8
Transportation & Warehousing	\$0.0	\$11.9	\$11.9
Information, Finance, Insurance, Real Estate, & Rental	\$3.5	\$68.5	\$72.0
Professional- Scientific and Tech Services	\$0.0	\$29.2	\$29.2
Mgmt of Companies, Administrative & Waste Svc.	\$0.0	\$17.1	\$17.1
Educational, Health, & Social Services	\$3.4	\$29.9	\$33.3
Arts, Entertainment, Recreation, Accommodation, & Food Services	\$1.0	\$11.6	\$12.6
Other Services	\$0.5	\$7.1	\$7.6
Government	\$0.0	\$2.8	\$2.8
<b>Total</b>	<b>\$839.0</b>	<b>\$317.7</b>	<b>\$1,156.7</b>

Note: Rows may not equal due to rounding.

The estimated economic impact of the Marcellus Shale development in 2009 in West Virginia is deemed to be conservative. Estimates of the economic benefits of royalty payments, bonuses to landowners, exploration of the Marcellus Shale, pipeline and transportation of the natural gas extracted from the Marcellus Shale, processing of the natural gas, and severance taxes paid to the state were not included in the economic impact estimates. Data for these additional aspects of the Marcellus Shale development in West Virginia in 2009 were not available from the survey of industry representatives or through publically available databases.

#### ***2.4.E. Future Economic Impacts of the Marcellus Shale Development***

The development of the Marcellus Shale in West Virginia is expected to continue to have a significant economic impact on the state's economy into the future. Estimation of the economic impacts of this development for 2010 thru 2015 was completed using the IMPLAN® input-output modeling system and responses to a survey of industry operators in West Virginia. The Marcellus Shale operators were asked to provide their 2009 expenditures as well as an estimation of the level of growth expected for each year (2010-2015) based on 2009 EIA forecasted average wellhead price for natural gas. Responses from the industry suggested that there could be a range of development expected over the next five years. For this study three levels of growth were projected and analyzed in more details: no growth (i.e. same level of development each year as there was in 2009), 5 percent growth each year, and 20 percent growth each year.

The future economic impacts under these three different growth scenarios are shown in Table 9. The levels of employment and employee compensation impacts vary greatly by not only the year but also by range of growth per year. The employment impact of Marcellus Shale development

for 2010 was estimate at between 7,600 and 8,500 additional jobs depending upon the growth rate. By 2015 the number of additional jobs created in 2015 was estimated to be between 6,600 and 19,600. The employee compensation impacts range from less than \$300 million each year with no growth to approximately \$890 million in 2015 with 20 percent growth each year.

<b>Table 9: Future Total Economic Impacts of Marcellus Shale Development in West Virginia 2010-2015</b> (Based on 0, 5, and 20 percent growth in drilling activity each year)					
	<b>Employment (Jobs)</b>			<b>Employee Compensation<sup>1</sup> (millions 2009\$)</b>	
	<b>0%</b>	<b>5%</b>	<b>20%</b>	<b>5%</b>	<b>20%</b>
2010	7,600	8,000	8,500	\$300	\$330
2011	7,400	8,200	10,700	\$330	\$430
2012	7,200	8,400	12,500	\$350	\$515
2013	7,000	8,500	14,500	\$360	\$615
2014	6,800	8,600	16,900	\$380	\$740
2015	6,600	8,800	19,600	\$400	\$890

1: Note that zero growth in 2009 dollars will be the same impact for each year.

As in the estimation of the economic impact of the Marcellus Shale development in West Virginia in 2009, the future economic impacts of the Marcellus Shale are conservative. Due to data limitations, the economic benefits of royalty payments, bonuses to landowners, exploration of the Marcellus Shale, pipeline and transportation of the natural gas extracted from the Marcellus Shale, processing of the natural gas, and severance taxes paid to the state were not included in the economic impact estimates. The economic impact of these aspects of the Marcellus Shale development on the state’s economy could be substantial especially if the level of growth in the Marcellus Shale drilling and development from 2010 to 2015 is high.

While these future economic impact estimates give light to the significance of the Marcellus Shale development to the West Virginia economy through 2015, the future of the industry is reliant on many outside influences. Future development of the Marcellus Shale in the state is dependent on changes to federal and state policies as well as changes to tax and environmental policies in other Marcellus Shale states. The level of development is also dependent on the market price of natural gas.

### 3. Tax Policy Issues Facing the Natural Gas Industry and Marcellus Shale Development

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Tax policy affects the natural gas industry and the development of the Marcellus Shale play in a variety of ways. Property taxes and severance taxes are some of the most prominent tax instruments that directly affect firms operating in the Marcellus Shale play. However, the general tax policy environment (e.g. personal income taxes, corporate income taxes, business and occupation taxes, sales taxes, taxes on goods that are complementary to natural gas production such as drill bits, etc.) influences how profitable the industry will be as well as where capital investment will take place. For example, corporate income taxes are levied by state and federal governments for natural gas firms operating within the Marcellus Shale play, as are sales taxes for the value of natural gas purchased by consumers.

Marcellus Shale natural gas exploration, drilling, production, and distribution activities are also influenced by taxes on other economic sectors (e.g. the trucking industry, engineering services, pipeline infrastructure manufacturers, storage solutions, etc.) as well as by taxes on lease and royalty earnings by land owners. Understanding the general tax climate as well as specific taxes such as the property tax and the severance tax is important for illustrating how taxation affects the natural gas industry in the state.

According to the Tax Foundation, West Virginia has the 29<sup>th</sup> highest overall state and local tax burden in the United States. As for other states with significant Marcellus Shale deposits, Kentucky is ranked 25<sup>th</sup> highest, Maryland is ranked 4<sup>th</sup> highest, New York is ranked 2<sup>nd</sup> highest, and Pennsylvania is ranked 11<sup>th</sup> highest. Thus, for overall state and local tax burden, West Virginia's general tax policy climate is relatively more conducive to natural gas industry operability than other states with significant Marcellus Shale deposits.

However, for state corporate income taxation per person, West Virginia ranks 7<sup>th</sup> highest, whereas Kentucky (32), Maryland (29), New York (8), Ohio (45), and Pennsylvania (15) all rank lower, i.e. their per capita state corporate income tax is less burdensome than West Virginia's. This measure does not exactly capture the burden on incorporated firms in the natural gas industry, however, as the metric depends largely on the structure of the economy and population in each state. When comparing the actual state corporate income tax rate, Kentucky has a graduated tax rate from 4 percent (greater than zero but less than or equal to \$50,000) to 5 percent (greater than \$50,000 but less than or equal to \$100,000) to 6 percent (any corporate income greater than \$100,000). Maryland has a flat corporate income tax rate at 8.25 percent, New York's rate is 7.1 percent, Ohio's rate is only 0.26 percent, and Pennsylvania's rate is 9.99 percent. West Virginia's corporate income tax rate is 8.5 percent.

It is also important to recognize that the federal corporate tax rate in 2009 was 35 percent, which implies that for most firms operating within the Marcellus Shale play, their total corporate income tax burden is above 40 percent.

When taking into account the corporate tax burden, the individual income tax burden, sales taxes, unemployment insurance taxes, and property taxes, West Virginia ranks 37<sup>th</sup> in the Tax Foundation's overall State Business Tax Climate Index for FY 2010. Other states with significant Marcellus Shale development activity are ranked as follows: Kentucky is ranked 20<sup>th</sup>, Maryland is ranked 45<sup>th</sup>, New York is ranked 49<sup>th</sup>, Ohio is ranked 47<sup>th</sup>, and Pennsylvania is ranked 27<sup>th</sup>.

### 3.1. Property Taxes

The property tax liability for natural gas firms varies across states and localities. . A natural gas firm's property tax liability typically depends on the assessed value of equipment utilized in natural gas production as well as the assessed value of the property itself. However, some state and local governments do not levy property taxes on the assessed market value of natural gas infrastructure or mineral ownership. For instance, Pennsylvania does not currently assess property taxes on oil and gas interests.<sup>18</sup> Infrastructure used for natural gas extraction and production in the Marcellus Shale play (e.g. drilling rigs, gas wells, machinery and equipment) is excluded from real property tax assessment in Pennsylvania. Further, in some cases settlement basins, wastewater treatment plants, and other land utilization that facilitates mineral extraction may be precluded from property tax assessment.<sup>19</sup>

The natural gas industry is subject to property taxes in West Virginia.<sup>20</sup> According to West Virginia property tax law, natural gas properties are valued for property taxation purposes according to one of four categories: producing property, non-producing property, barren property, or plugged and/or abandoned property. These categories indicate that natural gas can be owned without being produced or a title may exist where no natural gas is known to be present or is un-producible/depleted. A producing property is one that has produced natural gas at any time during the calendar year preceding tax assessment and a non-producing property is one that did not produce any natural gas during the same time period. Barren property consists of parcels of land where the evidence suggests that natural gas is unlikely to be present. Values are determined separately for the working interest and the royalty interest based on a yield capitalization model for net receipts and gross royalty payments, respectively.

Table 10 details the property taxes paid by the oil and natural gas industry in West Virginia from 2006 to 2009. Over these four years, nominal oil and natural gas property tax revenues have increased 151 percent. From 2006 to 2008, McDowell, Wyoming, Kanawha, and Lewis counties had the highest level of oil and natural gas property tax revenues. In 2009, Wyoming had the highest tax revenue at \$7.9 million with Kanawha, McDowell, and Logan counties with property tax revenues above \$6.5 million.

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<sup>18</sup> This results from a State Supreme Court case (*Independent Oil & Gas Association v. Fayette Co.*, 572 Pa. 240, 814 A.2d 180 [2002]) that found that there is no authority under Pennsylvania law to impose a real estate (ad valorem) tax on oil and gas interests.

<sup>19</sup> *Ibid.*

<sup>20</sup> For property taxes in West Virginia, ad valorem rates are applied to natural gas along with oil under West Virginia Legislative Rule Title 110, Series 1J. Similar policies apply to coal ownership under Title 110, Series II. Natural gas resource ownership is taxed whether or not the resource is being produced and a title of ownership may exist even if no natural gas is known to be present.

**Table 10: West Virginia Oil and Natural Gas Property Tax Estimates  
2006-2009**

	<b>2006</b>	<b>2007</b>	<b>2008</b>	<b>2009</b>
BARBOUR	\$630,206	\$891,705	\$1,054,642	\$955,305
BERKELEY	\$0	\$0	\$0	\$547
BOONE	\$1,446,881	\$2,137,622	\$3,020,550	\$4,716,982
BRAXTON	\$472,565	\$787,418	\$921,247	\$1,007,920
BROOKE	\$0	\$0	\$0	\$3,701
CABELL	\$146,432	\$182,103	\$197,138	\$486,167
CALHOUN	\$639,032	\$941,977	\$1,092,874	\$1,242,738
CLAY	\$450,343	\$630,824	\$629,880	\$710,036
DODDRIDGE	\$1,718,627	\$2,489,532	\$2,996,462	\$5,310,479
FAYETTE	\$505,650	\$728,550	\$633,443	\$1,001,027
GILMER	\$991,214	\$1,453,106	\$1,599,754	\$1,871,396
GRANT	\$11,427	\$13,204	\$16,662	\$30,211
GREENBRIER	\$0	\$0	\$0	\$21,126
HAMPSHIRE	\$0	\$0	\$0	\$7,245
HANCOCK	\$683	\$664	\$1,008	\$10,366
HARDY	\$0	\$0	\$0	\$10,530
HARRISON	\$1,880,939	\$2,858,290	\$3,258,330	\$4,880,455
JACKSON	\$838,461	\$1,262,816	\$1,404,872	\$2,289,293
JEFFERSON	\$0	\$0	\$0	\$34
KANAWHA	\$2,926,566	\$3,867,984	\$4,641,946	\$7,656,563
LEWIS	\$2,336,841	\$3,428,092	\$3,821,229	\$4,442,385
LINCOLN	\$1,464,648	\$1,928,347	\$2,184,564	\$4,249,409
LOGAN	\$1,861,976	\$3,315,593	\$3,472,997	\$6,559,123
MARION	\$500,797	\$891,722	\$1,319,683	\$2,169,292
MARSHALL	\$57,965	\$65,257	\$130,791	\$198,100
MASON	\$47,811	\$64,250	\$82,968	\$237,304
MCDOWELL	\$3,301,830	\$5,407,254	\$5,352,632	\$7,079,231
MERCER	\$276,030	\$359,694	\$383,250	\$633,009
MINERAL	\$778	\$730	\$1,410	\$27,825
MINGO	\$2,073,077	\$2,615,934	\$2,915,687	\$4,156,004
MONONGALIA	\$477,802	\$599,259	\$541,738	\$730,328
MONROE	\$0	\$0	\$0	\$1,302
MORGAN	\$61	\$61	\$61	\$2,534
NICHOLAS	\$198,593	\$303,681	\$280,461	\$391,100
OHIO	\$20	\$20	\$20	\$2,361
PENDLETON	\$23	\$29	\$41	\$22,334
PLEASANTS	\$91,825	\$165,004	\$255,611	\$305,787
POCAHONTAS	\$18,395	\$18,576	\$16,611	\$27,575
PRESTON	\$92,560	\$102,090	\$95,443	\$119,454
PUTNAM	\$565,371	\$832,401	\$982,212	\$1,816,635
RALEIGH	\$655,281	\$987,787	\$938,101	\$1,432,138
RANDOLPH	\$232,713	\$281,842	\$309,259	\$309,441
RITCHIE	\$1,231,105	\$1,700,279	\$2,291,763	\$3,663,364
ROANE	\$650,630	\$901,666	\$1,026,103	\$1,098,128
SUMMERS	\$3,376	\$4,183	\$5,198	\$9,945
TAYLOR	\$239,206	\$323,415	\$340,624	\$467,732
TUCKER	\$110,133	\$159,281	\$174,502	\$178,370
TYLER	\$527,192	\$837,871	\$1,077,098	\$1,925,635
UPSHER	\$760,295	\$987,375	\$1,143,436	\$1,528,456
WAYNE	\$979,565	\$1,293,128	\$1,392,318	\$2,288,010
WEBSTER	\$5,760	\$7,579	\$8,896	\$20,539
WETZEL	\$505,370	\$815,479	\$1,001,536	\$1,754,424
WIRT	\$96,342	\$121,492	\$129,360	\$238,707
WOOD	\$52,334	\$66,904	\$79,794	\$130,250
WYOMING	\$3,175,656	\$5,262,077	\$5,117,924	\$7,932,563
<b>STATE TOTALS</b>	<b>\$35,250,387</b>	<b>\$52,094,147</b>	<b>\$58,342,129</b>	<b>\$88,360,914</b>

Source: Data collected from West Virginia Tax Department Property Tax Division.

Varying tax rates and property tax laws illustrate how different the tax policy regime vary across states, which can have significant implications for the location, development, and production decisions of natural gas firms.

### 3.2. Severance Taxes

Firms involved in Marcellus Shale gas drilling and production activities in West Virginia face a severance tax at the rate of 5 percent of the gross value of natural gas production (see WV code §11-13A-3a and WV code §11-13A-5a).<sup>21</sup> The West Virginia severance tax is an excise tax imposed on the severance or physical extraction of natural resources in the state (e.g. coal, natural gas, limestone, etc.). All businesses involved in West Virginia in natural gas production for sale, profit, or commercial use must pay the severance tax. Exemptions to the natural gas severance tax include: free natural gas provided to any surface owner; natural gas well producing on average less than 5,000 cubic feet per day; and for a maximum of 10 years, all natural gas produced from a well which has not produced marketable quantities of gas for 5 consecutive years prior to being placed back into production and thereafter produces marketable quantities.

Severance taxes matter for Marcellus Shale development for a number of reasons. First and foremost, they affect the level of profitability of drilling and development operations in the Marcellus Shale region. As Brandly and Barnett (1999) argue, since severance taxes reduce the net price received by natural gas firms, this lowers the expected stream of future profits from each well that has been drilled. Weinstein (2005) argues that the burden of severance taxes is not borne by consumers, but moreover by producers due to reduced profits. Second, wells that are marginal in production prior to the implementation of a tax may be plugged and abandoned due to the after-tax unprofitability of production in such wells (see Brandly and Barnett, 1999). This has significant implications for economic efficiency, as some natural gas that would have been produced prior to the tax is no longer extracted. Given that well closure entails casing and cement, it may not be profitable to re-enter the same well spot even if prices increase in later periods. In other words, there may be an irreversible effect of the severance tax on production. Lastly, severance taxes affect the location decisions of firms operating within the Marcellus Shale play. Holding the expected extraction level or rate of a particular well constant, a firm will likely engage in exploration, drilling, and development operations in the region with the more favorable tax, regulatory, and legal climate.

There is a significant variation in severance tax rates across states with Marcellus Shale. Maryland, New York, and Pennsylvania do not currently have severance taxes on the value of natural gas drilling or production in those states while West Virginia's severance tax rate is at 5 percent of the gross value of natural gas production. However, as discussed below, there is still variation in the regulatory environments in which natural gas firms operate, thus neither the absence nor presence of a severance tax nor the variation in the rate itself is necessarily the prime determinant of Marcellus Shale gas drilling and production in these states.

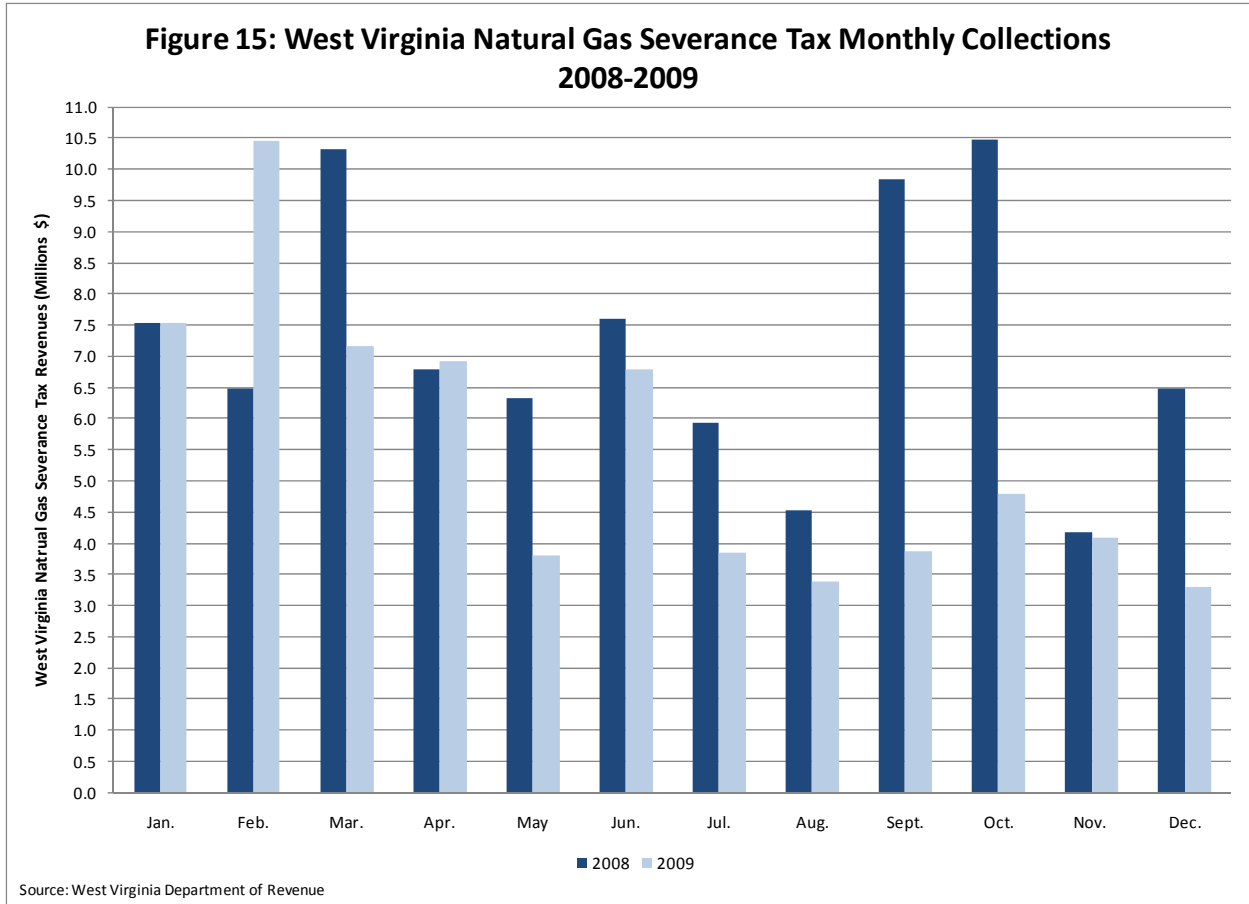
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<sup>21</sup> Gross value is different from market value, where gross value takes into account the valuation at the point of extraction and the market value takes into account the valuation after refining and processing for a final market product.

Ohio imposes a severance tax on natural gas drilling and production at a rate of 2.5 cents per thousand cubic feet of natural gas (Ohio § 5749.02). There are particular exemptions to this tax regarding whether the state owns the property from which firms sever natural resources. Ohio code §5749.04 further implies that a firm must have a license or permit in order to extract natural resources, though the fee for this license or permit is only \$50. The National Conference of State Legislatures (NCSL) reports that in addition to the resource severance tax, the State of Ohio has implemented an oil and gas marketing program and an assessment process. Additionally, there is a gas ad valorem tax that is variable by county.

Maryland and New York do not have a severance tax on natural gas drilling and production (NCSL, 2010). With Marcellus shale deposits that are relatively close to the surface, drilling is relatively less expensive and less technologically difficult in New York than other states with significant Marcellus Shale deposits. However, most firms engaging in natural gas drilling and production in New York has ceased to operate due to regulations by various commissions. The state has not issued permits for drilling and all drill rigs, for the most part, have moved to bordering areas in Pennsylvania.

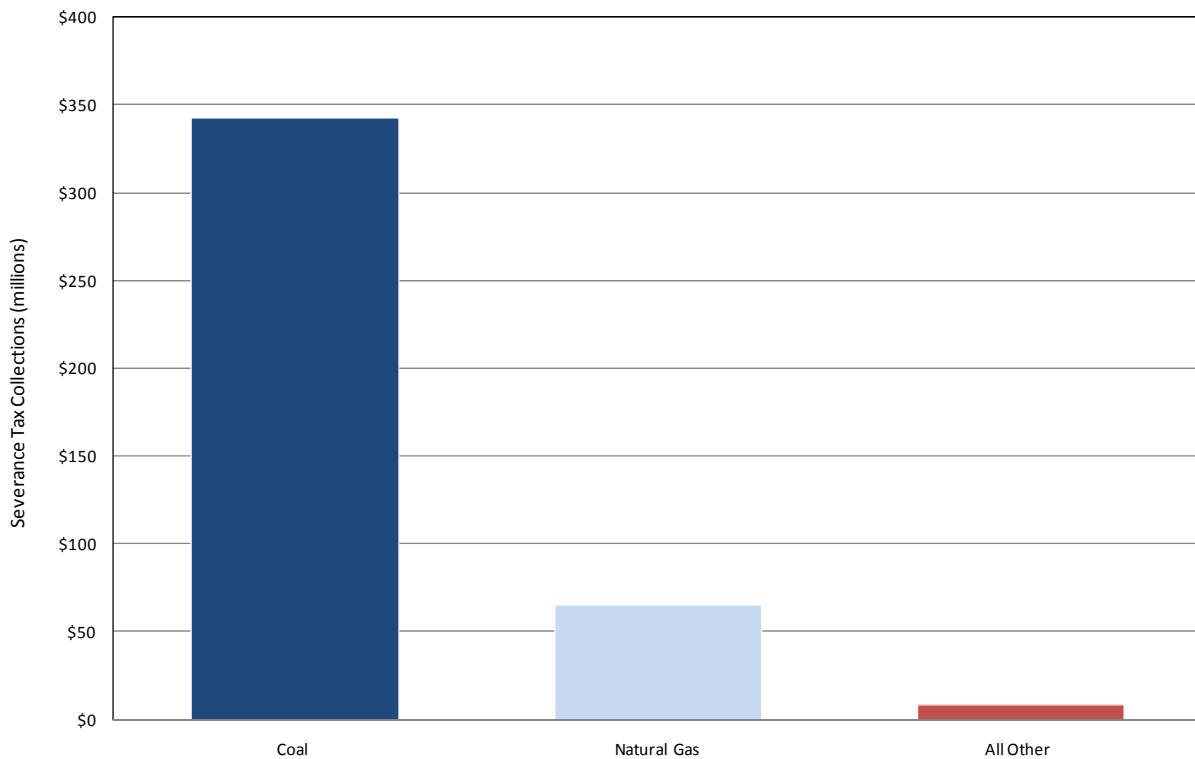
While Pennsylvania does not currently have a severance tax on natural gas drilling and production, Gov. Rendell recently signed a bill (SB 1042) that would apply a severance tax on Marcellus Shale natural gas. The magnitude of the severance tax as well as the expenditure distribution of the revenues will not likely be decided until the end of the year, however. A spokesman for Governor Rendell had previously indicated that the severance tax would likely be modeled after West Virginia's severance tax system.



As shown in Figure 15, West Virginia collected over \$86.4 million in severance taxes from the natural gas industry in 2008 and \$65.9 million in 2009. Monthly severance tax collections for 2008 and 2009 have ranged between \$3.3 million to \$10.5 million.

Natural gas is not the only natural resource in West Virginia on which severance taxes are levied. West Virginia code §11-13A states that severance taxes can be levied on the extraction of the following resources: coal, natural gas, oil, methane, sand, gravel, limestone, and other natural resources. For 2009, West Virginia collected \$416.9 million in severance taxes (Figure 16). Of the \$416.9 million, severance taxes levied on coal accounted for 82 percent while natural gas accounted for 15.8 percent.

**Figure 16: West Virginia Severance Tax Collections by Industry 2009**



Source: Data provided by the West Virginia Department of Revenue

Severance taxes collected in West Virginia are spread across four funds: general revenue, infrastructure, local dedication, and transfers to other state funds. In 2009, approximately \$323.6 million of severance taxes went into the state’s general fund. Severance taxes levied on coal accounted for 80.5 percent of the \$323.6 million while natural gas severance taxes accounted for 17.3 percent (Table 11). The infrastructure fund received \$24 million in severance tax collections, 8.7 percent of which were paid by the natural gas industry. The natural gas industry in West Virginia also accounted for 22.9 percent of the \$33.7 million of severance taxes that were distributed to local governments.

**Table 11: West Virginia Severance Tax Revenue Distribution by Fund 2009**

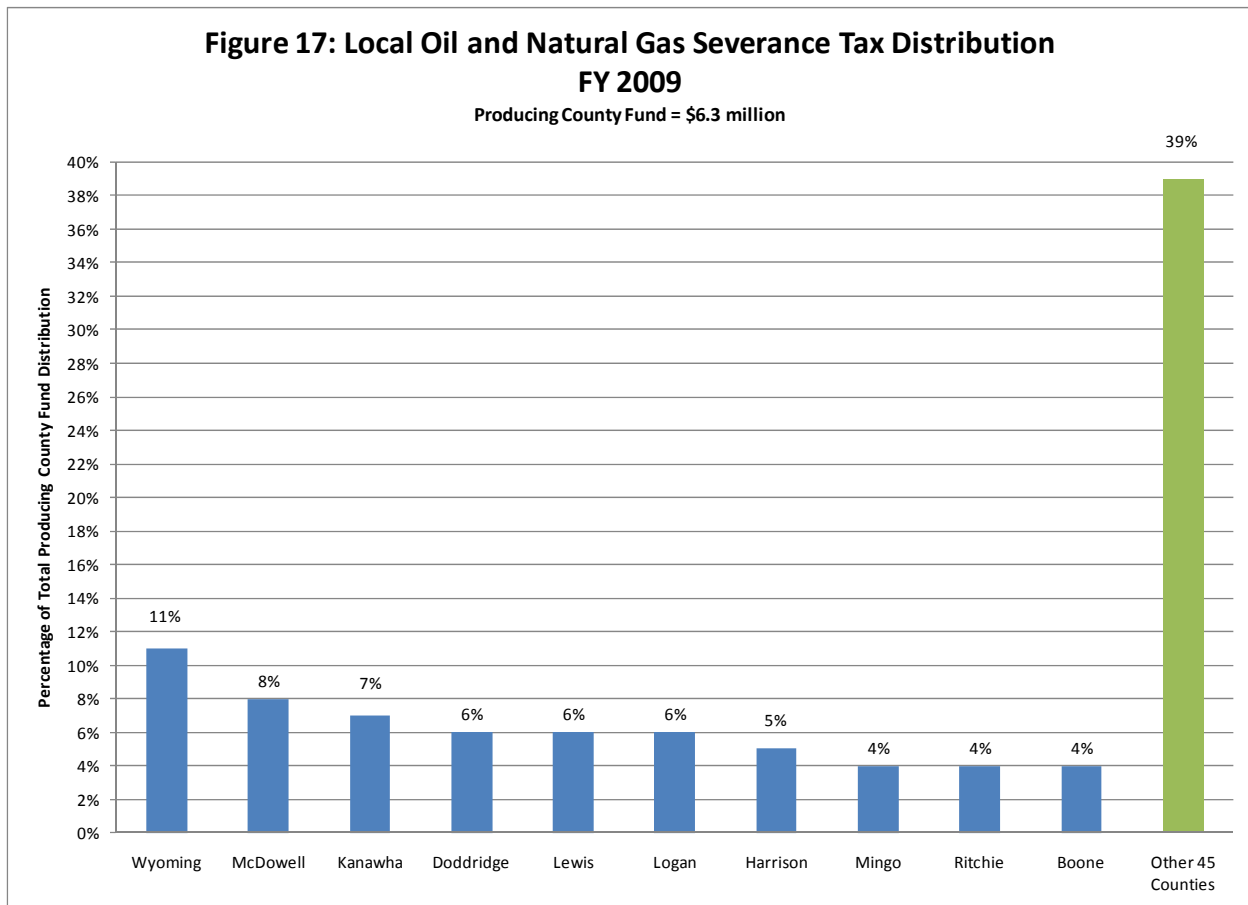
	<b>General Revenue Fund</b>	<b>Infrastructure Fund</b>	<b>Local Dedication</b>	<b>Transfers to Other State Funds</b>
Coal	80.5%	90.0%	73.9%	99.9%
Natural Gas	17.3%	8.7%	22.9%	0.1%
Oil	1.3%	0.4%	1.9%	0.0%
Other	0.9%	0.8%	1.3%	0.0%

Source: West Virginia Department of Revenue

According to §11-13A-5a of West Virginia code, natural gas severance tax collected must be distributed annually to the state’s counties and municipalities in the following manner:

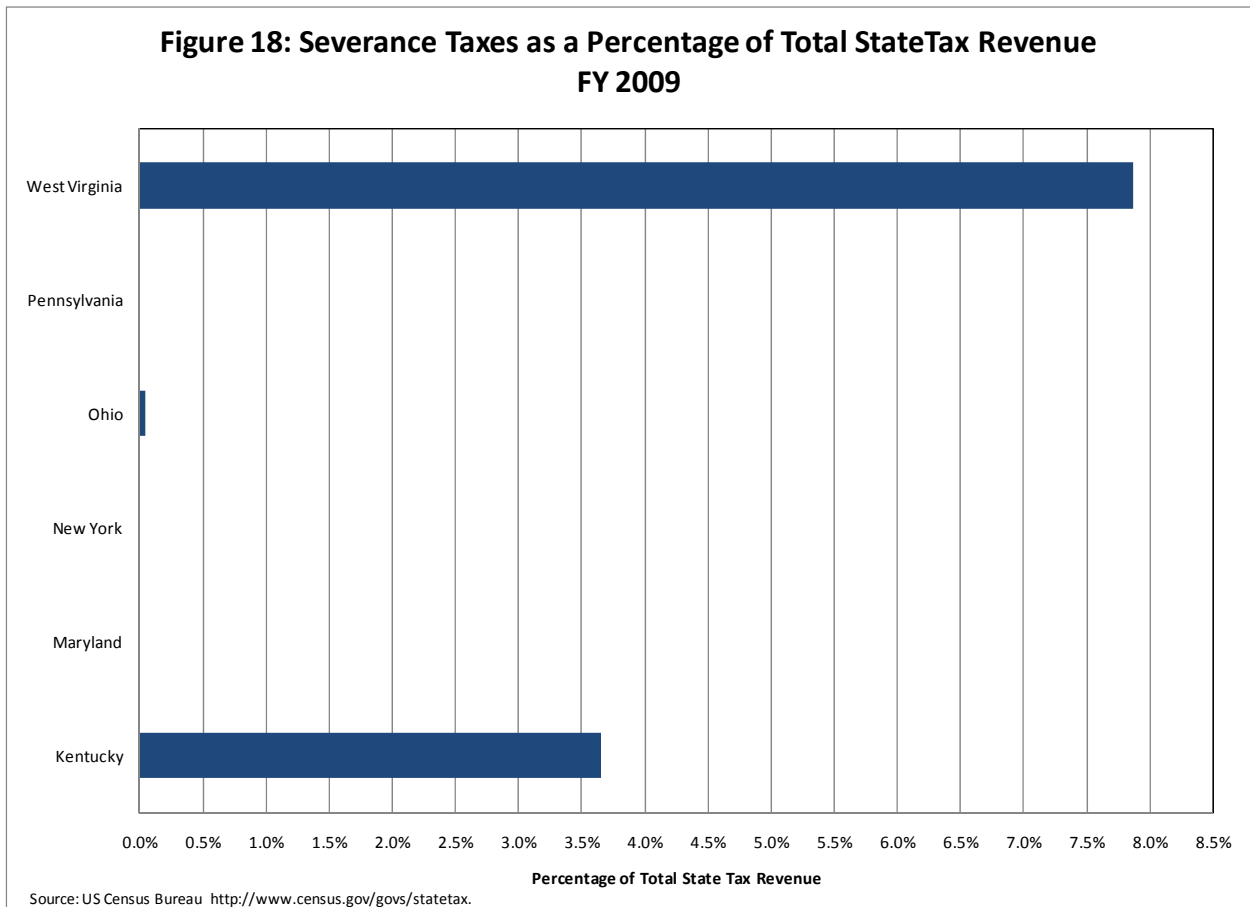
- 75% of tax collections are distributed to producing counties based upon the county’s share of total annual statewide production
- 25% of tax collections are distributed to all counties and cities based upon their share of state population; counties receive their share based on unincorporated population while municipalities receive funds based upon their population.

For FY 2009, the local natural gas and oil severance tax distribution to producing counties totaled \$6.3 million (Figure 17). Six southern counties in the state received approximately 40 percent of the oil and natural gas severance tax distribution to producing counties. Those counties include: Wyoming, McDowell, Kanawha, Logan, Mingo, and Boone. North central West Virginia counties of Doddridge, Lewis, Harrison and Ritchie received 21 percent of the distribution or \$1.3 million.



The importance of severance taxes as revenue sources for state governments varies widely across states. West Virginia is one of 34 states that have implemented a severance tax as of FY 2009. Data from the US Census Bureau suggest that West Virginia received a relatively large share of state tax collections from its severance tax, with severance tax revenue comprising 7.8 percent of

revenue generated in FY 2009. In comparison with neighboring states, West Virginia has relatively higher severance tax revenues as well as a higher revenue proportion coming from its severance taxes (Figure 18). Kentucky received approximately \$356 million from its severance tax in FY 2009, but this figure only comprises 3.6 percent of total tax collections. Virginia only receives 0.1 percent of its total tax revenue from severance taxes (around \$2 million), whereas Ohio receives \$11 million. Maryland, New York, and Pennsylvania do not have a severance tax and therefore do not receive any revenue from this tax instrument. Interestingly, Alaska receives 77 percent of its total budget revenue from its severance tax revenue, which contributes more than \$3.8 billion to state coffers. Missouri had the smallest reported severance tax revenue across all the states, with only \$18,000 in revenue.



## 4. Other Policy Issues Facing the Natural Gas Industry and Marcellus Shale Development

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This section describes the general policy environment facing the natural gas industry in West Virginia. The economic impact of the Marcellus Shale play—the sales, jobs, wages, and tax revenues that come from natural gas drilling and development operations in the State—depends upon the general policy environment to a large degree. As discussed above, firms involved in Marcellus Shale drilling and production operations in West Virginia face an array of state and federal taxes, including the severance tax and the property tax. In addition to statutory and permit concerns, we will also discuss other relevant policy issues in this section, taking into account economic conditions, environmental concerns, and the shared use of public resources.

We conclude this section with a discussion of the permitting process, workforce development, and road access and shared utilization in order to highlight the multiple facets of the policy environment that are faced by firms engaging in natural gas exploration, drilling, production, and distribution.

### 4.1. Environmental and Regulatory Issues

While natural gas is relatively more efficient and clean burning than other fossil fuels<sup>22</sup>, there are still environmental concerns regarding its extraction, production, and distribution. The natural gas industry faces environmental regulation by state and federal departments of environmental protection as well as other entities who have the authority to influence how firms can engage in drilling and development operations in the Marcellus Shale play.

These environmental regulatory requirements vary across states (and even river basins), much like the other tax and policy issues illustrated above, though unlike the property tax and severance tax there are environmental and regulatory constraints for all states with Marcellus Shale drilling and development operations.

Given that hydraulic fracturing requires a high amount of surface and ground water utilization, water management is a critical aspect of natural gas production in the state. There are also environmental concerns regarding some of the additives used in fracturing fluids. In addition to water utilization and management issues, firms operating within the industry must submit permits for new wells and face continuous regulation of the “design, location, spacing, operation, and abandonment” of wells. There are other environmental concerns for the industry, including site management in all of its facets, emissions control, ecological impact at the well head, and post-production well management. Further, well blowouts can lead to significant flowback control problems as well as the release of natural gas into the environment.

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<sup>22</sup> Natural gas has significantly lower carbon emissions relative to other fossil fuels (MIT Report, 2010).

#### **4.1.A. Federal Regulations**

At the federal level, environmental regulations are enforced by the U.S. Environmental Protection Agency. The Clean Water Act and the Safe Drinking Water Act both regulate how water resources can be utilized and must be managed by firms in the natural gas industry. As discussed by ALL Consulting LLC (2009b), the Clean Water Act (CWA) "regulates surface discharges of water associated with shale gas drilling and production, as well as storm water runoff from production sites." According to their report, the Safe Drinking Water Act (SDWA) also "regulates the underground injection of fluids from shale gas activities." Yet as discussed in the section regarding future federal policy, there are currently federal regulatory exemptions to the practice of hydraulic fracturing that some members of Congress are seeking to replace.

When Marcellus Shale drilling and production takes place on land that is owned by the federal government, the Bureau of Land Management and the U.S. Forest Service also manage utilization by natural gas firms. Companies that operate on federal lands must adhere to the National Environmental Policy Act (NEPA). Firms operating in the Marcellus Shale natural gas industry must also adhere to other pieces of federal legislation and regulatory frameworks, including the Clean Air Act, the National Emission Standards for Hazardous Air Pollutants, the Resource Conservation and Recovery Act, the Solid Waste Disposal Act, the Endangered Species Act, wildlife regulations, the Comprehensive Environmental Response, Compensation, and Liability Act, the Emergency Planning and Community Right-to-Know Act, and the Occupational Safety and Health Act (ALL Consulting, 2009b).

Of additional concern for natural gas producers in the Marcellus Shale region is the possibility of new federal legislation that would limit the extent of greenhouse gas emissions. While the incidence of such regulation would likely fall on coal and oil producers that emit relatively greater amounts of carbon dioxide and other greenhouse gases, the fact that natural gas is largely comprised of methane has important implications for regulatory incidence. While the natural gas industry may fare relatively better than the oil and coal industries due to the less carbon-intensive nature of natural gas, it may face significant challenges with overarching greenhouse gas mitigation measures that regulate the release of methane into the atmosphere.

However, there is fundamental uncertainty regarding the climate change policy regime. As a MIT report (2010) illustrates, "the absence of a clear international regime for mitigating [greenhouse gas] emissions also raises questions about the likely stringency of national policies over coming decades." If climate change legislation is enacted that minimizes the extent of carbon emissions, then the natural gas industry may see greater profit opportunities given a substitution from coal and oil utilization toward natural gas. However, if legislation is enacted that regulates the array of greenhouse gases—including methane—then industry outcomes will be uncertain. In other words, if carbon *and* methane emissions are equally regulated, then it may imply a proportional decline in natural gas production.

#### **4.1.B. State Regulations**

Along with the regulatory constraints that have been implemented by various federal bureaus and agencies, there are also additional environmental regulations or protection measures that vary across states. The West Virginia Department of Environmental Protection's Office of Oil and

Gas (OOG) is responsible for all permits and regulations on natural gas development in West Virginia. The OOG mandates that natural gas firms and operators utilize best management practices for drilling sites and access roads. Natural gas firms must also adhere to the Erosion and Sediment Control Best Management Practice Manual. Firms operating in West Virginia must adhere to the DEP's fee schedule, which specifies different well work fees depending on the depth and types of wells.

In the State of West Virginia, natural gas producers must enter into a compliance agreement regarding abandoned wells with the Office of Oil and Gas of the West Virginia Department of Environmental Protection (see the Abandoned Well Act, W.Va. Code §22-10-1 or WV Code §22-10-9). See also West Virginia's Oil and Gas Act, W.Va. Code §22-6-1. Abandoned wells are required to be plugged with cement or other substances. Yet even given these environmental regulations, it is estimated that there are nearly 12,000 abandoned oil and gas wells in the State.

As an example of environmental regulations in other states, the New York Department of Environmental Conservation (Division of Mineral Resources) has a statute that implies that "the drilling, casing, and completion program adopted for any well shall be such as to prevent pollution. Pollution of the land and/or surface or ground freshwater resulting from exploration or drilling is prohibited" (6 NYCRR, Part 554). Yet it is also important to note that New York river basin commissions have imposed permit requirements for drilling in particular watersheds that nearly preclude Marcellus Shale drilling and development operations in these regions (see below). In Pennsylvania, Pennsylvania, the Independent Regulatory Review Commission recently passed a series of rules that require natural gas firms to treat the flowback/wastewater that is a byproduct of hydraulic fracturing to drinking water standards. These rules will eventually flow to the Pennsylvania Senate and House environment committees and subsequently to the Attorney General's office.

#### *4.1.C. Water Regulations*

As discussed above, one of the environmental concerns regarding natural gas drilling operations in the state surrounds the process of hydraulic fracturing. In order to make natural gas drilling economically viable, operators engage in a horizontal drilling procedure that pumps a fracturing fluid into the Marcellus Shale play, which generates fractures in the shale because of the high pressure at which the fracture fluid is administered. This fracture fluid is largely comprised of water and often comes from surface water, ground water, municipal water, re-used water, or water that has been trucked into the well pad. After the fracture fluid flows out of these fractures, natural gas is released for subsequent well capture.

This hydraulic fracturing process requires a large amount of water, posing possible issues for aquifer depletion or surface water overutilization. Utilization of water resources for hydraulic fracturing and the management of the waste water produced from this process is therefore a key environmental concern for firms operating in the Marcellus Shale natural gas industry in West Virginia. There are also concerns about the potential environmental impact of the chemicals utilized during hydraulic fracturing. Hydraulic fracture solutions are predominantly comprised of water (typically more than 99 percent), sand, and lubricating gels, though there are various chemical components included in the solution that may be environmentally hazardous.

Of additional concern for natural gas operators is that along with natural gas, fracture fluid and ground water is returned from the well. This return water must be managed in a way that does not impose environmental damage. Further, naturally occurring radioactive material may also be brought to the surface during drilling and production. This is more of a workplace hazard than an environmental impact and OSHA regulates such effects.

In the State of West Virginia, the Water Resources Protection Act (Ch. 22 Article 26) requires firms that withdrawal more than 750,000 gallons in any month for one facility to register with the West Virginia Department of Environmental Protection's Division of Water and Waste Management (DWWM). If natural gas firms seek to construct centralized ponds for water storage for use in hydraulic fracturing, they must comply with the West Virginia Department of Environmental Protection's DWWM as well (Ibid). Since natural gas firms engaging in horizontal drilling operations typically utilize between 2 million to 4 million gallons of water for hydraulic fracturing, this regulation applies to the vast majority of well heads if they directly utilize nearby water reservoirs or aquifers.

The West Virginia Department of Environmental Protection's OOG assesses violations of WV Codes §22-6, §22-10, §22-11, §22-12, §22-21 on the basis of four factors: seriousness, negligence, good faith and history. For instance, the criterion of 'seriousness' depends upon the degree of harm or potential for harm to human health or the environment and ranges from 'minor', 'moderate', and 'major.' However, the violation fines range from \$200 at the lowest range of the 'minor' category to \$5000 at the highest range of the 'major' category. The particular degree of 'negligence' increases the base assessment from the seriousness criterion. Conversely, the degree of 'good faith' reduces the base assessment, yet there is no sanctioning element with this criterion. Lastly, the number of previous violations is considered in determining the final assessment, with more than 20 violations increasing the base assessment by \$3200, for instance, and 1-5 violations increasing the base assessment by \$200. In addition to these factors, penalties also include an amount that takes into account the economic benefit of noncompliance, which is calculated using a method by the Environmental Protection Agency (EPA).

#### *4.1.D. Environmental Interest Groups*

Along with the formal environmental and land use constraints implemented by state and federal governments, there are also informal constraints on natural gas exploration, land use, production, and distribution posed by interest groups formed by surface owners or those concerned with the environmental impact of natural gas drilling and production. In this section, we will consider some of the issues raised by environmental and surface owners' interest groups.

For instance, some of the concerns of the West Virginia Surface Owners' Rights Organization (WV-SORO) center around (1) notification to surface owners for land entry, (2) improvements to the Surface Damage Compensation Act, (3) increasing the distance of wells from buildings and water wells, (4) general concern for water resources and withdrawals for hydraulic fracturing, (5) clearer construction guidelines for pits, (6) proper treatment of wastewater and flowback, (7) disclosure by companies about the chemical composition of fracture fluid, (8) regulation of the

toxicity of fracture fluids, etc. Further, they advocate for (9) publicly available data on water tests and (10) improved state road traffic issues and damage repair, as well as (11) more and better trained state inspectors, among other issues.

While the industrial and residential utilization of natural gas as an energy source produces relatively less carbon emissions than oil or coal, many environmental groups claim that natural gas production and consumption is still environmentally hazardous. This criticism emerges not necessarily because of the combustion byproducts/emissions of natural gas, but moreover because of the site and water resource impact of natural gas drilling.<sup>23</sup> For instance, the environmental website, <http://www.landandwater.org> claims that some of the environmental issues surrounding natural gas extraction and distribution involve "...pipelines, drilling pads, and wastewater pits scarring our landscapes; air pollution from every stage of production; heavy rigs damaging our roads; billions of gallons of water taken from our streams; and operational errors contaminating our land and water." As the WV DEP confirms, the transportation of water tanks to and from natural gas rigs can lead to increases in truck traffic that can lead to road damage, increases in dust in the air, and safety concerns with other vehicles.

The West Virginia Environmental Council (WVEC) argues that the utilization of water resources should be regulated from "Cradle to Grave." For one, they advocate for the position that the State of West Virginia should develop a permit system for water withdrawals. They similarly argue for the public disclosure and regulation of the chemical contents of fracture fluids as well as an improved treatment of wastewater from fracture flowback and fluid byproducts. The WVEC also raises concerns regarding solid waste disposal pits and abandoned wells. They suggest improvements in administration, among other policy reforms. Other issues include "increased sedimentation from well roads, damage to the state road system from increased truck activity, dust and other air quality issues, increased land disturbance and habitat fragmentation caused by well spacing issues, and potential problems of drilling in areas of "karst" geology."

Among other policy reforms, the West Virginia Farm Bureau argues for the following changes in the policy regime: (1) deeds should reflect mineral ownership, (2) surface owners should receive advance notice of mineral extraction, (3) "landowners should have the right to redeem mineral interests under their property if the mineral interest owner does not do so", (4) "timber cleared from extraction site and access roads to site should be appraised by certified appraiser", (5) "secondary roads leading to the extraction site should be inspected by WVDOH prior to and following the extraction for any damages, (6) natural gas extraction sites "should have on-site water treatment and reuse of water" as they argue that this "decreases road wear/damage," improves safety, reduces emissions, and improves the environmental footprint, (7) there should be improved sediment control for the protection of streams, (8) "the extracting entity should be responsible to the landowner for the activities of any contractor employed to perform work at the extraction site, and for any damages caused by the contractor."<sup>24</sup>

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<sup>23</sup> However, natural gas is largely comprised by methane, which is a greenhouse gas and still of environmental concern at the macro level (See [www.naturalgas.org](http://www.naturalgas.org) for natural gas composition levels).

<sup>24</sup> Other policy proposals may be found at <http://www.dep.wv.gov/oil-and-gas/GI/Documents/OOG%20Program%20Review/Addressing%20Member%20Concerns%20DEP%20presentation.pdf>

#### **4.1.E. Summary of Environmental and Regulatory Issues**

In sum, natural gas producers in the State face an array of state and federal regulatory and environmental issues, both formally and informally. These regulatory and environmental issues (e.g. surface owner legislation, forced pooling legislation, water regulations and water management, road impacts and repairs, permitting issues, and other forms of environmental legislation) pose significant impediments to Marcellus Shale drilling and development operations in the State. Citizen constraints as well as formal regulations will continue to put pressure on natural gas firms to continually improve their environmental impact.

Companies involved in natural gas drilling and development operations as well as other companies involved in engineering and distribution services have become aware of the environmental challenges posed by hydraulic fracturing. With improved casing and cementing of wells as well as the development of ‘green’ fracturing fluids (e.g. Schlumberger), firm-driven solutions to environmental challenges are emerging. For instance, Range’s system leads to a recycling of wastewater used in the hydraulic fracturing process and CNX similarly recycles a portion of Marcellus flowback. Further, companies like Advanced GeoServices Corporation (who received a grant from the National Science Foundation) have been working to develop a flowback wastewater treatment process.

Academic researchers, in conjunction with private firms, have conducted research on fracture water treatment technology. For instance, researchers at the West Virginia Water Research Institute at the National Research Center for Coal and Energy at West Virginia University have collaborated with FilterSure Incorporated to develop a demonstration project that recycles fracture water for reuse in the hydraulic fracturing process, reducing the existence of flowback as well as the need for surface water for drilling.

Collaboration between academics, industry executives, and environmental scientists has led to developments that will mitigate the long run environmental impact of horizontal drilling and hydraulic fracturing. A 2010 MIT report argues that “government-sponsored research on the fundamental challenges of unconventional gas development, particularly shale gas, should be greatly increased in scope and scale

#### **4.2. Legal Environment**

Along with the tax and environmental regulatory policy regime, the legal climate matters for natural gas firms seeking to invest capital resources in Marcellus Shale exploration, drilling, and production. West Virginia’s legal climate is ranked 50<sup>th</sup> among all U.S. states by the Institute for Legal Reform (which is affiliated with the U.S. Chamber of Commerce), which illustrates why the legal environment in West Virginia could act as a constraint on natural gas drilling and development operations. As an anecdotal example of how the legal climate can affect the natural gas industry, as reported by *The Economist* (2010), West Virginia’s Supreme Court declined the appeal of a \$405 million verdict against three natural gas companies that operate in the State. As a result of this finding, Chesapeake Energy Corporation cancelled plans to establish a regional headquarters in Charleston and subsequently cut 215 jobs (Ibid).

#### 4.2.A. Permits and the Permitting Process

All firms operating in the natural gas industry must receive a permit before they can engage in Marcellus Shale drilling and development operations, regardless of the state. The West Virginia Department of Environmental Protection (WV DEP) Office of Oil and Gas<sup>25</sup> regulates the exploration and development of natural gas within the state. Through this process the WV DEP requires all developers to obtain various permits prior to beginning operations. Table 3 lays out the permit fees imposed by the WV DEP. To drill a new production well with a pit for well work wastes, an operator would have to pay \$650 in permit fees (\$100 + \$400 + \$150) while the operator would pay \$900 to drill a deep well with a pit. The WV DEP also issues permits on the water and bonds needed for wells to be drilled in West Virginia.

Table 12: West Virginia Department of Environmental Protection Well Work Fees	
	Fee
Deep well work except plugging	\$650
CBM well work except plugging	\$650
Shallow well work except plugging	\$400
Permit to construct a pit or dispose of well work waste	\$100
Well fee to go into the reclamation fund	\$150
Convert an existing shallow well into an injection well without a pit	\$550
Convert an existing deep well into an injection well without a pit	\$800

Source: West Virginia Department of Environmental Protection Office of Oil and Gas

In Pennsylvania, natural gas firms drilling in the Marcellus Shale must obtain well permits from the Pennsylvania Department of Environmental Protection. The base fee is \$900 and there is an additional \$100 fee per 500 feet of drill distance. In addition to the permit fees, Marcellus Shale drillers face an orphan well surcharge and an abandoned well surcharge of \$200 and \$50 per well respectively.

Firms operating within the Delaware River Basin must now obtain approval through the Delaware River Basin Commission for natural gas extraction projects, either for current production or for the sake of exploration. In effect, all new permits for wellheads are temporarily banned, even those for exploratory wells. This implies that counties in Pennsylvania with significant Marcellus Shale deposits that are located in the Delaware River Basin—such as Wayne, Pike, Monroe, Carbon, Schuylkill, Luzerne, and Lackawanna—face a drilling moratorium due to environmental concerns for the Delaware River. The Susquehanna River Basin Commission also requires permits for natural gas drilling and hydraulic fracturing.

#### 4.2.B. Divided Estates

Another legal issue facing the natural gas industry in West Virginia is the issue of divided estates (also referred to as split estates). When the ownership of mineral rights and the ownership of

<sup>25</sup> For more information to fees and permits for natural gas wells go to <http://www.dep.wv.gov>.

property rights are split between two agents, the estate is said to be divided. This may occur if a landowner had previously sold the mineral rights to his or her property or if the mineral rights had been severed from the property title prior to purchase or reception of property. As an example, a firm operating in the natural gas industry may have purchased the mineral rights to a particular property while the actual property title is held by another agent. When this is the case, utilization by a firm may intrude upon the property title holder's utilization of property on which the firm has established a wellhead. This can also occur in the context of federally-owned lands, where a natural gas firm may purchase the mineral rights for a particular tract of land from the federal government. Property titles typically specify ownership rights of minerals or the surface property.

Given the surge in leasing activity in the past few years in the Marcellus Shale region, this is an important legal issue to assess for natural gas firms. The legal challenge arising from divided estates occurs because the property title's owner may seek financial or environmental remediation in the event that the mineral rights owner does not properly compensate the property owner in the event of an ecological or land use tort. For instance, if an operator produces an excess of fluid discharge in the drilling process and does not properly address waste water treatment or management, a property owner may seek financial compensation through a legal tort case. As another example, conflict between the owner of mineral rights and the owner of the property title may occur because the mineral rights owner did not provide advanced notice to the property owner.

### **4.3. Road Utilization**

One of the biggest issues regarding the development of the Marcellus Shale in West Virginia is road utilization. The Marcellus Shale development has significantly increased the amount of natural gas traffic within the state. Roadways, from interstates to one-lane gravel county roads, have had to endure an increase in traffic especially heavy load traffic. Issues such as road conditions, truck length, and truck weight are major concerns facing the natural gas industry. West Virginia Code §17C-17 specifies the traffic regulations and laws of the road as it relates to size, weight, and load. West Virginia limits the length and weight of all motor vehicles including passenger vehicles and tractor trailers. The West Virginia Public Service Commission, however, does have the authority to authorize special permits for excess size and weight. All loads in West Virginia must also be securely fastened and not allowed to leak or escape; this includes the transporting of compressed gas containers.

The West Virginia Division of Highways (WV DOH) issued a manual on road usage applicable to the natural gas industry in 2004 which is currently being enforced. Drilling companies are to meet with the local WV DOH office to discuss plans, including exact well locations, access routes, length of operations, and number of wells, prior to moving into an area to drill. Natural gas drilling companies need to meet with a WV DOH representative in the field and film the traffic route to the well site(s) to get a pre-drilling road condition assessment. All roads to a well location must be kept in a non-muddy condition and a car must be able to travel without trouble. Drillers are encouraged to upgrade roadways prior to beginning drilling operations especially in soft areas and areas with poor drainage. The WV DOH requires right of access permits for constructing access, maintaining, repairing, and improving public road and transportation

facilities. Access permits require the drilling company to provide a bond that will compensate the WV DOH for improvements to the roadway as a result of the drilling operation. Bond levels set by the WV DOH are as follows: \$100,000 per paved road mile and \$50,000 per gravel and tar and chip road mile. Bonds are held by the WV DOH until drilling operations are completed and the roadway to the location is left in its original or better condition.

The Wetzel County Action Group has been the leading interest group as it pertains to road utilization in the Marcellus Shale development area located in Marshall and Wetzel counties. Members of the group argue for safety on the roadways traveled by the natural gas industry. Safety issues include not only the weight and length of natural gas vehicles but also the times and speed in which these vehicles travel. During times when road conditions are poor, such as in snow, rain, or fog, the interest group argues that the natural gas traffic should be limited in order for the residents of the area to be safe. Also, the members push for all natural gas traffic to obey all speed limits and to maintain even lower speeds around residences.

#### **4.4. Workforce Development**

Within the Marcellus Shale play, natural gas operators typically lack the skilled workforce that is required for efficient drilling, development, and production operations. As companies come to the region to drill and develop the Marcellus Shale, their offices, yards, staging areas, and workers have not located to the region yet. In fact, natural gas companies are known for commuting long distances to operate. Thus, many workers in the natural gas industry in West Virginia come from outside the state.

Currently there are programs being offered by community colleges in the state to increase the natural gas skills of West Virginia residents. These programs work to increase the knowledge of safe working practices and of the processes and technologies used in the industry. To be a successful candidate to work in the natural gas industry, a West Virginia resident should be CPR/First Aid certified and have RigPass certification.

Many skills outside of the basic rig-hand skills are required for successful development of the Marcellus Shale in West Virginia. Engineers, welders, electricians, truck drivers, and many other types of industrial skilled individuals are needed and hired daily in the natural gas industry.

## 5. Conclusion

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The natural gas industry in West Virginia has a substantive influence on the state's economy. Natural gas production in the Marcellus Shale play has led to a significant economic and revenue impact for the state, contributing to a significant amount of job creation and inducing much economic activity in other sectors of the economy. Along with the economic and revenue aspects of Marcellus Shale development, we have assessed some of the regulatory, legal, and environmental issues surrounding natural gas drilling and development operations in the state. Some of these issues include how roads are utilized in the state by natural gas producers, how property and mineral ownership can be legally separated (or fused), and whether the natural gas industry has a sufficiently large labor pool from which to draw experienced technicians and drill workers.

The economic impact estimates produced in this report illustrate that the oil and natural gas industry employed almost 10,000 individuals and paid more than \$550 million in wages. This economic activity further generated a business volume impact of more than \$12 billion to the state's economy, generating more than 24,000 jobs. As for the Marcellus Shale play, drilling and development operations led to more than \$2.3 billion worth of business volume, generating around 7,600 jobs. In contributing more than \$65 million in state severance taxes and \$88 million in property taxes to the state, the natural gas industry has led to a significant revenue windfall for West Virginia's state government.

In sum, the economic and revenue impacts of the natural gas industry and the Marcellus Shale play development are substantive. While there are many issues surrounding the extraction, production, and distribution of natural gas in the state—including legal, environmental, and regulatory hurdles—the industry has had a profound influence on the state's economy.

# Appendix A: Natural Gas Industry NAICS Code Definitions

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## **211: Oil and Gas Extraction**

Industries in the Oil and Gas Extraction subsector 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, de-silting 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.

Establishments in this subsector include those that operate oil and gas wells on their own account or for others on a contract or fee basis. Establishments primarily engaged in providing support services, on a fee or contract basis, required for the drilling or operation of oil and gas wells (except geophysical surveying and mapping, mine site preparation, and construction of oil/gas pipelines) are classified in Subsector 213, Support Activities for Mining.

### **213111: Drilling Oil and Gas Wells**

This U.S. industry comprises establishments primarily engaged in drilling oil and gas wells for others on a contract or fee basis. This industry includes contractors that specialize in spudding in, drilling in, re-drilling, and directional drilling.

### **213112: Support Activities for Oil and Gas Operations**

This U.S. industry comprises establishments primarily engaged in performing support activities on a contract or fee basis for oil and gas operations (except site preparation and related construction activities). Services included are exploration (except geophysical surveying and mapping); excavating slush pits and cellars, well surveying; running, cutting, and pulling casings, tubes, and rods; cementing wells, shooting wells; perforating well casings; acidizing and chemically treating wells; and cleaning out, bailing, and swabbing wells.

### **221210: Natural Gas Distribution**

This industry comprises: (1) establishments primarily engaged in operating gas distribution systems (e.g., mains, meters); (2) establishments known as gas marketers that buy gas from the well and sell it to a distribution system; (3) establishments known as gas brokers or agents that arrange the sale of gas over gas distribution systems operated by others; and (4) establishments primarily engaged in transmitting and distributing gas to final consumers.

### **237120: Oil and Gas Pipeline and Related Structures Construction**

This industry comprises establishments primarily engaged in the construction of oil and gas lines, mains, refineries, and storage tanks. The work performed may include new work, reconstruction, rehabilitation, and repairs. Specialty trade contractors are included in this group if they are engaged in activities primarily related to oil and gas pipeline and related structures

construction. All structures (including buildings) that are integral parts of oil and gas networks (e.g., storage tanks, pumping stations, and refineries) are included in this industry.

**333132: Oil and Gas Field Machinery and Equipment Manufacturing**

This U.S. industry comprises establishments primarily engaged in (1) manufacturing oil and gas field machinery and equipment, such as oil and gas field drilling machinery and equipment; oil and gas field production machinery and equipment; and oil and gas field derricks and (2) manufacturing water well drilling machinery.

**486210: Pipeline Transportation of Natural Gas**

This industry comprises establishments primarily engaged in the pipeline transportation of natural gas from processing plants to local distribution systems.

## Appendix B: Economic Impact Definitions

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<b>Business Volume:</b>	Sales plus net increase in finished inventories and the value of intra-corporate shipments. Equals output (see below) plus the cost of goods sold in retail and wholesale trade.
<b>Employment:</b>	The number of jobs in a business, industry, or region. Also, the number of jobs attributable to an impact (see below). This is a measure of the number of full-time and part-time positions, not necessarily the number of employed persons. Jobs are annual average by place of work. A job year is equivalent to one job for one year.
<b>Employee Compensation:</b>	Wages and salaries plus employers' contribution for social insurance (social security, unemployment insurance, workers compensation, etc.) and other labor income (pension contributions, health benefits, etc.). By place of work unless otherwise stated.
<b>Impacts:</b>	The results of the recirculation of funds throughout a regional economy due to the activity of a business, industry, or institution. Estimated by tracing back the flow of money through the initial businesses' employees and suppliers, the businesses selling to the employees and suppliers, and so on. Thus, they are a way to examine the distribution of industries and resources covered in the costs of the initial activity.
<b>Output:</b>	For most sectors, measured as sales plus net inventories and the value of intra-corporate shipments. For retail and wholesale trade, measured as gross margins (i.e. sales minus cost of goods sold, also equal to the mark-up on goods sold).
<b>Value Added:</b>	A measure of the value created by a business or industry or attributable to an impact (see above). Equal to the value of production minus the cost of purchased goods and services. Also equal to employee compensation plus capital income (profits, interest paid, depreciation charges), and indirect business taxes (e.g. severance, excise). Corresponds to the aggregate concepts of gross domestic product (GDP).

# Appendix C: Marcellus Shale Industry Survey

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## Economic Impact of Marcellus Shale Drilling in West Virginia: 2009 Industry Survey

The West Virginia Oil and Natural Gas Association commissioned the West Virginia University Bureau of Business and Economic Research (BBER) to examine the economic impact of Marcellus Shale Development in West Virginia. To better understand the economic contributions of the industry, BBER has developed this survey. If you have any questions feel free to contact Dr. Tom S. Witt (BBER Director) at 304.293.7835 [tom.witt@mail.wvu.edu](mailto:tom.witt@mail.wvu.edu) or Amy Higginbotham (BBER economist) at 304.293.7534 [afhigginbotham@mail.wvu.edu](mailto:afhigginbotham@mail.wvu.edu). Please return the survey to the above no later than **June 1, 2010**. For more information on the BBER please visit <http://www.bber.wvu.edu>.

Company Name: \_\_\_\_\_

Company Address: \_\_\_\_\_  
Street City State Zip

Company Contact Person: \_\_\_\_\_  
Name Phone Number

\_\_\_\_\_ E-mail Address

1. Percentage of total business that was devoted to Marcellus Shale drilling and development in West Virginia?

2009 \_\_\_\_\_%

2. What are the most significant regulatory issues or tax policies that could impede your Marcellus Shale drilling and development operations in West Virginia in the future? \_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

3. What are the major workforce development issues facing your firm today? \_\_\_\_\_

\_\_\_\_\_

**Please fill out the remainder of the survey with regards to all Marcellus Shale Drilling and Development Operations in West Virginia in calendar year 2009.**

4. What aspects of Marcellus Shale drilling and development did your company participate in during calendar year 2009?

Land Leasing/Farm Outs \_\_\_\_\_ (acres)                      Drilling Marcellus Shale \_\_\_\_\_ (wells)

Location Setup/Building \_\_\_\_\_ (wells)                      Well Completion \_\_\_\_\_ (wells)

5. List the West Virginia county or counties where your company engaged in Marcellus Shale drilling and development in calendar year 2009 (Jan. 1 – Dec. 31): \_\_\_\_\_  
\_\_\_\_\_

6. Did your company create or continue a partnership or farm out with another company or companies for the purposes of Marcellus Shale drilling during calendar 2009? Yes \_\_\_\_\_ No \_\_\_\_\_

6.a. If the partnerships or farm out were created or continued in calendar year 2009, list the name of the company or companies in the partnership:  
\_\_\_\_\_

7. What were the total expenditures with regards to Marcellus Shale drilling in West Virginia in calendar year 2009 for the following categories:

Land Leasing/Farm Out \$ \_\_\_\_\_                      Drilling Marcellus Shale \$ \_\_\_\_\_

Location Setup/Building \$ \_\_\_\_\_                      Well Completion \$ \_\_\_\_\_

8. What were your company's West Virginia Marcellus Shale drilling expenditures for the following categories:

Wages & Benefits \$ \_\_\_\_\_                      Trucking \$ \_\_\_\_\_

9. Did your company contract out Marcellus Shale drilling and development operations? Yes \_\_\_\_\_ No \_\_\_\_\_

9.a. If contractors were used, what percentage of operations for each category were contractors employed?

Location Setup/Building \_\_\_\_\_%

Well Completion \_\_\_\_\_%

Drilling Marcellus Shale \_\_\_\_\_%

10. What was the total number of employees (full and part time) that were devoted to Marcellus Shale drilling and development operations in West Virginia in calendar year 2009 for the following categories:

Land Leasing \_\_\_\_\_                      Drilling Marcellus Shale \_\_\_\_\_

Location Setup/Building \_\_\_\_\_                      Well Completion \_\_\_\_\_

11. What percentage of your Marcellus Shale workforce resided in West Virginia in calendar year 2009? \_\_\_\_\_ %

12. What were the taxes paid to state or local governments for Marcellus Shale drilling and development operations by your company in calendar year 2009?

Severance taxes \$ \_\_\_\_\_

Personal property taxes \$ \_\_\_\_\_

Sales and use taxes \$ \_\_\_\_\_

All other taxes and fees \$ \_\_\_\_\_

Real property taxes \$ \_\_\_\_\_

13. By what percentage does your company expect to grow from year to year from 2010 to 2015 in the Marcellus Shale drilling and development industry: (2009 EIA forecasted average wellhead price for natural gas per thousand cubic feet in parentheses)

2010 \_\_\_\_\_% (\$6.01)                      2012 \_\_\_\_\_% (\$6.09)                      2014 \_\_\_\_\_% (\$6.22)

2011 \_\_\_\_\_% (\$5.97)                      2013 \_\_\_\_\_% (\$6.11)                      2015 \_\_\_\_\_% (\$6.29)

14. Please indicate if you would be willing to participate in a more detailed survey of Marcellus Shale drilling and development operation expenditures in West Virginia in 2008 and 2009. This will permit the BBER to develop a more comprehensive model of the Marcellus Shale industry in West Virginia.

Yes \_\_\_\_\_

No \_\_\_\_\_

Completed questionnaires can be faxed to 304.293.7061 or return by email to amy.higginbotham@mail.wvu.edu . Or if you prefer, mail to Marcellus Shale Project, Bureau of Business and Economic Research, West Virginia University, P.O. Box 6025, Morgantown, WV 26506-6025.

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