THE ECONOMIC IMPACT OF NATURAL GAS UNITIZATION IN WEST VIRGINIA

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Executive Summary

West Virginia has the third-largest proved natural gas reserves in the country, behind only Texas and the state's northern neighbor, Pennsylvania. Despite this potential, natural gas production growth in West Virginia over the last decade has lagged behind Pennsylvania and Ohio, the two other major producers in the Marcellus region.

One potential reason for the slower growth in West Virginia, which has been cited by the Oil & Gas industry, is the lack of a natural gas pooling or unitization law, which is present in Ohio and most other natural gas producing states. Pennsylvania also has a unitization law, but it does not apply to natural gas in the Marcellus shale formation. Unitization would effectively treat an entire geologic shale formation as one resource unit, thus allowing production of the entire unit.

In this study, we examine the potential economic impact of instituting a unitization law in West Virginia. The economic impact of natural gas unitization will depend largely on the increase in drilling and production that will come as a result of resource unitization. We define two scenarios whereby drilling activity in West Virginia is assumed to increase by either 5 percent or 10 percent above current levels. We then estimate the additional economic activity from three major sources: well construction, spending due to ongoing production, and royalties paid to rights-holders within the state.

Total economic impacts for these three categories are listed in Table 1. We estimate cumulative economic impacts over a five-year period from construction, drilling, and completion to be between $1.1 billion and $2.1 billion, with employment between 4 thousand and 8 thousand job-years.[1] Operational impacts are between $12.8 million and $25.6 million over five years. And impacts from royalties are expected to yield between 500 and 1,000 job-years.

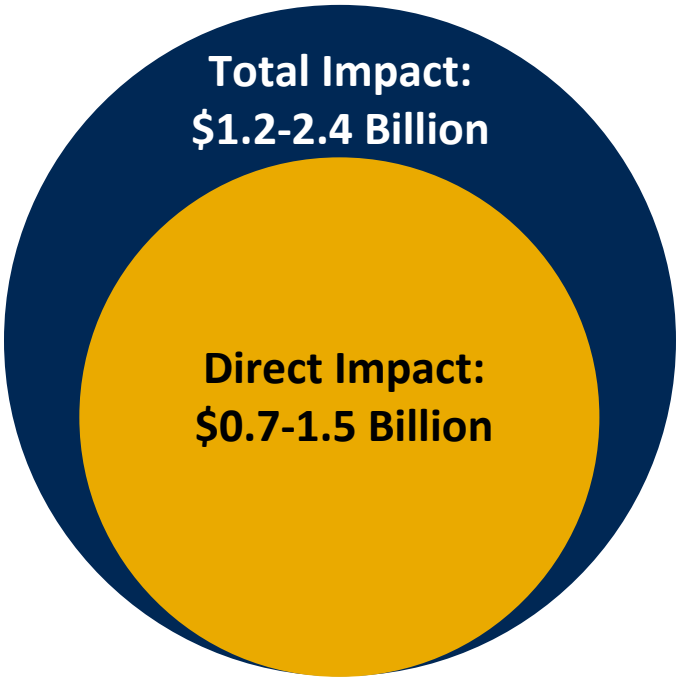
Table 1: Cumulative 5-Year Estimated Economic Impacts from Unitization

Source	5 Percent Scenario		10 Percent Scenario	
	Output ($, millions)	Employment (job-years)	Output ($, millions)	Employment (job-years)
Construction, Drilling and Completion	1,055.6	4,184	2,111.2	8,367
Operations	12.8	61	25.6	123
Royalties	155.1	506	310.1	1,012
Total	**1,223.5**	**4,751**	**2,446.9**	**9,502**

[1] One job-year is calculated as one person employed either full or part-time for one year. If one person is employed for two years then that is considered two job years.

Total economic impacts are shown in Figure 1. We estimate the total potential economic impact of a natural gas unitization law to be between $1.2 billion and $2.4 billion over five years, with about $0.7 billion to $1.5 billion coming directly from the natural gas industry. Total employment impacts are expected to be between 4,700 and 9,500 job-years.

Figure 1: Total Potential 5-Year Economic Impact of Natural Gas Unitization



1 Introduction

According to the US Energy Information Administration, West Virginia has the third-largest proved natural gas reserves in the country, behind only Texas and the state's northern neighbor, Pennsylvania (EIA 2021b). Despite this potential, natural gas production growth in West Virginia over the last decade has lagged behind Pennsylvania and Ohio.

One potential reason for the slower growth in West Virginia, which has been cited by the Oil & Gas industry (Kerchival 2015), is the lack of a natural gas pooling or unitization law, which is present in Ohio and most other natural gas producing states (Kleit, Leelachutipong & Wang 2020). Pennsylvania also has a unitization law, but it does not apply to natural gas in the Marcellus shale formation (Baillie 2011).[2]

Unitization would effectively treat an entire geologic shale formation as one resource unit, thus allowing production of the entire unit. This would have the effect of grouping together natural gas mineral rights in areas where a majority of rights holders have agreed to sell these rights, thus allowing the production of these resources in the entire unit. Rights holders who have not agreed to sell their mineral rights would be included in the resource unit, and their resources would be extracted along with all the resources in the unit. These rights-holders would be paid an average royalty common to the unit. Because resources from non-consenting rights holders are included in the unit, this type of policy is considered a form of "forced pooling."

The Gas and Oil Association of WV has commissioned this study to examine the potential economic impact of instituting a unitization law in West Virginia. We begin with a brief overview of the state of the natural gas industry in the state. We then forecast natural gas production absent any policy changes, followed by an examination of the potential economic impact if a unitization law were passed in the state.

2 Natural Gas Overview

Between 2010 and the end of 2019, natural gas production in West Virginia grew at a rate of more than 26 percent per year on average (see Figure 1), rising from about 265 billion cubic feet (Bcf) to slightly less than 2.2 trillion cubic feet (Tcf) per year. Despite the economic effects of the Covid-19 epidemic, natural gas production continued to grow at a rapid pace in the first three quarters of 2020, rising more than 22 percent over the same period the previous year.

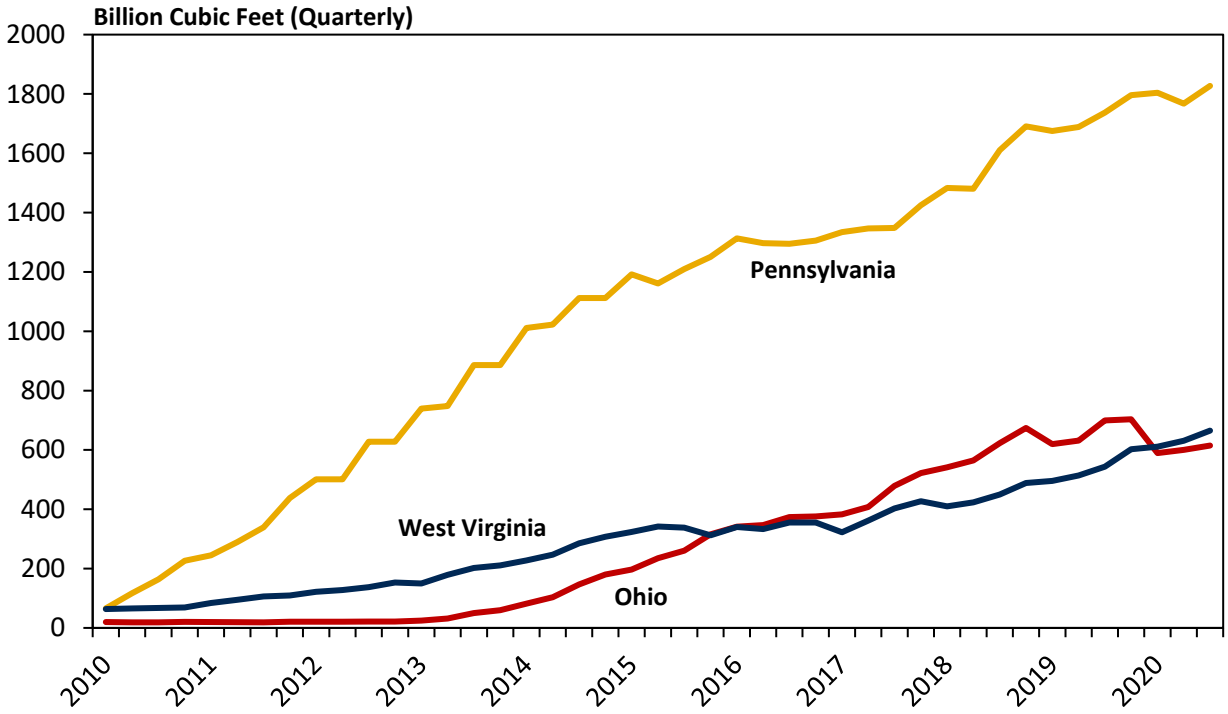
During this same period, natural gas production in Pennsylvania grew from 573 Bcf in 2010 to more than 6.9 Tcf in 2019, a 29 percent increase per year on average. Ohio production also rose rapidly, growing from about 78 Bcf in 2010 to 2.7 Tcf in 2019, a gain of more than 40 percent per year on average.

While production in West Virginia continued to climb in 2020, the state saw a significant drop off in new drilling activity during the year. The number of active drilling rigs in the state fell from an average of 18 rigs in 2019 to 8 operating rigs by the fourth quarter of 2020, a drop of more than half (Figure 2). The

[2] Pennsylvania's Oil and Gas Conservation Law, which allows unitization, does apply to the Utica shale formation (Chalfant and Corrigan 2019).

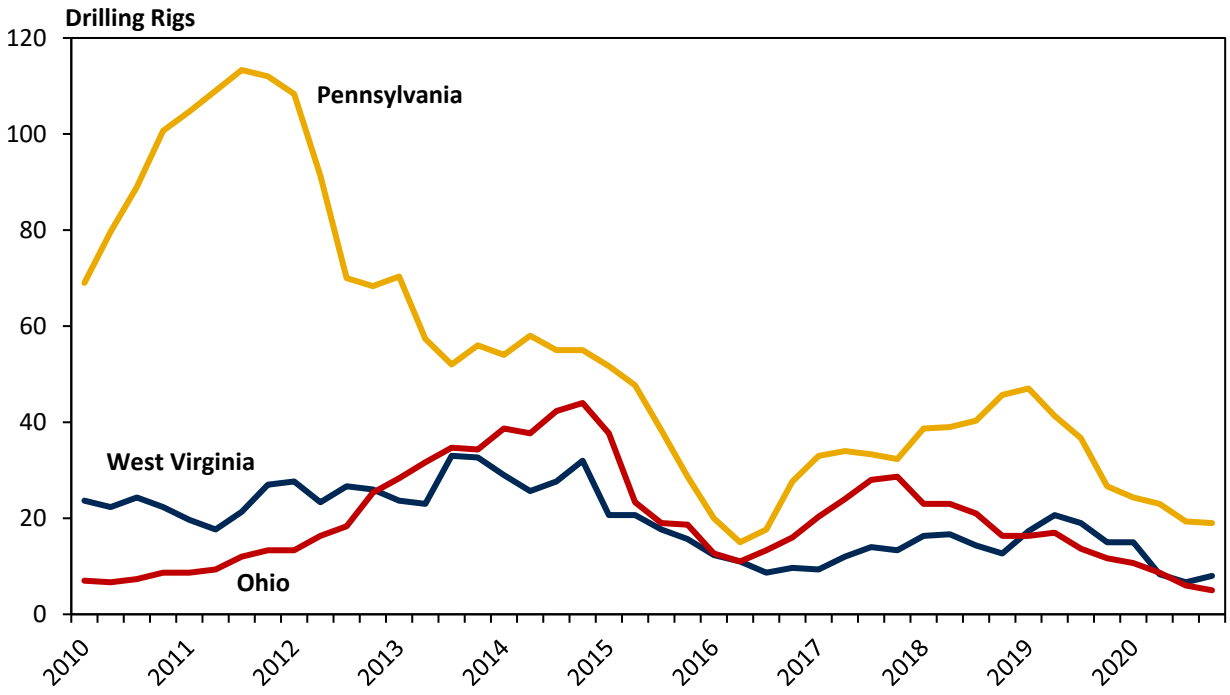
reduction in new drilling is likely to affect production over the course of 2021, as production in older wells declines and is not replaced by production from newly drilled wells.

Figure 2: Natural Gas Production



Source: US Energy Information Administration

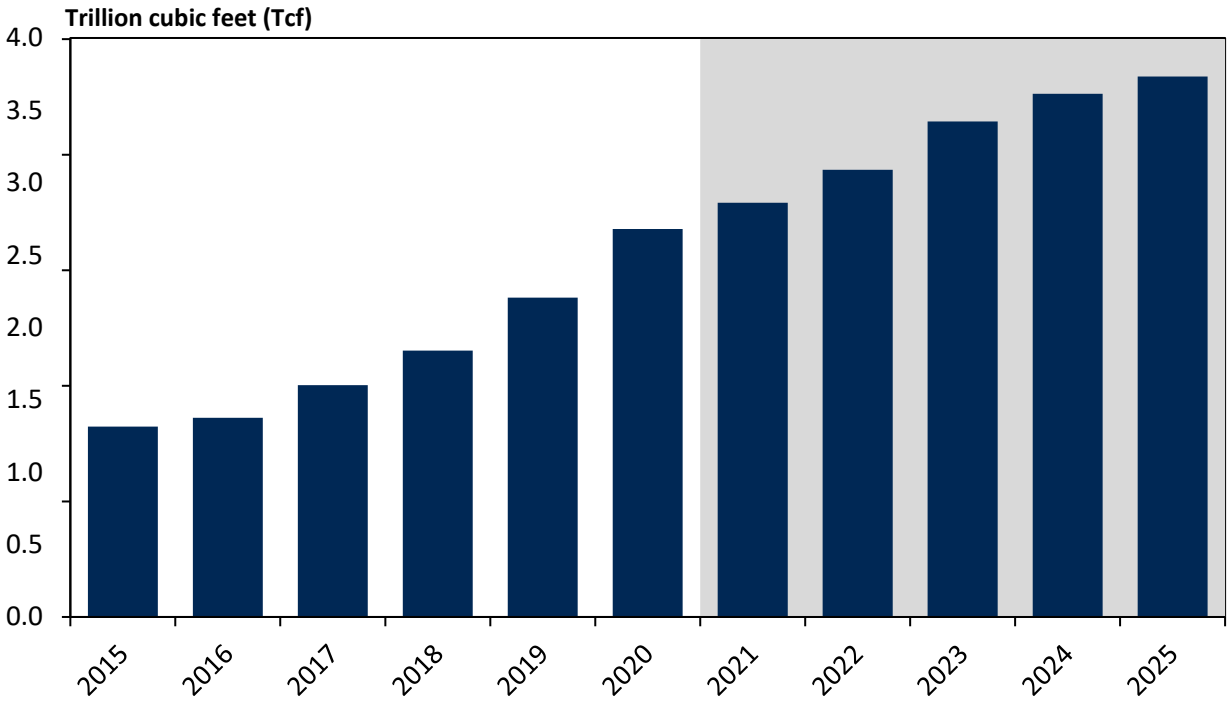
Figure 3: Drilling Rig Counts



Source: Baker Hughes

As shown in Figure 3, West Virginia's natural gas production is forecast to continue climbing over the next five years. Production is expected to grow to 2.9 Tcf in 2021, approximately 7 percent higher than the 2020 figure of 2.7 Tcf. Production is expected to rise to more than 3.7 Tcf by 2025, a gain of approximately 7 percent per year on average.

Figure 4: West Virginia Natural Gas Baseline Production Forecast



Source: WVU BBER Econometric Model

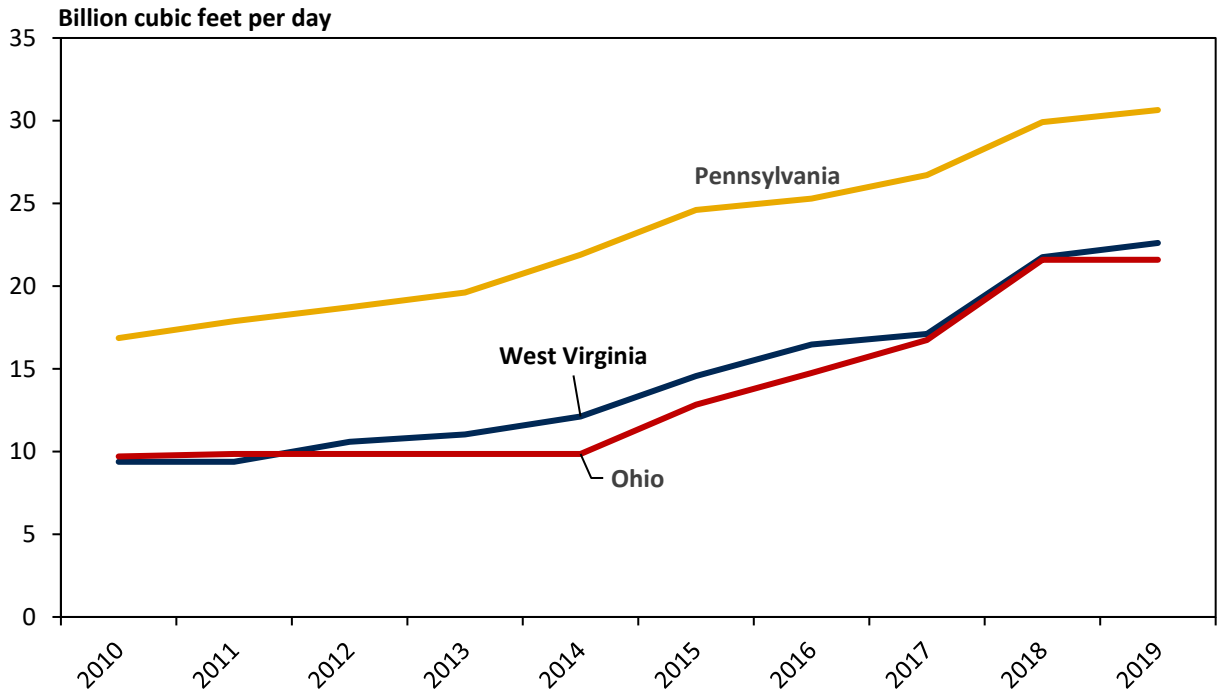
2.1 Pipeline Capacity

As natural gas production has ramped up in the last decade, new pipeline capacity has been installed to move the new supply to markets outside the Marcellus region. As shown in Figure 4, outgoing state-to-state pipeline capacity originating in West Virginia rose from about 9.3 billion cubic feet per day (Bcf/d) in 2010 to more than 22.9 Bcf/d in 2019, a gain of more than 10 percent per year on average. Ohio and Pennsylvania experienced similar increases in pipeline capacity with a 6.8 percent and 9.2 percent average annual gain, respectively.

Pipeline growth was a major factor in increased employment in the pipeline construction industry during this decade, particularly in 2018 and 2019. Pipeline construction employment totaled more than 14,000 jobs in West Virginia in the latter half of 2018, but fell to just over 3,000 jobs by the middle of 2020 as several major pipeline projects completed or were suspended. To a lesser degree, Pennsylvania and Ohio also experienced declines in pipeline construction employment during this period. In Ohio pipeline construction employment fell from a little over 6,000 jobs in 2018 to about 4,000 in 2020. Pennsylvania's employment peaked in 2019 at about 11 thousand jobs, which had fallen to less than 6,500 by the second quarter of 2020.

Increased pipeline capacity is an indicator of strong demand for the region's natural gas in the larger population centers along the east coast. The additional pipeline capacity allowed West Virginia to become the largest net exporter of natural gas in the country. In 2019 the state sold 90 percent of total natural gas production outside the state's borders (EIA 2021). This compares with 77 percent net exports in Pennsylvania and 56 percent in Ohio.

Figure 5: Outgoing State-to-State Natural Gas Pipeline Capacity



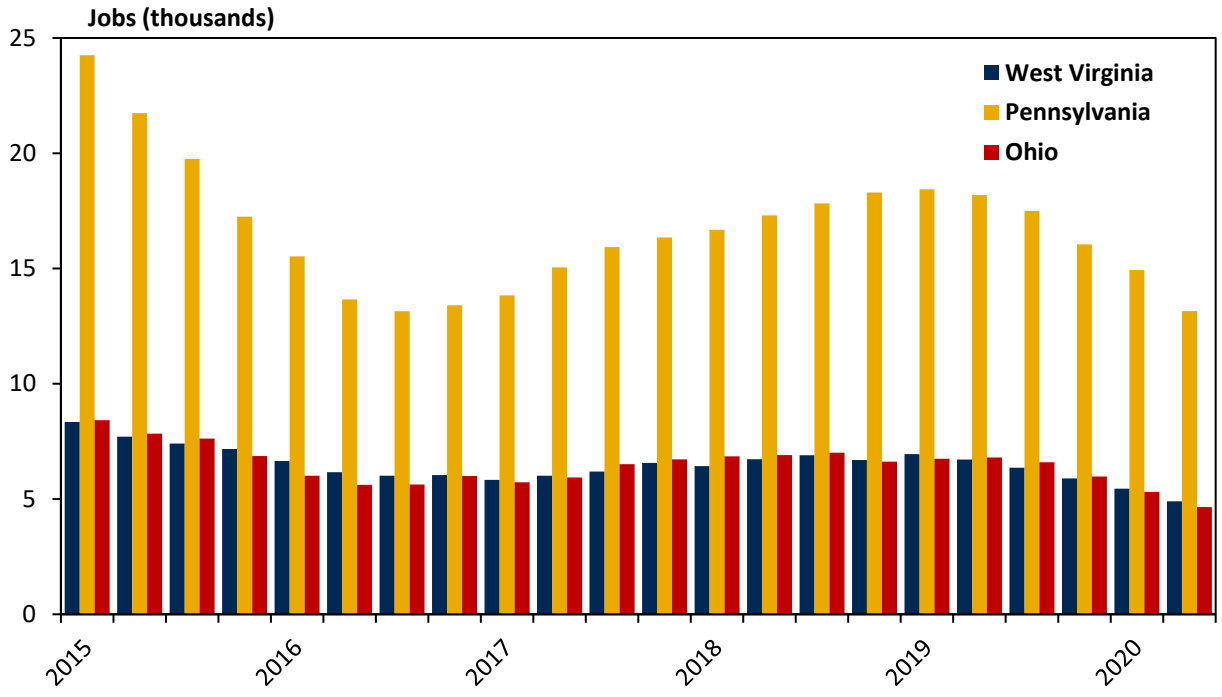
Source: US Energy Information Administration

2.2 Employment

The Covid-19 pandemic has taken its toll on natural gas industry employment, which includes drilling, production and support services. Gas industry employment in West Virginia fell to 4,898 jobs in the second quarter of 2020, a drop of more than 1,800 from the same quarter the previous year, a decline of more than 27 percent (see Figure 5).

Pennsylvania and Ohio experienced similar employment declines in their natural gas industries. Pennsylvania's second quarter 2020 employment fell by more than 5,000 jobs to 13.2 thousand, a decline of just under 28 percent from the same quarter in 2019. Ohio's employment in second quarter 2020 fell by almost 32 percent from 2019 levels to about 4,650 jobs.

Figure 6: Natural Gas Employment

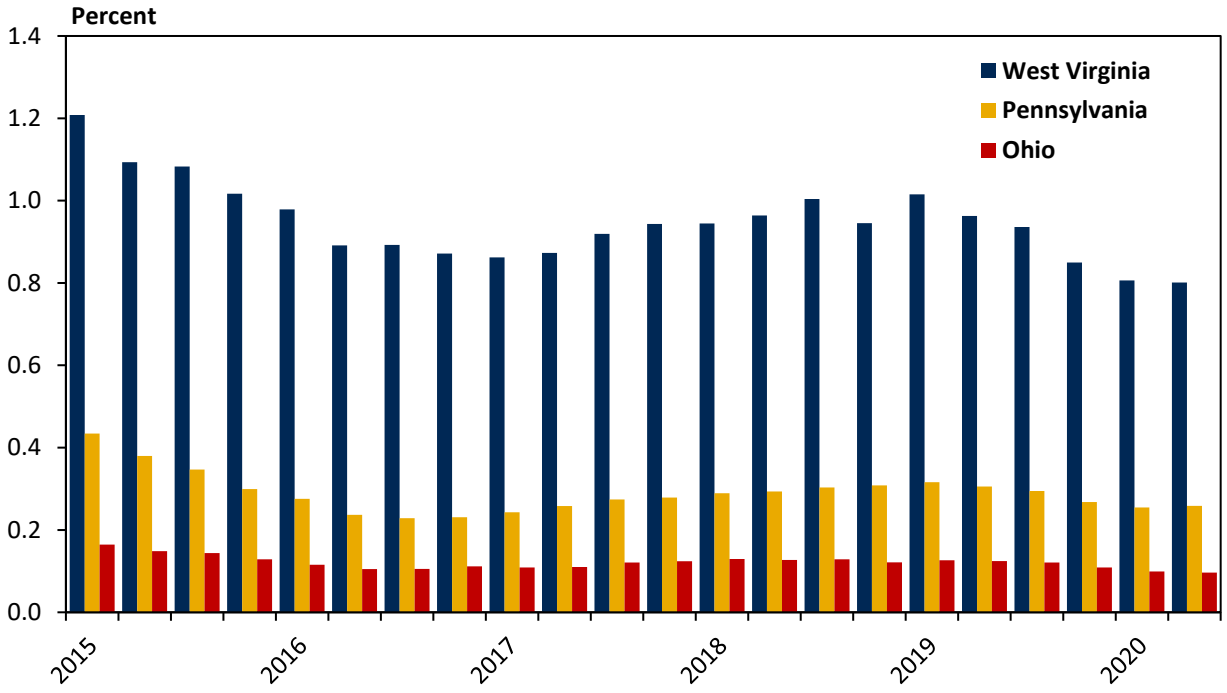


Source: US Bureau of Labor Statistics

Though all three states experienced similar declines in employment in 2020, West Virginia's job losses represent a greater share of total employment, as shown in Figure 6. Natural Gas industry employment has consistently been at or near 1 percent of West Virginia's total employment for much of the last five years. However, with the recent declines, employment has fallen to about 0.8 percent of total employment as the Covid job losses have generated a disproportionately large impact in the state.

Natural Gas industry employment is a much smaller share of total employment in the two neighboring states. Industry employment in Pennsylvania represented between 0.2 and 0.4 percent of total state employment over the course of the last five years. In Ohio, that number was between 0.1 percent and 0.16 percent of total employment.

Figure 7: Natural Gas Employment as a Share of Total Employment



Source: US Bureau of Labor Statistics

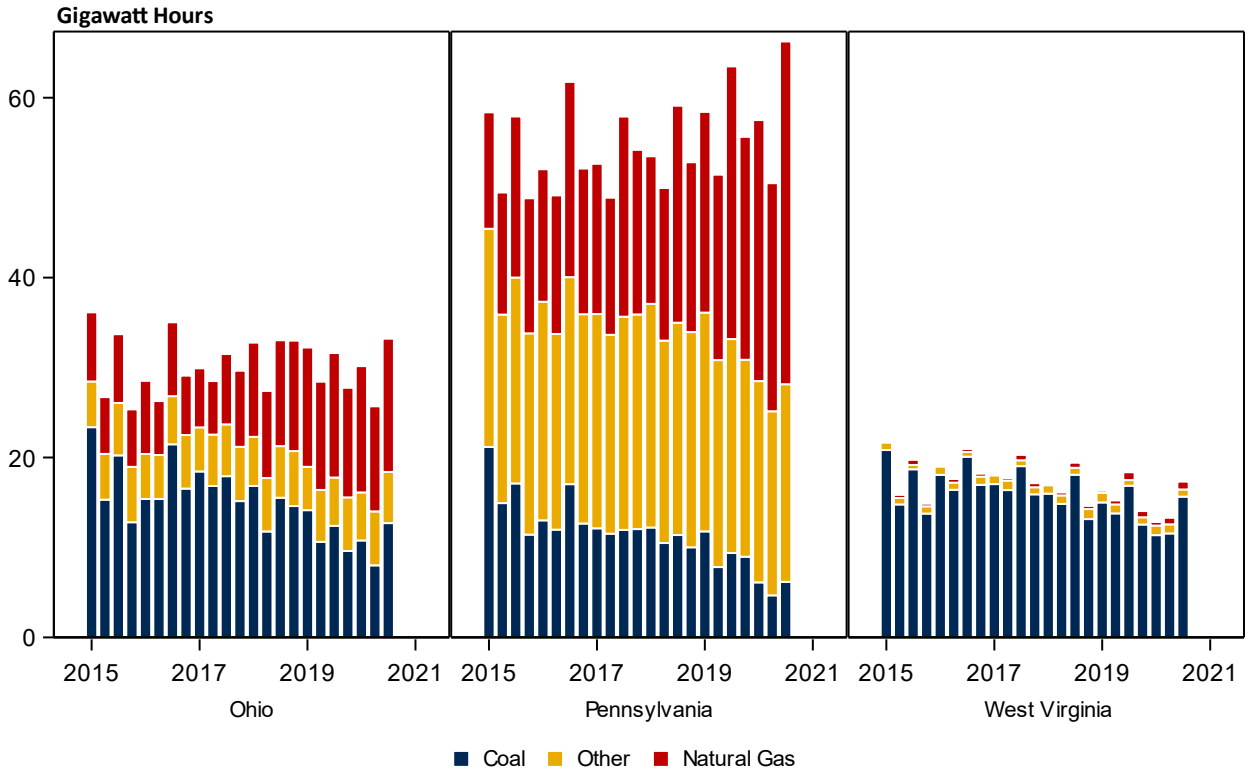
2.3 Electricity Production

Ohio and Pennsylvania have capitalized on their natural gas resources to be used for electricity production. Total electricity production from natural gas-fired power plants in Pennsylvania rose from 59 thousand gigawatt hours (GWh) in 2015 to more than 98 thousand GWh in 2019, a gain of 13 percent on an average annual basis (see Figure 7). This increase has resulted in natural gas increasing from about 28 percent of the state's total generation in 2015 to about 43 percent in 2019.

Ohio experienced a similar increase in natural gas generation, with the total rising from 28 thousand GWh to more than 51 thousand GWh hours, a gain of more than 16 percent per year on average. As a share of total generation, natural gas rose from about 23 percent of Ohio's generation mix in 2015 to nearly 42 percent in 2019.

In contrast, West Virginia's generation mix has remained largely dominated by coal-fired power generation over the past five years. Natural gas generation was approximately 1.5 thousand GWh in 2015, and rose to approximately 2.2 thousand GWh in 2019, a gain of 14 percent per year on average. However, natural gas represents about 3.5 percent of the state's total generation mix, compared with more than 90 percent for coal-fired power.

Figure 8: Electricity Generation



Source: US Energy Information Administration

2.4 Tax Rates

Lastly we compare the tax rates that may affect natural gas producers and mineral rights holders in the three Marcellus states. As shown in Table 1, the taxes that apply to natural gas producers vary considerably between the three jurisdictions.

Most directly, two of the states impose some form of a severance tax on natural gas production. West Virginia's severance tax is 5 percent of net gross value, which takes into account the total value of natural gas sold minus certain types of costs. Ohio's severance tax is a flat 2.5 cents per Mcf of production, while Pennsylvania does not currently impose a severance tax on natural gas production.

Individuals who earn royalties from their mineral rights to natural gas pay income taxes that income. Currently West Virginia's top income tax rate is 6.5 percent of all income above $60 thousand. Ohio imposes an income tax of 4.797 percent on income above $221,300, with lower tax rates in lower income brackets. Finally, Pennsylvania imposes a flat tax of 3.07 percent on all income.

State sales taxes are fairly uniform across the three states. West Virginia has a statewide sales tax of 6 percent, though several municipalities also can impose up to an additional 1-percent sales tax on purchases in their jurisdictions. Pennsylvania's sales tax is also 6 percent with the potential for locally imposed taxes. Lastly, Ohio's statewide sales tax is 5.75 percent with additions in certain local jurisdictions.

Property taxes are also an important source of revenue for local governments within each of these three states. West Virginia's base property tax rate is 2 percent, of which just 0.1 percent goes to the state government, with the remainder going to local governments. Counties, municipalities, and school districts can also impose additional property taxes through local millage elections. In Ohio and Pennsylvania, property taxes are mostly determined at the local level. Ohio's average local property tax rate is 6.7 percent. Pennsylvania's average rate was unavailable.

Table 2: 2020 Tax Rates

	West Virginia	Ohio	Pennsylvania
Natural Gas Severance Tax Rate	5 percent of net gross value	2.5 cents per Mcf	None
Top Marginal Personal Income Tax Rate	6.5 percent on income greater than $60,000	4.797 percent on income greater than $221,300	3.07 on all income
State Sales Tax Rate	6 percent (local rates also apply)	5.75 percent (local rates also apply)	6 percent (local rates also apply)
State Commercial Property Tax Rate	2 percent base rate including local share on 60 percent ad valorem valuation (additional local rates may also apply)	Locally determined. Average tax rate 6.7 percent	Locally determined

Sources: State tax web sites, Tax Foundation

3 Direct Impact of Natural Gas Unitization

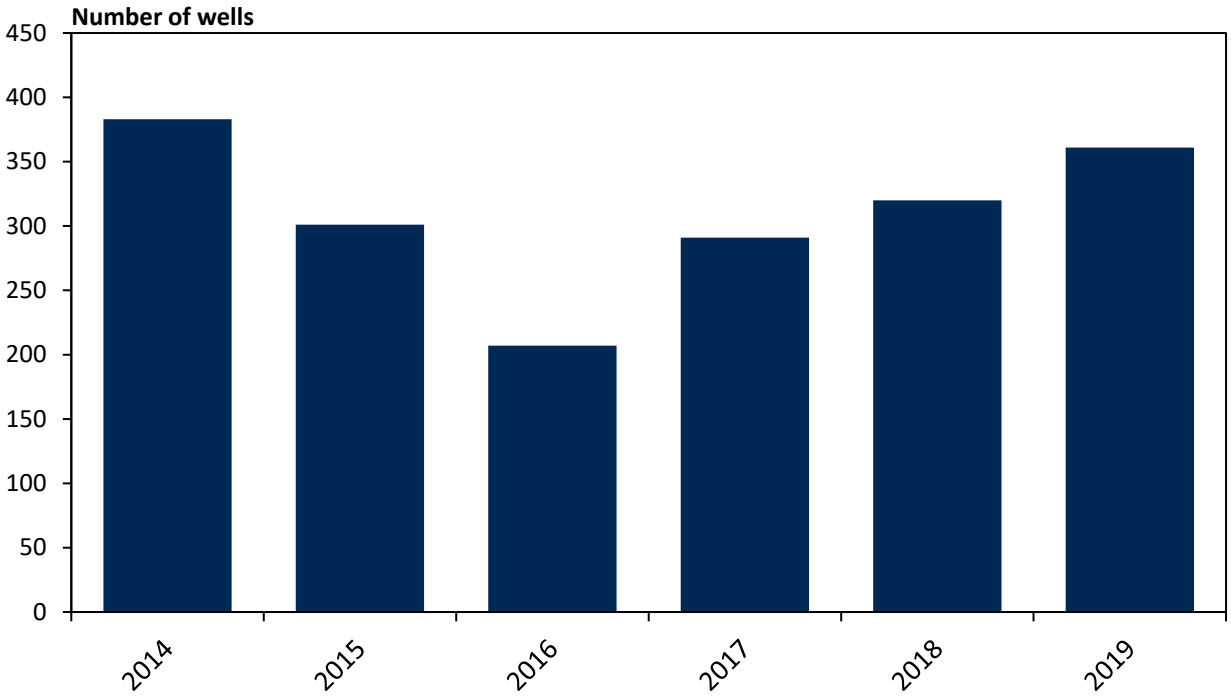
The economic impact of natural gas unitization will depend largely on the increase in drilling and production that will come as a result of resource unitization. In this study we do not attempt to forecast the amount of additional capacity and production that will result from a unitization law. Instead, we build a scenario of potential economic activity that may result from such a policy and then estimate the potential economic impacts associated with that additional activity.

Because a new unitization law would primarily result in an increase in new wells being drilled within the state, we begin our scenario with an assumption about the increase in drilling that may result from the law. We follow this with an estimate of total expenditures associated with construction of these wells, spending due to ongoing production, and royalties paid to rights-holders within the state.

3.1 Additional Well Capacity

As shown in Figure 8, the number of natural gas wells drilled in the state has fluctuated considerably between 2014 and 2019, the most recent year available. The number of wells drilled was at its peak in 2014, when 383 wells were drilled in the state. But that number fell by nearly half by 2016, when only 207 wells were drilled. By 2019, drilling had recovered to 361 wells. On average, approximately 311 wells were drilled each year during this period.

Figure 9: Number of New Wells Drilled in West Virginia



Source: WV Department of Environmental Protection. Author Calculations.

For our economic impact scenario, we assume that a natural gas unitization law will increase drilling by between 5 and 10 percent above the current pace of drilling.[3] This will result in approximately 15 to 30 additional wells drilled each year over the five years post-unitization. For this section we will assume that unitization will go into effect in 2021 and will continue for the five-year horizon of our study, resulting in an additional 75 to 150 wells drilled over the five year period as a result of a unitization law.

3.2 Well Construction and Completion Costs

The first type of cost we consider is construction and drilling of the new wells for each year. For the purposes of this study, we will assume that each well pad can hold six wells. Also, we assume each well will receive hydraulic fracturing—known as completion—only once per well. Our assumptions for construction and drilling costs are shown in Table 2. Because construction and drilling occurs only once per well, the table shows annual costs for each of our two scenarios, along with the total five-year cost. Based on industry averages, we assume that each well pad will cost $1.5 million, and that drilling and completion will cost approximately $8.3 million per well. Total annual costs for the 5-percent scenario are slightly more than $128 million with a total five-year cost of $641 million. For the 10-percent scenario, annual costs are $256.5 million for a total five-year cost of nearly $1.3 billion.

Table 3: Drilling Cost Assumptions

Type of Cost	Cost per Unit ($, millions)	5 Percent Scenario		10 Percent Scenario	
		Additional Construction	Total Cost ($, millions)	Additional Construction	Total Cost ($, millions)
Well Pad Construction	1.5	2.5	3.75	5	7.5
Well Drilling and Completion	8.3	15	124.5	30	249
Total Annual Cost			**128.25**		**256.5**
Total 5-Year Cost			**641.25**		**1,282.5**

3.3 Ongoing Well Operation Costs Per Well

Once the wells are drilled, gas companies also have ongoing operational costs in order to continue production of natural gas. Industry sources estimate that operations costs total approximately $37 thousand per well per year. In Table 3, we show operational costs for each of the two scenarios.

For the 5-percent scenario, the number of operating wells increases by 15 wells each year. We assume that all wells will continue operating throughout the five-year period, for a total cost of $8.3 million. The 10-percent scenario adds 30 wells per year, for a total of 150 new wells in operation by the end of 2025. Total five-year cost for this scenario is nearly $17 million.

[3] This assumption is based on data from our industry partners and is not a forecast of how many additional wells will be drilled as a result of unitization.

Table 4: Operating Cost by Year

Year	Cost per Well ($, thousands)	5 Percent Scenario		10 Percent Scenario	
		Number of Additional Wells	Total Cost ($, millions)	Number of Additional Wells	Total Cost ($, millions)
2021	37	15	0.6	30	1.1
2022	37	30	1.1	60	2.2
2023	37	45	1.7	90	3.3
2024	37	60	2.2	120	4.4
2025	37	75	2.8	150	5.6
Total		**225**	**8.3**	**450**	**16.7**

3.4 Royalties

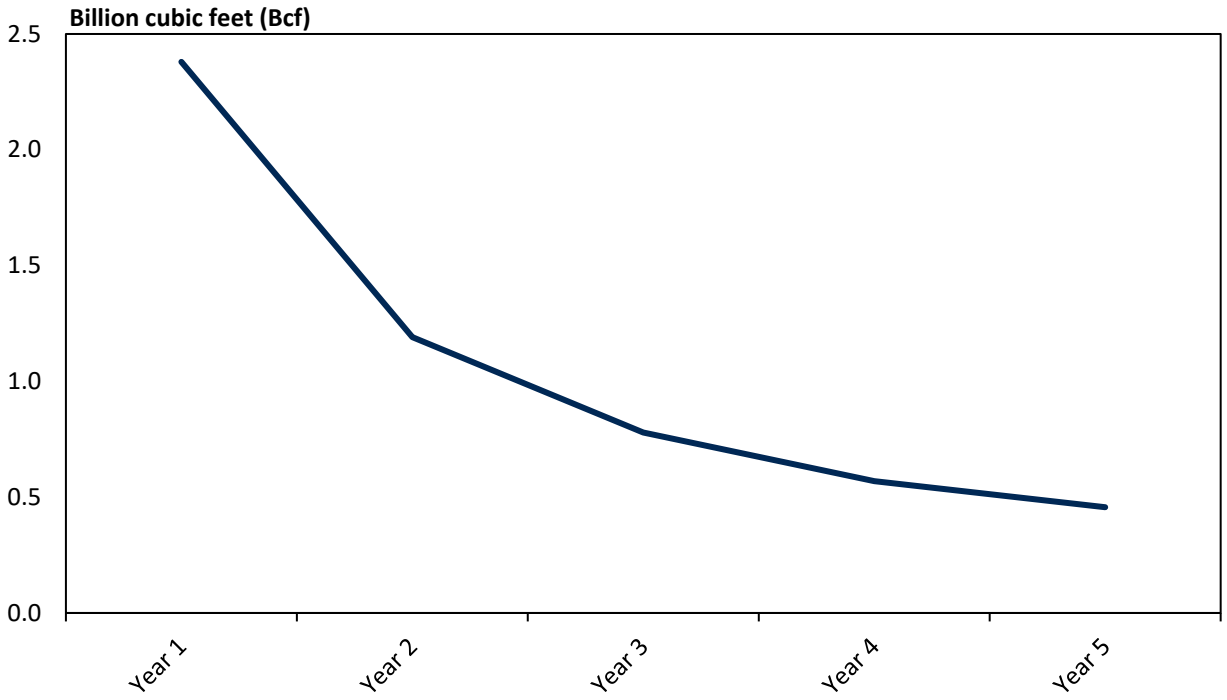
While construction and production costs are mostly based on the number of wells, royalties to resource rights-holders are based on the value of the natural gas produced. To estimate the total amount of royalty revenue paid to households within the state, we must take into account three factors:

1. Production per additional well;
2. The regional natural gas price;
3. The royalty rate paid to mineral-rights holders.

Production from natural gas wells is not uniform across a well's lifespan. The bulk of production from a newly drilled well comes in the first year of operation, during which production can be more than twice that of subsequent years. In Figure 9, we show the average production by year of operation for wells drilled in West Virginia since 2014.[4] As shown, production in the first year of operation averaged 2.4 billion cubic feet during this period. Production fell to less than 1.2 Bcf in the second year of operation, followed by a slower decline over the next three years.

[4] Averages are for the most recent two years of complete data available. For example, Year 1 includes the average first-year production for wells drilled in 2018 and 2019. Year 5 includes production for wells drilled in 2014 and 2015.

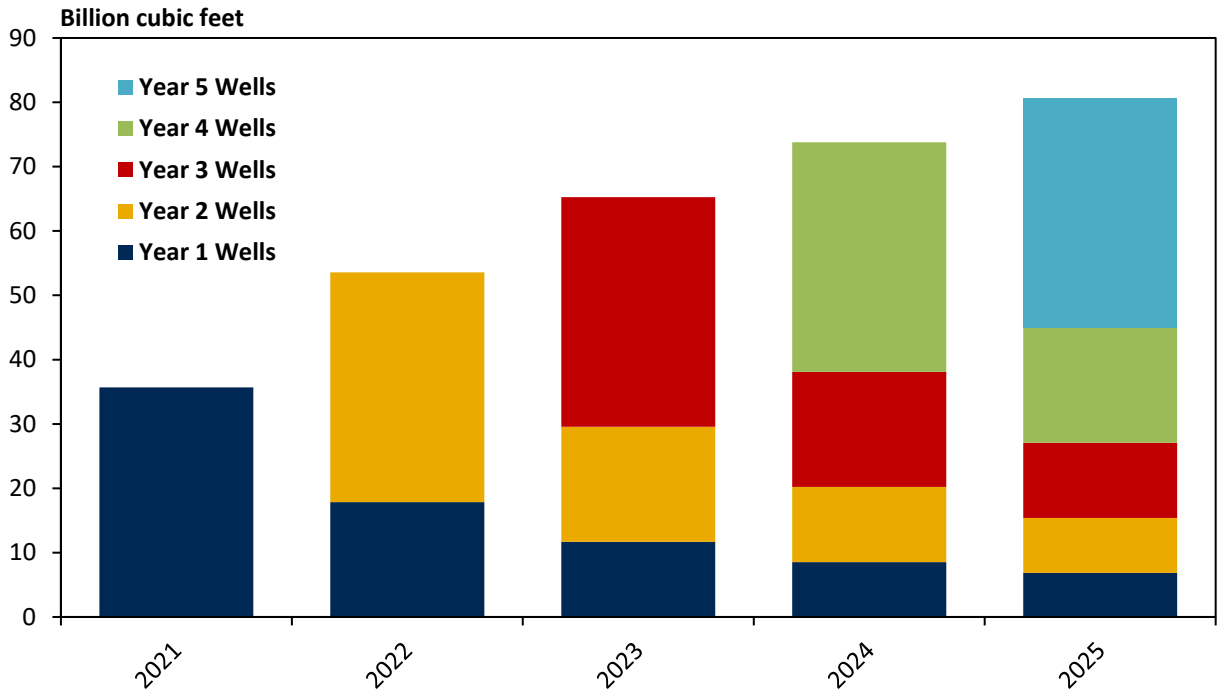
Figure 10: Average Production per Well by Year of Operation



Source: WV Department of Environmental Protection, Author Calculations.

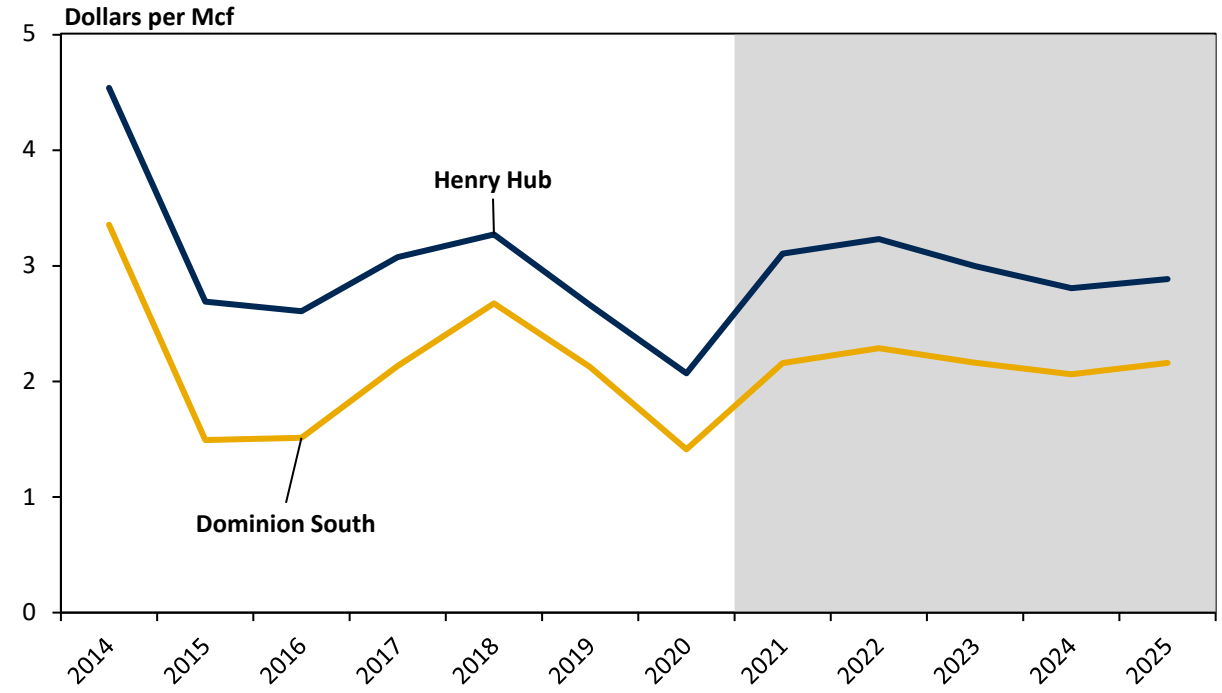
For each scenario, we use our assumption of the additional wells drilled in each of the next five years to project the additional production that would result from these wells using the average production defined above. Projected production for the 5-percent scenario is shown in Figure 10. As each new batch of wells comes online, production is added to the wells drilled in the previous year. For example, in 2021, production from the first year's wells would total approximately 36 Bcf. In 2022, production would continue for those wells drilled in the previous year at the lower rate of 18 Bcf, while production from the 15 new wells drilled that year would add another 36 Bcf, and so on through the five-year period. Total new production that would result in this scenario would be 309 Bcf over five years. The 10-percent scenario would result in a total production of twice this figure, or 618 Bcf.

Figure 11: Total Additional Natural Gas Production over Five Years (5 Percent Scenario)



Source: WV Department of Environmental Protections. Author Calculations.

Figure 12: Natural Gas Price Estimate



Source: Bloomberg. US Energy Information Administration. Author Calculations. Forecast in gray.

The value of the additional natural gas production will depend also on the price received by producers for their product. Natural gas prices fluctuate considerably over time, and often the royalties paid to rights-holders is highly influenced by the price in any given year. To estimate the price of natural gas for the 2021-2025 period, we rely on a price forecast performed by the US Energy Information Administration (EIA 2021a) in its Annual Energy Outlook. The EIA forecasts the price of natural gas at the benchmark Henry Hub trading center over a 30-year horizon.

However, prices paid to regional producers are generally lower than that at the Henry Hub. To estimate the value of local production we have produced an estimate of prices paid at the Dominion South trading hub in southwestern Pennsylvania, where much of the natural gas from the Marcellus region is traded. Prices at the Dominion South hub have averaged about 89 cents per Mcf lower than at the Henry Hub since 2014. However, the price spread has converged by about 1.8 percent per year during that same period. In order to calculate the value of natural gas from the additional wells, we project prices at the Dominion South Hub between 2021 and 2025 using the average convergence factor from the previous 7-year period. These prices are shown in Figure 11.

Lastly, we calculate the share of income that accrues to mineral-rights holders due to the increase in well drilling. Royalty terms are generally spelled out in private contracts between natural gas companies and mineral-rights holders within the state and are not publicly available. However, based on industry sources, we assume that average royalties net post-production costs amount to 12.5 percent of total gross value of natural gas production.

Based on these assumptions, we summarize total royalties paid to mineral-rights holders in Table 4. For the 5-percent scenario, royalties start at approximately $9.6 million in 2021 and rise to nearly $22 million by 2025 for a total of more than $83 million in additional household income due to royalties over five years. Again, the 10-percent scenario is twice this figure, for a total royalty payment of nearly $167 million over five years.

Table 5: Royalty Income

Year	Price ($/Mcf)	5 Percent Scenario		10 Percent Scenario	
		Additional Production (Bcf)	Total Royalties ($, millions)	Additional Production (Bcf)	Total Royalties ($, millions)
2021	2.15	35.7	9.6	71.4	19.2
2022	2.28	53.6	15.3	107.1	30.5
2023	2.16	65.2	17.6	130.5	35.2
2024	2.06	73.8	19.0	147.6	38.0
2025	2.16	80.6	21.8	161.3	43.5
Total		**308.9**	**83.2**	**617.8**	**166.5**

4 Economic Impact of Natural Gas Unitization

Having established the direct expenditures in the state's economy that can be expected to result from natural gas unitization, we now estimate the total economic impact of these expenditures. To estimate the economic impact, we apply a detailed model of the West Virginia economy that outlines how trade-flows among industries interact with key economic indicators such as employment, income, output, and tax revenue.[5] The expenditures associated with construction and drilling; operations; and royalties are referred to as the direct economic impact. However, the total economic impact of these activities is not limited to the direct impact, but also includes the secondary economic impacts accrued as those initial direct expenditures are re-spent throughout the rest of the economy.

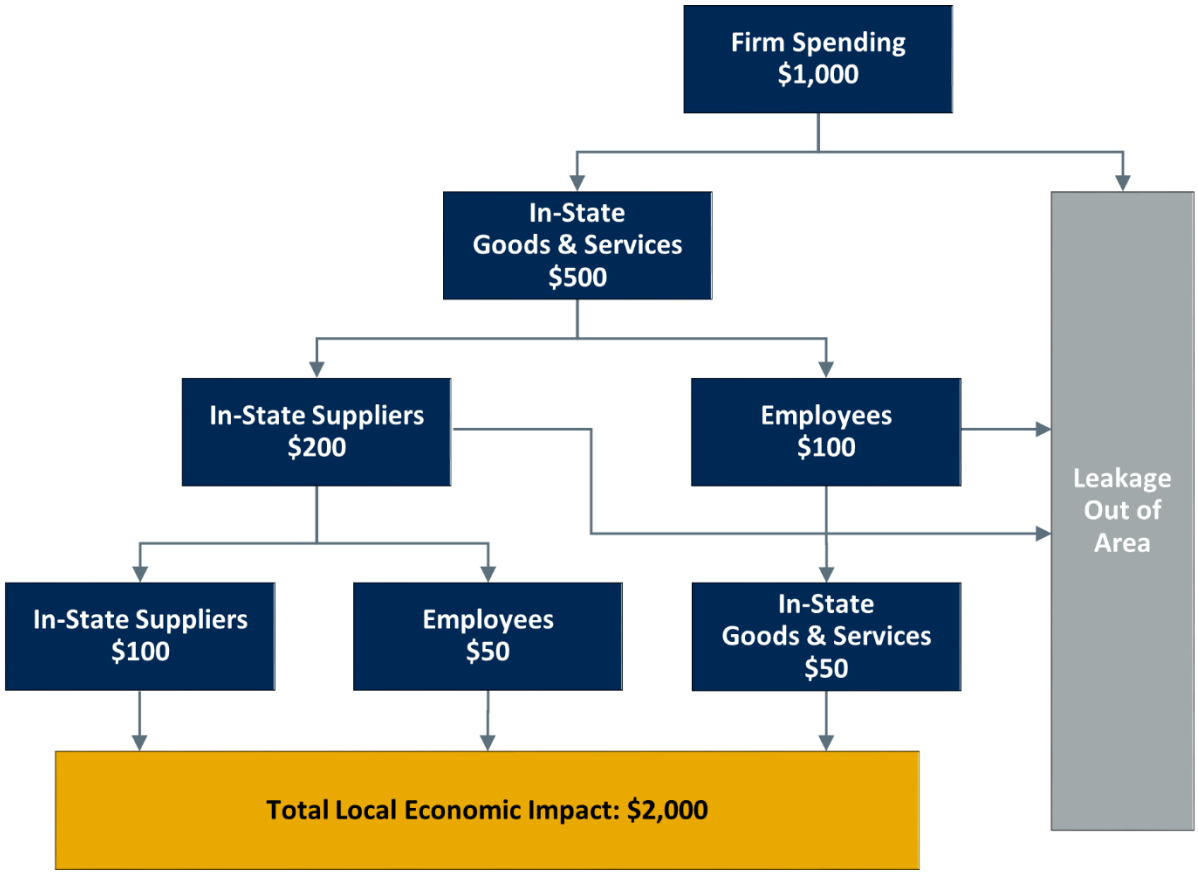
For example, to support its operations, natural gas companies will purchase items such as materials, utilities, office products, professional services, etc., from suppliers in West Virginia. Because of the increased demand for these inputs, local suppliers will increase their production correspondingly, and their subsequent suppliers will increase production, etc. This additional economic activity is referred to as indirect impacts. In addition, the companies and their suppliers employ workers, part of whose income will be spent in the West Virginia economy, which generates additional output, income, and employment. This activity is referred to as induced impacts.

These indirect and induced impacts together form what is known as the "multiplier effect." The original stimulus to the economy from the increased natural gas drilling is re-spent multiple times through the rest of the state's economy. At each stage, some of the expenditures "leak" out of West Virginia as they are spent outside of the state. The combined direct impact and secondary impacts together constitute the total economic impact of the operational expenditures connected to increased drilling activity. These multipliers and leakages are depicted in Figure 12.

Our model assumes that the impacts identified in the previous section will be spread across the state of West Virginia. Also, any workers are assumed to also be residents of West Virginia, and thus they will spend the majority of their income within the state.

[5] This study was conducted using the IMPLAN modeling software, an industry-standard input-output model of the economy. More information about IMPLAN can be found at http://www.implan.com.

Figure 13: Economic Impact Flow



4.1 Well Construction Impact

As estimated in the previous section, total spending on well construction and completion is expected to be between $641 million and $1.3 billion, depending on the scenario. As shown in Tables 5 and 6, direct expenditures would be expected to result in between 1,800 and 3,700 jobs spread over five years (job-years),[6] with between $154 million and $307 million in compensation. We estimate tax revenue from direct expenditures to be between $6.6 million and $13.1 million.

We estimate secondary impacts from the multiplier effect would result in between $414 million and $829 million in total output, for a total economic impact of between $1.1 billion and $2.1 billion over five years. Total employment impacts would range from nearly 4,200 job-years to 8,400 job-years with compensation of between $56 million and $113 million. Selected tax revenue is estimated to fall between $2.5 million and $5 million.

[6] One job-year is calculated as one person employed either full or part-time for one year.

Table 6: Cumulative 5-Year Impact of Well Construction and Completion (5-Percent Scenario)

	Direct Impact	Indirect & Induced Impact	Total Economic Impact
Output ($, millions)	641.3	414.3	1,055.6
Employment (job-years)	1,868	2,315	4,184
Employee Compensation ($, millions)	153.5	128.2	281.7
Selected Taxes ($, millions)	6.6	6.0	12.6

Notes: Output, Employee Compensation, and Tax Revenue are measured in 2021 dollars. Tax Revenue impact includes sales, personal income, property, and corporation net income taxes.

Table 7: Cumulative 5-Year Impact of Well Construction and Completion (10-Percent Scenario)

	Direct Impact	Indirect & Induced Impact	Total Economic Impact
Output ($, millions)	1,282.5	828.7	2,111.2
Employment (job-years)	3,736	4,631	8,367
Employee Compensation ($, millions)	306.9	256.5	563.4
Selected Taxes ($, millions)	13.1	12.1	25.2

Notes: Output, Employee Compensation, and Tax Revenue are measured in 2021 dollars. Tax Revenue impact includes sales, personal income, property, and corporation net income taxes.

4.2 Operations Impact

Using our estimates for operational expenditures from above, total 5-year spending is expected to be between $8.3 million and $16.6 million, for the 5-percent and 10-percent scenario respectively. As shown in Tables 7 and 8, these expenditures would be expected to result in between 34 and 67 jobs over five years with between $2.4 million and $4.9 million 31 in compensation. We estimate tax revenue from direct expenditures to be between $100 thousand and $200 thousand.

Secondary impacts from these direct expenditures are expected to produce $4.5 million and $9 million in total output, for a total economic impact of between $12.8 million and $25.6 million. We estimate total employment impacts to be between 61 jobs and 123 jobs with compensation of between $3.9 million and $7.7 million. Total tax revenue is estimated to fall between $161 thousand and $322 thousand.

Table 8: Cumulative 5-Year Impact of Operational Expenditures (5-Percent Scenario)

	Direct Impact	Indirect & Induced Impact	Total Economic Impact
Output ($, millions)	8.3	4.5	12.8
Employment (job-years)	34	28	61
Employee Compensation ($, millions)	2.4	1.4	3.9
Selected Taxes ($, thousands)	100.0	60.9	161.0

Notes: Output, Employee Compensation, and Tax Revenue are measured in 2021 dollars. Tax Revenue impact includes sales, personal income, property, and corporation net income taxes.

Table 9: Total 5-Year Impact of Operational Expenditures (10-Percent Scenario)

	Direct Impact	Indirect & Induced Impact	Total Economic Impact
Output ($, millions)	16.6	9.0	25.6
Employment (job-years)	67	55	123
Employee Compensation ($, millions)	4.9	2.9	7.7
Selected Taxes ($, thousands)	200.1	121.8	321.9

Notes: Output, Employee Compensation, and Tax Revenue are measured in 2021 dollars. Tax Revenue impact includes sales, personal income, property, and corporation net income taxes.

4.3 Royalties Impact

Lastly, we estimate the impact from royalty income. As estimated above, the direct impact of royalties is $83.2 million in the 5-percent scenario and $166.4 million in the 10-percent scenario. Because royalties accrue to households as income, they do not directly support any additional jobs or employee compensation. However, these households are expected to pay between $1.2 million and $2.4 million in taxes on these earnings.

We estimate that secondary impacts from this household income will support an additional $72 million to $144 million in output within the state's economy, for a total economic impact of between $155 million and $310 million. These secondary expenditures are expected to support between 500 to 1,000 jobs with compensation of $22.3 million to $44.6 million. Total taxes are between $4.4 million and $8.8 million.

Table 10: Total 5-Year Impact of Royalties (5-Percent Scenario)

	Direct Impact	Indirect & Induced Impact	Total Economic Impact
Output ($, millions)	83.2	71.9	155.1
Employment (job-years)	0	506	506
Employee Compensation ($, millions)	0	22.3	22.3
Selected Taxes ($, millions)	1.2	1.0	2.2

Notes: Output, Employee Compensation, and Tax Revenue are measured in 2021 dollars. Tax Revenue impact includes sales, personal income, property, and corporation net income taxes.

Table 11: Total 5-Year Impact of Royalties (10-Percent Scenario)

	Direct Impact	Indirect & Induced Impact	Total Economic Impact
Output ($, millions)	166.4	143.7	310.1
Employment (job-years)	0	1,012	1,012
Income ($, millions)	0	44.6	44.6
Selected Taxes ($, millions)	2.4	2.0	4.4

Notes: Output, Employee Compensation, and Tax Revenue are measured in 2021 dollars. Tax Revenue impact includes sales, personal income, property, and corporation net income taxes.

4.4 Total Impact

If we combine drilling, operations, and royalties, we estimate the total five-year economic impact of a natural gas unitization law to be between $1.2 billion and $2.4 billion (see Tables 12 and 13). Of this figure, between $732 million and $1.5 billion will come from direct expenditures by the natural gas industry. The remaining $491 million to $981 million is expected to come from secondary economic impacts as the direct impact works its way through the rest of the economy.

In all, we estimate these expenditures will support about 1,900 job-years to 3,800 jobs years directly, with an additional 2,900 to 5,700 job-years from secondary impacts. Total employee compensation for these workers is expected to be between $391 million to $782 million, with between $239 million and $478 million coming from direct impacts and the remainder from secondary impacts. We estimate these economic impacts to result in between $15 million and $30 million in state tax revenue, with $7.9 million to $15.7 million coming from direct expenditures by the natural gas industry.

Table 12: Total 5-Year Economic Impact (5-Percent Scenario)

	Direct Impact	Indirect & Induced Impact	Total Economic Impact
Output ($, millions)	732.8	490.7	1,223.5
Employment (job-years)	1,902	2,849	4,751
Employee Compensation ($, millions)	239.1	152.0	391.1
Selected Taxes ($, millions)	7.9	7.1	15.0

Notes: Output, Employee Compensation, and Tax Revenue are measured in 2021 dollars. Tax Revenue impact includes sales, personal income, property, and corporation net income taxes.

Table 13: Total 5-Year Economic Impact (10-Percent Scenario)

	Direct Impact	Indirect & Induced Impact	Total Economic Impact
Output ($, millions)	1,465.5	981.4	2,446.9
Employment (job-years)	3,804	5,698	9,502
Income ($, millions)	478.2	303.9	782.1
Selected Taxes ($, millions)	15.7	14.3	30.0

Notes: Output, Employee Compensation, and Tax Revenue are measured in 2021 dollars. Tax Revenue impact includes sales, personal income, property, and corporation net income taxes.

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