

2022

OHIO ENERGY INDUSTRY CONTRIBUTION ANALYSIS REPORT



THE OHIO STATE UNIVERSITY
EXTENSION



Ohio Energy Report # OER-122022

December 2022



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Modeling Software:

IMPLAN® model, 2020 Data, using inputs provided by the user and IMPLAN Group LLC, IMPLAN System (data and software), 16905 Northcross Dr., Suite 120, Huntersville, NC 28078 www.IMPLAN.com

Executive Summary

Section 1: Page 3

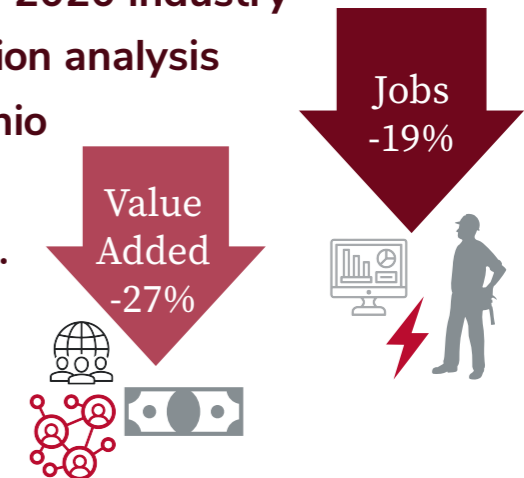


Executive Summary

Ohio supports a total population of over 11.6 million residents, 5.2 million housing units, and is home to more than 251,937 business enterprises (CFAES Knowledge Exchange, 2022). Energy development in Ohio is important for the future vitality of the state as it influences both economic growth and the general quality of life of Ohioans. This industry contribution analysis estimates the portion of the Ohio economy, in terms of jobs, labor income, value added and output, that are supported by the Ohio energy sector. The analysis uses an economic input-output (I-O) modeling software program, IMPLAN, to measure the economic contribution of the energy industries based on a current level of production using 2020 data. The IMPLAN model captures indirect and induced effects of existing industries on other sectors in the state.

As illustrated in Table 1, IMPLAN presents four key measures including total estimated jobs, labor income, value added, and output. The employment reported represents the total employment, which includes direct, indirect, and induced positions supported by the energy sector. In total, the energy sector supported 99,360 jobs in the Ohio economy in 2020. Labor income is the sum of employee compensation from wages and benefits as well as proprietor income payments received by self-employed individuals and unincorporated business owners. In total, the energy sector contributed \$8.2 billion in labor income to the Ohio economy in 2020. Value added, also referred to as contribution to state gross domestic product (GDP), represents the difference between output and the cost of intermediate inputs from the energy sector throughout the Ohio economy. In 2020, the Ohio energy sector contributed over \$19.9 billion in value added to the Ohio

When comparing results of the 2019 and 2020 industry contribution analysis for the Ohio energy sector.....



economy. Value added is the best measure of the economic contribution because it estimates the added benefit to the overall Ohio economy beyond the energy sector. Output signifies the total annual production value of the Ohio energy sector, which includes all components of production value or output. In 2020, the energy sector in Ohio had a total production value of over \$39.4 billion in total output.

Table 1. Summary of Estimated Economic Benefits of Energy Sector Industries in Ohio (2020)

Impact	Employment	Labor Income	Value Added	Output
Energy Mining and Extraction	43,018	\$2,719,480,412	\$5,607,383,014	\$11,408,542,357
Electric Generation	16,161	\$1,556,973,098	\$3,863,274,781	\$7,462,337,133
Energy Transmission and Distribution	40,182	\$3,931,661,095	\$10,466,098,228	\$20,538,744,862
Ohio Energy Sector Total	99,360	\$8,208,114,605	\$19,936,756,023	\$39,409,624,352

Source: IMPLAN. 2020.

Introduction: Ohio Energy Trends

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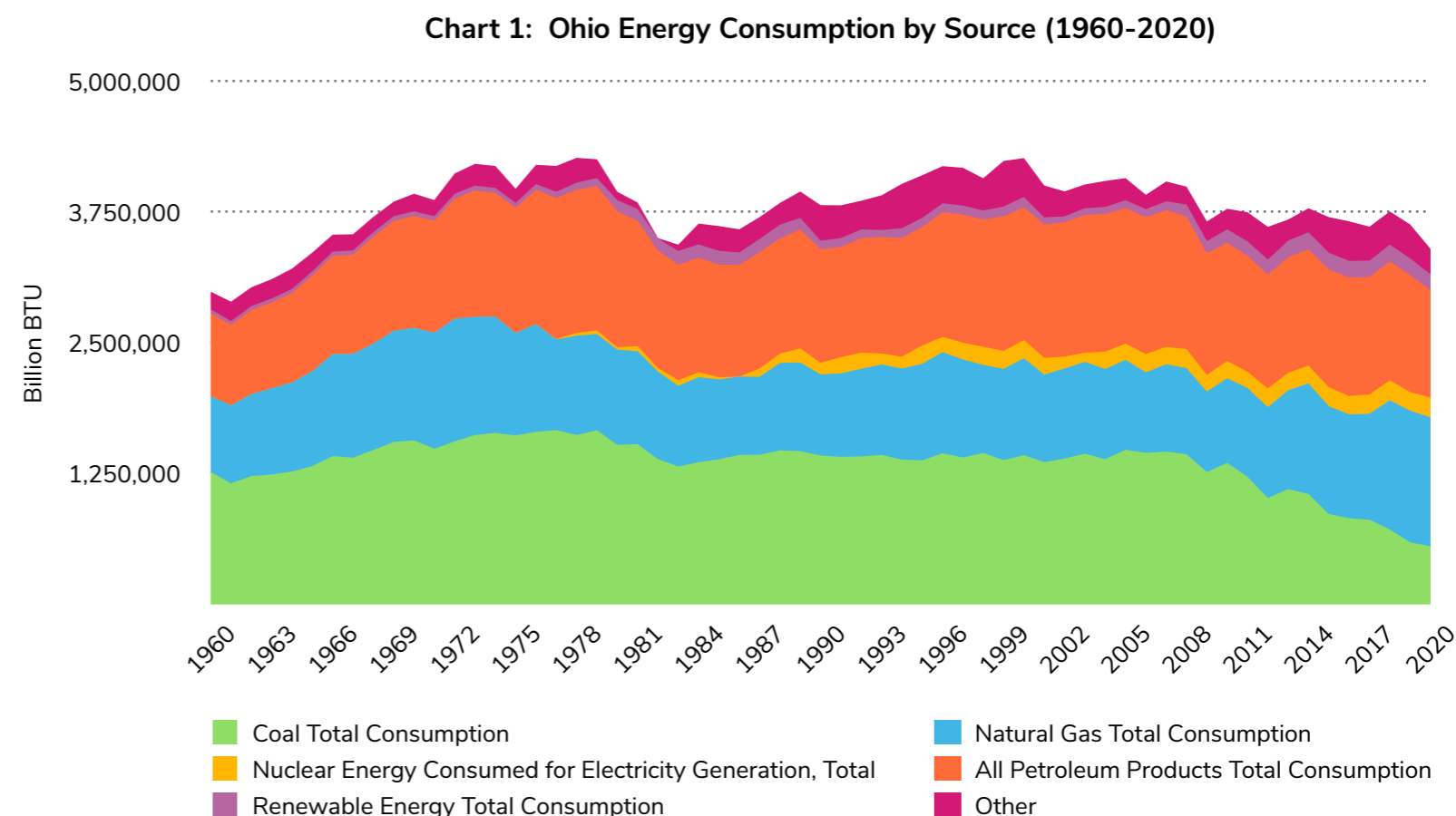


Introduction

Energy development in Ohio is important for the future vitality of the state as it influences both economic growth and the general quality of life of Ohioans. Ohio's economy competes daily on a global scale, which is driven by its strong manufacturing sector, primarily due to high energy-intensive industries, such as strong metals fabrication and chemical production industries. In order for Ohio's manufacturing sector to remain competitive, it is critical Ohio employers have access to reliable, yet affordable sources of energy. New methods of harnessing, controlling, and using energy has led to a much higher standard of living than that of previous generations. As a result, access to affordable energy directly influences our quality of life. This section reviews the Ohio energy trends, with an emphasis on the energy consumption, production, and the impacts to Ohioans. It also considers energy consumption and production trends by source compared to other states and the national average.

Primary Energy Consumption

Between 1980 and 2019, the total world energy consumption rose by 105% from 293 quadrillion British thermal units (Btu) in 1980 to more than



601 quadrillion Btu in 2019. Much of the worldwide growth in energy consumption is occurring in developing countries, while countries with strong established economies drive steady demand. Second only to China, the United States consumed 100.5 quadrillion Btu representing 16.6% of the world's primary energy consumption in 2019. Due to its large population and strong industrial economy, Ohio ranked seventh in the nation for total primary

energy consumption in 2020, consuming 3.4 quadrillion Btu.

Between 1960 and 2020, total primary energy consumption in Ohio increased by 13.6 percent (Chart 1). When comparing the consumption of Ohio energy sources in 2020, natural gas was the largest source representing 36% of Ohio's total primary energy consumption. Between 1960 and 2020 natural gas consumption in Ohio has increased by 70%, and Ohio consistently ranks

as one of the nation's top 10 consumers of natural gas, ranking seventh in 2020. High natural gas consumption in Ohio is driven primarily by electric power generation, as Ohio has rapidly transitioned from using coal as the largest source of electrical power generation, to natural gas. Natural gas has been the largest source of electrical power generation since 2019, accounting for roughly one-third of all natural gas consumed by Ohioans. The industrial sector and the residential sector each account for about one-fourth of the state's total natural gas consumption, while the balance is consumed in the commercial sector. Finally, Ohio is home to 24 underground natural gas storage fields with a combined capacity of 575 billion cubic feet, ranking Ohio as the seventh largest state for underground natural gas storage capacity, representing roughly 6% of the nation's total.

The second largest source of Ohio energy consumption in 2020 was from all petroleum products which increased by 29% since 1960, representing 30% of the total Ohio primary energy consumption in 2020. Ohio is among the top petroleum-consuming states ranking seventh in the nation in 2020. Total petroleum demand in the state far exceeds the state's production. Most of the petroleum consumed in

Ohio is related to motor gasoline or diesel fuel by the transportation sector which consumed 76% of all Ohio petroleum in 2020, followed by the industrial sector which represented 18% of Ohio petroleum consumption (USDOE/EIA, 2020).

In 2020, Ohio was the third largest coal consuming state in the nation behind Texas and Indiana. Just over 83% of the coal consumed in Ohio is used for electric power generation, with the remainder being consumed in the industrial sector. While coal has traditionally been the greatest source of energy in Ohio, the consumption of coal in Ohio has decreased by 56% between 1960 and 2020.

Related to electricity consumption, Ohio ranked fourth in the nation in 2020 for total retail electricity sales behind Texas (1), California (2), and Florida (3). The consumption of electricity in Ohio by sector was distributed relatively evenly, as the residential sector represented the largest amount of Ohio retail electricity sales at 37%, followed by the industrial sector which accounted for 33%, and finally the commercial sector at 30% of the total.

Energy consumption is influenced by various factors such as population growth,

transportation, economic activity, weather conditions, income, and the quality of life. Energy intensity measures energy consumption per unit of GDP and can help measure the energy efficiency and structural changes of an economy. A high-energy intensity indicates a high energy price or cost of converting energy into GDP, while a low energy intensity indicates a lower price or cost of converting energy into GDP. In 2020, the top three states ranked by energy intensity scores were Louisiana (18.9), Wyoming (13.91), and Alaska (12.76). In comparison, the states posting the three lowest energy intensity scores in 2020 were California (2.6), Massachusetts (2.56), and New York (2.36). Ohio posted an energy intensity score of 5.77 in 2020, which ranked 26th in the nation and was slightly higher than the national average of 5.05. From 1997 to 2020, the average energy intensity score for Ohio decreased by 35%, closely aligning with trends across the United States which decreased by 38% over the same time period. This trend suggests an increase in the cost of energy and improved energy efficiency of production processes in Ohio combined with structural changes in the economy, shifting away from the production of energy intensive materials such as primary metals production. This trend also supports the reduction of overall



energy consumption within the industrial sector from 1960 to 2020.

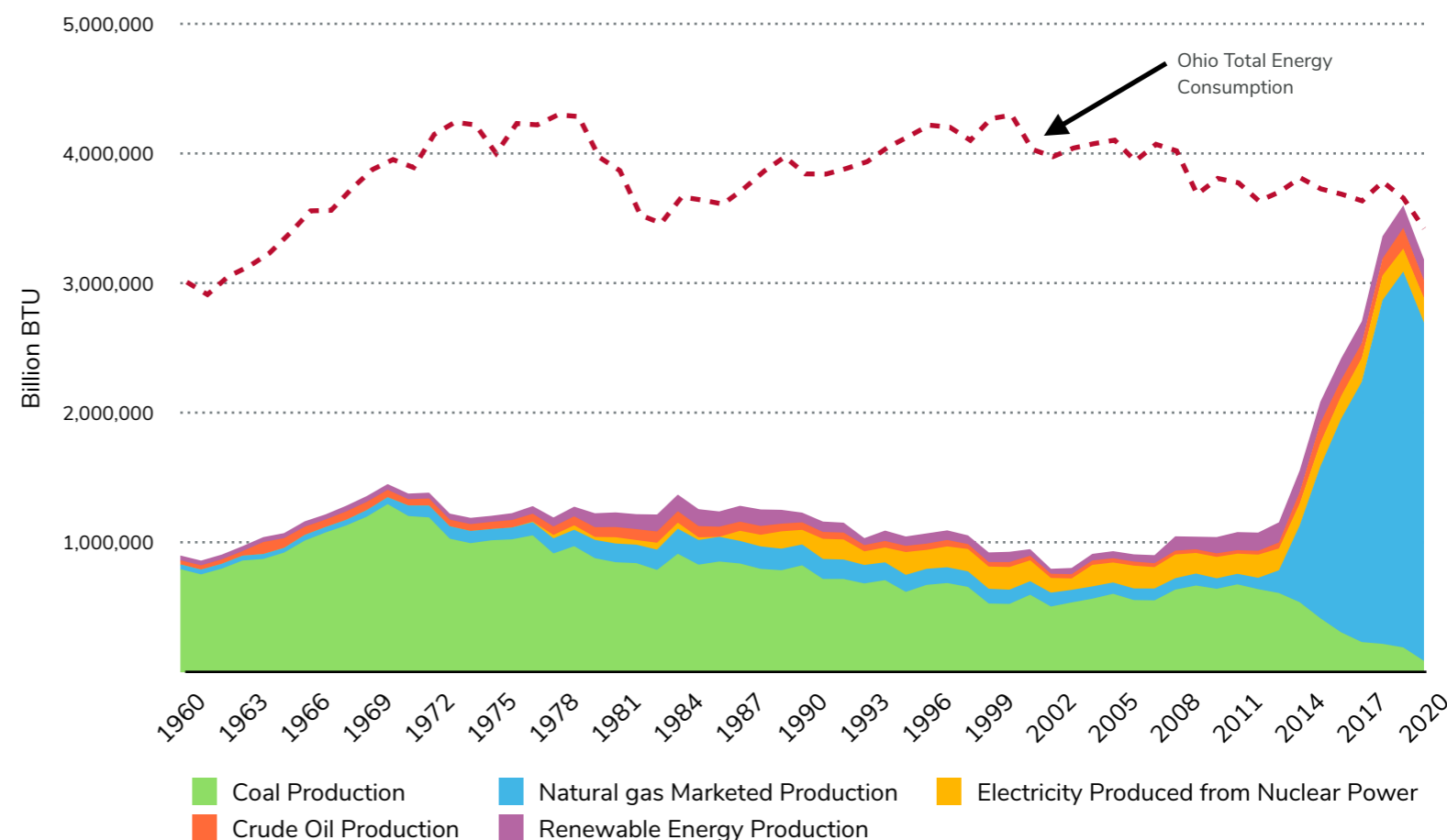
Energy Production

In 2020, Ohio ranked 10th in the nation in total energy production, producing 3,186.9 trillion Btu of energy. As a heavy consumer of energy, historically (1960-2013) Ohio's energy production only accounted for 30% of the total energy needed to meet the states consumption demands. However, starting in 2014 the gap between total energy production and consumption in Ohio began to tighten when Ohio's total energy production nearly exceeded the total consumption in 2019.

This unprecedented transition in Ohio's energy production is clearly driven by increased natural gas production from horizontal hydraulic fracturing in the Marcellus and Utica shale formations (Chart 2).

While structural transitions in energy markets are typically measured in decades, not years, most energy transitions are not as obvious as the natural gas production trends in Ohio. For example, when comparing production trends over the past decade, natural gas production in Ohio has increased by over 3,133% from 80,778 billion Btu in 2010 to over 2,611,802 billion Btu in

Chart 2: Ohio Energy Production by Source (1960-2020)



Source: USDOE/EIA. (2020). State Energy Production Estimates 1960 Through 2020.

2020 (Chart 2). In 2020, Ohio ranked 6th in the nation in natural gas production, accounting for 82% of the total energy production in Ohio. While Ohio has traditionally been a moderate producer of crude oil, new development activities related to horizontal hydraulic fracturing in the Utica shale formation has fostered an increase in Ohio's crude oil production by more than 389% from 27,678

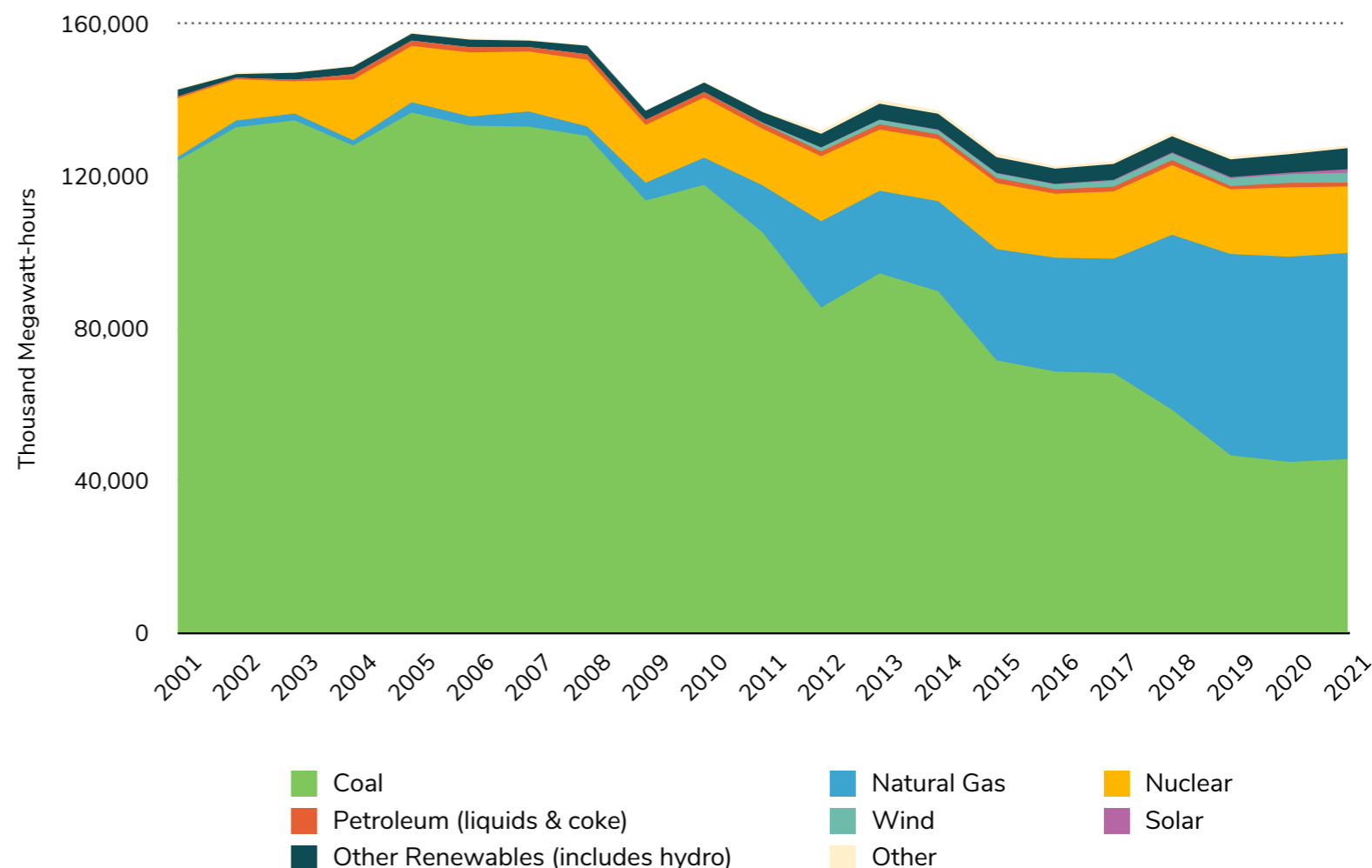
billion Btu in 2010 to 135,554 billion Btu in 2020. As a result, Ohio ranked 12th in the nation in crude oil production in 2020, accounting for 4% of the total energy production in Ohio. In addition, Ohio is consistently one of the top 10 refining states, home to four refineries with a combined capacity of 602,000 barrels of crude oil per calendar day to process crude oils into finished products. In 2020, Ohio ranked 7th in

the nation in ethanol production with seven ethanol plants currently in operation with the capacity to produce more than 740 million gallons of ethanol per year. Ohio also has one biodiesel plant that has a production capacity of about 71 million gallons per year .

Although Ohio's energy production from coal has dropped by 93% since its peak in 1970, the state ranked 15th in the country in coal production for 2020, accounting for 88,255 billion Btu or 3% of the total energy production in Ohio. In 2020, Ohio ranked 15th in the nation in nuclear energy production, accounting for 6% of the total energy production in Ohio.

While Ohio is one of the top states for electric generation, its generation does not meet demand; therefore the state is also a major importer of electricity. As illustrated in Chart 3, the primary source for electrical generation in Ohio is natural gas which accounted for 42% of Ohio's net electrical generation in 2020, closely followed by electric generation from coal accounting for 36% of the states total. In recent years Ohio has experienced new development and investments in renewable energy from utility-scale wind and solar generation facilities. As a result, in 2020 wind accounted for 2% of

Chart 3: Ohio Net Electric Generation



Source: USDOE/EIA. (2022). Electricity Data Browser.

Ohio's net electrical generation, while solar still represented less than 1% of total net electrical generation.



Methodology



Ohio Energy Sector IMPLAN Industry Contribution Analysis:

Methodology

This report measures the economic contribution of the Ohio energy sector, using IMPLAN 2020 data and software, developed by the IMPLAN Group LLC. IMPLAN utilizes an economic modeling technique called Input-Output analysis, which is a type of applied economic analysis that tracks the interdependence among various producing and consuming industries of an economy. It measures the relationship between a given set of demands for final goods and services and the inputs required to satisfy those demands. IMPLAN has data at the zip code, county, congressional district, state, and national levels. IMPLAN can be used to estimate the effect of a new economic change or contribution of an existing industry on a local or regional economy. For this report, the geographic area is the state of Ohio and unless otherwise noted, the data and dollar year is 2020.

Industry Contribution Analysis

The primary focus of this analysis is the overall contribution of the energy sector to the Ohio

economy. Using the IMPLAN Industry Contribution Analysis framework we can identify what industries and production activity is being supported by the target industry or industries in the region of study. In simple terms, the industry contribution analysis provides an understanding of how an existing industry is linked to the current economy. The Industry Contribution Analysis is a unique method that removes backward linkages or “buy backs” to the industry being analyzed and thus shows the way the energy industry is connected to the economy of the state.

Multi-Industry Contribution Analysis

By modeling the contribution of multiple industries combined within a single Group, IMPLAN will treat the analysis as a multi-industry contribution analysis. In a multi-industry contribution analysis, not only are the purchases from an industry to itself restricted, but the purchases from other industries to the

modeled contributing industry are also restricted. This produces results that only include direct effects for the industries included in your multi-industry contribution analysis and all indirect and induced effects to these industries would be restricted from being generated to avoid overestimating the size of the industries being studied.

Types of Economic Effects

Using the IMPLAN multi-industry contribution analysis method, we can estimate the extent to which the contribution of the energy sector in Ohio contributes to other employment, income, and value added. The IMPLAN multi-industry contribution analysis provides estimates for direct, indirect, and induced economic effects using 2020 IMPLAN data and dollar years for Ohio. A description of each economic effect is further described below:



- **Direct effects** are the value of energy sector production, employment, and value added (which includes labor income).
- **Indirect effects** occur as Ohio businesses provide goods and services used by the energy sector and when these businesses, in turn, make additional purchases from Ohio businesses.
- **Induced effects** occur as workers or proprietors in the directly and indirectly affected industries receive income that they then use to purchase goods and services from other businesses in Ohio, in addition to subsequent rounds of labor income spending.

Key Economic Metrics

IMPLAN presents four key measures including total estimated jobs, labor income, value added, and output. For this report, we focus on two primary measures of economic activity including employment and value added.

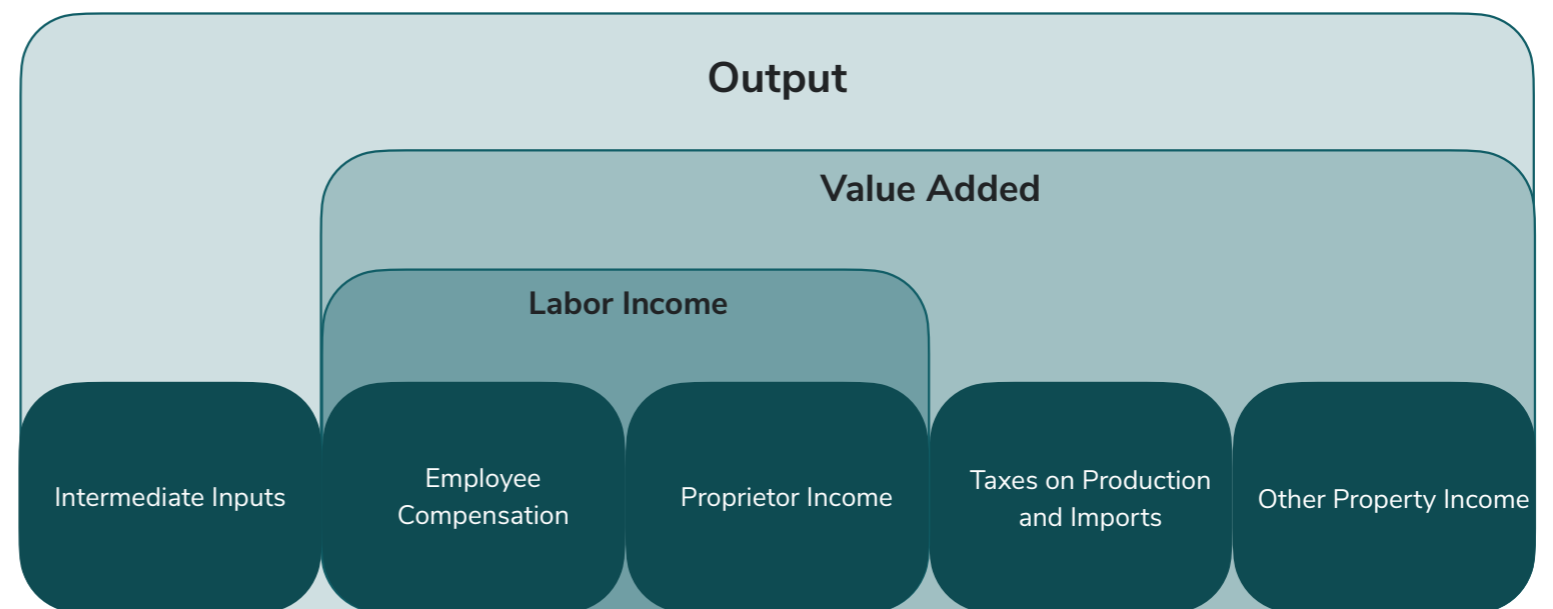
The total employment estimates reported by IMPLAN represents full and part-time annual average including the self-employed, all federal,

state, and local government employment and military employment (including overseas military). Employment in IMPLAN is an industry specific mix of full-time, part-time, and seasonal employment. It is an annual average that accounts for seasonality.

IMPLAN expresses output as an industry's annual production estimates for the year, representing the total value of production. Value added is a subset of total output and is a useful measure of wealth created by an economy. Value added is the difference between output and the cost of intermediate inputs, representing

the total annual market value of all final goods and services produced by the industry. As illustrated in Figure 1, value added is a large portion of output, as it encompasses employee compensation, proprietor income, taxes on production and imports, and other property income. In summary, value added is the wealth created by industry activity and is akin to contribution to GDP.

Figure 1: Industries in the Ohio Energy Sector



Source: IMPLAN. 2020.

Description of Energy Sector



Ohio Energy Sector IMPLAN Industry Contribution Analysis:

Description of Energy Sector

The primary focus of this report is to assess the overall contribution of the energy sector to the Ohio economy. For this analysis, we reviewed a total of 546 IMPLAN industry codes to identify specific energy industries that make up the overall energy sector in Ohio. Furthermore, the individual IMPLAN energy industries were categorized into one of the three energy sub-sections. These sub-sections were designed to capture the entire energy cycle from the production of primary energy fuels extracted from nature, to the conversion of primary energy sources into electricity, to the final delivery of energy resource to the end user. The three energy sub-sectors in this analysis include: 1) energy mining and extraction, 2) electric generation, and 3) energy transmission and distribution.

The analysis of the Ohio energy sector consisted of a multi-industry economic contribution analysis. Combining multiple industries into one individual contribution

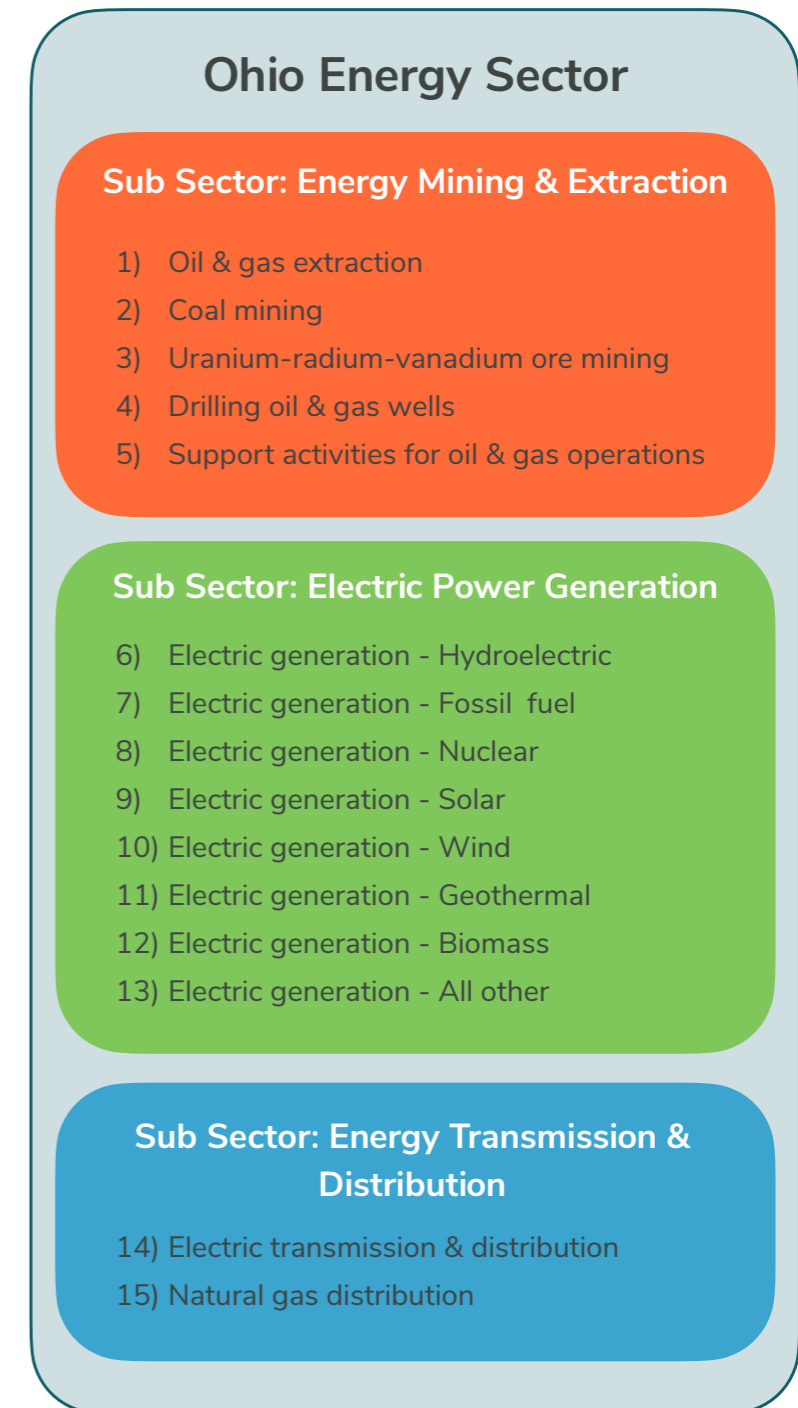
analysis allowed for detailed accounting of specific indirect and induced effects related to each industry. This ensured that the determination could be made where outputs in one industry represent inputs to another industry to avoid double-counting.

In total, there were 15 individual energy related industries included in the analysis that makeup the Ohio energy sector. Figure 2 outlines all 15 individual energy industries included in the Ohio energy sector and their corresponding energy sub-sectors. Each of the energy sub-sectors and industries are further described below.

Energy Mining & Extraction

The energy mining and extraction sub-sector focuses on industries engaged in the production of primary energy fuels which are captured or extracted from nature. In general, primary fuels are non-renewable and consist of

Figure 2: Industries in the Ohio Energy Sector



fossil fuel resources such as coal, oil, and natural gas. However, other examples of primary fuel include uranium and thorium.

The energy mining and extraction sub-sector was an aggregation of five individual industries that are further described below using definitions from the U.S. Census Bureau.

- 1) **Coal Mining:** This industry is comprised primarily of the exploration, development, extraction, and processing of coal.
- 2) **Oil and Gas Extraction:** This industry is comprised primarily of the exploration, development, and/or the production of petroleum and natural gas from wells using normal or enhanced drilling and extraction techniques.
- 3) **Drilling Oil and Gas Wells:** This industry is comprised of contractors that specialize in spudding in, drilling in, re-drilling, and directional drilling of oil and gas wells for others on a contract or fee basis.
- 4) **Support Activities for Oil and Gas Operations:** These companies are engaged in performing support activities for oil and gas

operations such as exploration, excavating slush pits, well surveying, cutting and pulling casings, cementing wells, shooting wells, acidizing and chemically treating wells, and cleaning out, bailing, and swabbing wells.

- 5) **Uranium, Radium, Vanadium Ore Mining:** This industry includes establishments primarily engaged in developing the mine site, mining, and/or preparing uranium-radium-vanadium ores.

Electric Power Generation

The electric power generation sub-sector focuses on industries engaged in the generation of electricity. In total this sub-sector includes eight individual IMPLAN industries from a mixture of renewable and non-renewable resources. It should be noted that some electric power generation resources such as coal, natural gas, and nuclear can be dispatched on demand, while other resources such as wind and solar are dependent on resource availability to generate electricity. The eight industries aggregated into the electric power generation sub-sector are further described below using definitions from the U.S. Census Bureau.

- 1) **Electric Power Generation - Hydroelectric:** This industry is engaged in operating hydroelectric power generation facilities, which use water power to drive a turbine to produce electric energy.
- 2) **Electric Power Generation - Fossil Fuel:** This industry is engaged in operating fossil fuel powered electric power generation facilities that use fossil fuels, such as coal, oil, or gas, to drive an internal combustion or combustion turbine conventional steam process to produce electric energy.
- 3) **Electric Power Generation - Nuclear:** This industry is engaged in the operation of nuclear electric power generation facilities that use nuclear power to produce electric energy.
- 4) **Electric Power Generation - Solar:** This industry is primarily engaged in operating solar electric power generation facilities that use energy from the sun to produce electric energy.
- 5) **Electric Power Generation - Wind:** This industry is primarily engaged in the operation of wind electric power generation facilities

Source: U.S. Census Bureau. (2022). North American Industry Classification System (NAICS).



that use wind power to drive a turbine and produce electric energy.

6) **Electric Power Generation - Geothermal:**

This industry is primarily engaged in operating geothermal electric power generation facilities that use heat derived from the Earth to produce electric energy.

7) **Electric Power Generation - Biomass:** This industry is primarily engaged in operating biomass electric power generation facilities that use wood, waste, and alcohol fuels to produce electric energy.

8) **Electric Power Generation - All other:** This industry is primarily engaged in operating electric power generation facilities using other forms of energy such as tidal waves to produce electric energy.

Energy Transmission & Distribution

The Energy transmission and distribution sub-sector focuses on industries engaged in the operation of transmission and distribution systems responsible for delivering energy

products from the source to the end use consumer. In total this sub-sector includes two individual industries that are further described below using definitions from the U.S. Census Bureau.

1) **Electric Power Transmission and**

Distribution: The electric power transmission industry includes establishments that operate the electric power transmission systems lines and transformer stations that move electricity from generation power plants to distribution centers or other electric utilities. In addition, this industry includes electric power brokers arranging the sale of electricity through the power distribution systems operated by others.

2) **Natural Gas Distribution:** This industry includes establishments engaged in operating gas distribution systems, gas marketers that buy gas from the well and sell it into a distribution system, gas brokers that arrange the sale of gas over gas distribution systems operated by others, and organizations that transmit and distribute natural gas to consumers.

Source: U.S. Census Bureau. (2022). North American Industry Classification System (NAICS).

Economic Contribution: Value Added

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Ohio Energy Sector IMPLAN Industry Contribution Analysis:

Value Added Contribution to GDP

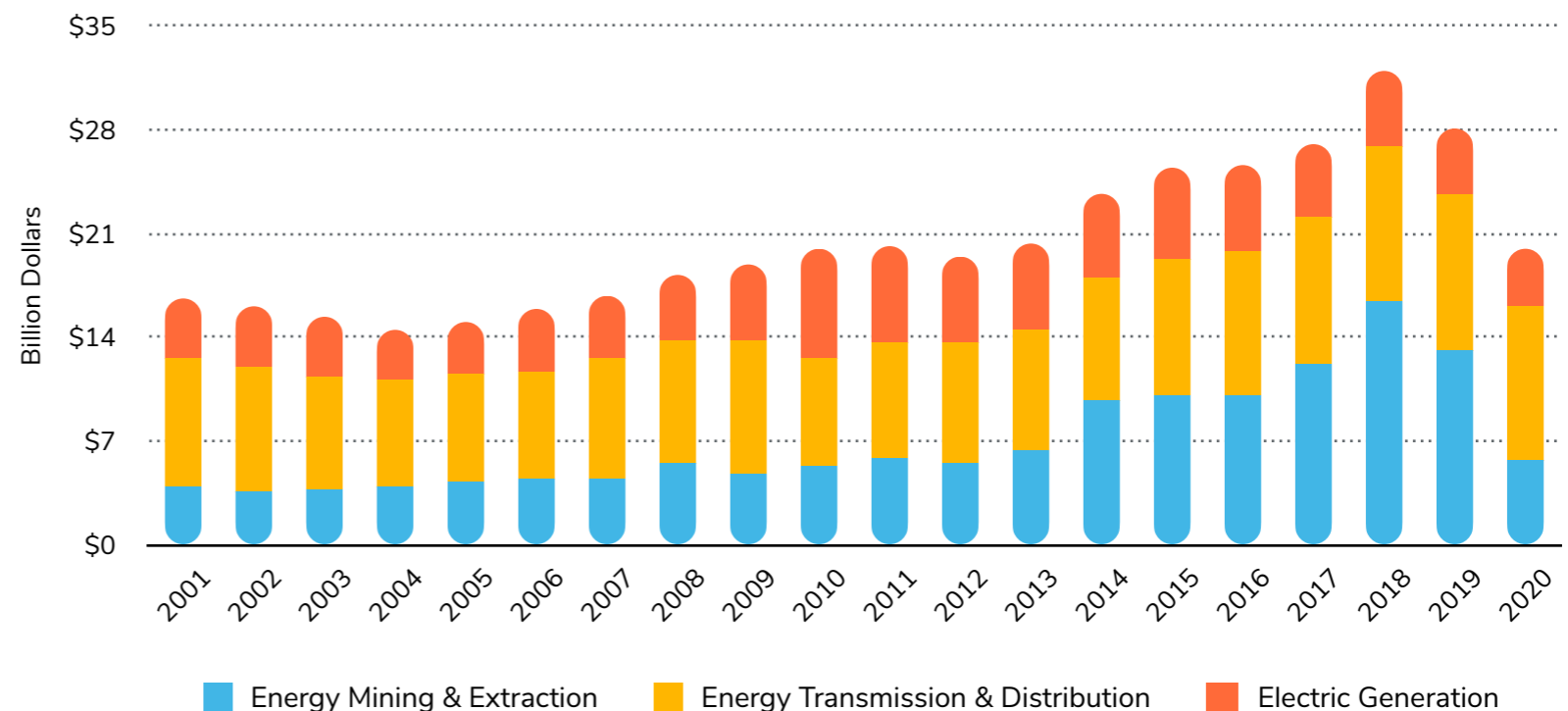
In this section we evaluate the impact of the Ohio energy sector to value added based on the industry contribution analysis. Value added is an economic metric to quantify the difference between the value of an industry's total output and the cost of its intermediate inputs. Value added includes all of the income generated at each stage of production and is equivalent to the sectors contribution to Gross Domestic Product (GDP). Because this industry contribution analysis includes all the energy industries in Ohio, the value added represents the gross state product of the energy sector for Ohio. To gain better insight into the historical trends of the energy sector's total contribution to gross state product, we consider the total value added from 2001 to 2020 which include direct, indirect, and induced contributions that were adjusted to reflect prices in 2020 real dollars (Chart 4). In 2001 the total estimated value added of the energy sector in Ohio was \$16.7 billion, which increased by 91% to a maximum of \$31.9 billion in 2018. Since the peak in 2018, the total value added from the energy sector in Ohio dropped

by 38% to \$19.9 billion in 2020. In 2020, the total value added of \$19.9 billion from the energy sector represented roughly 3% of Ohio's total Gross State Product.

The stacked bars in Chart 4 are broken down to illustrate the value added associated with each of the three energy sub-sectors including 1) energy mining and extraction, 2) energy transmission

and distribution, and 3) electric generation. In general, the energy transmission and distribution sector is the greatest contributor to the overall value added, averaging \$8.6 billion annually between 2001 and 2020, followed by energy mining and extraction averaging \$7 billion annually, and finally electric generation averaging \$4.9 billion annually.

Chart 4: Value Added - (Indexed to 2020 Dollars)



Source: IMPLAN. 2020.

When comparing the overall trends of the energy sub sectors growth and/or decline of value added, electric generation was the only energy sub sector that decreased, declining by 5% from 2001 to 2020. In contrast, it appears the overall trends of the total value added from the energy sector was primarily driven by the activity in the energy mining and extraction sub-sector which increased by 314% between 2001 and 2018, before declining 66% between 2018 and 2020. The next section will specifically focus on the Ohio energy sectors contribution to value added in 2020, including a review of the multipliers of individual industries, the impact of direct, indirect, and induced effects on total value added, and the contributions of employee compensation, proprietor income, other property income, and taxes on production to the total value added from the energy sector.

Value Added Multipliers

The presence of the energy sector operating in the Ohio economy introduces additional levels of spending in the overall economy. This additional spending causes a ripple, or multiplier effect throughout the economy.

The multiplier consists of the direct, indirect, and induced effects, that combined represent the total economic contribution. The multipliers for value

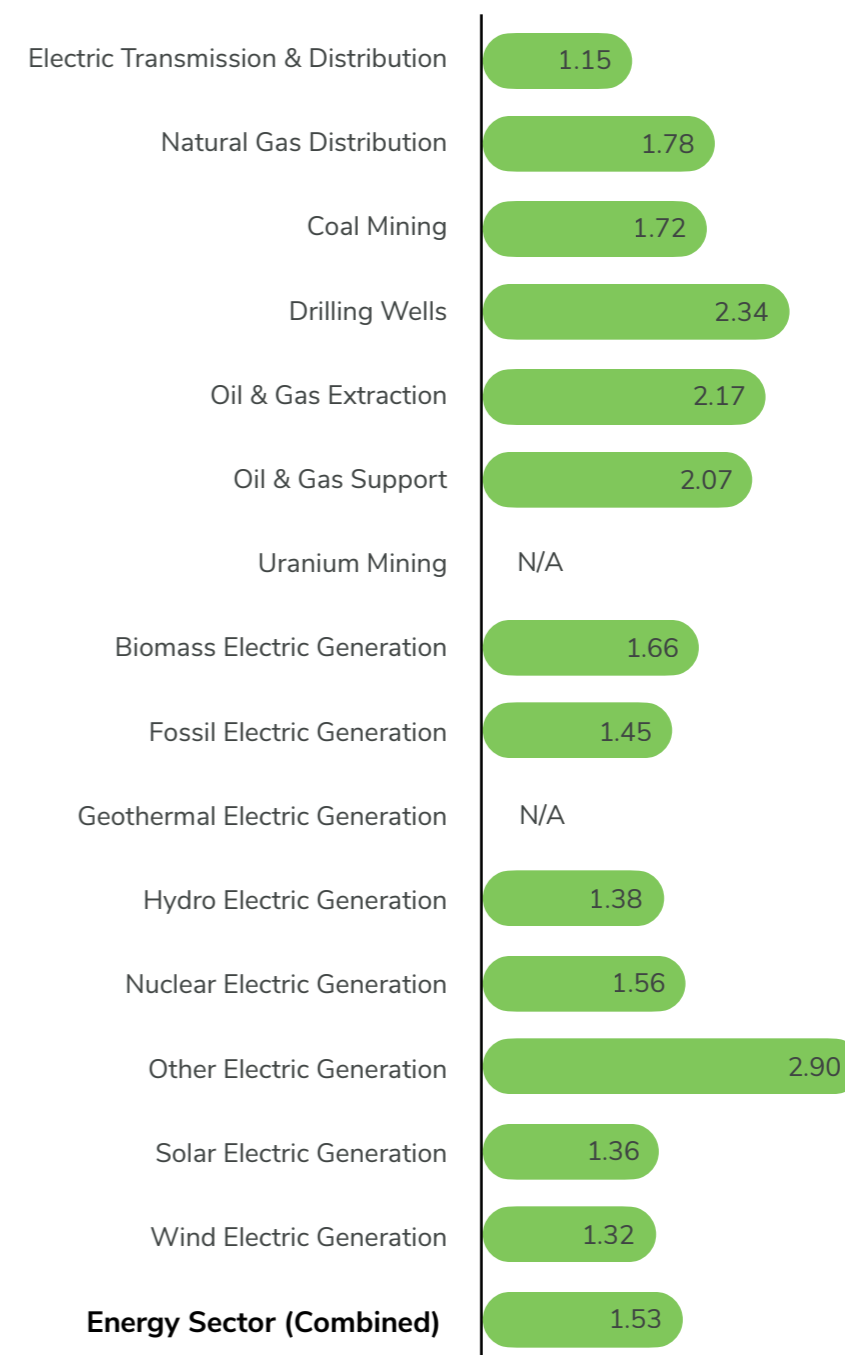
added are calculated by dividing the sum of the direct effects, indirect effects, and induced effects by the direct effects. Total value added multipliers represent the total value added supported as a result of \$1 of direct value added in the energy sector.

As shown in Chart 5, the overall value added multiplier for the energy sector combined industries in 2020 was 1.53, indicating for every \$1 of direct value added that the Ohio energy sector supports, an additional \$0.53 of value added was contributed to the state's economy. Value added multipliers for individual energy industries ranged from a high of 2.90 for the other electric generation industry to a low of 1.15 for the electric transmission and distribution industry, while the uranium mining and geothermal electric generation industries were not active in Ohio.

Direct, Indirect, & Induced Effects of Value Added

As illustrated in Table 2, the energy sector contributed a total of \$19.94 billion to the Ohio economy in 2020. Direct effects from within the energy sector represented \$13.01

Chart 5: Energy Sector Value Added Multipliers (2020)



Source: IMPLAN. 2020.



Table 2: Ohio Energy Sector Value Added Impact by Industry (2020)

IMPLAN Energy Industry	Value Added			Total	% of Total
	Direct	Indirect	Induced		
Oil & gas extraction	\$1.77 B	\$1.44 B	\$640.5 M	\$3.85 B	19.3%
Coal mining	\$218.8 M	\$53.3 M	\$103.6 M	\$375.8 M	1.9%
Uranium-radium-vanadium ore mining	\$0 M	\$0 M	\$0 M	\$0 M	0.0%
Drilling oil & gas wells	\$171.9 M	\$157.3 M	\$73.7 M	\$402.8 M	2.0%
Support activities for oil & gas operations	\$471.1 M	\$278.1 M	\$227.1 M	\$976.3 M	4.9%
Electric generation - Hydroelectric	\$4.1 M	\$0.7 M	\$0.9 M	\$5.7 M	0.0%
Electric generation - Fossil fuel	\$1.8 B	\$440.8 M	\$375.2 M	\$2.62 B	13.1%
Electric generation - Nuclear	\$673.4 M	\$178.1 M	\$196.9 M	\$1.05 B	5.3%
Electric generation - Solar	\$67.4 M	\$11.8 M	\$12.5 M	\$91.8 M	0.5%
Electric generation - Wind	\$61 M	\$13 M	\$6.8 M	\$80.7 M	0.4%
Electric generation - Geothermal	\$0 M	\$0 M	\$0 M	\$0 M	0.0%
Electric generation - Biomass	\$6.4 M	\$2.7 M	\$1.5 M	\$10.7 M	0.1%
Electric generation - All other	\$3 M	\$2.1 M	\$3.6 M	\$8.7 M	0.0%
Electric transmission & distribution	\$5.26 B	\$54.1 M	\$710.1 M	\$6.02 B	30.2%
Natural gas distribution	\$2.5 B	\$1.14 B	\$797.7 M	\$4.44 B	22.3%
Total Ohio Value Added Impact From Energy Sector (\$Billions)	\$13.01 B	\$3.77 B	\$3.15 B	\$19.94 B	100%

Source: IMPLAN. 2020.

billion accounting for 65% of the total value added. Through the business-to-business transactions, the energy sector contributes an additional \$3.77 billion through indirect effects, accounting for 19% of the total value added in Ohio. Finally, induced effects that result from household spending due to the economic activity generated by the energy sector represented an additional \$3.15 billion of induced effects, accounting for 16% of the total value added.

When evaluating the impact of individual industries within the energy sector, three individual industries accounted for just over 71% of the total value added in Ohio from the energy sector (Table 2). First, the electric transmission and distribution industry contributed 30.2% of the total value added including \$5.26 billion in direct value added impacts, \$54.1 million of indirect value added, and an additional \$710.1 million of induced value added contributions. The second largest contributor was the natural gas distribution industry, accounting for 22.3% of the total value added from the energy sector. The natural gas distribution industry contributed a total of \$4.44 billion in value added, including \$2.5 billion in direct value added, \$1.14 billion in indirect value added, and \$797.7 million of induced value added. Finally, the third largest industry was oil and gas extraction, accounting for 19.3% of the total value added from the energy sector consisting of \$1.77 billion in direct value added, \$1.44 billion of indirect value added contributions, and \$640.5 million from induced value added.

Core Components of Value Added

Value added is a measure of economic activity which includes all of the income generated at each stage of production and is equivalent to the industry's contribution to Gross Domestic Product (GDP). Value added provides a lot of information in just one number, as it consists of other property income, employee compensation, taxes on production and imports, and proprietor income.

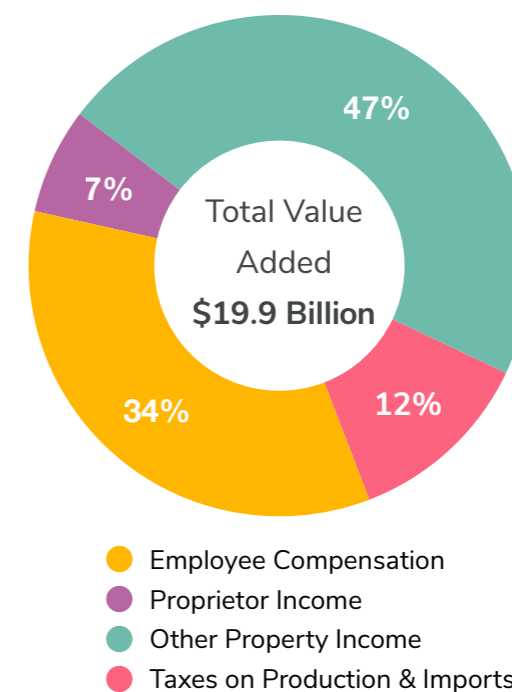
As illustrated in Chart 6, the largest component of total value added from the sector was other property income. Other property income is calculated as gross operating surplus minus proprietor income; it includes consumption of fixed capital, corporate profits, and business current transfer payments (net). Total value added from the energy sector in Ohio was driven by other property income which contributed \$9.3 billion to Ohio in 2020, representing 47% of the total value added. Next, employee compensation which includes the total payroll cost of the employee including wages and salaries, all benefits, and payroll taxes represented 34% or \$6.8 billion of the total value added contributions to Ohio in 2020. The taxes on production and imports which includes sales and excise taxes, customs duties, property taxes,

motor vehicle licenses, severance taxes, other taxes, and special assessments accounted for an estimated at \$4.2 billion or 12% of the total value added contributions from the Ohio energy sector in 2020. Finally, proprietor income which accounts for the production income of sole proprietorships, partnerships, and tax-exempt cooperatives contributed \$1.4 billion or 7% of the total value added contributions to Ohio in 2020.

Top 15 (Non-Energy) Industries

Chart 7 lists the top 15 non-energy industries by contribution to the total value added from indirect and induced affects related to the energy industry operating in Ohio. When combined, the top 15 non-energy industries contributed a total of \$3.8 billion in 2020 to the total value added from the Ohio energy sector. The non-energy industry with the highest contribution to the total energy sector value added was the monetary authorities and depository credit intermediation industry, contributing \$392.5 million of indirect value added and \$183.6 million of induced in total value added, yielding a total of \$576.1 million. The second largest non-energy industry contributor to total value added was the pipeline transportation industry which contributed an additional \$479.2 million to value added. Over

Chart 6: Summary of Value Added from the Ohio Energy Sector (2020)

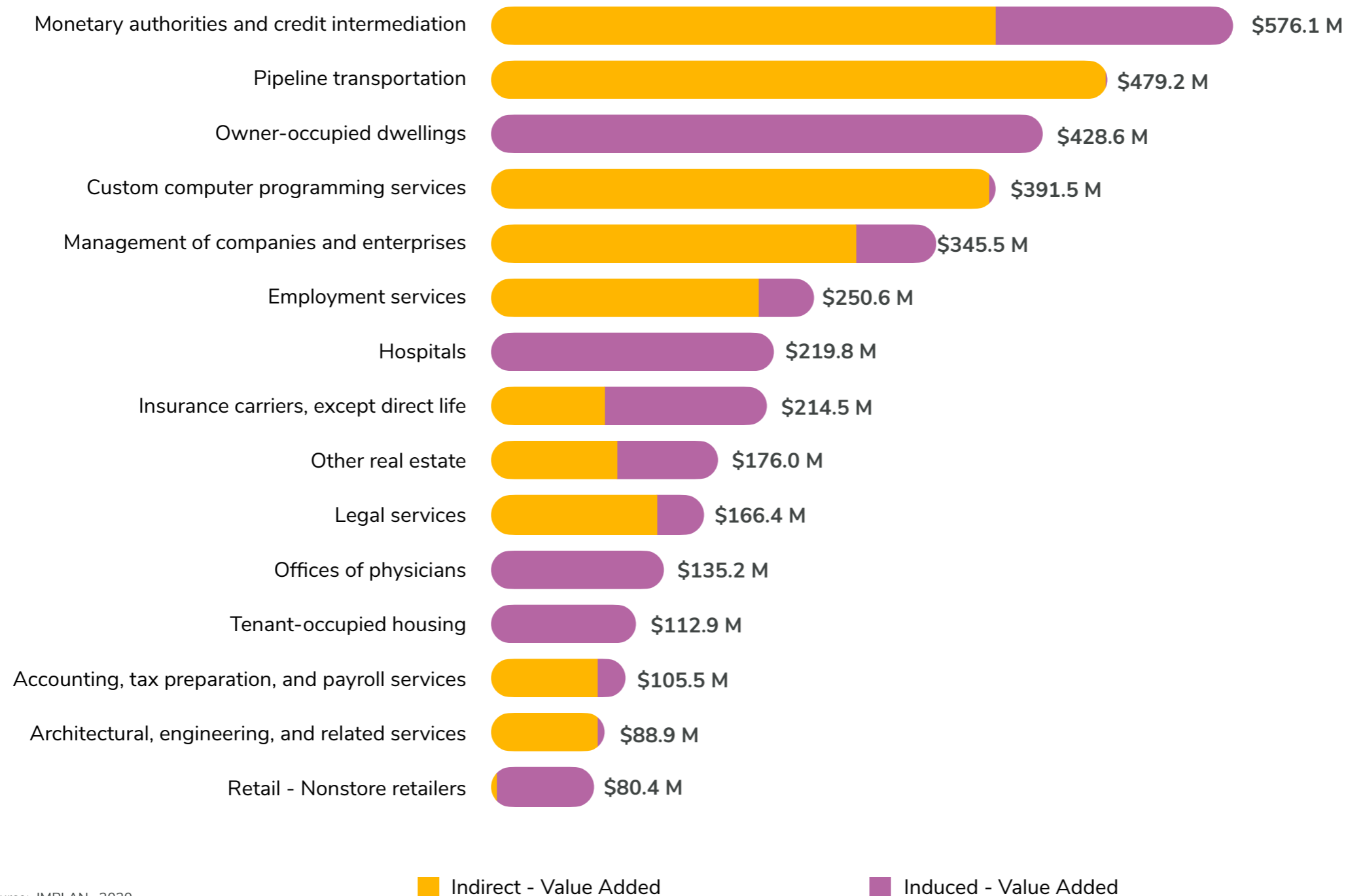


Source: IMPLAN. 2020.

99% of the value added from the pipeline transportation industry was related to indirect value added as a result of business-to-business transactions with the energy sector. Owner-occupied dwellings was the third largest non-energy industry, contributing \$428.6 million of induced value added resulting from the energy sector operating in Ohio. The owner-occupied dwellings sector represents the wealth generated from home ownership. Owning and maintaining a home is also a major area of spending and the owner-occupied dwellings sector captures that economic effect.



Chart 7: Top 15 (Non-Energy) Industries Contribution to Total Value



Source: IMPLAN. 2020.

Economic Contribution: Employment



Ohio Energy Sector IMPLAN Industry Contribution Analysis:

Contribution to Total Employment

In this section we evaluate the impact of the Ohio energy sector on employment based on the industry contribution analysis. Similar to the Bureau of Labor Statistics Census of Employment and Wages data, IMPLAN data uses a full-time/part-time annual average to define employment. For example, one job lasting 12 months is equal to two jobs lasting 6 months each, or three jobs lasting four months each. The Total Employment estimates reported by IMPLAN represents full and part-time annual average including the self-employed, all federal, state, and local government employment and military employment.

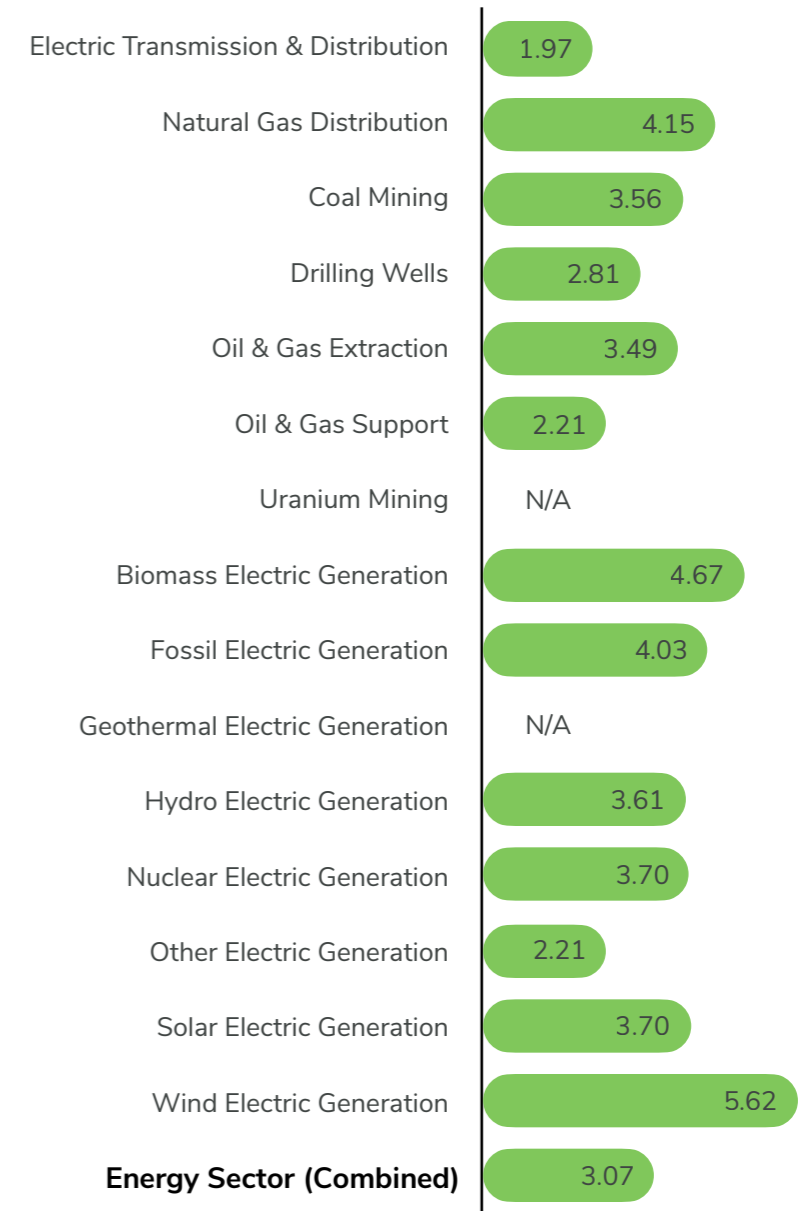
It is important to establish a clear understanding of how employment data from an industry contribution analysis is calculated and exactly what it represents when interpreting the results. The total employment impact is a sum of the direct, indirect, and induced employment as a result of the energy sector operating in Ohio. Direct employment is the direct number of jobs associated with the 15 energy industries that makeup the energy sector. Indirect employment represents the

number of jobs that are supported by the business to business transactions as a result of the economic activity generated by the energy sector operating in Ohio. Finally, induced employment represents the number of jobs supported by household spending as a result of the economic activity generated by the Ohio energy sector.

Employment Multipliers

The existence of the energy sector operating in the Ohio economy supports additional employment opportunities in the overall economy. Employment multipliers describe the total jobs generated as a result of 1 direct job in the impacted industry. The employment multipliers are calculated by dividing the sum of the direct employment, indirect employment, and induced employment by the direct employment. As illustrated in Chart 8, employment multipliers for individual energy industries ranged from a high of 5.62 for the wind electric generation industry to a low of 1.97 for the electric transmission and distribution industry, while the uranium mining and geothermal electric

Chart 8: Energy Sector Employment Multipliers



Source: IMPLAN. 2020.

generation industries were not active in Ohio. The overall employment multiplier for the combined energy sector was 3.07, indicating for every 1 direct job in the Ohio energy sector, an additional 2.07 jobs in other industries are supported by the energy sector in the Ohio economy.

Ohio Energy Sector Historical

Employment Trends

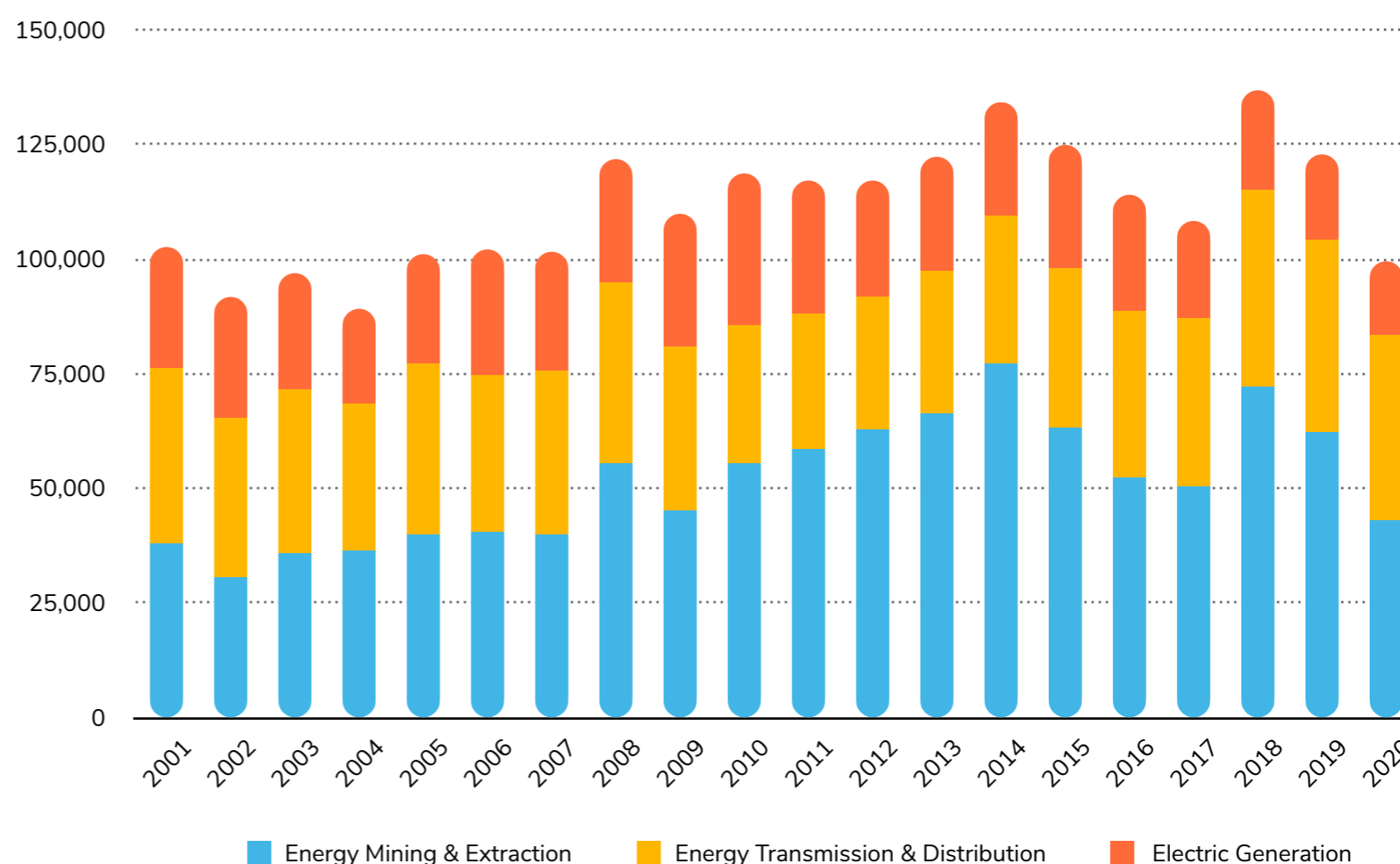
Using the three energy sub-sectors including 1) energy mining and extraction, 2) energy transmission and distribution, and 3) electric generation, Chart 9 illustrates the historical total employment impacts of the energy sector operating in Ohio. The employment data in Chart 9 represents the total employment impact which includes direct, indirect, and induced employment as a result of the respective energy sub-categories operating in Ohio.

As illustrated in Chart 9, the total employment impact from all three subsections increased by 33% between 2001 and 2018 when the combined employment impact reached 136,735 jobs. However since 2018, employment in the the Ohio energy sector has decreased by 27% to

99,360 jobs in 2020, which is the lowest employment total for the Ohio energy sector since 2004. When considering the growth and/or decline of employment in the energy sub-sectors, the electric generation was the only sub-sector that experienced a decrease (-39%) in employment from 26,364 jobs in 2001 to 16,161 jobs in 2020. When evaluating the employment impacts of the energy transmission and

distribution sub-sector, the employment trends have remain fairly consistent, steadily increasing by 4% from 38,538 jobs in 2001 to 40,182 in 2020. Finally, the energy mining and extraction sub-sector experienced the greatest variation increasing of 103% from 37,884 jobs in 2001 to a peak employment of 76,966 in 2014, however has since sharply declined by 44% to 43,018 jobs in 2020.

Chart 9: Historical Employment Trends by Energy Sub-Sector



Source: IMPLAN. 2020.



Ohio Energy Sector 2020 Employment Impact

In this section we explore the 2020 employment impacts from the industry contribution analysis of the energy sector operating in Ohio. Table 3 provides specific details of the total employment impact from the Ohio energy sector which includes an itemized breakdown of the employment impact by specific energy industry and employment impact type including direct, indirect, and induced employment affects. Total employment impact for the Ohio energy sector in 2020 was 99,360 total jobs which were to a certain degree evenly distributed between direct jobs (32,362) associated with the energy sector, indirect jobs (32,106) as a result of business to business transactions, and induced jobs (34,892) supported by household spending.

The top overall employment impact was in the oil and gas extraction industry which accounted for 28,024 total jobs, including 12,886 indirect jobs which was the highest number of indirect jobs associated with a specific energy industry. The natural gas distribution industry was the second largest among the energy sector supporting a total of 23,674 Ohio jobs, including the largest number of induced jobs (8,836) related to household spending. Next, the electric transmission and distribution industry ranked third with a total of 16,508 jobs, including 8,395 direct jobs associated to the industry. Additional jobs related to the energy mining and extraction sub-sector include the drilling oil and gas wells industry which supported 3,309 total jobs and the coal mining industry which supported an additional 2,176 jobs in Ohio.

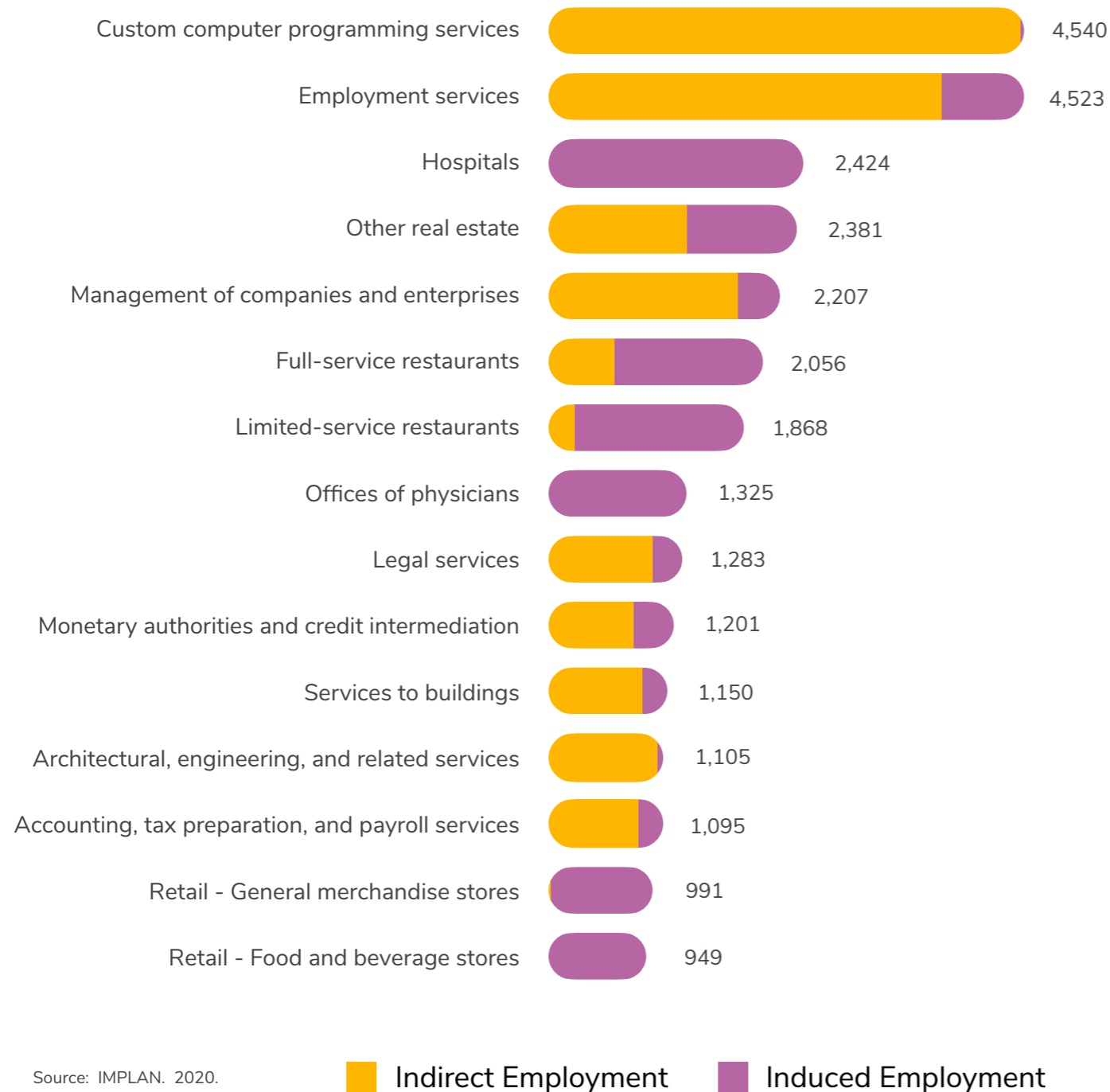
The greatest employment impact from electric generation sub-sector was in the fossil fuel electric generation industry which supported total employment of 10,188 jobs, representing 63% of all jobs related to electric

Table 3: Ohio Energy Sector Employment Impact by Industry (2020)

IMPLAN Energy Industry	Direct	Indirect	Induced	Total Jobs	% of Total
Oil & gas extraction	8,040	12,886	7,097	28,024	28.2%
Natural gas distribution	5,702	9,137	8,836	23,674	23.8%
Electric transmission & distribution	8,395	250	7,862	16,508	16.6%
Electric generation - Fossil fuel	2,530	3,501	4,156	10,188	10.3%
Support for oil & gas operations	4,297	2,697	2,515	9,509	9.6%
Electric generation - Nuclear	1,412	1,625	2,180	5,217	5.3%
Drilling oil & gas wells	1,176	1,317	816	3,309	3.3%
Coal mining	611	414	1,151	2,176	2.2%
Electric generation - Solar	91	108	138	337	0.3%
Electric generation - Wind	42	118	75	235	0.2%
Electric generation - All other	49	20	40	108	0.1%
Electric generation - Biomass	11	25	17	53	0.1%
Electric generation - Hydroelectric	6	6	10	22	0.0%
Uranium-radium-vanadium ore mining	0	0	0	0	0.0%
Electric generation - Geothermal	0	0	0	0	0.0%
Total Ohio Employment Impact From Energy Sector	32,362	32,106	34,892	99,360	100%

Source: IMPLAN. 2020.

Chart 10: Top 15 (Non-Energy) Industries by Employment Impact from Energy Sector (2020)



generation. Additional jobs from industries in the electric generation sub-sector include 5,217 total jobs related to nuclear electric generation, while solar generation supported a total of 337 jobs, and the wind generation industry accounted for a total of 235 jobs in 2020.

Top 15 (Non-Energy) Industries by

Employment Impact

Chart 10 lists the top 15 non-energy industries by indirect and induced employment related to the energy industry operating in Ohio. Combined, the top 15 non-energy industries contributed a total of 29,100 jobs representing 29% of the total 99,360 jobs in 2020 related to the Ohio energy sector. The non-energy industry with the greatest contribution to the energy sector employment was the custom computer programming services industry, supporting a total of 4,540 jobs in 2020 as a result of the energy sector operating in Ohio. Over 98% of the jobs from the custom computer programming services industry was related to indirect employment resulting from business-to-business transactions with the energy sector. The second largest non-energy industry contributor to employment was the employment services industry which supported 3,747 indirect jobs and 776 induced jobs, yielding a total of 4,523 Ohio jobs in 2020. Spending on hospitals and health care is commonly found in the top spending across all industries. Hospitals were the third largest non-energy industry, supporting 2,424 induced jobs resulting from household spending as a result of the economic activity generated by the Ohio energy sector.



Economic Contribution: Occupational Analysis

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Ohio Energy Sector IMPLAN Industry Contribution Analysis:

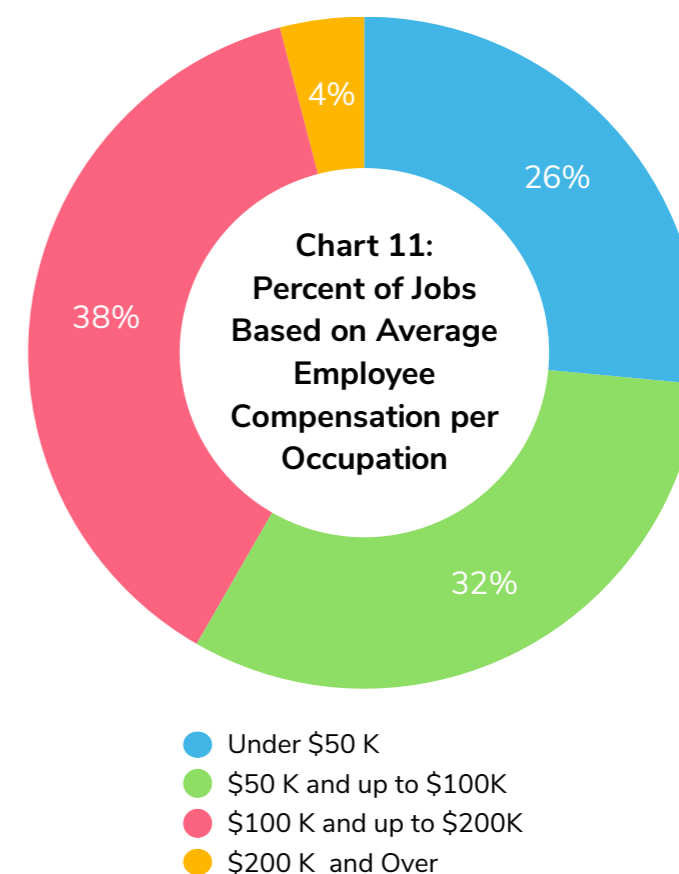
Employment Impact on Occupations

In this section we evaluate the occupational impact of the Ohio energy sector and the associated core competencies based on the industry contribution analysis. The IMPLAN occupational data can be filtered into several levels of detail, including 802 detailed occupations, 454 broad groups, 97 minor groups, and 23 major groups. For this industry contribution analysis, we have filtered the occupational data for the 2020 Ohio energy sector to the most specific 5-digit occupational detail level which includes 802 individual occupations.

The occupation impact data for the energy sector industry contribution analysis provides a combination of total employee compensation, occupational wage and salary employment, average employee compensation, and average hours worked for the impacted occupations. The employee compensation represents the total payroll cost of an employee including wages and salaries, all benefits such as health care and retirement, and payroll taxes. The wage and salary employment is simply a count of salaried and/or wage-earning employees for each

occupation that excludes proprietors. The average employee compensation per wage and salary employee is calculated as the total employee compensation divided by the count of wage and salary employment for the respective occupation. Finally, the average hours worked per year is calculated as total hours worked in a specific occupation, divided by the count of wage and salary employment.

In total there were 780 occupations supported by the energy sector operating in Ohio with the average annual employee compensation ranging from a low of \$9,591 for private household cooks to a high of \$405,966 for anesthesiologists. The average annual employee compensation among all 708 occupations was \$82,843 per year. Chart 11, provides a summary of the percentage of jobs based on the amount average annual employee compensation for that respective occupation. As illustrated in Chart 11, 42% of the jobs supported by the Ohio energy sector are in occupations that have an average employee compensation of \$100,000 or more.



Source: IMPLAN. 2020.

The occupation impact data in Figure 3 outlines a summary of the top 20 occupations based on total employee compensation. In addition, the table provides the wage and salary employment, average employee compensation, and average hours worked for each of the top 20 occupations supported by the Ohio energy sector. Combined, the top 20 occupations accounted for 18,814 jobs representing over \$2.63 billion in total employee compensation for Ohio.



Figure 3: Energy Sector Top 20 Occupations by the Total Contribution to Employee Compensation

	Total Contribution to Employee Contribution	Occupational Wage and Salary Employment	Average Employee Compensation	Average Hours Worked per Year
Electrical Power-Line Installers and Repairers	\$303 M	2,024	\$149,723	2,296
General and Operations Managers	\$291.8 M	1,486	\$196,336	2,242
Software Developers, Quality Assurance and Testers	\$175.6 M	1,291	\$136,056	2,008
Customer Service Representatives	\$165.8 M	2,406	\$68,900	1,726
Supervisors of Mechanics, Installers, and Repairers	\$153 M	944	\$162,095	2,284
Project Management Specialists and Operations	\$152.8 M	1,093	\$139,882	2,002
Electrical Engineers	\$148.1 M	776	\$190,938	2,123
Control and Valve Installers and Repairers	\$126 M	944	\$133,466	2,222
Accountants and Auditors	\$111.8 M	957	\$116,806	1,995
Power Plant Operators	\$104.9 M	666	\$157,350	2,419
Financial Managers	\$102.8 M	443	\$232,240	2,140
Computer Systems Analysts	\$100.5 M	702	\$143,048	2,068
Management Analysts	\$95.6 M	626	\$152,719	2,065
Supervisors of Office and Administrative Support	\$93 M	872	\$106,631	1,973
Registered Nurses	\$90.4 M	1,087	\$83,118	1,750
Computer and Information Systems Managers	\$90.4 M	410	\$220,172	2,167
First-Line Supervisors of Production and Operation	\$87.1 M	522	\$166,766	2,230
Electrical and Repairers, Powerhouse, and Substation	\$82.2 M	511	\$160,957	2,360
Lawyers	\$79.5 M	414	\$192,236	2,148
Industrial Machinery Mechanics	\$76.1 M	640	\$118,939	2,124

Source: IMPLAN. 2020.

The electrical power-line installers and repairers occupation had the largest total employee contribution of \$303 million from 2,024 jobs in Ohio. The average employee compensation for the electrical power-line installers and repairers occupation was \$149,723 per worker, which consisted of an average wage and salary income of \$104,441 plus an additional \$45,282 in wage and salary supplements such as benefits and bonuses.

The second largest occupation by employee contribution was general and operations managers which supported 1,486 jobs and \$291.8 million in total employee compensation. The average employee compensation for the general and operations managers occupation was \$196,336 per worker, which consisted of an average wage and salary income of \$157,781 plus an additional \$38,556 in wage and salary supplements such as benefits and bonuses.

Software developers and software quality assurance analysts and testers was the occupation with the third largest total employee contribution of \$175.6 million from 1,291 jobs. The average employee compensation for the software developers and software quality assurance analysts and testers occupation was \$136,056 per worker, which included an average wage and

salary income of \$117,362, plus an additional \$18,694 in wage and salary supplements such as benefits and bonuses.

Core Competencies: Knowledge, Skills, and Abilities

The core competency for occupations are broken down into the core knowledge, skills, and abilities that are essential traits for a worker to successfully complete the required task of an occupation. The core competency analysis included 33 unique knowledge elements, 35 unique skill elements, 52 unique ability elements that are assigned points that indicate the level of importance, or rank a given competency to a specific occupation.

Workers that are knowledgeable about a topic have mastered concepts, acquired facts, and information from sources such as books, journals, internet, traditional classroom-style courses and lectures, or hands on experience. Below is a list of the top five knowledge based core competencies for the occupations supported by the energy sector operating in Ohio.

1) **Customer and Personal Service** - Knowledge of principles and processes for providing

customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction.

- 2) **English Language** - Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
- 3) **Computers and Electronics** - Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- 4) **Mathematics** - Knowledge of arithmetic, algebra, geometry, calculus, statistics, and applications.
- 5) **Administration and Management** - Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

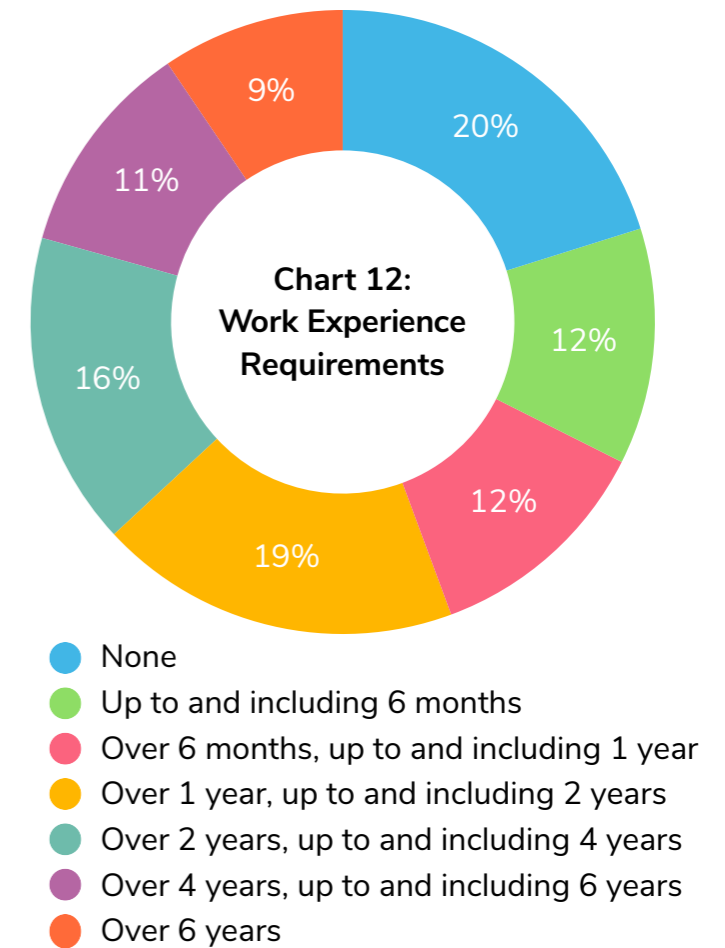


A skill is the ability to apply knowledge required to capably perform a certain task. Below is a list of the top five skills based core competencies for the occupations supported by the energy sector operating in Ohio.

- 1) **Active Listening** - Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- 2) **Speaking** - Talking to others to convey information effectively.
- 3) **Reading Comprehension** - Understanding written sentences and paragraphs in work-related documents.
- 4) **Critical Thinking** - Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions, or approaches to problems.
- 5) **Monitoring** - Monitoring/Assessing performance of yourself, other individuals, or organizations to make improvements or take corrective action.

An ability is the possession of the methods, skills, and traits necessary to do a specific job. Below is a list of the top five abilities for workers to be successful at the occupations supported by the energy sector operating in Ohio.

- 1) **Oral Comprehension** - The ability to listen to and understand information and ideas presented through spoken words and sentences.
- 2) **Oral Expression** - The ability to communicate information and ideas in speaking so others will understand.
- 3) **Near Vision** - The ability to see details at close range (within a few feet of the observer).
- 4) **Written Comprehension** - The ability to read and understand information and ideas presented in writing.
- 5) **Problem Sensitivity** - The ability to tell when something is wrong or is likely to go wrong. It does not involve solving the problem, only recognizing that there is a problem.



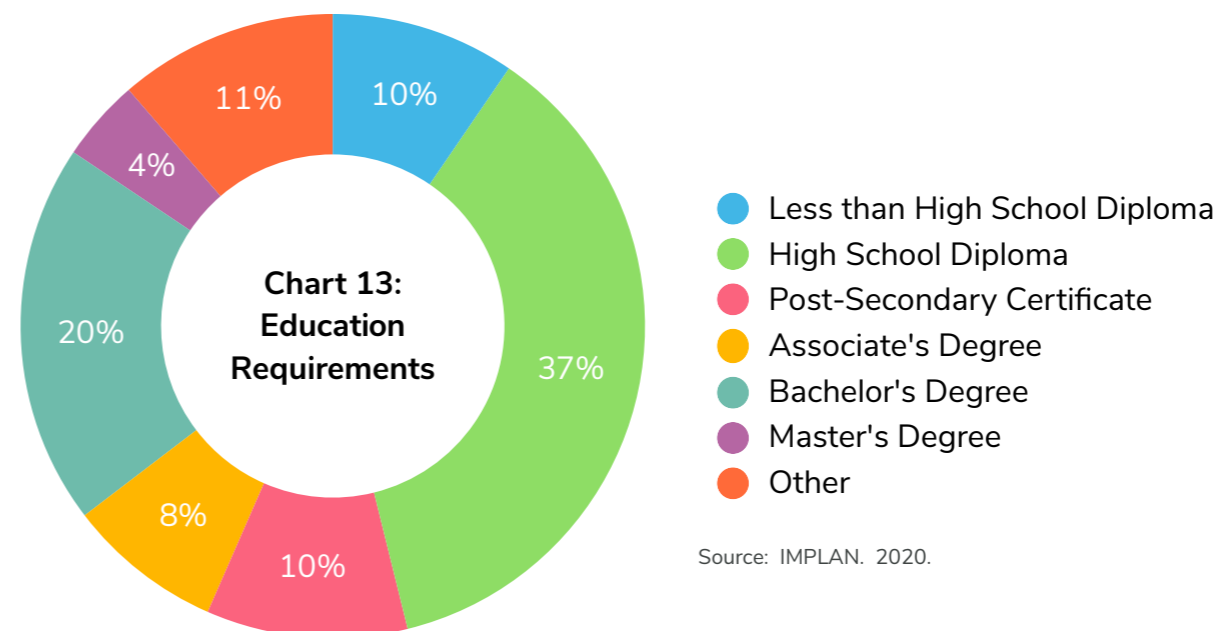
Source: IMPLAN. 2020.

Qualifications and Training

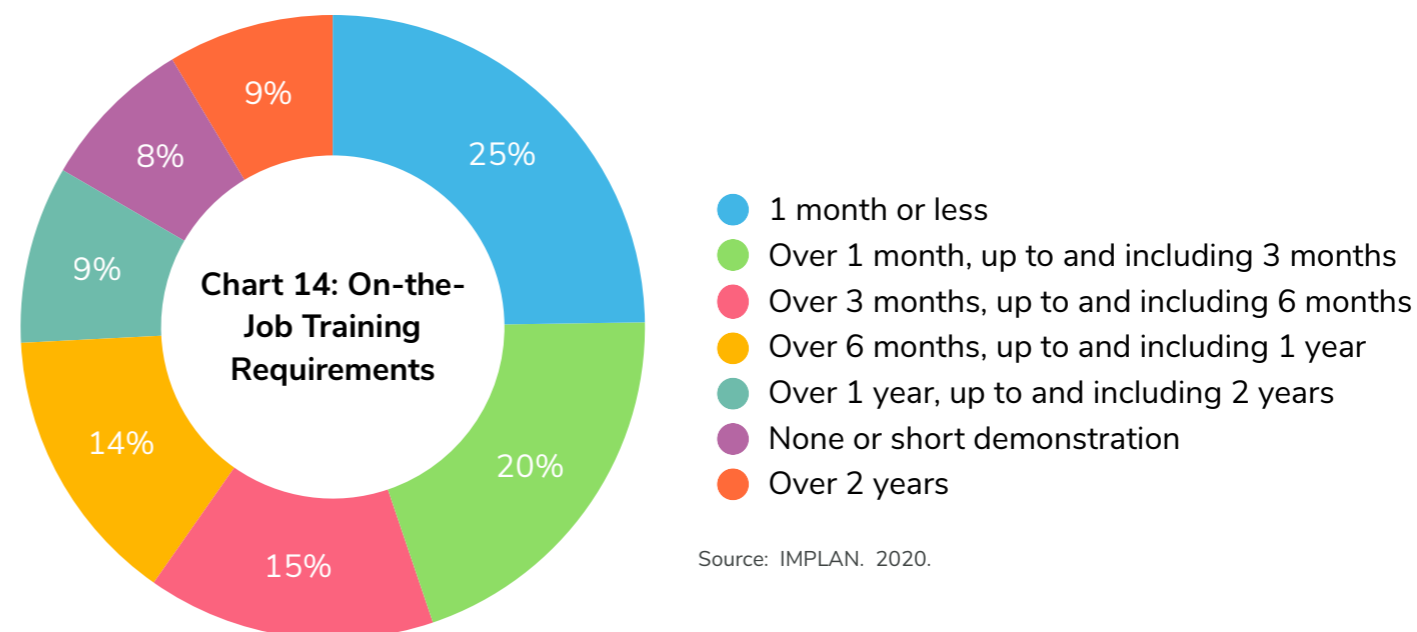
Chart 12 summarizes the amount of required work experience for the workers in occupations supported by the energy sector operating in Ohio. As illustrated in Chart 12, 20% of the positions do not require prior experience. However, 19% of the employees in occupations supported by the

energy sector were required to have between one and two years of experience. When combined, over 36% of the employees required over two years of prior work experience. Chart 13 summarizes the educational requirements for the occupations supported by the energy sector operating in Ohio. As shown in Chart 13, 10% of the jobs do not require a high school diploma. The leading form of educational requirements was high school diploma, which was required by 37% of available jobs. When combined, 32% of the employees required an Associate's (8%), Bachelor's (20%), or Master's Degree (4%), while a post-secondary certificate was required by 10% of workers. The remaining 11% of educational requirements was a combination of other categories, led by 7% of jobs that require some college courses.

There is a wide range of on the job training requirements for employees in occupations supported by the energy sector operating in Ohio. Chart 14 summarizes the length of on the job training requirements which included 25% of jobs that mandated less than one month of training, followed by 20% of positions that required up to three months of training, 15% of positions that took up to six months of training, and 14% of the employees that needed training for up to one year.



Source: IMPLAN. 2020.



Source: IMPLAN. 2020.



Final Observations



Ohio Energy Sector IMPLAN Industry Contribution Analysis:

Final Observations

Ohio's economy competes daily on a global scale, which was historically driven by a strong manufacturing sector that included high energy-intensive industries, such as strong metals fabrication and chemical production industries. In recent years, Ohio has seen growth in more service oriented sectors such as financial services, leisure and hospitality, government, data processing, and web hosting. Regardless of the structural mix of the economy, to remain competitive it is critical that Ohio employers have access to reliable, yet affordable sources of energy.

While globally the demand for energy consumption has increased significantly over the past 50 years, energy consumption in Ohio has been decreasing since the year 2000. The primary factor for the recent decrease in energy consumption in Ohio is related to structural changes in the economy leading to a reduction in energy use in the industrial sector. Other factors, such as efficiency improvements associated with electrical appliances, industrial equipment, and buildings as well as an increase in the miles per

gallon ratings for light duty vehicles, have slowed energy demand as well.

Finally, the coronavirus pandemic quarantines induced a global economic crisis as many businesses struggled to keep operations running, leading to an unforeseen reduction in energy demand. According to EIA Acting Administrator Stephen Nalley, "It will take a while for the energy sector to get to its new 'normal', as the pandemic triggered a historic energy demand shock that led to decreases in energy production, and sometimes volatile commodity prices in 2020. The pace of economic recovery, advances in technology, changes in trade flows, and energy incentives will determine how the United States produces and consumes energy in the future (USDOE/EIA, 2021)."

The purpose of this study was to quantify the contribution of the energy sector on the Ohio economy. The analysis found that in 2020 the Ohio energy sector contributed 3% to the overall Ohio value added and 1.5% to the total Ohio employment. However, the energy sector

industries still support a significant number of jobs (99,360), labor income (\$8.2 Billion), and value added (\$19.9 Billion) for the state of Ohio. In addition to the direct impact in the energy industries, the sectors benefitting most from the energy sector are in industries across the financial and support services spectrum including custom computer programming services, employment services, hospitals, management of companies and enterprises, and monetary authorities and credit intermediation.

The unprecedented growth in Ohio's natural gas production driven primarily by horizontal hydraulic fracturing in the Marcellus and Utica shale formations is the core driver in the Ohio energy sector. For example, activities related to oil and gas drilling, extraction, and distribution represented 69% (64,515 jobs) of the total jobs and 69% (\$9.6 billion) of the total value added related to the Ohio energy sector. Projecting forward, Ohio will likely see significant investments and development from utility scale solar electric generation facilities currently under review by the Ohio Power Siting Board.



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Ohio Energy Sector IMPLAN Industry Contribution Analysis:

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Glossary of Key Terms

Section 10: Page 38



Ohio Energy Sector IMPLAN Industry Contribution Analysis:

Glossary of Key Terms

Industry Contribution Analysis (ICA) - Industry Contribution Analysis (ICA) is a method used to estimate the wider economic contribution of an existing Industry or group of Industries in a region, at their current levels of production. ICA shifts the traditional I-O framework to see what Industries, and what level of production in these Industries, is being supported by current activity. ICA Events are distinct from Impact Events because they employ a constraint that removes feedback linkages or buy backs to the Industry being analyzed.

Multipliers - A measure of an industry's connection to the wider local economy by way of input purchases, payments of wages and taxes, and other transactions.

Sector - In the national economic accounts, the institutional units that make up the total economy: business, households and institutions, and general government.

Industry - A group of establishments engaged in the same or similar types of economic activity.

Data Year - The year of the dataset that the analysis is utilizing.

Dollar Year - The year represented by the values in the Event.

Direct Effects - The set of expenditures applied to the I-O multipliers for impact analysis. It is one or more production changes or expenditures made by producers/consumers as a result of an activity or policy. Direct effects can be positive or negative. These initial changes are determined by an analyst to be a result of this activity or policy being analyzed. Applying these initial changes to the multipliers in IMPLAN will then display how the Region will respond economically or is connected to these initial changes.

Indirect Effects - Economic Effects stemming from business to business purchases in the supply chain.

Induced Effects - Economic Effects stemming from household spending of Labor Income, after removal of taxes, savings, and commuter income.

Employment - Employment in IMPLAN is an Industry-specific mix of full-time, part-time, and seasonal employment. It is an annual average that accounts for seasonality and follows the same definition used by the BLS and BEA. IMPLAN Employment is not equal to full time equivalents. Includes wage and salary employment and proprietors.

Source: Clouse, C. 2022. IMPLAN. Glossary



Labor Income - All forms of Employment income, including Employee Compensation (wages, salaries, and benefits) and Proprietor Income.

Gross Domestic Product (GDP) - The final market value of the goods and services produced by labor and property located within the borders of the Region. Since 1991, GDP has been the featured measure of U.S. production.

Value Added - The difference between an Industry's or establishment's total Output and the cost of its Intermediate Inputs; it is a measure of the contribution to GDP. Value Added is a large portion of Output, as it encompasses Labor Income (LI), Other Property Income (OPI), and Taxes on Production and Imports (TOPI).

Output - For all Industries, output equals the value of Industry production, which is equal to sales plus net inventory change. In IMPLAN these are annual production estimates for the year of the dataset in producer prices. Note that for wholesale and retail sectors, Output is equal to gross wholesale margin or gross retail margin, respectively, not gross sales. The value of production for wholesale and retail sectors is the value of the services they provide; it does not include the value of the items sold within their establishment.

Proprietor Income - The current-production income of sole proprietorships, partnerships, and tax-exempt cooperatives. Excludes dividends, monetary interest received by non-financial business, and rental income received by persons not primarily engaged in the real estate business.

Other Property Income (OPI) - Calculated as Gross Operating Surplus minus Proprietor Income; OPI includes consumption of fixed capital (CFC), corporate profits, and business current transfer payments (net).

Employee Compensation - Employee Compensation in IMPLAN is the total payroll cost of the employee including wages and salaries, all benefits (e.g., health, retirement), and payroll taxes.

Taxes on Production & Imports less Subsidies (TOPI) - TOPI includes sales and excise taxes, customs duties, property taxes, motor vehicle licenses, severance taxes, other taxes, and special assessments.

Appendix:

- Economic Indicators
- Employment Impacts
- Value Added Impacts
- Occupation Impact



Appendix A: Economic Indicator Summary (Ohio / Data Year 2020 / Dollar Year 2020)

Event Name	Region	Impact	Employment	Labor Income	Value Added	Output
Fossil (ICA) Impact	Ohio (2020)	1 - Direct	2,530	\$476,673,788	\$1,801,364,604	\$3,734,082,061
Solar (ICA) Impact	Ohio (2020)	1 - Direct	91	\$18,016,243	\$67,443,045	\$109,742,672
Wind (ICA) Impact	Ohio (2020)	1 - Direct	42	\$5,622,367	\$60,976,141	\$107,305,898
Hydro (ICA) Impact	Ohio (2020)	1 - Direct	6	\$1,316,601	\$4,091,647	\$6,598,655
Nuclear (ICA) Impact	Ohio (2020)	1 - Direct	1,412	\$289,356,129	\$673,359,350	\$1,309,337,133
Geothermal (ICA) Impact	Ohio (2020)	1 - Direct	0	\$0	\$0	\$0
Biomass (ICA) Impact	Ohio (2020)	1 - Direct	11	\$1,404,515	\$6,446,060	\$16,156,287
Other Generation (ICA) Impact	Ohio (2020)	1 - Direct	49	\$5,942,314	\$3,012,935	\$10,663,154
Electric T&D (ICA) Impact	Ohio (2020)	1 - Direct	8,395	\$1,422,246,389	\$5,259,149,810	\$11,204,109,428
Coal Mining (ICA) Impact	Ohio (2020)	1 - Direct	611	\$175,545,928	\$218,844,545	\$347,682,444
O&G Extraction (ICA) Impact	Ohio (2020)	1 - Direct	8,040	\$196,700,654	\$1,774,984,657	\$4,501,050,710
Drilling Wells (ICA) Impact	Ohio (2020)	1 - Direct	1,176	\$56,784,672	\$171,900,827	\$459,649,319
O&G Support (ICA) Impact	Ohio (2020)	1 - Direct	4,297	\$289,877,836	\$471,075,100	\$1,028,925,093
Gas Distribution (ICA) Impact	Ohio (2020)	1 - Direct	5,702	\$887,185,565	\$2,500,306,401	\$4,828,807,760
Uranium Mining	Ohio (2020)	1 - Direct	0	\$0	\$0	\$0
Fossil (ICA) Impact	Ohio (2020)	2 - Indirect	3,501	\$287,768,677	\$440,763,230	\$774,490,391
Solar (ICA) Impact	Ohio (2020)	2 - Indirect	108	\$7,445,615	\$11,846,767	\$21,144,561
Wind (ICA) Impact	Ohio (2020)	2 - Indirect	118	\$8,155,350	\$12,976,026	\$23,160,091
Hydro (ICA) Impact	Ohio (2020)	2 - Indirect	6	\$441,303	\$702,159	\$1,253,240
Nuclear (ICA) Impact	Ohio (2020)	2 - Indirect	1,625	\$111,948,875	\$178,122,543	\$317,919,749
Geothermal (ICA) Impact	Ohio (2020)	2 - Indirect	0	\$0	\$0	\$0
Biomass (ICA) Impact	Ohio (2020)	2 - Indirect	25	\$1,709,241	\$2,719,584	\$4,854,015
Other Generation (ICA) Impact	Ohio (2020)	2 - Indirect	20	\$1,346,654	\$2,142,669	\$3,824,315
Electric T&D (ICA) Impact	Ohio (2020)	2 - Indirect	250	\$26,855,470	\$54,117,259	\$125,608,238
Coal Mining (ICA) Impact	Ohio (2020)	2 - Indirect	414	\$32,762,029	\$53,321,725	\$97,630,432
O&G Extraction (ICA) Impact	Ohio (2020)	2 - Indirect	12,886	\$1,106,058,968	\$1,436,948,150	\$2,397,898,190
Drilling Wells (ICA) Impact	Ohio (2020)	2 - Indirect	1,317	\$93,350,445	\$157,267,812	\$272,354,362
O&G Support (ICA) Impact	Ohio (2020)	2 - Indirect	2,697	\$173,812,620	\$278,112,939	\$515,779,319
Gas Distribution (ICA) Impact	Ohio (2020)	2 - Indirect	9,137	\$737,602,233	\$1,144,767,341	\$1,800,935,318
Uranium Mining	Ohio (2020)	2 - Indirect	0	\$0	\$0	\$0
Fossil (ICA) Impact	Ohio (2020)	3 - Induced	4,156	\$213,494,307	\$375,248,513	\$641,933,003
Solar (ICA) Impact	Ohio (2020)	3 - Induced	138	\$7,097,775	\$12,477,182	\$21,344,226
Wind (ICA) Impact	Ohio (2020)	3 - Induced	75	\$3,846,553	\$6,761,073	\$11,566,051
Hydro (ICA) Impact	Ohio (2020)	3 - Induced	10	\$490,317	\$861,891	\$1,474,410
Nuclear (ICA) Impact	Ohio (2020)	3 - Induced	2,180	\$111,995,893	\$196,860,522	\$336,764,818
Geothermal (ICA) Impact	Ohio (2020)	3 - Induced	0	\$0	\$0	\$0
Biomass (ICA) Impact	Ohio (2020)	3 - Induced	17	\$869,500	\$1,528,293	\$2,614,429
Other Generation (ICA) Impact	Ohio (2020)	3 - Induced	40	\$2,031,082	\$3,570,547	\$6,107,975
Electric T&D (ICA) Impact	Ohio (2020)	3 - Induced	7,862	\$403,933,473	\$710,077,377	\$1,214,701,047
Coal Mining (ICA) Impact	Ohio (2020)	3 - Induced	1,151	\$59,019,856	\$103,623,577	\$177,288,942
O&G Extraction (ICA) Impact	Ohio (2020)	3 - Induced	7,097	\$364,469,675	\$640,528,426	\$1,095,759,595
Drilling Wells (ICA) Impact	Ohio (2020)	3 - Induced	816	\$41,905,571	\$73,659,029	\$126,006,893
O&G Support (ICA) Impact	Ohio (2020)	3 - Induced	2,515	\$129,192,158	\$227,116,226	\$388,517,059
Gas Distribution (ICA) Impact	Ohio (2020)	3 - Induced	8,836	\$453,837,964	\$797,680,040	\$1,364,583,072
Uranium Mining	Ohio (2020)	3 - Induced	0	\$0	\$0	\$0
Source: IMPLAN. 2020.			99,360	\$8,208,114,605	\$19,936,756,023	\$39,409,624,353

Appendix B: Employment Impact Results - Top 100 (Ohio / Data Year 2020 / Dollar Year 2020)

	Industry Display	Direct Jobs	Indirect Jobs	Induced Jobs	Total Jobs
1	Electric power transmission & distribution	8,395	0	0	8,395
2	Oil & gas extraction	8,040	0	0	8,040
3	Natural gas distribution	5,702	0	0	5,702
4	Custom computer programming services	0	4,491	49	4,540
5	Employment services	0	3,747	776	4,523
6	Support activities for oil & gas operations	4,297	0	0	4,297
7	Electric power generation - Fossil fuel	2,530	0	0	2,530
8	Hospitals	0	0	2,424	2,424
9	Other real estate	0	1,323	1,058	2,381
10	Management of companies & enterprises	0	1,813	395	2,207
11	Full-service restaurants	0	643	1,413	2,056
12	Limited-service restaurants	0	251	1,617	1,868
13	Electric power generation - Nuclear	1,412	0	0	1,412
14	Offices of physicians	0	0	1,325	1,325
15	Legal services	0	1,002	281	1,283
16	Monetary authorities & depository credit intermediation	0	818	383	1,201
17	Drilling oil & gas wells	1,176	0	0	1,176
18	Services to buildings	0	909	241	1,150
19	Architectural, engineering, & related services	0	1,032	73	1,105
20	Accounting, tax preparation, bookkeeping, & payroll services	0	864	231	1,095
21	Retail - General merchandise stores	0	30	961	991
22	Retail - Food & beverage stores	0	12	937	949
23	Individual & family services	0	0	886	886
24	Computer systems design services	0	802	79	881
25	All other food & drinking places	0	174	650	824
26	Other financial investment activities	0	353	455	808
27	Religious organizations	0	0	804	804
28	Transit & ground passenger transportation	0	495	305	800
29	Truck transportation	0	470	309	779
30	Insurance carriers, except direct life	0	317	457	774
31	Automotive repair & maintenance, except car washes	0	221	547	768
32	Scenic & sightseeing transportation & support for transportation	0	643	108	750
33	Retail - Nonstore retailers	0	47	685	731
34	Pipeline transportation	0	724	3	727
35	Wholesale - Wholesale electronic markets & agents & brokers	0	645	76	721
36	Home health care services	0	0	703	703
37	Nursing & community care facilities	0	0	686	686
38	Securities & commodity contracts intermediation & brokerage	0	328	356	685
39	Maintenance & repair construction of nonresidential structures	0	549	107	657
40	Business support services	0	465	190	656
41	Investigation & security services	0	455	161	615
42	Management consulting services	0	405	208	612
43	Coal mining	611	0	0	611
44	Scientific research & development services	0	383	211	594
45	Insurance agencies, brokerages, & related activities	0	272	318	590
46	Landscape & horticultural services	0	365	187	552
47	Warehousing & storage	0	225	324	549
48	Retail - Miscellaneous store retailers	0	14	535	548
49	Personal care services	0	0	500	500
50	Junior colleges, colleges, universities, & professional schools	0	54	434	488

	Industry Display	Direct Jobs	Indirect Jobs	Induced Jobs	Total Jobs
51	Office administrative services	0	323	156	480
52	Couriers & messengers	0	212	253	465
53	Wholesale - Machinery, equipment, & supplies	0	421	33	454
54	Retail - Health & personal care stores	0	1	452	453
55	Other local government enterprises	0	319	132	450
56	Elementary & secondary schools	0	0	445	445
57	Tenant-occupied housing	0	0	439	439
58	Commercial & industrial machinery & equipment rental & leasing	0	397	31	428
59	Waste management & remediation services	0	327	85	413
60	Outpatient care centers	0	0	409	409
61	Marketing research & other professional, scientific, technical services	0	361	39	399
62	Child day care services	0	0	395	395
63	Offices of other health practitioners	0	0	389	389
64	Nondepository credit intermediation & related activities	0	126	255	381
65	Offices of dentists	0	0	366	366
66	Wholesale - Other durable goods merchant wholesalers	0	237	114	351
67	Car washes	0	60	277	337
68	Retail - Clothing & clothing accessories stores	0	1	332	332
69	Retail - Motor vehicle & parts dealers	0	30	295	325
70	Retail - Gasoline stores	0	89	235	324
71	Retail - Building material & garden equipment & supplies stores	0	103	205	307
72	Residential mental retardation, mental health, substance abuse	0	0	301	301
73	Local government electric utilities	0	291	4	294
74	Advertising, public relations, & related services	0	172	116	287
75	Postal service	0	159	122	281
76	Wholesale - Other nondurable goods merchant wholesalers	0	94	178	272
77	Retail - Sporting goods, hobby, musical instrument & book stores	0	7	261	267
78	Community food, housing, relief services, rehabilitation services	0	0	260	260
79	Rail transportation	0	248	10	258
80	Other personal services	0	12	244	256
81	Labor & civic organizations	0	0	246	246
82	Private households	0	0	244	244
83	Dry-cleaning & laundry services	0	36	201	238
84	Commercial & industrial machinery & equipment repair & maint.	0	142	96	238
85	Wired telecommunications carriers	0	109	123	232
86	Other educational services	0	7	221	228
87	Commercial Sports Except Racing	0	66	159	225
88	Funds, trusts, & other financial vehicles	0	3	204	207
89	Retail - Electronics & appliance stores	0	5	198	202
90	Wholesale - Professional & commercial equipment & supplies	0	61	141	201
91	Other amusement & recreation industries	0	13	187	200
92	Retail - Furniture & home furnishings stores	0	5	191	196
93	Other computer related services, including facilities management	0	156	26	182
94	Other support services	0	115	61	177
95	Electronic & precision equipment repair & maintenance	0	119	53	172
96	Data processing, hosting, & related services	0	98	71	168
97	Wholesale - Grocery & related product wholesalers	0	9	150	159
98	Fitness & recreational sports centers	0	11	147	158
99	Personal & household goods repair & maintenance	0	97	56	153
100	Promoters of performing arts & sports & agents for public figures	0	27	125	152

Source: IMPLAN. 2020.



Appendix C: Value Added Impacts Results - Top 25 Industries (Ohio / Data Year 2020 / Dollar Year 2020)

	Industry Display / Impact	Employee Compensation	Proprietor Income	Other Property Income	Taxes on Production & Imports	Value Added
1	Electric power transmission & distribution	\$1,253,583,179	\$168,663,210	\$2,889,715,955	\$947,187,466	\$5,259,149,810
2	Natural gas distribution	\$813,181,586	\$74,003,979	\$1,214,156,974	\$398,963,862	\$2,500,306,401
3	Electric power generation - Fossil fuel	\$421,756,925	\$54,916,863	\$873,473,121	\$451,217,695	\$1,801,364,604
4	Oil & gas extraction	\$82,993,307	\$113,707,347	\$1,470,512,894	\$107,771,109	\$1,774,984,657
5	Electric power generation - Nuclear	\$251,578,363	\$37,777,765	\$219,142,416	\$164,860,805	\$673,359,350
6	Monetary authorities & depository credit intermediation	\$102,281,043	\$2,499,945	\$463,163,308	\$8,141,748	\$576,086,044
7	Pipeline transportation	\$123,761,603	\$248,306,941	\$37,433,348	\$69,732,266	\$479,234,158
8	Support activities for oil & gas operations	\$266,202,276	\$23,675,561	\$162,451,186	\$18,746,078	\$471,075,100
9	Owner-occupied dwellings	\$0	\$0	\$367,654,206	\$60,990,802	\$428,645,008
10	Custom computer programming services	\$332,539,064	\$65,880,145	-\$3,036,154	-\$3,928,567	\$391,454,488
11	Management of companies & enterprises	\$302,864,566	\$50,009	\$37,841,271	\$4,698,942	\$345,454,787
12	Employment services	\$144,581,789	\$21,598,775	\$86,897,139	-\$2,496,323	\$250,581,380
13	Hospitals	\$188,494,846	\$1,759,506	\$31,007,179	-\$1,468,916	\$219,792,614
14	Coal mining	\$49,360,108	\$126,185,820	\$29,883,940	\$13,414,677	\$218,844,545
15	Insurance carriers, except direct life	\$69,183,518	\$1,855,704	\$129,758,179	\$13,715,356	\$214,512,757
16	Other real estate	\$27,643,025	\$19,115,603	\$118,981,796	\$10,290,672	\$176,031,095
17	Drilling oil & gas wells	\$46,606,829	\$10,177,843	\$105,315,193	\$9,800,962	\$171,900,827
18	Legal services	\$82,070,241	\$18,798,286	\$75,411,065	-\$9,912,478	\$166,367,115
19	Offices of physicians	\$131,252,451	\$16,511,945	-\$311,438	-\$12,220,854	\$135,232,105
20	Tenant-occupied housing	\$4,651,189	\$3,590,568	\$91,955,174	\$12,693,337	\$112,890,269
21	Accounting, tax preparation, bookkeeping, & payroll services	\$64,981,857	\$15,264,389	\$28,953,905	-\$3,728,988	\$105,471,163
22	Architectural, engineering, & related services	\$73,446,097	\$18,005,120	\$877,283	-\$3,422,941	\$88,905,559
23	Retail - Nonstore retailers	\$14,508,769	\$3,365,737	\$53,804,135	\$8,718,612	\$80,397,254
24	Nondepository credit intermediation & related activities	\$41,258,988	\$1,069,596	\$34,640,738	\$2,740,752	\$79,710,075
25	Scenic & sightseeing transportation & support activities for trans	\$44,392,983	\$38,210,750	-\$4,882,345	-\$98,205	\$77,623,183

Source: IMPLAN. 2020.

Appendix D: Occupation Impact Results (Ohio / Data Year 2020 / Dollar Year 2020 / Level 5 detail)

Occ Code	Dim Occupation Occupation	Employee Compensation	Wage & Salary Income	Supplements to Wages & Salaries	Wage & Salary Employment	Hours Worked
49-9051	Electrical Power-Line Installers & Repairers	\$303,028,948	\$211,381,119	\$91,647,829	2,024	4,647,327
11-1021	General & Operations Managers	\$291,815,435	\$234,510,144	\$57,305,291	1,486	3,332,309
15-1256	Software Developers & Software Quality Assurance Analysts & Testers	\$175,639,984	\$151,507,096	\$24,132,889	1,291	2,591,778
43-4051	Customer Service Representatives	\$165,776,901	\$126,307,587	\$39,469,315	2,406	4,153,518
49-1011	First-Line Supervisors of Mechanics, Installers, & Repairers	\$152,987,738	\$109,953,268	\$43,034,469	944	2,155,805
13-1198	Project Management Specialists & Business Operations Specialists, All Other	\$152,836,539	\$118,048,235	\$34,788,304	1,093	2,187,122
17-2071	Electrical Engineers	\$148,131,139	\$104,860,851	\$43,270,288	776	1,646,742
49-9012	Control & Valve Installers & Repairers, Except Mechanical Door	\$125,993,071	\$88,604,724	\$37,388,347	944	2,097,618
13-2011	Accountants & Auditors	\$111,773,861	\$90,887,827	\$20,886,035	957	1,909,148
51-8013	Power Plant Operators	\$104,856,455	\$73,157,566	\$31,698,889	666	1,612,277
11-3031	Financial Managers	\$102,812,510	\$84,065,215	\$18,747,295	443	947,388
15-1211	Computer Systems Analysts	\$100,457,632	\$80,597,793	\$19,859,839	702	1,452,349
13-1111	Management Analysts	\$95,623,705	\$74,168,720	\$21,454,984	626	1,292,979
43-1011	First-Line Supervisors of Office & Administrative Support Workers	\$92,965,730	\$72,348,018	\$20,617,713	872	1,719,753
29-1141	Registered Nurses	\$90,370,337	\$74,147,753	\$16,222,584	1,087	1,902,274
11-3021	Computer & Information Systems Managers	\$90,355,833	\$74,856,439	\$15,499,394	410	889,305
51-1011	First-Line Supervisors of Production & Operating Workers	\$87,131,216	\$63,047,381	\$24,083,835	522	1,165,053
49-2095	Electrical & Electronics Repairers, Powerhouse, Substation, & Relay	\$82,229,293	\$57,440,575	\$24,788,718	511	1,205,892
23-1011	Lawyers	\$79,510,099	\$66,112,399	\$13,397,700	414	888,376
49-9041	Industrial Machinery Mechanics	\$76,073,486	\$57,065,872	\$19,007,615	640	1,358,647
53-3032	Heavy & Tractor-Trailer Truck Drivers	\$71,860,972	\$59,183,161	\$12,677,811	1,005	2,095,892
43-9061	Office Clerks, General	\$71,410,252	\$57,115,694	\$14,294,559	1,424	2,275,452
11-9198	Personal Service Managers, All Other; Entertainment & Recreation Managers	\$70,897,505	\$54,900,678	\$15,996,828	336	723,031
11-9041	Architectural & Engineering Managers	\$69,088,734	\$51,291,718	\$17,797,015	260	590,433
29-1228	Physicians, All Other; & Ophthalmologists, Except Pediatric	\$67,677,598	\$55,856,891	\$11,820,707	221	485,875
41-3091	Sales Services Representatives, Except Advertising, Insurance, Financial Services, & Travel	\$67,409,261	\$55,141,256	\$12,268,004	714	1,431,354
41-4012	Sales Representatives, Wholesale & Manufacturing, Except Technical & Scientific Products	\$66,622,005	\$55,717,976	\$10,904,029	617	1,274,660
53-7062	Laborers & Freight, Stock, & Material Movers	\$63,435,773	\$52,226,195	\$11,209,578	1,500	2,444,018
47-1011	First-Line Supervisors of Construction Trades & Extraction Workers	\$61,314,456	\$49,284,795	\$12,029,660	476	1,042,115
11-2022	Sales Managers	\$52,236,785	\$43,231,580	\$9,005,205	238	528,026
47-2111	Electricians	\$51,245,502	\$37,275,042	\$13,970,459	400	809,888
13-1161	Market Research Analysts & Marketing Specialists	\$50,952,428	\$41,303,249	\$9,649,179	451	868,772
51-8092	Gas Plant Operators	\$50,176,154	\$36,686,433	\$13,489,721	365	829,638
43-6014	Secretaries & Administrative Assistants, Except Legal, Medical, & Executive	\$49,875,926	\$40,253,643	\$9,622,283	888	1,525,480
43-3031	Bookkeeping, Accounting, & Auditing Clerks	\$49,610,164	\$40,828,663	\$8,781,501	789	1,365,260
13-2098	Financial & Investment Analysts, Financial Risk Specialists, & Financial Specialists	\$49,456,873	\$39,794,954	\$9,661,918	328	697,228
49-9071	Maintenance & Repair Workers, General	\$46,265,942	\$35,743,844	\$10,522,098	610	1,198,457
11-3011	Administrative Services & Facilities Managers	\$45,779,706	\$34,930,234	\$10,849,472	242	495,468
17-2161	Nuclear Engineers	\$44,600,074	\$31,192,709	\$13,407,365	188	393,557
11-2021	Marketing Managers	\$44,128,486	\$36,274,936	\$7,853,550	193	392,241
47-2152	Plumbers, Pipefitters, & Steamfitters	\$42,382,780	\$30,558,511	\$11,824,269	361	734,883
13-1071	Human Resources Specialists	\$41,924,804	\$34,009,470	\$7,915,334	437	870,542
51-8012	Power Distributors & Dispatchers	\$41,481,626	\$28,946,585	\$12,535,041	242	591,058
15-1244	Network & Computer Systems Administrators	\$40,364,370	\$32,661,761	\$7,702,609	312	654,958
15-1232	Computer User Support Specialists	\$39,165,829	\$32,687,766	\$6,478,063	519	1,001,010
13-1028	Buyers & Purchasing Agents	\$38,596,524	\$29,541,673	\$9,054,851	299	586,080
11-1011	Chief Executives	\$38,473,397	\$30,896,149	\$7,577,248	116	267,637
47-5013	Service Unit Operators, Oil & Gas	\$36,248,281	\$31,093,015	\$5,155,266	472	1,225,348
17-3023	Electrical & Electronic Engineering Technologists & Technicians	\$35,583,106	\$25,568,919	\$10,014,187	259	562,835
41-2031	Retail Salespersons	\$35,015,307	\$29,292,006	\$5,723,301	1,196	1,672,270

Source: IMPLAN. 2020.





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