Economic and Fiscal Impact of Pennsylvania Shale Gas Development

APPROACH TO METHODOLOGY AND RESULTS

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FTI CONSULTING™

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EXECUTIVE SUMMARY

The Marcellus and Utica Shales, two of the world's largest natural gas fields, have transformed Pennsylvania into a major natural gas-producing state. From an economic perspective, the industry has created jobs, delivered strong wages, contributed to the state's gross domestic product, and generated significant state revenues from taxes and impact fees, to name a few.

Marcellus Shale Coalition ("MSC") engaged FTI Consulting ("FTI") to analyze the economic and fiscal impacts of the shale gas development industry ("the industry") on the Pennsylvania economy under three scenarios from 2022-2050. FTI created and distributed a survey to MSC board members to capture data on the industry's upstream, midstream, and downstream capital and operating expenditures to support this analysis. All survey responses were uploaded to a secure FTP site where only FTI's Economic Consulting employees could see the responses and which companies responded.

FTI developed a bottom-up approach to estimating industry expenditures per year using this survey data, data on individual natural gas wells, historical production, and forecasts of future Pennsylvania natural gas production across the three scenarios:

- Reference Case: the EIA's assessment of how U.S. and world energy markets would operate through 2050 based on current laws and regulations.
- High oil and gas supply (low prices): natural gas supply is higher than in the Reference case due to more optimistic resource availability and extraction technology assumptions. This leads to lower energy prices and increased natural gas use. In this study, these assumptions lead to more wells being drilled and higher Pennsylvania production at lower wholesale gas prices.
- Low oil and gas supply (high prices): natural gas supply is lower than in the Reference case due to more pessimistic assumptions about resource availability and extraction technology. This leads to higher energy prices and decreased natural gas use. In this study, these assumptions lead to fewer wells being drilled and lower Pennsylvania production at higher wholesale gas prices.

These forecasts were then applied to an economic impact model to determine the industry's total economic impact in 2022. Table 1 shows that the industry supported 123.1 thousand jobs in 2022 – roughly the population of the third-largest city in Pennsylvania. These jobs include those directly supported by the industry and those generated through the supply chain and employee spending across different sectors of the economy.

Table 1: 2022 Estimated Economic Impacts

	Category	Impact
	Employment (thousands)	123.1
	Output ($billions)	$41.4
	GDP ($billions)	$24.4
	Labor Income ($billions)	$12.0
	Federal Tax Revenues ($billions)	$2.6
	State and Local Tax Revenues ($billions)	$3.2

The total economic activity supported by the industry in 2022 was $41.4 billion, impacting Pennsylvania's GDP by $24.4 billion, greater than the GDP of 46 countries.[1]

2022 Labor income supported by the industry was $12.0 billion, generating an average compensation for the 123.1 thousand jobs supported of $97,482 - 113 percent higher than the median Pennsylvania wage.[2]

Federal tax revenues supported were $2.6 billion in 2022, while state and local tax revenues supported were $3.2 billion. Of these significant revenues, $279 million in revenues derived from Pennsylvania's unique Impact Fee was distributed directly to local communities in all 67 counties, as well as various environmental and conservation programs.

The state and local tax revenues supported were greater than the Commonwealth's 2022-2023 budget for the Pennsylvania State Police, State System of Higher Education, Public Utility Commission, Departments of Agriculture, Environmental Protection, Conservation and Natural Resources, Military and Veterans Affairs, House of Representatives, and Senate combined.[3]

Further, the industry paid an estimated $6.3 billion in royalties to private and government entities in 2022, a significant investment in the state's economy reflected in the economic outputs listed in Table 1.

Looking ahead, the industry's impact on Pennsylvania's economy is forecast to be robust for decades to come. Though 2022 was an exceptionally high-impact year due to a period of high natural gas prices, which in turn raised royalty payments to landowners and Impact Fee payments, among other effects, all three forecast scenarios show robust projections through 2050. FTI's study differs from other sound

[1] United Nations Statistics Division, 2021 GDP
[2] U.S. Bureau of Labor Statistics Occupational Employment and Wage Statistics, May 2022, Annual Median Wage for all Occupations in Pennsylvania, $45,790
[3] Pennsylvania General Fund Current Fiscal Year Enacted Budget, combined 2022-2023 budget of $2.8 billion

economic impact research on Pennsylvania's gas industry using IMPLAN in several key ways. It is essential to understand these differences before comparing results between studies.

1. FTI's study focuses on industries directly related to natural gas extraction and transportation. Studies with a broader focus, including crude oil and petroleum products, have used additional sectoral definitions, including gas stations, petroleum refining, asphalt paving, etc.
2. FTI's study is focused solely on the economic impact of shale gas development within the Commonwealth's borders. Other broader studies have, explicitly or implicitly, included impacts on Pennsylvania's economy from activity in other states that involve and benefit Pennsylvania businesses.

INTRODUCTION AND CONTEXT

Marcellus Shale Coalition engaged FTI Consulting to assess the economic and fiscal impacts of the shale gas industry on the Commonwealth of Pennsylvania. The analysis examines actual 2022 economic and fiscal impacts and includes three forecasted scenarios from 2023-2050:

- Base Case: based on the Energy Information Administration's (EIA) Annual Energy Outlook (AEO) 2023 Reference Case
- Low Prices: based on the EIA's AEO 2023 High Oil and Gas Supply Case
- High Prices: based on the EIA's AEO 2023 Low Oil and Gas Supply Case

Pennsylvania has a long history in the energy industry, being the birthplace of the American oil industry, with the first commercial oil well drilled in Titusville in 1859. In modern times, the state's focus has shifted toward producing natural gas with the development of the Marcellus and Utica shale formations.

One of the world's largest natural gas fields, the Marcellus Shale stretches across much of Pennsylvania and parts of neighboring states. It, along with the Utica Shale, has been known to contain natural gas for decades. However, it wasn't until the early 2000s that large-scale extraction became economically viable with technological advancements.

Developing unconventional shale gas formations has transformed Pennsylvania into the second-largest natural gas-producing state in the U.S. The industry has created a significant number of jobs, contributed to economic growth, and generated significant state revenues from taxes and impact fees.

The following section describes the methodology and approach used to develop inputs for the economic model underlying this analysis, the workings of the economic impact model, and the assumptions and the raw data sources used to construct the analysis.

METHODOLOGY AND APPROACH

SURVEY DISTRIBUTION

FTI created a survey to capture the financial and operational activities of the industry. The survey was distributed to the MSC board member companies by FTI.

The survey questions were categorized into "Upstream," "Midstream," and "Additional Spending." All survey responses were uploaded to a secure FTP site where only FTI's Economic Consulting employees could see the responses and which companies responded. FTI guaranteed the confidentiality of respondent data. The average costs derived from the survey were utilized along with data from the government and third-party commercial data vendors to estimate industry expenditures.

HISTORICAL AND FORECASTED NATURAL GAS MARKET ANALYSIS

HISTORICAL ANALYSIS

For the historical economic and fiscal impact analysis, FTI examined calendar year 2022. FTI combined the results of the survey of MSC board members with well data from WellDatabase[4] to estimate various industry expenditures during the year.

The survey questions were phrased in terms of typical costs per well and unit production. This allowed FTI to scale up the values provided in survey responses and calculate a PA-industry-wide estimate. FTI was then able to apply values to all wells drilled in Pennsylvania in 2022 rather than only those drilled by survey respondents.

Drilling and Completion Costs

Drilling and completing a natural gas well is a complicated process that involves many steps, starting with geologists and engineers identifying a suitable location. If the operator does not already own the land or mineral rights at this location, the operator must first secure leasing rights. Once the site has been chosen, rights acquired, and all necessary permits received, the site must be prepared for drilling under rigorous regulatory requirements. A drilling rig can then be transported to the site.

Drilling begins with a surface hole that is drilled to a predetermined depth. A steel pipe, called the surface casing, is inserted into this hole, and cement is pumped down to fill the space between the casing and the hole, isolating groundwater zones. The drill then continues deeper to the target formation. At some point, often called the kickoff point, the orientation of the well will change from a vertical borehole to a more horizontal orientation.

[4] https://welldatabase.com/

Another casing pipe is run down the hole to prevent the well from collapsing and to isolate the production zone from other zones. This casing is also cemented in place. The drilling costs are primarily a function of the vertical and horizontal drilling distances.

Based on the survey sample, we calculated the production-weighted average cost to drill vertical and horizontal feet.

After drilling, the well must be completed to allow the gas to flow from the shale formation. This often involves hydraulic fracturing, where water, sand, and chemicals are pumped down the well at high pressure to create fractures in the rock that allow the gas to flow into the well. This step usually takes between one and five days. After this step is completed, production tubing is run into the well. These completion costs are primarily a function of the length of the horizontal portion of the well.

Based on the survey sample, we calculated a production-weighted completion cost per lateral foot.

According to WellDatabase, 576 wells were drilled in 2022, with an average vertical length of 7,389 feet and an average lateral length of 10,294 feet. This results in a total vertical length drilled of 4,256,064 feet. The total lateral length is 5,929,344 feet.

While 576 wells were drilled in 2022, 441 wells were completed, according to WellDatabase. These wells had an average lateral length of 11,019 feet and total length of 4,859,379feet.

Well Operating and Maintenance Costs

The cost of a well over its productive life can generally be separated into two categories: fixed operating and maintenance costs ("FOM") and variable operating and maintenance costs ("VOM").

Fixed costs can include, among others, depreciation of installed equipment over time, the expense of insurance policies related to a well, lease payments for land, and labor salaries and wages of employees who operate and maintain the well regardless of the well's production level.

Variable costs can fluctuate depending on the well's production level. They can include the costs of energy used to operate equipment, chemicals, water-related costs, and costs of maintenance and repair of equipment, among others.

Based on the survey sample, we calculated an average production-weighted FOM. According to WellDatabase, there were 11,171 operating wells in 2022. Multiplying the two values together yields an industry-wide FOM estimate.

Gathering and Processing Costs

Natural gas gathering and processing are critical steps in producing market-ready natural gas. They involve the transportation of raw gas from the wellhead to processing facilities and the removal of impurities and natural gas liquids (NGLs) from the raw gas. Both gathering and processing have associated costs.

Gathering costs are associated with collecting raw natural gas from multiple production wells. The natural gas is typically collected through a network of pipelines known as a gathering system. This involves capital expenditures, the cost of installing and maintaining the gathering pipelines, and operational expenditures, including the labor and energy needed to run and maintain the systems.

After gathering, in some instances, natural gas liquids, including ethane, propane, and butane are separated from natural gas at processing and fractionation plants. Again, costs are split between capital expenditures to build the gas processing plants and operational expenses to run and maintain the plants.

Based on the survey sample, we calculated the average cost paid by producers to gather and process natural gas. We then applied this value to the U.S. Energy Information Administration ("EIA") 2022 total Pennsylvania production estimate of 7,483,255 MMcf to reach a resulting expenditure estimate.

The survey also queried respondents about capital and operational expenditures made on gathering and processing systems in 2022 and grossed up the values to the PA-industry level.

Pipeline Transportation

Intrastate and interstate natural gas pipelines are essential infrastructure systems that transport natural gas from production sources to consumers across different regions.

- **Intrastate natural gas pipelines** operate within the boundaries of a single state. They connect local gas production areas, storage facilities, and distribution centers to serve the energy needs of communities within that state.
- **Interstate natural gas pipelines**, on the other hand, traverse multiple states or even international boundaries. They form an extensive network that connects gas production regions to distant markets and major population centers. Interstate pipelines transport large volumes of natural gas over long distances, enabling the movement of gas from surplus regions to areas with high demand.

Based on the survey sample, we calculated a production-weighted average cost to move gas on intrastate and interstate pipelines *within the borders of the Commonwealth*. We multiplied that value by the EIA total production figure for the year of 7,483,255 MMcf to arrive at a resulting expenditure.

Gas Distribution

Natural gas distribution companies deliver natural gas safely and reliably to end-use consumers, including homes, businesses, schools, healthcare facilities and a host of other end-use consumers. They operate pipelines, storage facilities, and distribution systems to transport natural gas from suppliers to customers. Their key role is ensuring uninterrupted gas supply while adhering to safety regulations.

IMPLAN's 2022 Pennsylvania multipliers and study area data were used to assess the impact of Pennsylvania's gas distribution industry on the Commonwealth's economy.

Gas-fired Power Generation

Gas-fired power generation produces electricity using natural gas as the fuel source. Power generation companies operate gas-fired power plants to ensure safe and efficient electricity production for consumers. Pennsylvania has the fourth-highest total operating nameplate capacity for gas-fired generation at 28.1 GW, outranked only by the three highest population states, Texas, Florida, and California.[5]

[5] EIA Form 860M, May 2023

In 2021, the most recent year for which finalized EIA 923 exists, natural gas-fired power plants produced over half of all generation in Pennsylvania, significantly more than nuclear generation, the Commonwealth's second-highest generating category.[6]

IMPLAN's 2022 Pennsylvania multipliers and study area data were used to assess the impact of Pennsylvania's gas-fired power generation industry on the Commonwealth's economy. Since the IMPLAN sector accounts for all fossil-fuel generation in aggregate, a share of the impact to gas was assigned based on the relative share of natural gas nameplate capacity to all fossil fuel capacity.

Royalty Payments

Natural gas royalty payments are the financial compensation that mineral rights owners, often landowners, receive from energy production companies in return for extracting natural gas from their land. These payments are outlined in a lease agreement between the landowner and the energy company.

In Pennsylvania, the Guaranteed Minimum Royalty Act of 1979 establishes a minimum royalty payment rate of 12.5%, but the actual rate can be higher and is often subject to negotiation. This means landowners are entitled to at least 12.5% of the net revenue from the sale of natural gas extracted from their property after calculating any costs associated with getting gas to market as the lease contract may allow.

These royalty payments continue for as long as natural gas is produced from the landowner's property. The payment amount can fluctuate as natural gas production volumes and market prices fluctuate.

Estimating royalty payments is complex. An Independent Fiscal Office ("IFO") 2022 research brief attributes this difficulty to royalty payments not being reported separately from other payments on Pennsylvania tax returns.[7] FTI assumed a 15% average royalty rate for this analysis, yielding an estimated 2022 royalty payment total of $6.3 billion.

Impact Fee

The Pennsylvania natural gas Impact Fee was signed into law on February 14, 2012, as part of Act 13 of 2012. This legislation imposes a fee on the state's unconventional natural gas drilling activities, primarily supporting communities where natural gas development occurs.

The fee is tied to the price of natural gas and is structured to be higher during the early years of a well's life when production is highest and to decrease over time as well production declines. The Impact Fee applies to unconventional gas wells. Conventional wells are exempt.

The Pennsylvania Public Utility Commission (PUC) collects and distributes the fees. They also maintain an online, public reporting system that allows individuals to view distributions and see how the funds are used.[8]

The revenue generated from the Impact Fee is allocated among state, county, and municipal governments. A portion of the funds go to the state for distribution through grants for environmental

[6] EIA Form 923, 2022

[7] http://www.ifo.state.pa.us/download.cfm?file=Resources/Documents/RB%202019%20Natural%20Gas%20Royalties.pdf

[8] https://www.act13-reporting.puc.pa.gov/Modules/PublicReporting/Overview.aspx

initiatives across all counties, as well as funding for state agencies that oversee the industry. The remaining funds go to counties and municipalities that host drilling operations, and these funds can be used for various purposes, including infrastructure improvements, emergency preparedness, affordable housing programs, judicial services, and environmental preservation.

The PUC released the 2022 impact fee total on June 20, 2023, at $278,881,450.

FORECASTED ANALYSIS

The methodology employed for FTI's forecast analysis is consistent with that of FTI's historical analysis. Costs associated with individual wells drilled, completed, and already in operation were applied to the production generated from those wells. To generate inputs for future values, two primary tasks were completed.

1. First, FTI estimated how production from existing wells will decline over time.
2. Next, FTI estimated how many typical wells must be drilled and completed each year to achieve long-term production targets.

FTI accomplished these tasks using data from existing wells, as accessed through third-party WellDatabase, and natural gas production targets as implied within EIA's 2023 Annual Energy Outlook ("AEO").[9]

Forecast of Production from Existing Wells

Natural gas production from a well tends to decline over the life of the well due to many factors, including reservoir characteristics like the permeability of the rock, decreases in reservoir pressure over time as gas is extracted, and the infiltration of water over time into the well, among other factors.

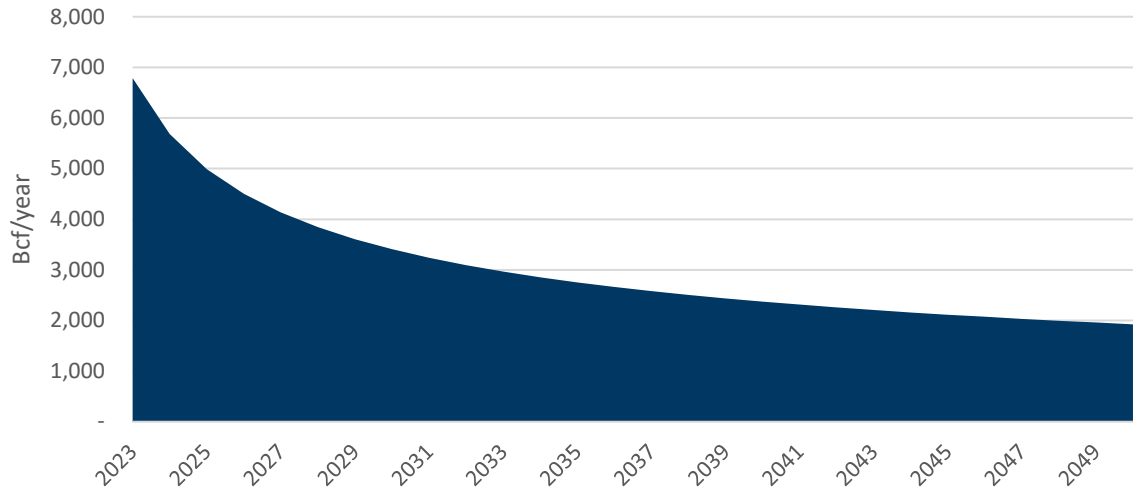
Luckily, the rate at which these declines happen over time, often referred to as a decline curve, is relatively well understood and able to be modeled, often with a set of equations developed by an American geologist named J.J. Arps in 1945. These are often referred to as Arps decline curves.

To project how many wells must be drilled every year in Pennsylvania to reach the AEO-implied production levels, FTI estimated how production from existing wells will decline over time and what the typical decline curve of newly drilled wells will look like. While wells can be restimulated during their decline curves to increase production, our methodology does not assume any restimulation, only new wells being brought online.

FTI utilized production forecasts from WellDatabase for existing operating wells. The production forecast is shown below in Figure 1. A level-shift adjustment was made to this curve to match actual January 2023 production as reported by the Commonwealth.

[9] https://www.eia.gov/outlooks/aeo/

Figure 1: Annual Production from Existing Wells



Next, FTI developed EIA-implied production targets to derive how much production must come online each year of the forecast period. Using a parameterized "typical well," FTI converted those volumes into the estimated number of wells that must be drilled and completed each year to fill the gap.

Production Targets

The National Energy Modeling System ("NEMS") is a model of the energy-economy interactions in the United States developed by the EIA. It is used to produce the EIA's Annual Energy Outlook, which provides projections for the United States' energy production, consumption, prices, and technology.

NEMS is a modular system, meaning it is composed of separate but interconnected modules that each represent different aspects of the energy sector. Each module models a specific energy supply (like oil and gas, coal, or renewable energy), demand (like transportation, residential, commercial, or industrial), or converting sector (like electricity). The Oil and Gas Supply Module generates oil and gas production forecasts.

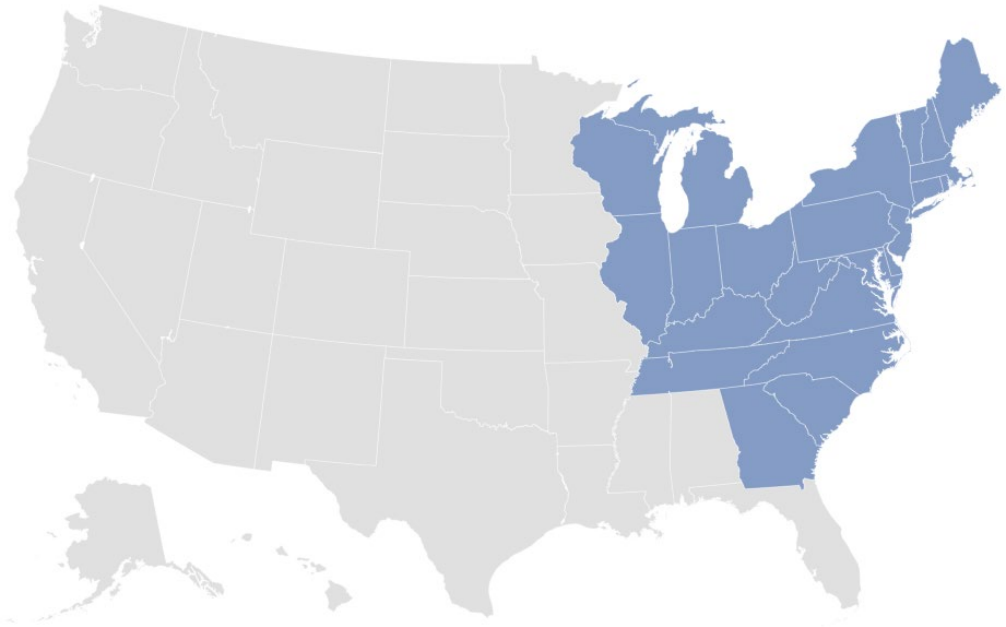
The AEO contains a Reference Case, or baseline forecast, and several alternative scenarios. FTI focused on the Reference Case, the High Oil and Gas Supply Case ("Low Price"), and the Low Oil and Gas Supply Case ("High Price").

In the High Oil and Gas Supply Case, natural gas supply is higher than in the Reference case due to more optimistic resource availability and extraction technology assumptions. This leads to lower energy prices and increased oil and natural gas use.

In contrast, the Low Oil and Gas Supply case assumes that oil and natural gas supply is lower than in the Reference case due to more pessimistic assumptions about resource availability and extraction technology. This leads to higher energy prices and decreased oil and natural gas use.

The NEMS's Oil and Gas Supply Module breaks the country into several large regions. Pennsylvania is located in the Module's East Region, shown below in Figure 2.

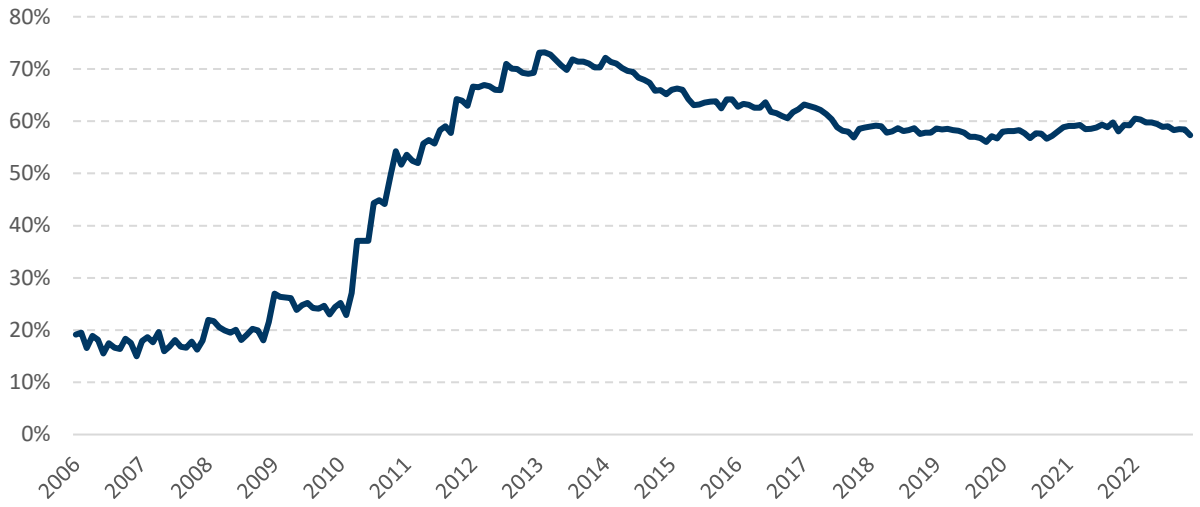
Figure 2: Depiction of NEMS East Region



While the region is geographically large, over 98% of gas produced in the East Region in 2021 came from Ohio (18%), Pennsylvania (59%), and West Virginia (21%).[10] Pennsylvania's share of East Region production has been remarkably steady, averaging 58% of total production since the second half of 2017, as shown in Figure 3.

[10] EIA State Level Gross Withdrawals and Production: https://www.eia.gov/dnav/ng/ng_prod_sum_dc_NUS_mmcf_m.htm

Figure 3: Pennsylvania Share of East Region Production



Given the historical stability, FTI's modeling assumed that Pennsylvania will continue to supply around 58% of East region gas throughout the forecast horizon. FTI applied this percentage to multiple scenarios from the AEO to derive Pennsylvania gas production forecasts.

With the estimated production from existing Pennsylvania wells from WellDatabase, FTI calculated the difference between the forecast amount and what existing wells will produce.

New Wells

Converting the "New Wells" share of the forecast to an actual drilling and completion schedule of wells per year required defining a "typical well" to be used.

FTI used the average vertical depth and horizontal length for all wells drilled in 2022 from the WellDatabase data previously referenced to define this typical well.

Next, FTI used the WellDatabase production forecasts for wells drilled in 2022 and adopted the median well's production profile based on total forecast production over 60 months.

Given the typical well's characteristics, FTI then calculated how many new wells would have to be drilled and completed each year of the forecast period to meet the three EIA AEO-implied production targets. This is shown in Figure 4 below.

Over the entire forecast period, the Reference case requires an average of 462 wells/year to be drilled and completed, the Low Price case requires 466 wells/year, and the High Price case 364 wells/year.

Figure 4: Forecast Well Drilling and Completion Schedule

Once the drilling and completion schedules were calculated, FTI applied the same costs per well and per unit production costs used in the historical analysis section. The only exception to this methodology was for calculating the Impact Fees, which require a detailed accounting of each well's age in each year of the forecast period and the application of the relevant EIA natural gas price forecast to determine the correct tranche of the 2022 fee schedule to use in each year. By applying the 2022 well, production, and impact fee values to future activity, the forecasts are inherently tied to real 2022 dollars.

ECONOMIC IMPACT METHODOLOGY

IMPLAN MODEL

The simulations were completed in IMPLAN, an input-output ("IO") model of local, state, regional, and national economies. IMPLAN illustrates the transactions and the flow of dollars in an economy, such as between economic sectors through industrial supply chains, workers with their employers through the labor market, and between the private and public sectors through taxes and public expenditures (e.g., property taxes supporting schools).

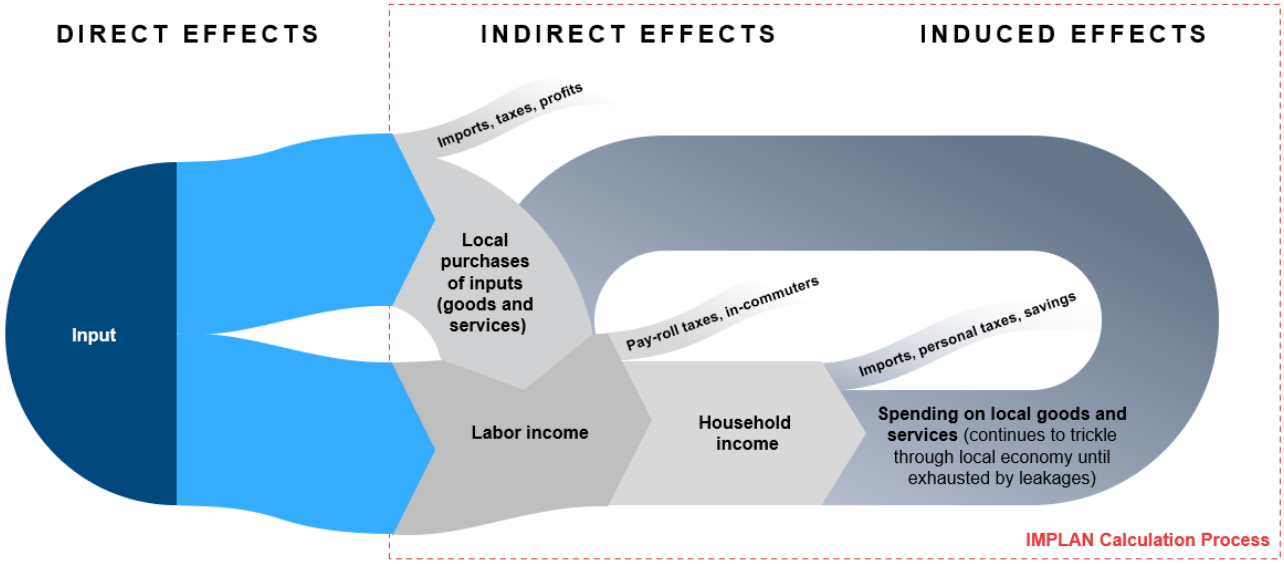
The IO methodology won its progenitor, Wassily Leontief, the Nobel Prize in 1973.[11]

IMPLAN models how an initial change, and in this case expenditures by the economic sector supported by the industry and allocated between sectors as described in Figure 5, influence the rest of the economy. These "ancillary" or "ripple" effects are described in detail as the following:

- **Direct Effect** – direct employment or expenditures associated with maintaining the industry. Examples include construction or environmental workers.
- **Indirect Effect** – the direct employment or expenditures effect on the regional supply chain. For instance, equipment and material inputs used in constructing new warehouses. The supply chain can also include services such as architecture, legal, and engineering services.
- **Induced Effect** – consumer spending by direct and indirect employees. Examples include the spending by direct employees or the employees of the businesses within the supply chain. These workers take their paychecks home and eventually spend them on their daily needs. This supports the other sectors of the economy, such as real estate, healthcare, education, retail, transportation, and entertainment.
- **Total Effect** – The total effect is the sum of the direct, indirect, and induced effects. Figure 5 shows a representation of these effects in IMPLAN as a flowchart.

[11] https://www.nobelprize.org/prizes/economic-sciences/1973/leontief/facts/

Figure 5 – IMPLAN Flowchart



The "Input" on the far left in dark blue flows into the direct effect of intermediate purchases. Both direct and indirect labor income then flow into household income (in gray in the middle of Figure 5) before cycling back into the economy through expenditures. The sum of the three represents the total economic impact.

INDUSTRY DATA

Using the industry cost data defined in the Historical and Forecasted Natural Gas Market Analysis section above, FTI created the inputs for the IMPLAN model using the economic sectors to accurately represent the direct industry activity, as shown in Table 2. The highlighted sectors only represent those included in the direct activity of the industry. Sectors used for the distribution of the impact fees are excluded.

Table 2: IMPLAN Sectors Simulated

IMPLAN Sector ID	Sector Name
20	Oil and gas extraction
35	Drilling oil and gas wells
36	Support activities for oil and gas operations
40	Electric power generation - Fossil fuel
48	Natural gas distribution
54	Construction of new highways and streets
56	Construction of other new nonresidential structures
286	Air and gas compressor manufacturing
419	Pipeline transportation
522	Grantmaking, giving, and social advocacy organizations
10009	Households

New economic activity included drilling and completion costs, well operation and maintenance, gathering and processing costs, pipeline transport, surface transportation, and company charitable activities. Households received an increase in real income through land use royalty payments.

The distribution of impact fees across economic sectors in Pennsylvania was based on the state's tax revenue allocation. This allocation reflects the utilization of collected funds at the county and municipality levels, as outlined by the PUC.[12] The distribution includes spending on social services, public infrastructure, public safety, and judicial services.

[12] https://www.act13-reporting.puc.pa.gov/Modules/PublicReporting/Overview.aspx

ECONOMIC AND FISCAL IMPACTS

This section describes the industry's estimated economic and fiscal impacts based on historical and forecasted data. The economic and fiscal impacts of the industry are estimated for the historic year 2022 and across three scenarios annually from 2023-2050 for the Commonwealth of Pennsylvania and are defined across four economic and two fiscal impacts, which are –

1. **Employment:** the number of jobs supported by the industry's activities
2. **Output:** sales or output supported by the industry's activities
3. **Gross domestic product:** the sum of all incomes related to production
    - Most typical of the total economic activity associated with a project or economic sector
    - Combination of sales, receipts, operating income, commodity taxes, and inventory changes minus its intermediate inputs (energy, raw materials, and semi-finished goods and services)
4. **Labor income:** the household income supported by the industry's activities
5. **State and local tax revenues** – incremental tax revenues for local governments and state governments collected resulting from the industry's activities
6. **Federal tax revenues** – incremental tax revenues for the federal government collected because of the increase in economic activity nationally attributable to the industry's direct and supported activities, which come most heavily from income and payroll taxes

Table 10 shows the average annual impacts for the three scenarios are similar. Based on projections, the average number of jobs supported over the modeled period is 110.7 thousand in the Reference case, 109.3 thousand in the High Price case, and 108.1 thousand in the Low Price case.

The average annual impact for each scenario is determined by taking the sum of the impact from 2022 through 2050 and dividing it by the number of years during that period to determine the annual average economic impact.

Table 3: 2050 and Cumulative Total Impacts by Scenario

	Metric	Units	2050 Total Impact	2023 – 2050 Cumulative Impact
Reference	Jobs	Thousands	118.5	3,213.6 person-years
Reference	Output	2022 $ Billions	$42.9	$1,160.0
Reference	GDP	2022 $ Billions	$25.5	$685.7
Reference	Labor Income	2022 $ Billions	$12.4	$331.9
Reference	Federal Taxes	2022 $ Billions	$2.7	$72.8
Reference	State and Local Taxes	2022 $ Billions	$3.3	$91.2
High Price	Jobs	Thousands	114.3	3,134.7 person-years
High Price	Output	2022 $ Billions	$39.7	$1,092.1
High Price	GDP	2022 $ Billions	$23.4	$642.6
High Price	Labor Income	2022 $ Billions	$11.5	$313.7
High Price	Federal Taxes	2022 $ Billions	$2.5	$68.8
High Price	State and Local Taxes	2022 $ Billions	$3.1	$86.4
Low Price	Jobs	Thousands	120.8	3,170.4 person-years
Low Price	Output	2022 $ Billions	$44.1	$1,156.7
Low Price	GDP	2022 $ Billions	$26.2	$683.5
Low Price	Labor Income	2022 $ Billions	$12.7	$330.0
Low Price	Federal Taxes	2022 $ Billions	$2.8	$72.4
Low Price	State and Local Taxes	2022 $ Billions	$3.4	$91.2

ECONOMIC IMPACT RESULTS

2050 Impacts

The level of industry activity and production typically determines the extent of its impact. In 2050, the expected employment impacts for the Pennsylvania economy is 118.5 thousand jobs in the Reference Case. Based on the High Price scenario, it is estimated that 114.3 thousand jobs will be supported in 2050. The Low Price scenario is expected to support 120.8 thousand jobs in 2050, and the Low Price will support 121 thousand jobs.

In relation to the Reference case, the Low Price case sees slightly higher economic impacts in 2050 due to more wells being drilled and completed and higher total production, which leads to more economic activity from all activities measured except for royalty payments, which are lower than in the Reference case due to lower wholesale gas prices.

The High Price case, on the other hand, has slightly lower economic impacts in 2050 due to fewer wells being drilled and completed and lower total production. Higher wholesale prices lead to increased royalty payments and impact fees compared to the Reference case, despite the lower drilling activity and production, but all other measures of industry activity are lower.

The total impacts of economic output usually mirror the impacts to employment. In 2050, the Low Price and Reference Case scenarios are projected to generate $44.1 and $42.9 billion in economic output, respectively. The High Price is estimated to generate $39.7 billion for the state.

The Low Price and Reference Case scenarios slightly outpace the High Price scenario in terms of output and employment, possibly due to the economies of scale in the labor force.

GDP is a portion of economic output, less the intermediate inputs produced throughout the supply chain. Therefore, GDP impacts generally follow the same trend as output over time. In 2050, the GDP impacts for the Reference Case are expected to total $25.5 billion. The Low Price and High Price scenarios are expected to generate $26.2 and $23.4 billion, respectively, in GDP.

Total labor income impacts are estimated to reach $12.4, $12.7, and $11.5 billion for the Reference Case, Low Price, and High Price scenarios, respectively.

In 2050, the Reference Case's combined federal, state, and local tax impacts are estimated to equal $6.0 billion, where $2.7 billion is for federal tax revenues and $3.3 is for state and local tax revenues. The Low Price scenario is expected to generate $6.2 billion in tax revenues in 2050. $2.8 billion of this would be generated by federal taxes and an additional $3.4 billion through state and local taxes. Lastly, combined federal, state, and local tax revenues are expected to total $5.6 billion for the High Price scenario in 2050. $2.5 billion is generated by federal tax revenues, with an additional $3.1 for state and local taxes.

Cumulative Impacts

Pennsylvania's shale gas development industry is a significant economic and fiscal growth driver. Based on three different scenarios, the High Price scenario exhibits the lowest aggregate total economic output from 2022-2050 at $1.09 trillion. The Low Price scenario is forecasted to generate $1.156 trillion in aggregate output. Finally, the Reference Case scenario is expected to yield the highest total output, with $1.160 trillion in total economic output over the period. While similar, the Reference Case is $3.3 billion higher than the Low Price scenario in terms of forecasted total economic output.

In terms of employment, the High Price scenario is expected to support the lowest cumulative number of jobs from 2022-2050, at 3.1 million person-years.[13] The Low Price scenario is forecasted to support 3.4 million person-years of employment. Finally, the Reference Case is expected to support the 3.3 million person-years of employment across these years.

[13] A person-year is defined for this purpose as one person holding full-time employment over the course of one year.

Total GDP impacts for the Low Price scenario are estimated to total $683.5 billion cumulatively from 2022-2050. The High Price scenario is expected to generate $642.6 billion in GDP, and the Reference Case is expected to generate $685.7 billion cumulatively.

The Reference Case generated the highest cumulative labor income, estimated at $331.9 billion for Pennsylvania residents. The Low Price scenario is estimated to generate $330.0 billion in labor income from 2022-2050, and the High Price scenario is estimated to generate $313.7 billion.

Combined federal ,state, and local tax revenues for the Reference Case are estimated at $164.0 billion, where federal tax revenues are $72.8 billion, and state and local revenues are $91.2 billion. The Low Price scenario is estimated to generate $163.6 billion cumulatively. Federal tax revenues would generate $72.4 billion, and state and local tax revenues would generate an additional $91.2 billion. Lastly, the High Price scenario would generate $155.2 billion in total tax revenues cumulatively, where $68.8 billion is for the federal government and $86.4 billion is for state and local governments.