

The Local Economic Impact of the Conventional Oil and Gas Industry in Pennsylvania

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Pennsylvania Grade Crude Oil Coalition



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EXECUTIVE SUMMARY

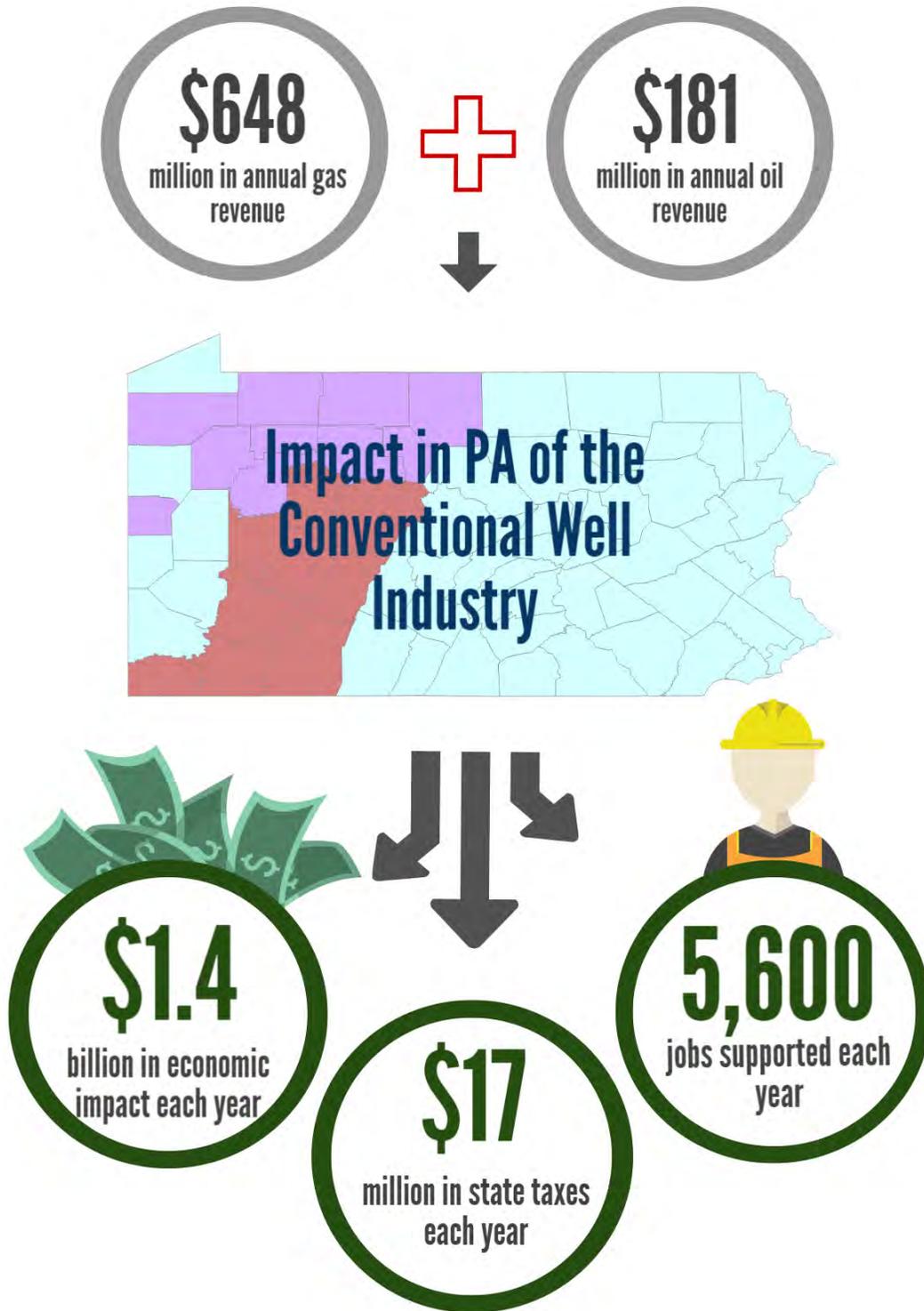
The conventional oil and gas industry has been a driving force in the Commonwealth of Pennsylvania (“Commonwealth”) for over a century. For the vast majority of this time, drilling has been limited to conventional wells. However, over the past eight years, a boom in unconventional drilling, spurred by the focus in the Marcellus shale, has upended Pennsylvania’s legacy oil and gas industry. The Pennsylvania Grade Crude Oil Coalition (PGCC) represents independent, conventional oil and gas producers and service providers in western Pennsylvania. Its mission is to advance local economies and energy independence by promoting conventional oil and gas production in a safe and environmentally sound manner.

Conventional oil and gas, while only a portion of the total gas and oil production in the Commonwealth, is a crucial driver of local economic and employment impact in the small communities in which it occurs. This report focuses on the operations of conventional oil and gas wells in 19 counties in western Pennsylvania (“19-County Region”) where there is significant conventional drilling activity, generate substantial economic impacts throughout the Commonwealth by utilizing local vendors, employing residents, and paying wages to their workers. The economic impacts include the direct activity of the conventional oil and gas industry and the spillover economic activity, induced and indirect impacts, it supports.

- Within the Commonwealth, the operations of the conventional oil and gas wells in the 19-County Region generate an estimated \$1.4 billion in total annual economic impact, of which \$1.2 billion occurs within the 19-County Region.
- The activity of the conventional oil and gas industry supports an estimated 5,600 jobs with \$241 million in earnings in the Commonwealth. Of that total employment impact, 4,700 jobs with \$185 million in earnings are supported within the 19-County Region.
- Additionally, the operations support \$17 million in annual tax revenues to the Commonwealth (see Figure ES.1).

The impacts of the conventional oil and gas industry are extremely important to the local economies in the 19-County Region. These counties and municipalities are less able to replace the income and employment generated by this industry with other jobs, making the health of the industry vital to their future.

**ES.1 – ESTIMATED TOTAL ECONOMIC IMPACT OF THE CONVENTIONAL WELL INDUSTRY
WITHIN THE COMMONWEALTH OF PENNSYLVANIA**



Source: PA.gov (2015), Energy Information Administration (2015), ESI (2016), IMPLAN (2013)

In addition to the economic and fiscal impacts generated as a result of oil and gas revenues within the 19-County Region, conventional well operators make additional monetary contributions to the state.

- Conventional well operators pay permit fees to the Pennsylvania Department of Environmental Protection (“DEP”) that range from \$250 to \$1,950 per well, depending on the well bore length. Permit fees from conventional and unconventional drillers support more than half of the approximately \$20 million annual budget of DEP’s Office of Oil and Gas Management.
- Conventional well operators also pay local taxes to the small municipal governments where they are located. These small municipalities rely on property taxes, income tax, and the local services tax for a large portion of their revenues.

The Bradford Refinery, located in McKean County, PA and operated by the American Refining Group (“ARG”), processes conventional oil and is the only Penn Grade crude refinery in the Commonwealth.

- Each year, the refinery generates an estimated \$93 million of economic impact in McKean County and supports 350 direct and 100 indirect, and induced jobs, for a total of 450 jobs supported.
- Within the Commonwealth of Pennsylvania, ARG generates \$173 million in economic impact and supports 540 jobs (350 of which are direct jobs) with \$36 million in earnings.

This study is not the first to examine the economic impact of the conventional oil and gas industry in Pennsylvania. In 2008, the Pennsylvania Economy League of Southwestern Pennsylvania estimated the economic benefits of the oil and gas industry within the Commonwealth. The 2008 study includes both the conventional and unconventional industries and provides a great understanding of the magnitude of the importance of the overall industry to the state. The study brought to light that incredible economic impact the oil and gas industry was having at that time, a boom period for the industry.

Our study is the first, to our knowledge, to focus on the importance of the economic impact of the conventional oil and gas industry to the counties and municipalities where it is located. The conventional oil and gas industry provides valuable jobs and tax revenue to these mostly rural areas and without it, will severely negatively impact the economies of these towns. As the industry ebbs and flows with changes in the world market, even during its current down years, it still plays a very important role in the economic and job base in these localities and will continue to play an important role in these municipalities in the future.

1.0 INTRODUCTION

1.1 PURPOSE OF THE STUDY

The Pennsylvania Grade Crude Oil Coalition (“PGCC”) was formed in 2013 by producers and refiners of conventional oil and gas to provide a voice to speak exclusively for members of the conventional oil and gas industry. The first well in Pennsylvania was drilled in Titusville in 1859 by Colonel Drake, and for over a century that conventional type of well prospered across western Pennsylvania. Conventional wells are shallow, vertical wells that produce modest amounts of oil and gas from sandstone formations. The oil is primarily used in lubricating products and the natural gas heats Pennsylvania homes and businesses.

Since 2000, large oil and gas companies across the United States have pursued new, “unconventional”, horizontal drilling and hydro-fracturing techniques.¹ The unconventional oil and gas industry is unique in many ways, with wells generally being deeper, costing significantly more, and having more ancillary impacts than their conventional predecessors. This has become apparent in Pennsylvania, where, a decade ago, unconventional techniques were introduced to explore the state’s massive shale deposits. Pennsylvania’s two most familiar shale formations are the Marcellus and Utica, and the huge volume of natural gas being produced via unconventional technology has transformed the state’s energy landscape.

The tremendous increase in natural gas production, utilizing the new unconventional techniques, has generated both joy and controversy in Pennsylvania. Although nothing new has unfolded in western Pennsylvania’s conventional oil and gas industry, the growth of the new unconventional industry has brought greater attention, and scrutiny, to all of Pennsylvania’s oil and gas operations—often without regard for the difference between conventional and unconventional.

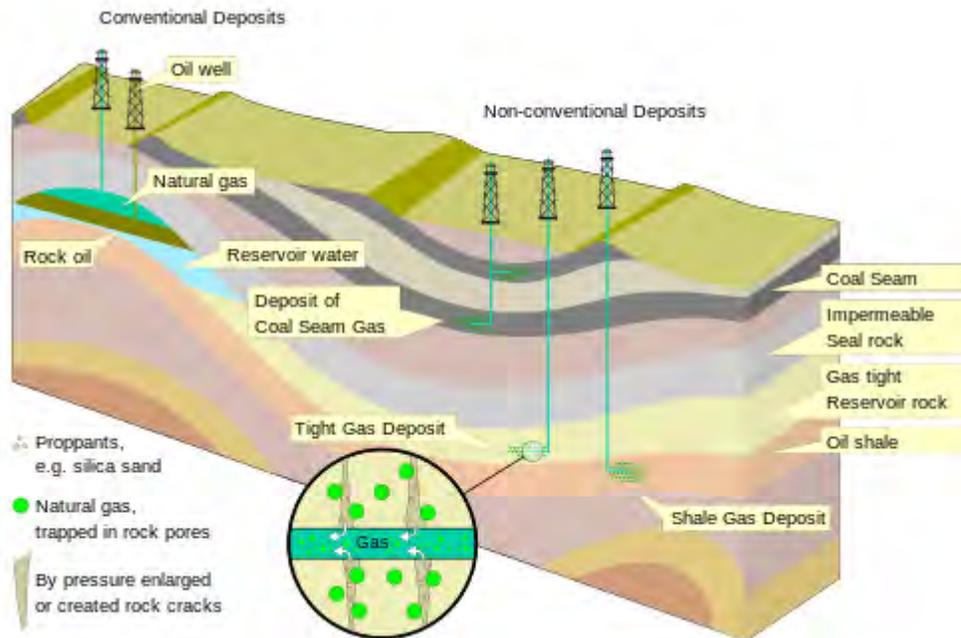
The differences between the two industries are significant (see Figure 1.1):

- The extent of surface impacts is markedly different, with unconventional wells requiring well sites 20 or more times larger than conventional sites;
- Unconventional wells generally generate gas pressures measured in the thousands of pounds while conventional wells are measured in the hundreds, quickly diminishing to double or single digits;
- Unconventional wells cost multiple millions of dollars and the burden of any new regulatory requirements represent a proportionately small percentage of unconventional capital costs, whereas new conventional well costs range from \$100,000 to \$250,000,

¹ See Appendix A for definitions of terms used in this report, including the difference between conventional and unconventional wells

- and any new regulatory costs represent a proportionately large percentage of total cost for conventional wells; and
- Impacts of unconventional wells in the form of truck traffic and water usage are many times larger than ancillary impacts related to conventional wells.

FIGURE 1.1 – IMAGE OF CONVENTIONAL AND UNCONVENTIONAL OIL AND GAS WELLS



Source: Wikipedia: Shale Gas (2014)

Nevertheless, new regulations proposed under the 2012 Oil and Gas Act 13 treated conventional and unconventional wells as a single industry, failing to fully account for the significant differences between the two industries.

PGCC formed and adopted the mission to “advance local economies and energy independence by promoting conventional oil and gas production in a safe and environmentally sound manner.” As to its mission to advance local economies and energy independence, PGCC is concerned that the economies of its industry are not well understood, including the economic impact of its industry across several small, rural communities. PGCC opposed the adoption of the proposed regulations on the basis the new regulatory package failed to properly differentiate between the conventional and unconventional industries.

In February of 2015, the Department of Environmental Protection (“DEP”) formed the Conventional Oil and Gas Advisory Committee for which PGCC Board Vice President Bruce Grindle and Pennsylvania Independent Oil and Gas Association (“PIOGA”) Operations Manager David Ochs serve as voting members. Other members include representatives from Pennsylvania Independent Petroleum Producers (“PIPP”), Pennsylvania Coal Alliance (“PCA”), and the Citizens Advisory Council (“CAC”). The committee aims to help advise DEP on the practices, regulation, and duties of the conventional oil and gas extraction industry. In order to serve as an informed member of the council, to improve its understanding of the economic context in which its industry operates, and to begin research in partnership with governmental agencies, PGCC reached out to the McKean County Economic Development Council. PGCC then engaged Econsult Solutions, Inc. (“ESI”) to undertake an economic and fiscal impact study to estimate the economic, employment, and tax revenue generated by the conventional oil and gas industry in the western counties of Pennsylvania.

In addition, ESI was asked to estimate the economic and fiscal impact of American Refining Group’s (“ARG”) Bradford Refinery, the world’s oldest continuously operating refinery. Located in McKean County, Pennsylvania, the Bradford Refinery is the last operating refinery in the Commonwealth using Pennsylvania crude oil as its primary feedstock. The refinery is exposed to the economic forces affecting the conventional oil and gas industry as a whole, and would be significantly impacted by new regulations imposed on conventional wells.

This study can be used to help local municipalities, PGCC, legislators, regulators, and the general public to better understand the nature, impact and the economic value of the conventional oil and gas industry to the local economies of these western Pennsylvania communities. This study provides order-of-magnitude estimates of the potential negative impacts to local economies if the conventional industry is forced to scale back significantly.

1.2 CONVENTIONAL OIL AND GAS PRODUCTION IN CONTEXT

Pennsylvania has a rich history of oil and gas production; beginning with the country’s first commercial oil well, drilled in the state in 1859.² Unconventional drilling in the Marcellus and Utica shales has received much attention for the past several years. Its prominent growth has eclipsed the importance of the conventional oil and gas industry to the local economies.

Conventional oil and gas production occurs in many small communities where it has considerable localized economic and employment impact. Regulations that fail to differentiate between various methods of drilling and production and fail to take into account the current and future economic importance of the conventional oil and gas industry to many smaller

² U.S. EIA, Pennsylvania State Profile and Energy Estimate, <https://www.eia.gov/state/analysis.cfm?sid=PA>

communities would have a disproportionately negative impact on (and could even collapse) the conventional oil and gas industry in western Pennsylvania.

The massive increase in oil and gas production in the United States, and in Pennsylvania in particular, has brought oil and gas prices in the United States down. Our examination focuses on how state regulatory changes, not macro-market conditions, could deal a decisive blow to the conventional drilling industry's ability to continue operations. The oil and gas industry is sensitive to supply and demand across the world, which are influenced by several factors outside the control of most suppliers. Even as the industry is experiencing oversupply and prices are at near record lows, some expect the oversupply to diminish and prices to slowly rise.³

However, others also forecast excess supply conditions to continue far into the future. Under conditions of significant oversupply, many producers will experience severe financial distress and may have to reduce output or even shut down temporarily, and some even permanently in the medium to long term. Nevertheless, the current prices of natural gas and oil do not reflect the economic importance of the industry in terms of economic output and employment into the future in the communities where the industry is located. The industry will continue despite its reaction to current market pricing, and the income and economic impact generated will remain important for small towns in these counties.

1.3 REPORT STRUCTURE

This report begins by describing the oil and gas industry as a whole and highlighting the geographies in which conventional oil and gas drilling take place in Pennsylvania (Section 2). Next the report provides three distinct but related analyses:

- (1) Estimates the economic impact generated by the conventional oil and gas industry in Pennsylvania, and thereby measures the potential loss of economic drivers in many small communities' economies (Section 3),
- (2) Estimates the economic impact of the Bradford refinery located in Bradford, PA, owned by ARG (Section 4),
- (3) Comments on the negative impacts associated with a potential increase in abandoned wells in Pennsylvania (Section 5).

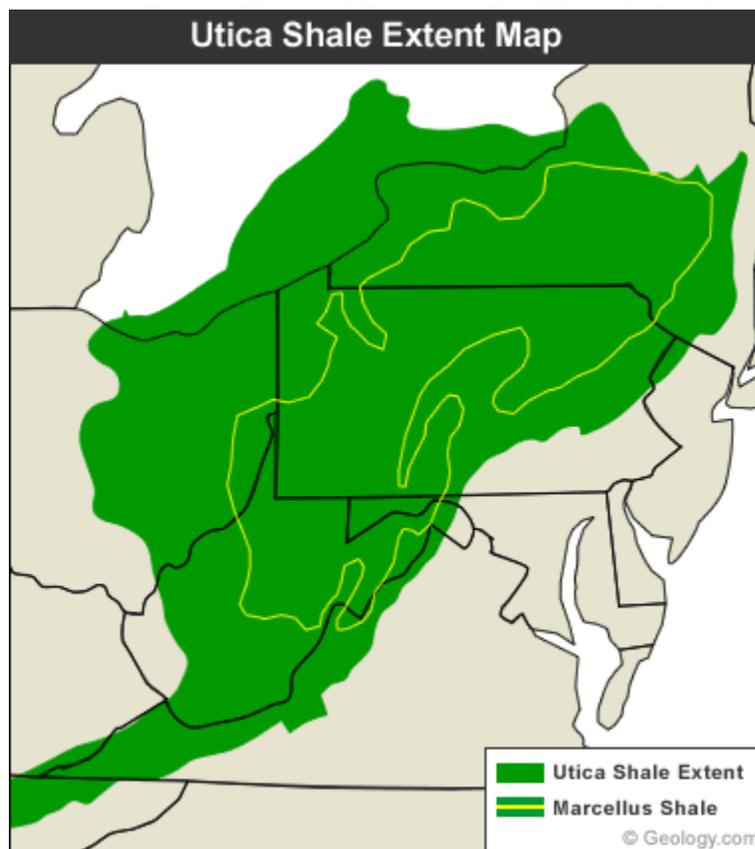
³ Woodall, Candy, "The Rise and Fall – and Rise? Of PA's Oil and Gas Industry," March 17, 2016. http://www.pennlive.com/news/2016/03/the_rise_and_fall_and_rise_of.html

2.0 OIL AND GAS WELLS IN PENNSYLVANIA

2.1 OIL AND GAS WELLS IN PENNSYLVANIA

Western Pennsylvania has rich oil and natural gas resources accessible using conventional and unconventional technologies. While the Utica shale and the Marcellus shale cover a significant portion of Pennsylvania, they both also extend into Ohio, West Virginia, New York and Quebec (see Figure 2.1).⁴

FIGURE 2.1 – MAP OF THE BOUNDARIES OF THE MARCELLUS AND UTICA FORMATIONS



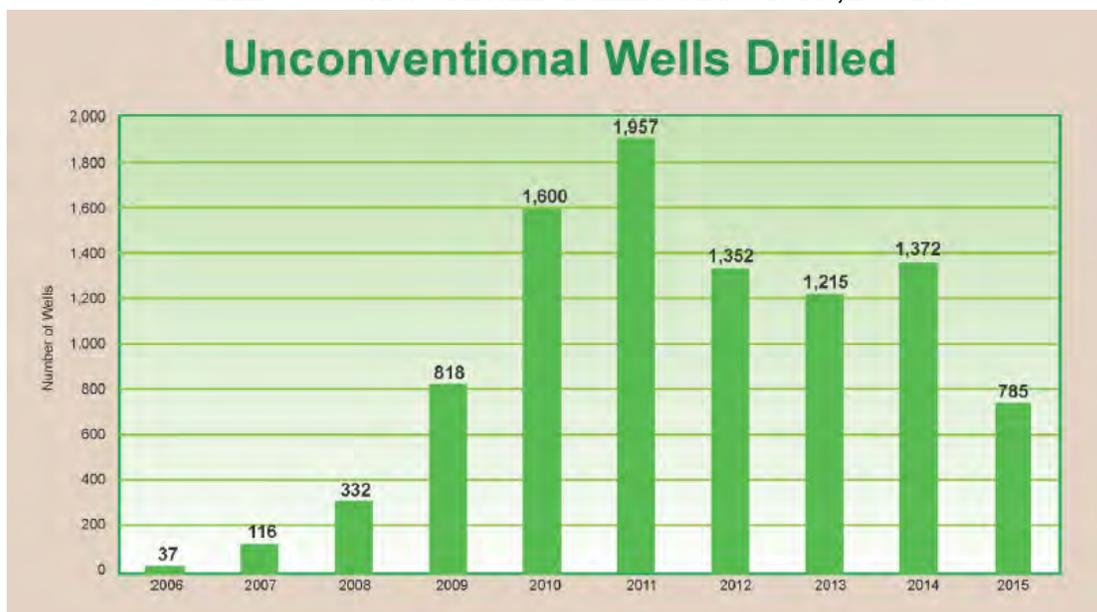
Source: Geoscience News and Information Geology.com (2015), Energy Information Administration (2015), United States Geological Survey (2015)

⁴ Appendix B has maps from DEP's website showing active and non-active conventional oil and gas wells in Pennsylvania.

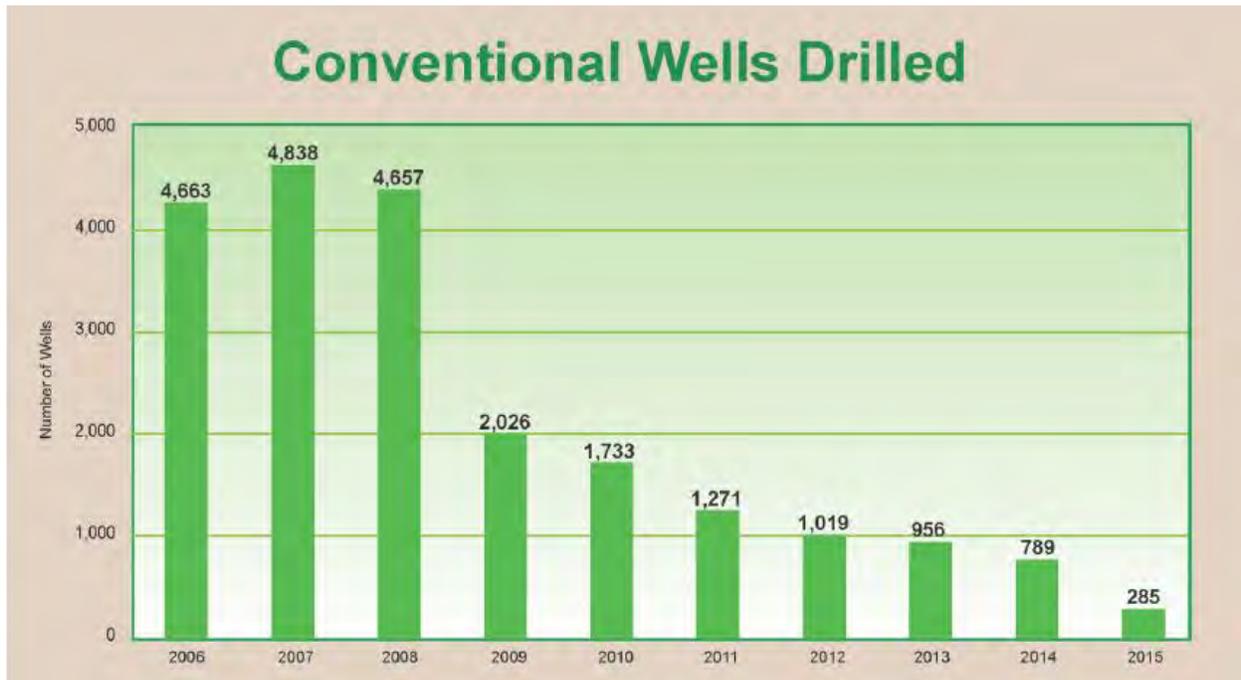
There are three basic sequential steps in the oil and gas process – permitting, drilling, and production. Market conditions influence each but with different time lags. Discovery of new supplies and new technologies in the 21st century saw each of these increase to unprecedented levels (both in Pennsylvania and nationwide). The recent oversupply world market conditions have significantly reduced permitting, new drilling and production. Nationwide natural gas production is down 4 percent and oil production down 10 percent. The decreases are even larger in the conventional realm.

The number of total permits issued by the Pennsylvania Environmental Protection Department (DEP) decreased in recent years because of the oversupply and the declining market price of both oil and gas. As the price of natural gas increased slightly in 2013, the number of permits mirrored the rise. While there was a substantial increase in the number of permits issued for unconventional wells in Pennsylvania between 2008 and 2013, the number of permits issued for conventional wells slowly declined since (see Figure 2.2 and Figure 2.3). This reflects the boom in drilling unconventional wells in the Marcellus and Utica shale, a change in Pennsylvania well casing regulations, and gas pipeline restrictions imposed by the large volumes of gas brought online by unconventional gas drilling. The reduction in drilling activity due to oversupply and extremely low prices has impacted the conventional oil and gas producers in Pennsylvania and the industries and suppliers that support drilling and production activities.

FIGURE 2.2 – UNCONVENTIONAL WELLS DRILLED IN PENNSYLVANIA, 2006-2015

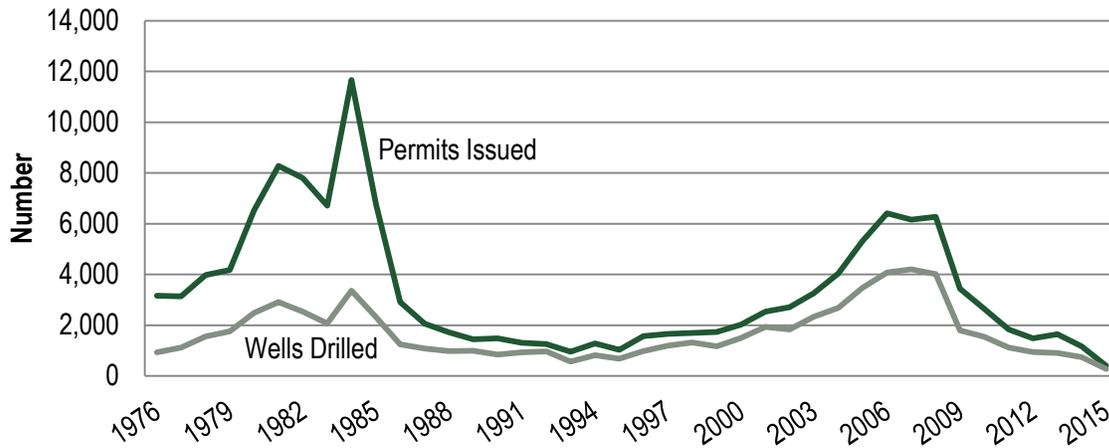


Source: PA Department of Environmental Protection (2015)

FIGURE 2.3 –CONVENTIONAL WELLS DRILLED IN PENNSYLVANIA, 2006-2015

Source: PA Department of Environmental Protection (2015)

The actual number of unconventional and conventional wells drilled in Pennsylvania is less than the number of well drilling permits issued by DEP (see Figure 2.4). A well drilling permit is valid for a year and can be extended if approved by DEP. An operator may commence drilling at any time during the period that the permit is in effect. Depending on individual business practices, oil and gas operators may secure a well drilling permit far in advance of commencing drilling operations. In some cases, an operator may also determine that a site is not suitable for drilling after getting the permit.

FIGURE 2.4 – PERMITS ISSUED AND CONVENTIONAL (1976-2016) AND UNCONVENTIONAL (2006-2016) WELLS DRILLED

Source: Falcede Energy Consulting LLC (2016)

Before 2008, the production of natural gas in Pennsylvania relied primarily on conventional wells. Decades ago, Marcellus shale was thought to have limited potential for natural gas production. Since, it has been named the largest source of natural gas in the United States.⁵ The growth of the unconventional gas market is reflected in the increase in new permits, wells drilled, and even more so in the dramatic increase in overall production since 2009. Pennsylvania has become the second largest producer of natural gas in the U.S. behind Texas⁶ Across conventional and unconventional wells, as of 2016, there are 129,368 active wells in Pennsylvania (see Table 2.1).

TABLE 2.1 – ACTIVE CONVENTIONAL AND UNCONVENTIONAL WELLS IN PENNSYLVANIA 2016

Type of Well	Number of Active Wells
Conventional Oil or Gas	119,534
Unconventional Oil or Gas	9,834
Total All Wells	129,368

Source: Pennsylvania Department of Environment Protection

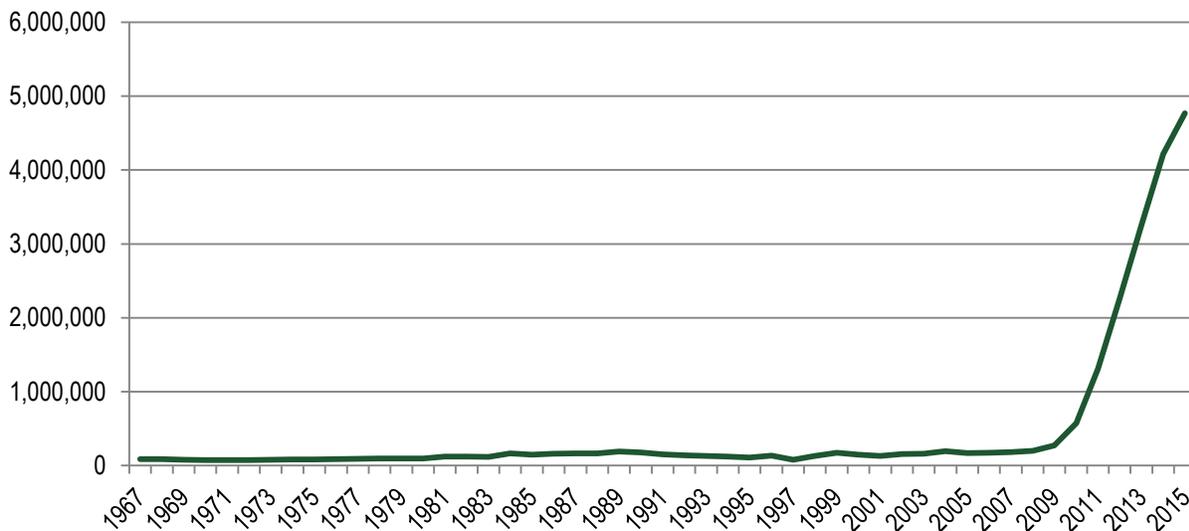
⁵ U.S. Energy Information Administration, "Top 100 U.S. Oil and Gas Fields", March 2015

⁶ U.S. Energy Information Administration, <https://www.eia.gov/tools/faqs/faq.cfm?id=46&t=8>, accessed 10/14/2016

In 2012, the Marcellus shale became the leading producer of both shale gas and natural gas in the U.S.⁷ In 2015, over 4.6 billion Mcf⁸ (4.6 trillion cubic feet) of natural gas came from unconventional wells in Pennsylvania as compared to the 78 million Mcf (78 billion cubic feet) produced in 2009.⁹ The production of natural gas has escalated at an exponential rate over the last seven years with most of the production coming from unconventional drilling (see Figure 2.5 and Figure 2.6). Despite the significant reduction in permitting and new drilling activity, production from already drilled unconventional wells remains at extremely high levels.

A high level of domestic and international production is keeping energy prices low. Most of the decline in natural gas prices is due to the current abundance of oil and gas supplies worldwide. The depressed prices are good for consumers/end users but bad for producers. In reaction to prices, and because the costs of drilling are more than the revenues received, the drilling of new wells has slowed, most notably conventionally drilled wells.

FIGURE 2.5 – PENNSYLVANIA NATURAL GAS MARKETED PRODUCTION (MMCF¹⁰)



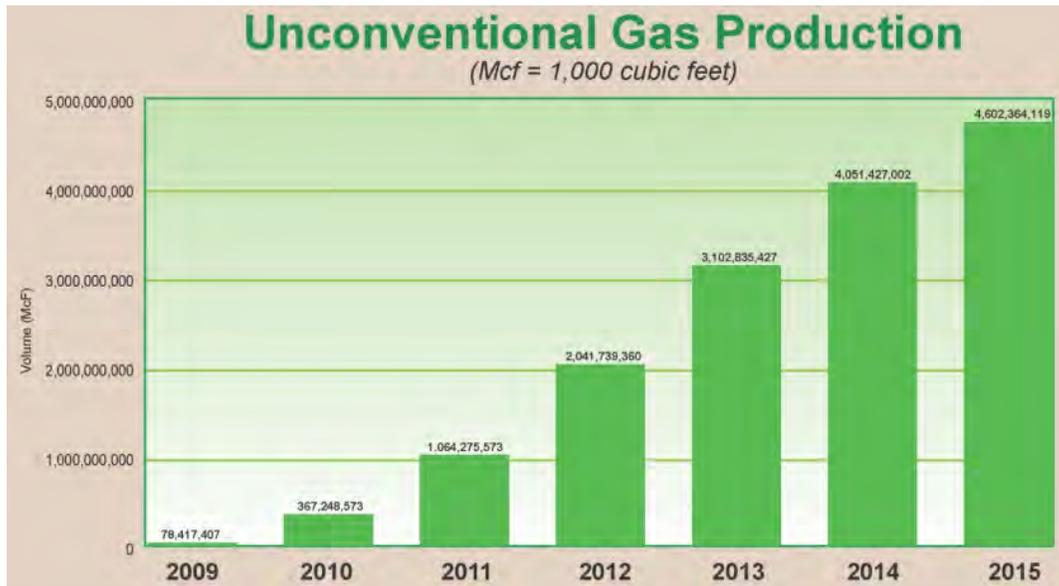
Source: U.S. Energy Information Administration (2016)

⁷ This includes drilling activity outside of Pennsylvania as the Marcellus shale spans several states

⁸ Mcf = one thousand cubic feet

⁹ 2015 Oil and Gas Annual Report, Pennsylvania Department of Environmental Protection, 2015

¹⁰ MMcf = million cubic feet

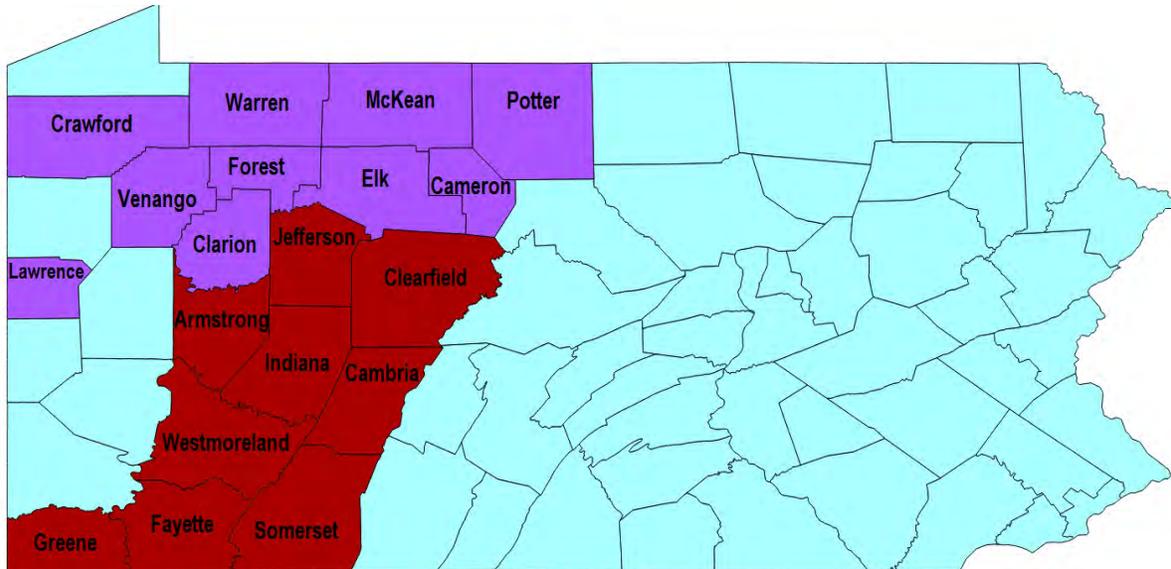
FIGURE 2.6 – GROWTH OF UNCONVENTIONAL GAS PRODUCTION IN PENNSYLVANIA 2009 - 2015

Source: Marcellus Shale Coalition

2.2 LOCATION OF CONVENTIONAL OIL AND GAS WELLS

This report focuses on 19 counties in western Pennsylvania (referred to as the “19-County Region” throughout this report) (see Figure 2.7). Most of the conventional wells in the northwest portion of Pennsylvania are conventional oil and most of the wells in the southwest are conventional gas. For this economic impact analysis, the aggregate impact of all 19 counties is presented. While there are conventional oil and gas wells in other counties in Pennsylvania, these 19 have the most significant well activity and conventional production is an important part of their local economies (see Table 2.2). The economic analysis will include the production and revenues associated with the active oil and gas wells in the 19-County Region. In Figure 2.7, the northwest counties are shaded purple and the southwest counties are shaded red.

FIGURE 2.7 – NINETEEN COUNTIES WITH SIGNIFICANT CONVENTIONAL OIL (NORTHWEST PA) AND GAS (SOUTHWEST PA) WELL ACTIVITY INCLUDED IN OUR ANALYSIS



Source: PGCC (2016)

TABLE 2.2 – COUNTIES WITH SIGNIFICANT CONVENTIONAL OIL AND GAS WELL ACTIVITY INCLUDED IN OUR ANALYSIS

Northwest	Southwest
Cameron	Armstrong
Clarion	Cambria
Crawford	Clearfield
Elk	Fayette
Forest	Greene
Lawrence	Indiana
McKean	Jefferson
Potter	Somerset
Venango	Westmoreland
Warren	

Source: PGCC (2016)

2.3 DEMOGRAPHICS OF COUNTIES WITH SIGNIFICANT CONVENTIONAL WELL ACTIVITY

The counties in which there is significant conventional oil and gas activity are rural. While the 19-County Region represent 29 percent of the counties in the state (67 counties total), they account for only 11 percent of the Commonwealth's population and tend to be smaller, poorer, and less densely populated than compared to the average across the state.

In 2015, Pennsylvania's population was 12,802,503, up by 0.8 percent from 2010.¹¹ In contrast, every one of the 19 counties experienced population loss, with an average population loss of 2.9 percent (see Table 2.3). Loss of population means a reduction in tax base for these small towns, many of which are heavily reliant on property and income taxes. Reductions in jobs and/or population will directly affect these two local taxes.

¹¹ U.S. Census Quickfacts

TABLE 2.3 - POPULATION CHANGE BY COUNTY

County	Region	Population (2015)	Population Growth
			Rates (2010 to 2015)
Armstrong	Southwest	67,052	-2.7%
Cambria	Southwest	136,411	-5.1%
Cameron	Northwest	4,732	-6.9%
Clarion	Northwest	39,989	-1.2%
Clearfield	Southwest	80,994	-0.8%
Crawford	Northwest	86,484	-2.6%
Elk	Northwest	30,872	-3.4%
Fayette	Southwest	133,628	-2.2%
Forest	Northwest	7,410	-4.0%
Greene	Southwest	37,519	-3.0%
Indiana	Southwest	86,966	-2.2%
Jefferson	Southwest	44,430	-1.7%
Lawrence	Northwest	88,082	-3.4%
McKean	Northwest	42,412	-2.4%
Potter	Northwest	17,093	-2.1%
Somerset	Southwest	75,522	-2.9%
Venango	Northwest	53,119	-3.4%
Warren	Northwest	40,396	-3.4%
Westmoreland	Southwest	357,956	-2.0%
Subtotal	Western PA	1,431,067	-2.9%
Total PA		12,802,503	0.8%

Source: U.S. Census Quickfacts

The average per capita income and median household income across these 19 counties as of 2014 are approximately 80 percent of the average for the Commonwealth (see Table 2.4). None of the counties has median incomes above the state's average.

TABLE 2.4 – INCOME CHARACTERISTICS BY COUNTY

County	Median Household Income (in 2014 dollars)	% of Pennsylvania Median Household Income	% of National Median Household Income
Armstrong	\$45,375	85%	85%
Cambria	\$42,304	80%	79%
Cameron	\$41,157	77%	77%
Clarion	\$42,880	81%	80%
Clearfield	\$41,510	78%	78%
Crawford	\$43,622	82%	82%
Elk	\$46,576	88%	87%
Fayette	\$38,879	73%	73%
Forest	\$36,037	68%	67%
Greene	\$46,485	88%	87%
Indiana	\$45,168	85%	84%
Jefferson	\$42,295	80%	79%
Lawrence	\$43,991	83%	82%
McKean	\$42,913	81%	80%
Potter	\$41,862	79%	78%
Somerset	\$44,255	83%	83%
Venango	\$43,291	82%	81%
Warren	\$44,391	84%	83%
Westmoreland	\$51,593	97%	96%
Pennsylvania	\$53,115		
United States	\$53,482		

Source: U.S. Census Quickfacts, U.S. Census American Community Survey (2010-2014)

On average, these counties have a slightly higher unemployment rate than the Commonwealth as a whole (see Table 2.5). Only Elk and Warren counties had lower unemployment than the state average. Overall, the region saw employment growth from 2013 to 2014, with the average slightly higher than the state overall, which is in part due to increased demand for energy and drilling. In particular, Forest County saw an almost 15 percent increase in employment from 2013 to 2014, which is likely due to an increase in staff at the prison in Marienville. Despite this increase, Cameron and Forest counties have less than 2,000 persons employed as of 2014. These statistics show that a change in an entire industry can have significant impacts on employment in these mostly rural areas.

TABLE 2.5 – EMPLOYMENT TRENDS BY COUNTY¹²

County	Unemployment Rate (May 2016)	Total Employment (2014)	Employment Percent Change (2013-2014)
Armstrong	7.2%	14,409	-0.4%
Cambria	6.7%	47,647	-1.0%
Cameron	6.9%	1,613	2.2%
Clarion	6.2%	10,982	0.6%
Clearfield	7.1%	26,170	-0.3%
Crawford	5.8%	27,502	-0.3%
Elk	5.4%	14,499	4.9%
Fayette	8.3%	36,687	4.1%
Forest	7.1%	1,225	14.7%
Greene	7.7%	14,203	-2.6%
Indiana	7.3%	26,933	5.8%
Jefferson	6.6%	14,023	4.1%
Lawrence	6.5%	27,359	2.2%
McKean	6.6%	13,223	-5.6%
Potter	7.7%	4,230	0.4%
Somerset	7.0%	18,761	-0.1%
Venango	7.0%	16,234	-1.6%
Warren	5.2%	14,084	0.7%
Westmoreland	5.8%	123,755	0.5%
Subtotal	6.7%	453,539	1.5%
Pennsylvania	5.5%	6,070,170	1.3%

Source: U.S. Census Quickfacts, Bureau of Labor Statistics

¹² Based on information from the Census Bureau and BLS, there is a lot of data missing for these counties in terms of employment. Because of this, the calculated total employment is based on estimated ranges that can go from 0-19, 22-99 or even 1000-2,499. Because of that, the numbers can show extreme growth or vice versa.

3.0 ECONOMIC IMPACT OF CONVENTIONAL OIL AND GAS DRILLING

3.1 2011 TO 2015 PRODUCTION AND REVENUE

Worldwide production, demand, and the resulting prices impact the oil and gas industry in Pennsylvania. In the past ten years the industry has seen great variability, from a boom period to the current period of oversupply and low prices. With prices so low, many producers in the state have reduced their production to some of the lowest levels in recent years. When market forces change, as they always do, production will increase again.

Given the variability in the industry over the past several years, we used production levels and prices for the years 2011 to 2015 and averaged them to provide a smoothed amount of annual direct impact. Production and revenues were first determined individually for each year and for each county in the 19-County Region from 2011 to 2015. By using five years of data for each county, an average annual economic impact was determined for the 19-County Region. For the 5 year period from 2011 to 2015, conventional wells in the 19-County region produced a cumulative total of 144.6 Bcf¹³ of gas and 2.0 million barrels of oil. (see Table 3.1).

¹³ Billion cubic feet

TABLE 3.1 – AVERAGE ANNUAL PRODUCTION BY COUNTY FOR 2011-2015 (CONVENTIONAL WELLS)

County	Gas Quantity (Mcf)	Oil Quantity (Barrels)
Armstrong	16,531,795	10,228
Cambria	1,033,541	0
Cameron	67,025	0
Clarion	4,019,331	9,935
Clearfield	6,467,897	69
Crawford	10,788,536	117,144
Elk	2,900,348	211,013
Fayette	9,024,312	4,725
Forest	3,522,348	284,328
Greene	16,147,243	67,488
Indiana	29,382,748	3,262
Jefferson	11,475,429	1,781
Lawrence	317,123	34
McKean	5,478,694	682,287
Potter	1,552,357	1,797
Somerset	290,967	0
Venango	5,246,453	100,228
Warren	4,353,616	459,797
Westmoreland	15,959,885	32,379
19-County Subtotal	144,559,647	1,986,494

Source: PA DEP Oil & Gas Reporting Website (2015)¹⁴, Falcede Energy Consulting, LLC (2016)

¹⁴ Adjustments were made to the reported production values on the DEP Oil and Gas Reporting Website, <https://www.paoilandgasreporting.state.pa.us/publicreports/Modules/Welcome/Agreement.aspx>
See Appendix C for additional details.

To estimate the annual economic impact of the oil and gas industry within Pennsylvania, we used 2011 to 2015 production and pricing data to determine gas and oil revenues within each of the 19 counties. Oil and gas prices provided by PGCC for each year,¹⁵ in combination with production from conventional wells, were used to estimate average annual revenues within each county.¹⁶ It is estimated that the 19-County Region generated \$648.4 million in gas revenue and \$180.6 million in oil revenue from conventional wells each year (see Table 3.2).¹⁷

TABLE 3.2 –AVERAGE ANNUAL REVENUE BY COUNTY FOR 2011-2015 (CONVENTIONAL WELLS) (\$ MILLIONS, \$2016)¹⁸

County	Gas Revenue	Oil Revenue	Combined Revenue
Armstrong	\$68.9	\$0.9	\$69.8
Cambria	\$4.3	\$0.0	\$4.3
Cameron	\$0.3	\$0.0	\$0.3
Clarion	\$19.2	\$0.9	\$20.1
Clearfield	\$27.3	\$0.0	\$27.3
Crawford	\$46.5	\$10.7	\$57.2
Elk	\$12.3	\$19.1	\$31.4
Fayette	\$38.6	\$0.4	\$39.0
Forest	\$20.1	\$26.2	\$46.3
Greene	\$76.7	\$6.0	\$82.7
Indiana	\$122.7	\$0.3	\$123.0
Jefferson	\$44.9	\$0.2	\$45.1
Lawrence	\$1.3	\$0.0	\$1.3
McKean	\$29.1	\$62.7	\$91.8
Potter	\$7.3	\$0.2	\$7.5
Somerset	\$1.2	\$0.0	\$1.2
Venango	\$32.3	\$8.9	\$41.2
Warren	\$28.0	\$41.1	\$69.1
Westmoreland	\$67.4	\$3.0	\$70.4
Total	\$648.4	\$180.6	\$829.0

Source: PGCC (2016), ESI (2016)

¹⁵ See Appendix D for details on the conventional oil and natural gas prices used in our calculations for each year of production

¹⁶ See Appendix E for the detailed calculation for Armstrong County to illustrate the methodology used to determine annual revenues.

¹⁷ All dollar values are shown in 2016 dollars for modeling purposes. Estimated revenues for earlier years were adjusted for inflation in order to consistently combine each of the five years and arrive at an average dollar amount in \$2016.

¹⁸ Totals may not sum due to rounding.

3.2 ECONOMIC IMPACT METHODOLOGY

This analysis uses IMPLAN, an input output modeling software, to estimate the economic impacts of the conventional oil and gas industry. IMPLAN is an industry standard tool to assess the economic and job creation impacts of economic development projects, the creation of new businesses, and public policy changes. IMPLAN translates an initial amount of direct economic activity into the total amount of economic activity that it supports, which includes multiple waves of spillover impacts generated by spending on goods and services and by spending of labor income by employees. Direct economic activity generated by the conventional well industry translates into additional economic activity:

- First, some portion of the direct expenditures goes to the purchase of goods and services which gets circulated back into an economy when those goods and services are purchased from local vendors. This represents the “**indirect effect**,” and reflects the fact that local purchases of goods and services support local vendors, who in turn require additional purchasing with their own set of vendors.
- Second, annual salaries are paid to the conventional well employees. That labor income gets circulated back into an economy when those employees spend some of their earnings on various goods and services. This represents the “**induced effect**,” and reflects the fact that some of those goods and services will be purchased from local vendors, further stimulating a local economy.

The total economic impact is the sum of its own direct economic footprint and the indirect and induced effects generated by that direct footprint (see Figure 3.1).

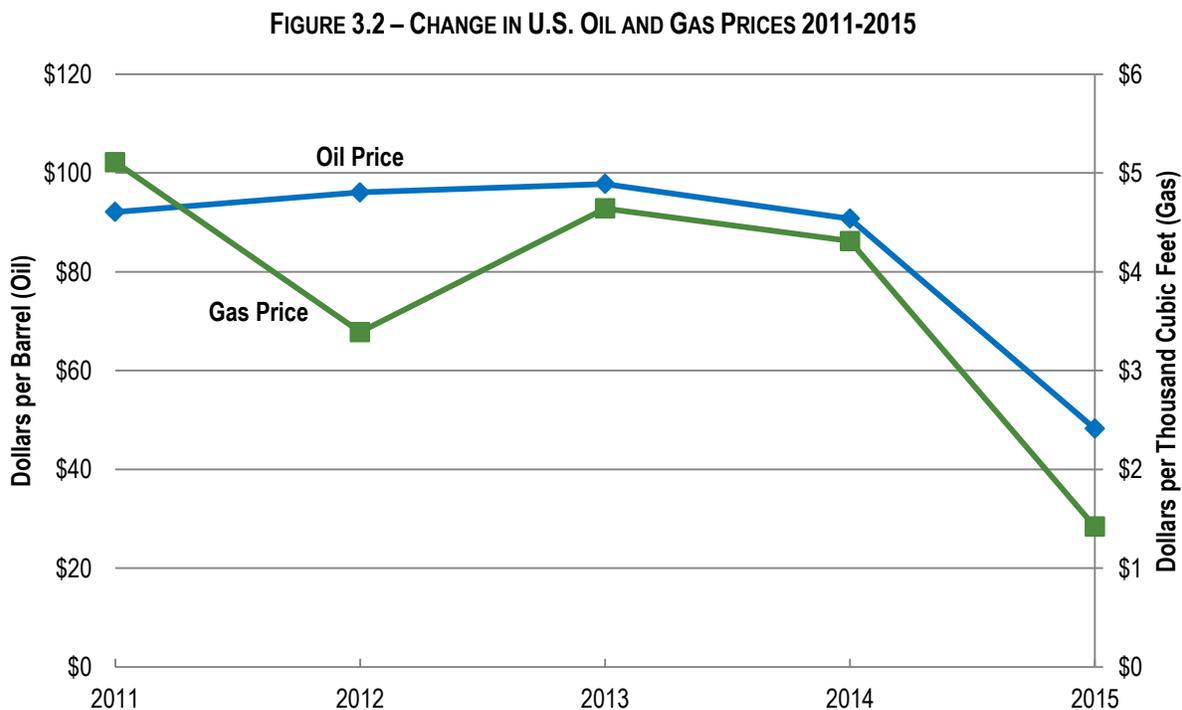
FIGURE 3.1 - ECONOMIC IMPACT METHODOLOGY



Source: ESI (2016), Piktochart (2016)

3.3 ESTIMATED ECONOMIC IMPACT OF CONVENTIONAL OIL AND GAS WELLS IN THE 19-COUNTY REGION

It is important to note that the impacts calculated and described below apply to the 2011 to 2015 period. Because gas and oil prices, as well as total production within each county vary significantly across time, we created an annual snapshot using a five-year average. As previously noted, the prices of crude oil and natural gas declined significantly between 2014 and 2015 and, in general, increase and decrease significantly from year to year. The conventional well industry’s variability suggests that it is most appropriate to look at multiple years of data rather than one year (see Figure 3.2). The estimated economic impacts represent the industry’s average annual impact between 2011 and 2015. Average gas price in 2016 through September was \$1.06 and the average oil price in 2016 through November was \$41.55. Because annual production and year-end average pricing were not available for the entirety of 2016 at the time of this analysis, the annual impact for 2016 was not included in the economic impact model. However, it is important to note the continuing downward trend of oil and gas prices.

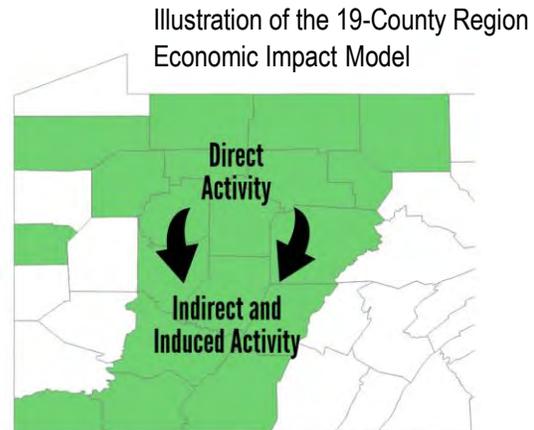


Source: PGCC (2011-2015)

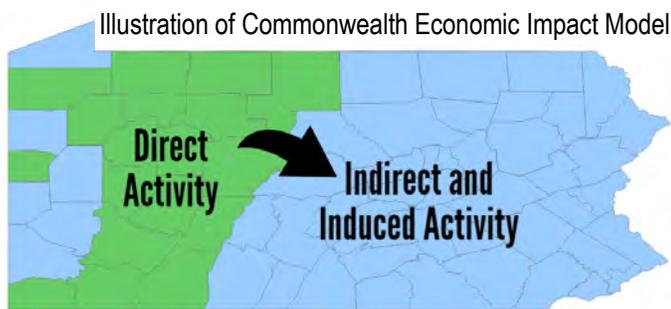
The operations of the conventional oil and gas wells in the 19-County Region generate significant economic impact throughout the Commonwealth by utilizing local vendors and

employing commonwealth residents, including those businesses and employees that are not located in the 19-County Region. We estimated the total economic impact for two geographies using the drilling activity from the 19-County Region for each.

- 1) First, we modeled the total economic impact contained to the 19-County Region to show the magnitude of the economic impact, including the spillover effects of the direct activity at the conventional wells, to this specific geography within the Commonwealth.



- 2) Second, we modeled the total economic impact from the drilling in the 19-County Region across the entire Commonwealth to show that the indirect and induced impacts, the spending by businesses and jobs supported by conventional well activity, are not contained only to those counties.



Drilling activity in the 19-County Region supports businesses and jobs across the state, in counties outside of where most of the drilling takes place.

ESTIMATED ECONOMIC IMPACTS IN THE 19-COUNTY REGION

As shown in Figure 2.7, most of the conventional oil activity takes place in the northwest portion of the 19-County Region and most of the conventional gas activity takes place in the southwest portion. The economic impacts in the ten northwest counties and in the nine southwest counties were modeled separately. They were added together to get the economic impact in the 19-County Region. In aggregate in the 19-County Region, the annual economic impact is approximately \$1.2 billion and the activity of the conventional oil and gas wells supports approximately 4,700 total jobs and \$185 million in earnings (see Table 3.3).

**TABLE 3.3 - ESTIMATED ANNUAL ECONOMIC IMPACT OF CONVENTIONAL WELLS
IN THE 19-COUNTY REGION FROM 2011-2015 (\$ MILLIONS)¹⁹**

Economic Impact	Northwest	Southwest	19 County Total
Direct Output	\$366	\$463	\$829
Indirect & Induced Output	\$138	\$226	\$364
Total Output	\$504	\$689	\$1,193
Total Employment (FTE)	1,900	2,800	4,700
Total Earnings	\$80	\$105	\$185

Source: PA.gov (2015), Energy Information Administration (2015), ESI (2016), IMPLAN (2013)

ESTIMATED ECONOMIC IMPACTS IN THE COMMONWEALTH

The total impact in the Commonwealth includes all the economic impacts within the 19-County Region plus the indirect and induced (spillover) effects realized in the other 48 counties. The difference between the total output, total employment, and total earnings between the 19-County Region and the Commonwealth of Pennsylvania comes from the indirect and induced impact in those 48 counties. Within the Commonwealth of Pennsylvania, the operations of the conventional oil and gas wells in the 19-County region generate nearly \$1.4 billion in economic impact and support 5,600 jobs with \$241 million in earnings (see Table 3.4).

**TABLE 3.4 - ESTIMATED ANNUAL ECONOMIC IMPACT OF CONVENTIONAL WELLS IN
THE COMMONWEALTH OF PENNSYLVANIA FROM 2011-2015 (\$ MILLIONS)¹**

Economic Impact	Total Commonwealth
Direct Output	\$829
Indirect & Induced Output	\$546
Total Output	\$1,375
Total Employment (FTE)	5,600
Total Earnings	\$241

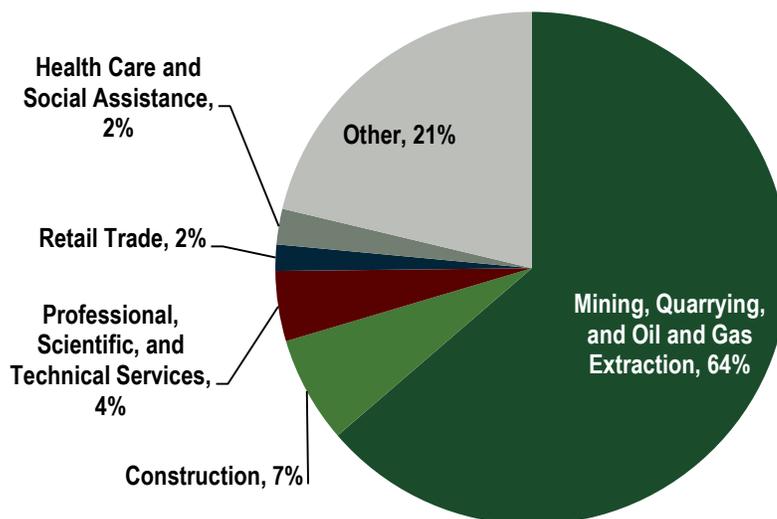
Source: PA.gov (2015), Energy Information Administration (2015), ESI (2016), IMPLAN (2013)

¹⁹ Since the 19-County region is contained wholly in the Commonwealth, its economic impacts as shown in Table 3.4, are included in the economic impacts in the Commonwealth (Table 3.5). Therefore, of the \$1.375 billion of total economic impact in the Commonwealth, \$1.193 billion occurs in the 19-County Region. And, since the model assumes that 4,700 of the 5,600 total employees supported reside in the 19-County Region, 900 employees outside of that region, across the Commonwealth, have jobs supported because of the conventional oil and gas activity taking place in the 19-County Region.

INDUSTRIES SUPPORTED BY THE CONVENTIONAL OIL AND GAS INDUSTRY

It is noteworthy to mention that the operations of the conventional wells in Pennsylvania affect a large variety of industries, not just the mining, quarrying, and oil and gas extraction industry. Sixty-four percent of the economic impact is from direct activity in the mining, quarrying, and oil and gas extraction industry. By purchasing additional goods and services within Pennsylvania, the indirect and induced impact spans industries such as the construction industry, the professional services industry, and the retail trade industry (see Figure 3.3 and Appendix F).

FIGURE 3.3 - ESTIMATED ECONOMIC IMPACT OF CONVENTIONAL WELLS IN THE COMMONWEALTH OF PENNSYLVANIA BY INDUSTRY



Source: PA.gov (2015), Energy Information Administration (2015), ESI (2016), IMPLAN (2013)

The way in which the direct economic impacts and spillover impacts affect these various industries is illustrated in Figure 3.3. Specifically, the induced impacts are generated through local spending by the employees of the conventional wells while the indirect impacts are generated by spending on local goods and services needed to operate the wells. Each industry (in this case, the conventional oil and gas well industry) has unique spillover effects, which dictate the magnitude and variety of indirectly affected industry impacts.

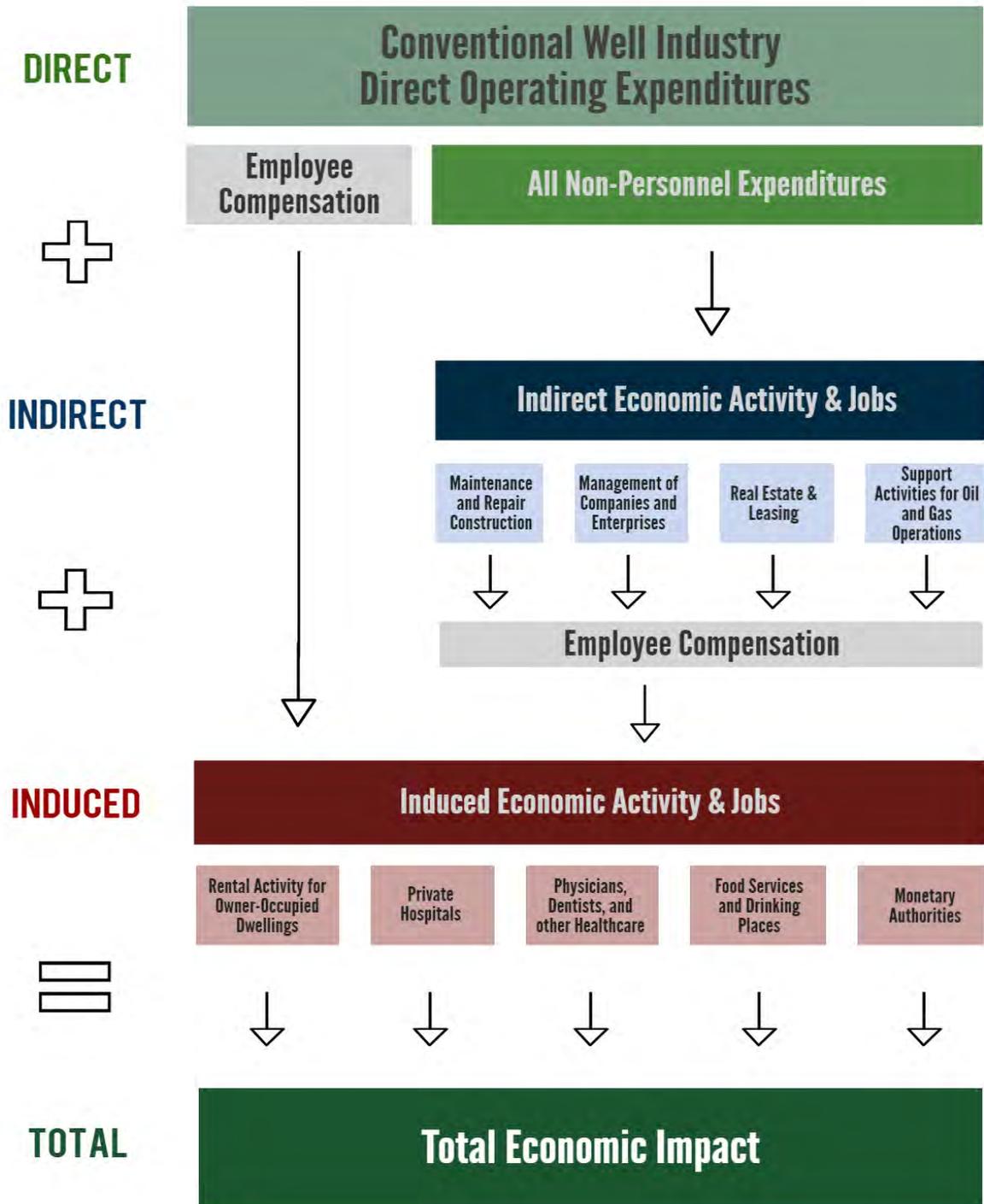
The indirect impacts fall largely in four main categories:

- the maintenance and repair construction industry,
- the management of companies and enterprises industry,
- the real estate and leasing industry, and
- the support activities for oil and gas operations industry (which includes heavy equipment and fleet purchases).

The induced impacts fall in five main industries:

- the rental activity industry,
- the private hospital industry,
- the health care industry,
- the food service industry, and
- the monetary authority industry (see Figure 3.4 and Appendix F).

FIGURE 3.4 – VISUALIZATION OF THE ECONOMIC IMPACT OF CONVENTIONAL WELLS IN THE COMMONWEALTH OF PENNSYLVANIA BY INDUSTRY

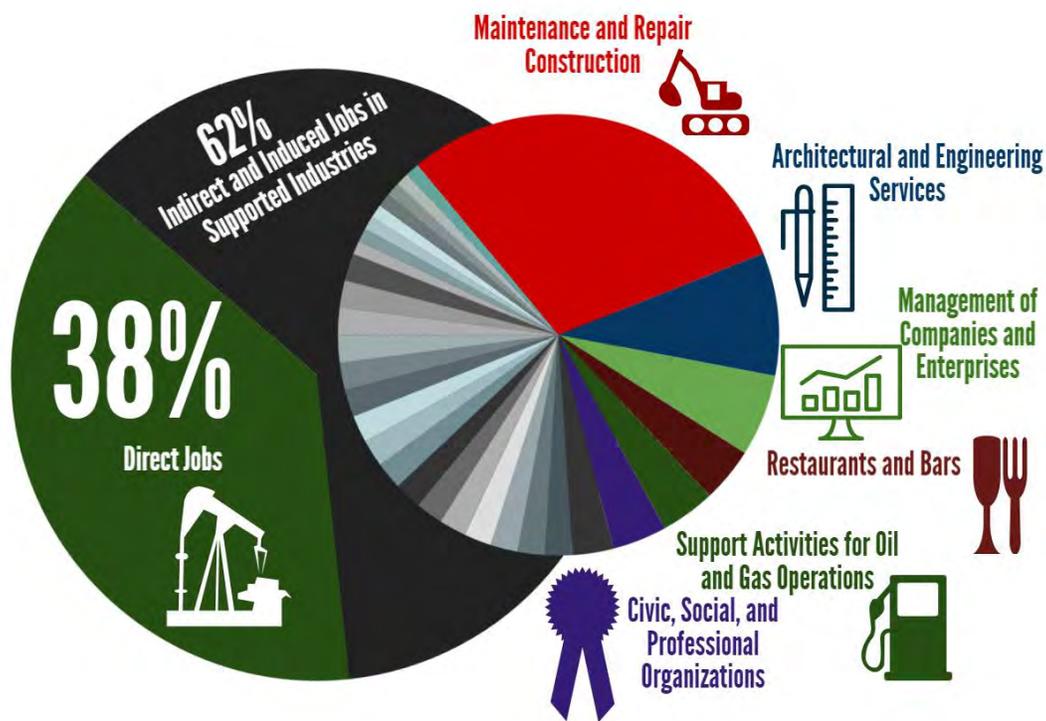


Source: Piktochart (2016), ESI (2016), IMPLAN (2013)

3.4 ESTIMATED EMPLOYMENT IMPACT OF CONVENTIONAL OIL AND GAS WELLS IN PENNSYLVANIA

Similar to the total economic impact, jobs supported by the conventional oil and gas industry include many other industries. Thirty-eight percent of the jobs supported in the 19-County Region (approximately 2,100 jobs) are the direct jobs involved in the operations of these wells and are in the mining, quarrying, and oil and gas extraction industry. Sixty-two percent of the jobs supported (approximately 3,500 jobs) by the conventional oil and gas industry are indirect and induced jobs in other industries that geographically, are across all of Pennsylvania. These include the construction industry, the professional, scientific, and technical services industry, and the retail trade industry (see Figure 3.5 and Appendix G).

FIGURE 3.5 - ESTIMATED EMPLOYMENT IMPACT OF CONVENTIONAL WELLS IN THE COMMONWEALTH OF PENNSYLVANIA BY INDUSTRY



Source: PA.gov (2015), Energy Information Administration (2015), ESI (2016), IMPLAN (2013)

3.5 ESTIMATED FISCAL IMPACT OF CONVENTIONAL OIL AND GAS WELLS IN THE 19-COUNTY REGION

The operations of the conventional oil and gas wells in the 19-County Region also support significant tax revenues for the Commonwealth in the form of income, sales, and businesses taxes. It is estimated that these conventional wells generate an estimated \$17 million in taxes each year for the Commonwealth of Pennsylvania (see Table 3.5).²⁰

Not calculated as part of this analysis but important to note is the local fiscal impact generated by this industry. Direct wages paid to conventional well employees will yield income and local services taxes to their local municipalities. In addition, the wages of those employed in the industries supported by the conventional well industry also contribute to the income and local services tax revenues in their respective municipalities.

TABLE 3.5 – ESTIMATED ANNUAL FISCAL IMPACT OF CONVENTIONAL WELLS IN THE 19 COUNTIES TO THE COMMONWEALTH OF PENNSYLVANIA (\$ MILLIONS)

Pennsylvania Tax Categories	Annual Tax Revenues
Income	\$7
Sales & Use	\$8
Business	\$2
Total Taxes	\$17

Source: PA.gov (2015), Energy Information Administration (2015), ESI (2016), IMPLAN (2013), State of Pennsylvania Tax Compendium (2013)

3.6 FEES AND LOCAL TAXES

CONVENTIONAL WELL PERMITTING FEES

Conventional well operators pay permit fees to the DEP that range from \$250 to \$1,950, depending on the well bore length. Permit fees from conventional and unconventional drillers support more than half of the approximately \$20 million annual budget of DEP's Office of Oil and Gas Management, with the remainder coming from other fees, fines, and penalties. The office is responsible for regulating oil and gas development and production and ensuring that

²⁰ This is for taxes paid to the Commonwealth government. Local earned income taxes collected within municipalities and school districts generate additional tax revenues for those governments but are not included in table 3.5.

the activities protect the Commonwealth's natural resources and environment. Through permit fees, the oil and gas industry helps insure that taxpayer money isn't needed to support drilling activities.

A surcharge is added to the permit fee for both conventional and unconventional wells to fund DEP's Orphan and Abandoned Well Plugging Program. The orphan well surcharge is \$200 and \$100 for gas and oil well permits, respectively. The abandoned well surcharge is \$50 for all well permits. Safely plugging a well can cost anywhere from \$5,000 to \$200,000 for all well types. The DEP currently has 12,383 total wells on its abandoned and orphan list. The DEP has plugged over 3,500 wells, 34 of which were completed in 2015.

LOCAL TAX REVENUES

As mentioned previously in this report, the operations of the conventional wells represent not only statewide tax revenues, but also tax revenues to the small municipal governments where they are located. These small municipalities rely on property taxes, income tax, and the local services tax for a large portion of their revenues. The latter two are directly based on wages and employment, respectively. In many cases, the local tax revenues from the conventional well industry are a significant part of their municipal budgets. It would be extremely difficult for these municipalities to operate and deliver services without these tax revenues.

The municipalities provide public services, such as fire and police departments, snow removal, trash collection, libraries, and routine street maintenance. Without the conventional oil and gas wells, these towns would suffer job loss, tax loss, and decreased business activity. Many of these smaller towns do not have robust job bases and as shown previously in Table 2.3 and all have had population decreases from 2010 to 2015. Those employed or supported by the conventional oil and gas industry may need to move in search of other job opportunities, negatively impacting the property tax base. Additionally, the job loss created by a cessation of operations would cause negative spillover impacts within the local area. The loss of income for families of these displaced workers would discourage local spending on goods and service. This could, in turn, create additional job loss, continuing to deplete a municipality's economy.

3.7 ESTIMATED AVERAGE ECONOMIC IMPACT ON A PER WELL BASIS

The conventional well industry within the 19-County Region of western Pennsylvania has a significant impact across the state. As previously shown in Table 2.1, there are 129,368 total active wells in Pennsylvania. Of those active wells, 119,534 are conventional oil and gas wells. The majority (90 percent or about 107,500 wells) of the conventional oil and gas wells are located in the 19-County Region. Each of the 107,500 conventional oil and gas wells in the 19-County Region contributes to the total economic impact of the entire industry within the Commonwealth of Pennsylvania.

Although wells differ in annual production, size, and product output, it is helpful to scale the impacts to a per well basis to gauge the change in output resulting from an individual well. Due to the variability in type and size of well, the estimates represent an average per well impact, rather than a precise impact attributed to a specific well. Using the average annual economic impacts from the 2011 to 2015 period, each of the 107,500 wells generate \$12,800 in economic impact and support \$160 in taxes to the Commonwealth government each year (see Table 3.6).

TABLE 3.6 - ESTIMATED ANNUAL ECONOMIC IMPACT IN THE COMMONWEALTH OF PENNSYLVANIA OF EACH CONVENTIONAL WELL IN THE 19-COUNTY REGION

Active Conventional Wells in 19-County Region	107,500
Total Output in PA	\$12,800
Total Taxes in PA	\$160

Source: PA.gov (2015), Energy Information Administration (2015), ESI (2016), IMPLAN (2013)

3.8 ESTIMATED MARGINAL ECONOMIC IMPACT OF VARYING OIL AND GAS PRICES

It is important to understand how the overall economic impact of the conventional well industry increases or decreases with a change in market price. As discussed, the economic impact model uses production and prices from 2011 to 2015 to account for variability in the industry. To illustrate the effect of prices on economic impact, ESI developed a model to estimate the impact of an additional dollar in price for both gas and an additional ten dollars in price for oil. Holding the level of production constant, an increase in price would lead to additional revenue for well owners. As previously shown, these revenues stimulate the economy by supporting employment and businesses in their communities.

Using the 2011 to 2015 average annual production levels, every \$1 per thousand cubic feet in gas price leads to \$145 million in revenue within the 19-County Region. With these revenues, a \$1 increase in natural gas price will generate an additional \$240 million in total economic impact, support an additional 1,000 jobs, and create an additional \$3.0 million in tax revenues for the Commonwealth government. Every additional \$10 per barrel in crude oil first purchase price²¹ leads to an estimated \$20 million in revenue for conventional well owners within the 19-County Region. These revenues generate an additional \$33 million in total economic impact,

²¹ A larger margin in price was used for oil prices due to the significant variability of crude oil prices per barrel each year. For example, the Pennsylvania crude oil first purchase price fell from \$80.07 per barrel in 2014 to \$38.98 per barrel in 2015.

and support an additional 130 jobs and \$400,000 in tax revenues to the Commonwealth government (see Table 3.7).

**TABLE 3.7 – ESTIMATED MARGINAL EFFECT OF INCREASED OIL AND GAS PRICES
WITHIN THE COMMONWEALTH OF PENNSYLVANIA**

	Gas Price Impact	Oil Price Impact
Increase in Price	\$1	\$10
Annual Average Production, 2011-2015 (Mcf) (Barrels)	144,559,647	1,986,494
Increase in Revenue (\$M)	\$145	\$20
Total Output (\$M)	\$240	\$33
Total Employment (FTE)	1,000	130
Total Taxes (\$M)	\$3.0	\$0.4

*Source: PGCC (2016), ESI (2016),
IMPLAN (2013), State of Pennsylvania Tax Compendium (2013)*

4.0 ECONOMIC IMPACT OF THE BRADFORD REFINERY

4.1 ABOUT THE BRADFORD REFINERY

The Bradford Refinery, located in McKean County, PA, processes conventional oil and is the only Penn Grade crude refinery in the Commonwealth. The refinery is operated by ARG, opened in 1881, and is the oldest continuously operating refinery in the U.S. Each year, ARG purchases approximately 3.5 million barrels of crude from regional producers in New York and Pennsylvania.²² The refinery has a daily operating capacity of 11,000 barrels and specializes in waxes, lubricant base oils, gasoline, fuels, and petroleum specialties. The operations are split into three major processing areas: the crude distillation tower, the naphtha splitter and platformer, and a lubes processing.

4.2 DIRECT SPENDING AT THE BRADFORD REFINERY

ARG is committed to serving its local community, both environmentally and economically. In 2015, ARG estimated that approximately \$117 million worth of crude oil and other raw materials were purchased from suppliers in northwestern Pennsylvania and western New York. By using locally sourced materials, ARG is stimulating the states' economies, helping local businesses, and supporting additional jobs beyond those directly employed at the refinery. ARG's use of Pennsylvania crude is consistent with state government efforts to utilize its supply of natural resources in local manufacturing processes.

In addition to its purchases of crude oil and raw materials, ARG spends approximately \$27 million in salaries and benefits for its 350 employees and pays \$6.7 million in utilities annually. In 2015, ARG paid an estimated \$516,000 in taxes, including \$132,800 to local school districts and \$163,200 to the City of Bradford and McKean County (see Table 4.1).

²² This includes Pennsylvania and New York.

TABLE 4.1 – OPERATING EXPENSES OF THE BRADFORD REFINERY IN 2015 (\$ MILLIONS)

Category	Total Expenditure²³	Modeled in McKean County	Modeled in Pennsylvania
Crude Oil ²⁴	\$91	\$19	\$77
Other Raw Materials	\$26	\$26	\$26
Wages & Benefits	\$27	\$27	\$27
Utilities & Local Taxes	\$7	\$7	\$7
Total Output	\$151	\$79	\$136

Source: ARG (2016), Econsult Solutions (2016), IMPLAN (2013)

4.3 ANNUAL ECONOMIC IMPACT OF THE BRADFORD REFINERY

Because ARG sources products and workers locally whenever possible, the direct operating expenditures and jobs available at ARG will significantly affect both McKean County and the Commonwealth as a whole. Each year, the refinery generates an estimated \$93 million of economic impact in McKean County and supports 450 direct, indirect, and induced jobs. Within the Commonwealth of Pennsylvania, ARG generates \$173 million in economic impact and supports 540 jobs with \$36 million in earnings (see Table 4.2).

TABLE 4.2 - ESTIMATED ECONOMIC IMPACTS OF THE BRADFORD REFINERY IN MCKEAN COUNTY AND THE COMMONWEALTH OF PENNSYLVANIA IN 2015 (\$ MILLIONS)

Economic Impact	McKean County	Total PA
Direct Output	\$79	\$136
Indirect & Induced Output	\$14	\$37
Total Output	\$93	\$173
Total Employment (FTE)	450	540
Total Earnings	\$30	\$36

Source: ARG (2016), Econsult Solutions (2016), IMPLAN (2013)

²³ Includes purchases of crude oil from New York

²⁴ Based on information provided by ARG, the model assumes 85 percent of \$91 million of crude oil was purchased from Pennsylvania sources, of which 25 percent was purchased within McKean County.

Not only does ARG economically benefit the local community through jobs and local vendors, but the refinery also makes significant philanthropic contributions to the area. In 2015, ARG won the Pennsylvania Governor's ImPAct Award in the Community ImPAct category for the North Central region, after being a finalist for the award in 2014. Community ImPAct is awarded to companies that are committed to the growth of its employees and community. With a focus on local healthcare, education, human services, and economic development, ARG is committed to improving the lives of its rural and sometimes underserved community and residents. ARG and its philanthropic foundation donate millions of dollars to local non-profits directly and through its employee donation-matching program with hopes to spur business activity and create jobs for the community members.

5.0 ABANDONED WELLS

5.1 ABOUT ABANDONED WELLS

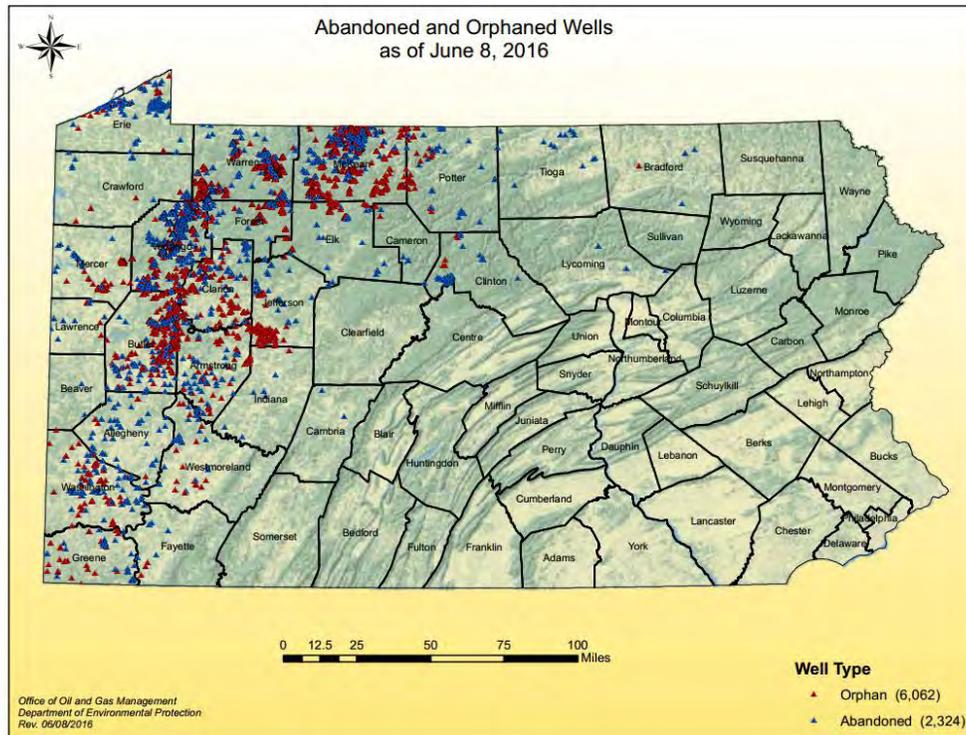
When wells are no longer used or have no foreseeable production, they are plugged to prevent oil and gas reserves from migrating and contaminating water, soil and air and posing other health and human safety hazards. Plugging wells that are no longer in production is an important safety practice. As the conventional oil and gas industry faces current severe market conditions, and the potential of new regulations, the number of wells that may come out of production and need to be plugged could be high.

Operators are responsible for plugging their wells, however, with the long history of drilling in Pennsylvania there are many wells in Pennsylvania that are not plugged and have no identified operator to plug the well. In these instances, it is the state's responsibility to plug the well, with half the battle being identifying the wells.

According to the DEP, there are approximately 350,000 total oil and gas wells in Pennsylvania drilled since 1859.²⁵ Wells without identifiable owners and no longer in production, called abandoned and orphaned wells, pose significant environmental and safety risks for Pennsylvania citizens. How to deal with these abandoned and orphaned wells is a major public policy issue for Pennsylvania and many other states. There are an estimated 200,000 abandoned and orphaned wells in Pennsylvania.²⁶ The exact figure is unknown, but the DEP estimates 8,000 identified wells are serious risks (see Figure 5.1).

²⁵ The 350,000 wells include both conventional and unconventional oil and gas wells. This number accounts for all the wells that have been drilled since 1859. Table 2.1 shows that there are approximately 100,000 active wells in 2016. The difference accounts for plugged, abandoned, and orphan wells.

²⁶ Conti, David "Efforts under way to find abandoned Pa. gas, oil wells" *Trib Live*, March 12, 2016

FIGURE 5.1 – ABANDONED AND ORPHANED WELLS CLASSIFIED AS SERIOUS RISK

Source: DEP (2016)

5.2 COST OF PLUGGING WELLS

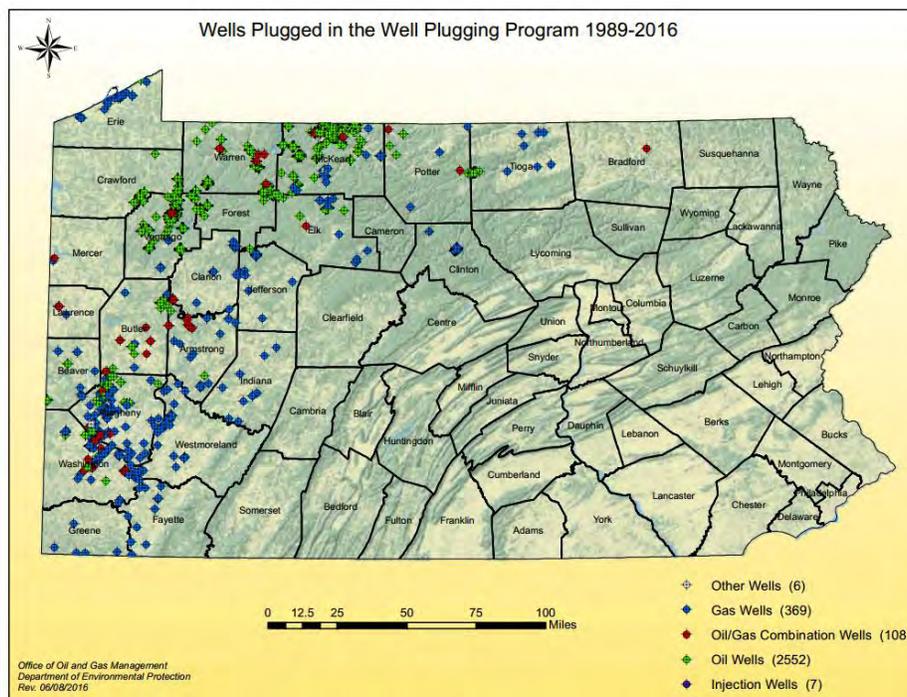
The current economic reality is new potential regulations could economically harm the conventional oil and gas industry and could lead to an accelerated rate of abandonment, due to the already reduced financial capacity of the industry to properly plug them. When the owner or operator of a well is unknown or out-of-business, the responsibility for plugging the wells will usually fall on the state.

The DEP's Abandoned and Orphan Well Plugging Program was established under the authority of the Oil and Gas Act to plug oil and gas wells with no responsible party. If not addressed properly, wells have the potential to cause health, safety or environmental hazards.²⁷ Approximately 3,000 wells have been plugged in the program since 1989 (see Figure 5.2). As compared to the estimated number of abandoned wells, 200,000, and those considered a serious risk, 8,000, there is still significant work remaining.

²⁷PA DEP, Abandoned and Orphaned Well Program website, <http://www.dep.pa.gov/Business/Energy/OilandGasPrograms/OilandGasMgmt/Pages/Abandoned-and-Orphan-Well-Program.aspx>

Plugging a well depends on the type of well, depth, and other factors. Costs identified for plugging conventional wells range from \$5,000 to \$29,000.²⁸ When one operator costed out the proposed Act 13 regulations (that were since abrogated for conventional wells and portions stayed by the Pennsylvania Commonwealth Court for unconventional wells), its costs would have risen from \$29,000 to \$49,000 to plug a well. Expenditures on plugging wells can have a one-time positive economic effect in the purchase of materials and paying of wages to plug the well. However, the expenditures are shifted from other uses and are non-recurring. If the well is no longer used but still has reserves, then future production and usage is lost, which presents a much greater economic loss over the long run.

FIGURE 5.2 – WELLS PLUGGED IN THE WELL PLUGGING PROGRAM 1989-2016



Source: DEP (2016)

²⁸ PA DEP. Natural Gas Wells Owned and Operated by Homeowners, Fact Sheet, 12/2014, <http://www.eibrary.dep.state.pa.us/dsweb/Get/Document-104831/8000-FS-DEP2868.pdf>

5.3 FUTURE ECONOMIC IMPACT OF PLUGGING WELLS WITH ACTIVE RESERVES

Should potential future regulations be so restrictive that productive, inactive, or shut-in wells, must cease production for the short to near-term, these wells may require plugging, ending their contribution to their local economies. When macro-market conditions improve for the conventional oil and gas industry, the local economies where recently active wells may be plugged, will not receive the jobs and economic benefit of an improving industry. It is important to re-iterate the conventional oil and gas industry in Pennsylvania is impacted by national and worldwide market conditions, including international politics.

The oversupply and low prices have brought the conventional oil and gas industry to a crawl in recent years; however, it does not mean that production levels and prices will always be where they are today. Operators are waiting for current market conditions to improve. Additional negative forces upon the conventional drilling industry would severely cripple the current and future existence of the industry, an industry that is very important to the smaller, rural communities in western Pennsylvania. Once a well with reserves is plugged, its future production is lost, which presents a greater loss over the long run economically in terms of available natural gas and oil supply, economic output, jobs, and tax revenues.

6.0 CONCLUSION

The conventional oil and gas industry is an important source of employment, economic, and fiscal activity in the rural communities where they exist. Over the past ten years, unconventional drilling in the Marcellus and Utica shales has eclipsed the conventional natural gas industry. However, the conventional oil and gas industry is still a significant part of the economies in the communities where production occurs.

The conventional oil and gas industry supports employment in their communities that then generates income and local services tax to those municipalities and income taxes to the Commonwealth. The employees of the industry spend their earnings in their communities, supporting local businesses. In addition, the conventional oil and gas industry also supports local businesses by its direct spending on materials and purchases, generating more economic activity in their communities.

The conventional oil and gas companies and subsequently their communities are already dealing with macro-market impacts of high supply and low prices. Additional negative impositions on the conventional oil and gas industry could cause it to constrict so much that many of the companies could cease to operate, plugging or abandoning wells with reserves. The shuttering of the conventional oil and gas industry in these small communities could have significant negative impacts in terms of the loss of jobs and taxes from the industry itself and from the businesses supported by the spending by the industry and its employees. The loss of the ripple effect of industry and employee spending can be just as significant as the loss of the direct economic and fiscal impacts from the industry itself.

The current economic reality is that new potential regulations that would economically harm the conventional oil and gas industry could lead to an accelerated rate of abandonment, due to the already reduced financial capacity of the industry to properly plug them. Once wells with reserves are plugged, all current and future employment and economic benefits are lost. Smaller municipalities will need to cope with the direct loss of employment opportunities for its residents, a smaller tax base for the public services it renders, and the ripple effects throughout their local economies. Market conditions are not constant, they will change over time, and with increases in prices, the conventional oil and gas industry will benefit, as will the communities in which they operate.

APPENDIX A – DEFINITIONS OF DIFFERENT TYPES OF WELLS

TABLE A.1 - DEFINITIONS OF DIFFERENT TYPES OF WELLS

Term	Definition
Conventional Well ²⁹	Drilled into permeable geologic formations, such as sandstone, which have accumulated oil or gas over centuries, typically a shallow and vertically drilled well
Unconventional Well ³⁰	Drilled into impermeable geologic formations, such as shale, which require horizontal well drilling and high volume hydraulic fracturing to expose more of the formation to the well bore
Active	A well currently producing oil and/or gas
Plugged ³¹	A production well that can no longer be used is closed to prevent the oil and gas reservoir fluids from migrating uphole over time and possibly contaminating other formations and/or fresh water aquifers. It is plugged by setting mechanical or cement plugs in the wellbore at specific intervals to prevent fluid flow
Abandoned ³²	A registered well that has not been operated in a year and has an inactive status, must be plugged by the operator
DEP Orphaned ³³	Certain oil and gas wells abandoned before April 1985 (based on the amended Oil and Gas Act of 1984), can be plugged by the DEP if landowners, leaseholders, and oil and gas operators have received no economic benefit from the well after April 18, 1979
DEP Abandoned ³⁴	When no responsible party is identified, they are plugged utilizing the surcharges from the orphan and abandoned plugging funds through the Well Plugging Program
DEP Plugged ³⁵	Wells plugged by the DEP through their well plugging program

²⁹ Conventional and unconventional can “refer to the type of well that is drilled or the geologic formation into which drilling occurs.”
http://files.dep.state.pa.us/OilGas/BOGM/BOGMPortalFiles/Annual_Report/2014/2014_Annual_Report_for_web_July1.pdf

³⁰ *ibid*

³¹ Technology Subgroup of the Operations & Environment Task Group, Paper #2-25, Plugging and Abandonment of Oil and Gas Wells, NPC North American Resource Development Study, 9- 15- 2011, http://www.npc.org/prudent_development-topic_papers/2-25_well_plugging_and_abandonment_paper.pdf

³² PA DEP, Act 13 Frequently Asked Questions, 3-9-2012, http://files.dep.state.pa.us/oilgas/oilgaslandingpagefiles/act13/act_13_faq.pdf

³³ PA DEP’s Online Library, <http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-103461/8000-FS-DEP1670.pdf>

³⁴ *ibid*

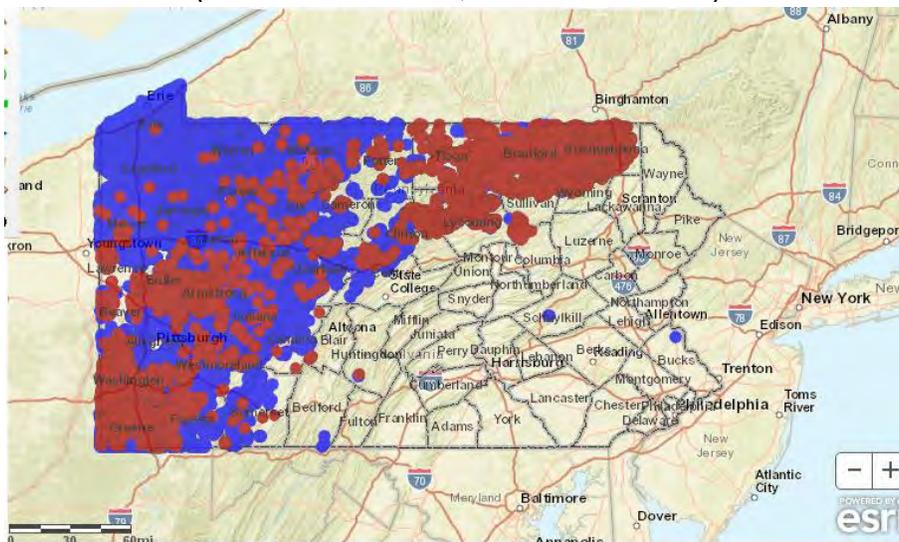
³⁵ *ibid*

APPENDIX B – ADDITIONAL CONVENTIONAL WELL MAPS

Data available to download from the state includes:

- Status of the well (active, abandoned, capped, uncapped, etc.)
- The owner of the well
- County
- Latitude and Longitude
- Amount of gas produced and # of days in operation
- Amount of oil produced and # of days of oil production
- Differentiates between conventional and unconventional wells
- Data can be accessed from the Office of Oil and Gas Management, Pennsylvania Department of Environmental Protection

**FIGURE A.1 – CONVENTIONAL AND UNCONVENTIONAL WELLS, OIL AND GAS, ACTIVE
(RED = UNCONVENTIONAL, BLUE = CONVENTIONAL)**



Source: PA Environmental Protection Agency, ESI, Esri (2016)

FIGURE A.2 – CONVENTIONAL WELLS, GAS, PLUGGED

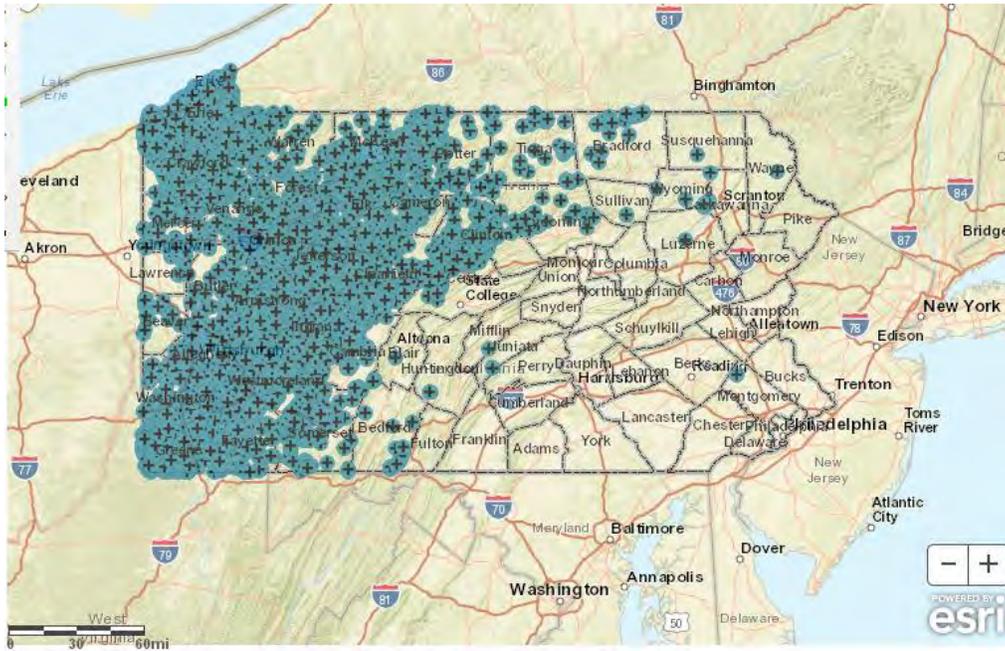


FIGURE A.3 – CONVENTIONAL WELLS, GAS, ABANDONED

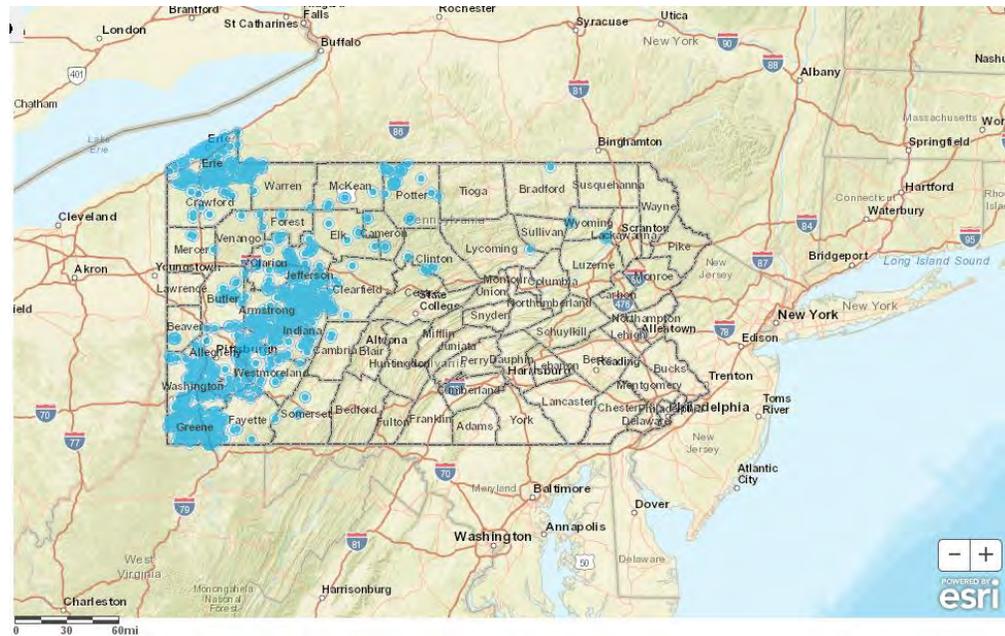


FIGURE A.4 – CONVENTIONAL WELLS, GAS, DEP ORPHANED

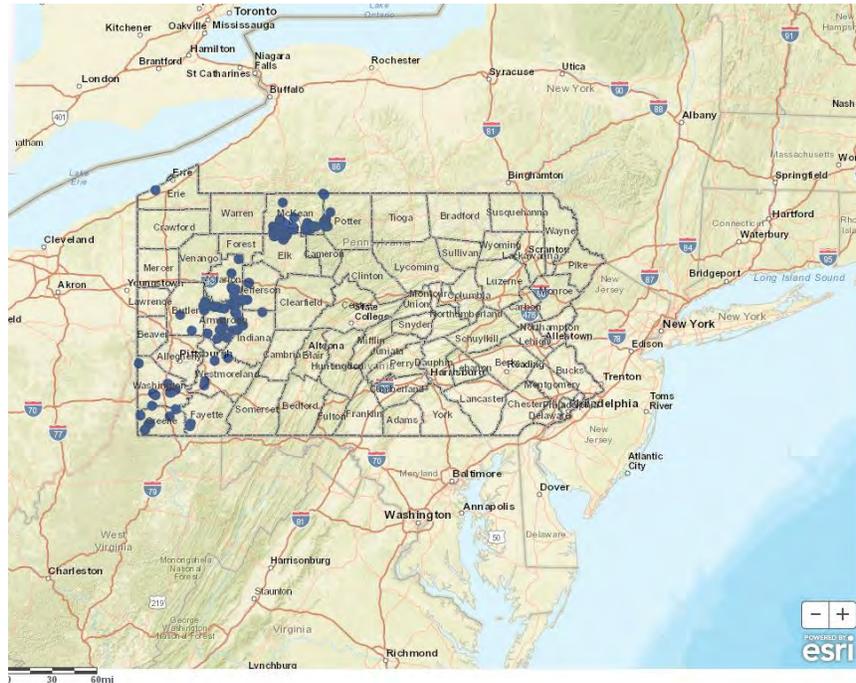


FIGURE A.5 – CONVENTIONAL WELLS, GAS, DEP PLUGGED

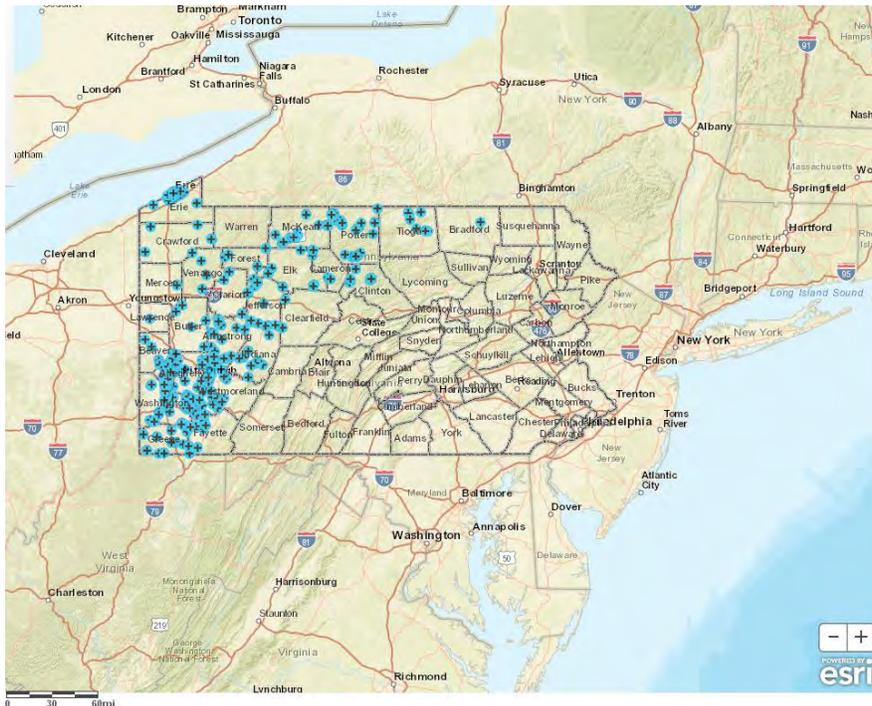


FIGURE A.6 – CONVENTIONAL WELLS, GAS, DEP ABANDONED

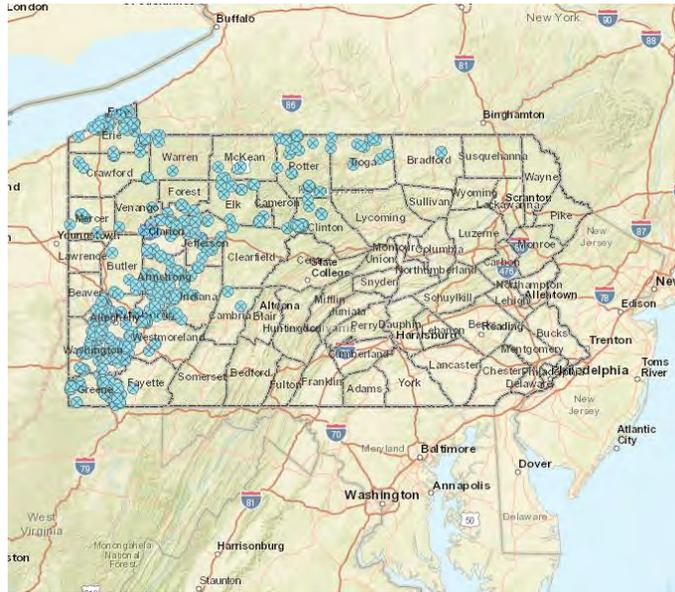


FIGURE A.7 – CONVENTIONAL WELLS, OIL, PLUGGED

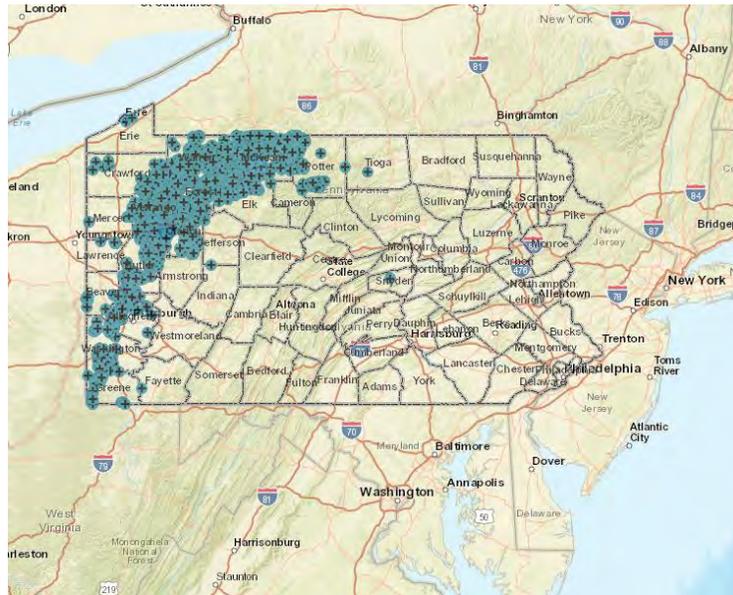


FIGURE A.8 – CONVENTIONAL WELLS, OIL, ABANDONED



FIGURE A.9 – CONVENTIONAL WELLS, OIL, DEP ORPHANED

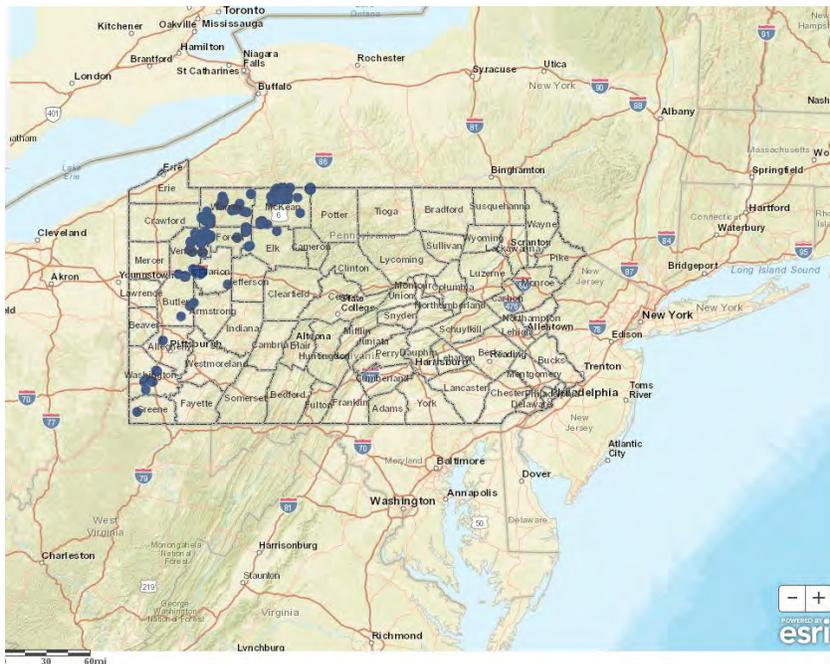


FIGURE A.10 – CONVENTIONAL WELLS, OIL, DEP PLUGGED



FIGURE A.11 – CONVENTIONAL WELLS, OIL, DEP ABANDONED



APPENDIX C – PA DEP OIL & GAS REPORTING WEBSITE

ESI collected data on conventional well gas and oil production using the PA DEP Oil & Gas Reporting Website. The site requires each user to agree to the terms below:

Pennsylvania's Oil and Gas Act requires unconventional well operators to submit production reports to the Department of Environmental Protection (DEP) monthly. The initial report must be filed with the department by March 31, 2015. This report must include the production data from January 1, 2015 to January 31, 2015. Subsequent reports must include production data for each calendar month within 45 days after the last day of each month. All other oil and gas operators are required to submit production reports on an annual basis on Feb. 15 for the previous calendar year. DEP makes every practical effort to post these reports as soon as possible after they are filed.

The Oil and Gas Act reporting is a self-reporting system, meaning that data is reported from producers to DEP as required by law. All production data is posted as it was received from the unconventional well operators. DEP does not independently verify the data before it is posted.

While the Oil and Gas Act requires accurate and on-time data reporting by producers, and the producers and DEP endeavor to correct any errors discovered after the data is posted, DEP makes no claims, promises or guarantees regarding the accuracy, completeness or timeliness of the operators' data that DEP is required to post.

DEP expressly disclaims any liability for errors or omissions related to the production data contained within these reports. No warranty of any kind is given by DEP with respect to the production data contained within these reports posted on its website.

However, the data collected through the PA DEP Oil & Gas Reporting Website was reviewed by Falcede Energy Consulting, LLC (Falcede). Falcede determined that several counties (Clarion County, McKean County, and Warren County) had wells that had misreported totals for natural gas production. As stated by Raymond Follador of Falcede Energy Consulting,

"These incorrect entries were all the result of improper placement of the decimal point by either the producer or the DEP. They were vetted by comparing the production figure entered for the same well(s) in adjacent years and/or comparing the production entry to other wells posted in the same township and county. The said entries were commonly associated with the same producer so it was not a random occurrence."

The revised values, calculated by Falcede, are shown in blue in Table C.1.

TABLE C.1 – CONVENTIONAL NATURAL GAS PRODUCTION

County	YEAR - Mcf				
	2011	2012	2013	2014	2015
Armstrong	19,571,707	17,840,594	16,136,878	15,475,258	13,634,536
Cambria	1,165,450	1,072,421	996,875	1,005,083	927,874
Cameron	77,805	85,827	64,540	51,543	55,412
Clarion	4,636,160	4,127,005	4,027,430	3,789,529	3,516,532
Clearfield	8,450,020	6,559,135	6,324,426	5,759,587	5,246,319
Crawford	15,516,767	11,120,781	10,592,120	9,274,552	7,438,460
Elk	3,738,396	3,312,896	2,808,617	2,479,487	2,162,346
Fayette	11,210,215	8,999,045	10,973,351	7,420,918	6,518,029
Forest	4,497,972	3,850,799	3,304,243	3,238,324	2,720,400
Greene	25,056,484	20,248,864	13,606,243	11,655,887	10,168,735
Indiana	35,534,674	31,091,894	28,306,017	27,781,676	24,199,481
Jefferson	11,713,772	12,196,275	9,731,704	10,356,510	13,378,882
Lawrence	337,549	335,853	332,208	313,507	266,497
McKean	6,301,214	5,734,105	5,234,741	5,583,621	4,539,789
Potter	757,239	506,111	5,498,471	568,977	430,989
Somerset	309,760	278,749	350,867	292,381	223,076
Venango	7,869,760	4,339,749	4,927,118	4,664,141	4,431,497
Warren	4,807,184	4,811,306	4,214,091	4,329,817	3,605,683
Westmoreland	18,827,799	16,082,605	15,101,737	17,840,264	11,947,019
Total	180,379,927	152,594,014	142,531,677	131,881,062	115,411,556

Source: DEP (2016), Falcede Energy Consulting (2016)

Falcede also reviewed the annual oil production for each county during each year between 2011 and 2015 to assure that the correct values were being used in the economic impact model. The DEP reported production totals were deemed correct and are shown in Table C.2.

TABLE C.2 – CONVENTIONAL OIL PRODUCTION

County	YEAR - Bbls				
	2011	2012	2013	2014	2015
Armstrong	12,129	11,529	12,129	5,979	9,372
Cambria	1	1	0	0	0
Cameron	0	0	0	0	0
Clarion	8,975	10,424	12,435	10,715	7,124
Clearfield	87	109	23	0	127
Crawford	161,686	130,000	96,471	112,250	85,315
Elk	225,111	238,890	221,730	201,449	167,886
Fayette	3,851	5,224	5,575	4,430	4,546
Forest	377,576	329,912	260,024	268,297	185,831
Greene	26,353	44,347	101,459	103,200	62,081
Indiana	4,479	2,549	3,816	2,550	2,915
Jefferson	879	1,997	2,903	2,719	406
Lawrence	0	0	0	85	85
McKean	849,960	857,560	608,932	637,105	457,876
Potter	2,082	3,006	1,695	1,117	1,084
Somerset	0	0	0	0	0
Venango	71,475	79,835	104,138	156,568	89,123
Warren	445,582	412,143	464,512	567,906	408,841
Westmoreland	38,523	40,497	38,462	25,265	19,148
Total	2,228,749	2,168,023	1,934,304	2,099,635	1,501,760

Source: DEP (2016)

APPENDIX D – PRICES USED TO DETERMINE GAS AND OIL REVENUES

The average natural gas price for each year from 2011 to 2015 are shown in Table D.1. The 2016 value is an average in 2016 for January through September. Average gas price in 2016 through September was \$1.06. Because annual production and year-end average pricing was not available for the entirety of 2016, the annual impact for 2016 was not included in the economic impact model. The prices used in the model were provided by members of PGCC and adjusted using the British thermal unit (btu) values shown in Table D.2.

TABLE D.1 – NATURAL GAS PRICE

Year	Gas Price
2011	\$5.11
2012	\$3.39
2013	\$4.64
2014	\$4.31
2015	\$1.42

Source: PGCC (2011-2016), Cameron Energy Company (2011-2016)

The BTU adjustment accounts for the substantial difference in composition of the gas extracted in each county. Natural gas is composed mostly of methane but is also made up of various natural gas liquids (NGLs) such as ethane, butane, and pentane called condensates. The higher the concentration of methane, the dryer the gas. When NGLs, or “condensates”, are present, the gas is considered wet.

NGLs can be extracted from the natural gas and sold at a higher price than the gas itself. To account for this additional revenue within the economic impact model, ESI determined the annual natural gas revenue by inflating the natural gas prices by the county specific BTU multipliers.

TABLE D.2 – BTU VALUES

County	BTU Values (Average)	Multiplier (Price/mcf x BTU Factor)
Armstrong	1,025	1.025
Cambria	1,025	1.025
Cameron	1,025	1.025
Clarion	1,180	1.180
Clearfield	1,025	1.025
Crawford	1,025	1.025
Elk	1,025	1.025
Fayette	1,025	1.025
Forest	1,386	1.386
Greene	1,125	1.125
Indiana	1,025	1.025
Jefferson	1,025	1.025
Lawrence	1,025	1.025
McKean	1,308	1.308
Potter	1,025	1.025
Somerset	1,025	1.025
Venango	1,479	1.479
Warren	1,593	1.593
Westmoreland	1,025	1.025

Source: PGCC (2011-2016)

The oil prices in Table D.3 were the oil prices paid by ARG Refinery from 2011 to 2015 and provided to ESI by members of PGCC. The average oil price in 2016 through November was \$41.55. Because annual production and year-end average pricing was not available for the entirety of 2016, the annual impact for 2016 was not included in the economic impact model.

TABLE D.3 – OIL PRICE

Year	Oil Price
2011	\$92.11
2012	\$96.07
2013	\$97.77
2014	\$90.76
2015	\$48.23

Source: PGCC (2011-2016), Cameron Energy Company (2011-2016)

APPENDIX E – EXAMPLE CALCULATION OF AVERAGE ANNUAL REVENUES BY COUNTY

To illustrate the method used to develop revenue estimates for each of the 19 counties, the step-by-step calculation for Armstrong County is provided below.

The average annual gas revenue in Armstrong County for the five-year period between 2011 and 2015 was determined through the following steps (see Table E.1):

1. Production totals for 2011 through 2015 were collected from the PA DEP Oil & Gas Reporting Website and then reviewed by Falcede Energy Consulting, LLC (Falcede).
2. The price of natural gas for each year was provided by PGCC members as discussed in Appendix D.
3. BTU values, which take into account the additional revenue associated with the condensate, were also provided by PGCC members as discussed in Appendix D.
4. Individually for each year, production was multiplied by the price of gas in that year and the BTU multiplier specific to Armstrong County to arrive at an estimate of total year-end revenue.
5. These revenue totals were inflated to 2016 dollars in order to show total revenue and total impact in 2016 dollars for consistency.
6. The resulting total revenue in Armstrong County over the five-year period is \$344 million (in \$2016). While each year varied considerably between 2011 and 2015, the average annual revenue was \$68.9 million.

TABLE E.1 – CALCULATION OF ANNUAL GAS REVENUE IN ARMSTRONG COUNTY

Gas	2011	2012	2013	2014	2015	Total	Annual Average
Production	19,571,707	17,840,594	16,136,878	15,475,258	13,634,536	82,658,973	16,531,795
Price of Gas	\$5.11	\$3.39	\$4.64	\$4.31	\$1.42		
BTU Value	1.025	1.025	1.025	1.025	1.025		
Total Revenue	\$102,511,708	\$61,991,604	\$76,746,992	\$68,365,821	\$19,845,067	\$329,461,192	\$65,892,238
Inflation	1.07	1.05	1.04	1.02	1.02		
Total Revenue (in \$2016)	\$109,687,528	\$65,091,184	\$79,816,871	\$69,733,137	\$20,241,968	\$344,570,690	\$68,914,138

The average annual oil revenue in Armstrong County for the five-year period between 2011 and 2015 was determined through the following steps (see Table E.2):

1. Production totals for 2011 through 2015 were collected from the PA DEP Oil & Gas Reporting Website and then reviewed by Falcede Energy Consulting, LLC (Falcede).
2. The price of oil for each year was provided by PGCC members as discussed in Appendix D.
3. Individually for each year, production was multiplied by the price of oil in that year to arrive at an estimate of total year-end revenue.
4. These revenue totals were inflated to 2016 dollars in order to show total revenue and total impact in 2016 dollars for consistency.
5. The resulting total revenue in Armstrong County over the five-year period is \$4.6 million (in \$2016). While each year varied considerably between 2011 and 2015, the average annual revenue was approximately \$921,000 million.

TABLE E.1 – CALCULATION OF ANNUAL GAS REVENUE IN ARMSTRONG COUNTY

Oil	2011	2012	2013	2014	2015	Total	Annual Average
Production	12,129	11,529	12,129	5,979	9,372	51,138	10,228
Price of Oil	\$92.11	\$96.07	\$97.77	\$90.76	\$48.23		
Total Revenue	\$1,117,202	\$1,107,591	\$1,185,852	\$542,654	\$452,012	\$4,405,311	\$881,062
Inflation	1.07	1.05	1.04	1.02	1.02		
Total Revenue (in \$2016)	\$1,195,406	\$1,162,971	\$1,233,286	\$553,507	\$461,052	\$4,606,222	\$921,244

APPENDIX F – INDUSTRIES INDIRECTLY SUPPORTED BY THE OPERATIONS OF CONVENTIONAL OIL AND GAS WELLS

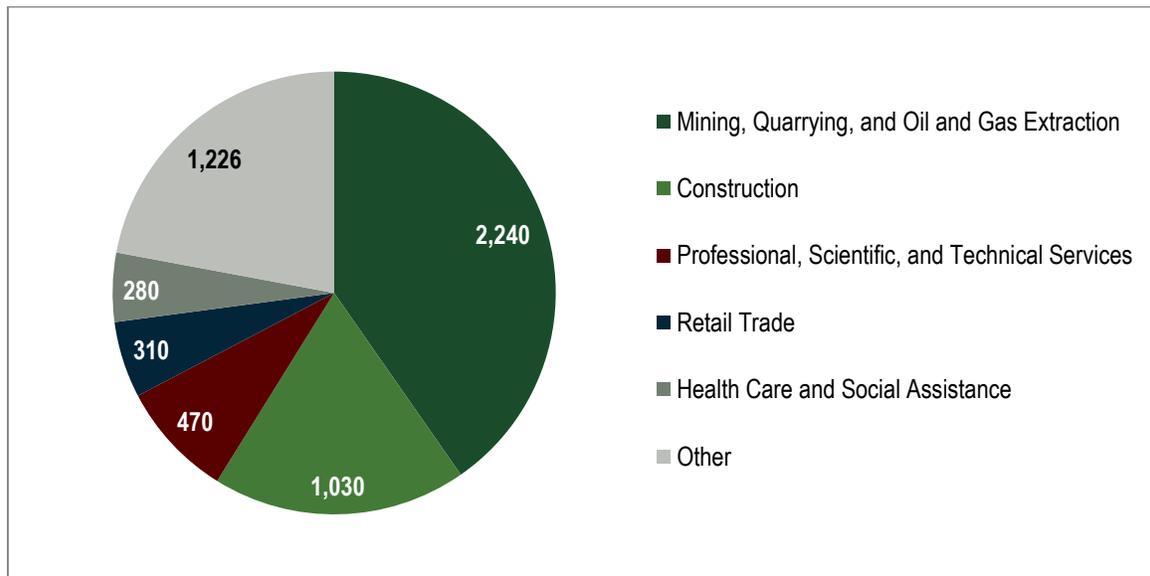
While the direct impact falls within the extraction of oil and natural gas industry, the indirect impact falls within the following industries:

1. Maintenance and repair construction of nonresidential structures (NAICS 23 Construction)
2. Management of companies and enterprises (NAICS 55 Management of Companies and Enterprises)
3. Lessors of nonfinancial intangible assets (NAICS 53 Real Estate and Rental and Leasing)
4. Support activities for oil and gas operations (NAICS 21 Mining, Quarrying, and Oil and Gas Extraction)
5. Architectural, engineering, and related services (NAICS 54 Professional, Scientific, and Technical Services)
6. Electric power generation, transmission, and distribution (NAICS 22 Utilities)
7. Monetary authorities and depository credit intermediation activities (NAICS 52 Finance and Insurance)
8. Custom computer programming services (NAICS 54 Professional, Scientific, and Technical Services)
9. Commercial and industrial machinery and equipment rental and leasing (NAICS 53 Real Estate and Rental and Leasing)
10. Extraction of oil and natural gas (NAICS 21 Mining, Quarrying, and Oil and Gas Extraction)
11. Legal services (NAICS 54 Professional, Scientific, and Technical Services)
12. Wholesale trade businesses (NAICS 42 Wholesale Trade)
13. Natural gas distribution (NAICS 22 Utilities)
14. Petroleum refineries (NAICS 32 Manufacturing)
15. Telecommunications (NAICS 51 Information)
16. All other miscellaneous professional, scientific, and technical services (NAICS 54 Professional, Scientific, and Technical Services)
17. Scientific research and development services (NAICS 54 Professional, Scientific, and Technical Services)
18. Accounting, tax preparation, bookkeeping, and payroll services (NAICS 54 Professional, Scientific, and Technical Services)
19. Real estate establishments (NAICS 53 Real Estate and Rental and Leasing)
20. Transport by truck (NAICS 48 Transportation and Warehousing)
21. Iron and steel mills and ferroalloy manufacturing (NAICS 33 Manufacturing)
22. Securities, commodity contracts, investments, and related activities (NAICS 52 Finance and Insurance)
23. Transport by pipeline (NAICS 48 Transportation and Warehousing)
24. Petrochemical manufacturing (NAICS 32 Manufacturing)

APPENDIX G – EMPLOYMENT SUPPORTED BY THE OPERATIONS OF CONVENTIONAL OIL AND GAS WELLS

The total employment impact includes all direct, indirect, and induced jobs supported by the conventional well industry in Pennsylvania. The estimated job figures shown are full-time equivalent annual jobs within each industry.

**FIGURE G.1 – ESTIMATED EMPLOYMENT IMPACT OF CONVENTIONAL WELLS
IN THE COMMONWEALTH OF PENNSYLVANIA BY INDUSTRY**



Source: PA.gov (2015), Energy Information Administration (2015), ESI (2016), IMPLAN (2013)