

Michigan's Oil and Natural Gas Industry: Economic Contribution

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Executive Summary

Michigan's oil and natural gas industry plays an important role in Michigan's economy creating tens of thousands of jobs and billions of dollars of income for Michigan residents. In 2014, 62 of Michigan's 83 counties produced oil and/or natural gas, and historically, 65 of Michigan's counties have had production. Of Michigan's 83 counties, 82 have economic activity resulting from the presence of the oil and natural gas industry.

Oil and natural gas have a wide range of uses. Michigan natural gas is used to generate electricity and heat homes and businesses. Petroleum products are obviously used to power cars, but they are also used in the production of fertilizer, plastics, pharmaceuticals, dyes, detergents, and many other products.

Oil and natural gas economic activity generates hundreds of millions of tax dollars for Michigan governments including cities, villages, townships, and schools. Royalties paid on oil and natural gas extracted from state land help to support public outdoor recreation in Michigan through the purchase and development of land for outdoor recreation and by providing operating support for state parks. Royalty and lease payments relating to oil and natural gas on private lands are an important income source for thousands of Michiganders.

This report estimates the contributions of the oil and natural gas industry to Michigan's economy. These estimates include the production of oil and natural gas from extraction, to transportation including pipelines, to refining. The estimates do not include broader definitions of oil and natural gas activities such as gasoline service stations and the many broader uses of the products such as power generation or the manufacturing of plastics. By focusing strictly on the production process of the oil and natural gas industry, we gain a better picture of how the economy is affected by the industry's presence in Michigan. The direct employment estimates in this report represent the sectors that would be lost to the economy without the presence of the oil and natural gas production industry in Michigan.¹

The oil and natural gas industry in Michigan:

- Directly employed 22,781 workers statewide, which supported an additional 24,324 jobs, for a total of 47,105 jobs in 2015.
- Drove a total \$13.6 billion in economic output, making up 3 percent of the state's overall gross domestic product (GDP) in 2015.
- Generated approximately \$419 million in state and local taxes, including \$146 million in sales tax, \$160 million in local property taxes, \$60 million in severance tax payments, and \$53 million in income taxes in 2015.²
- Paid approximately \$250 million in leasing and royalty payments to private landowners in 2014.

Employment in the Michigan oil and natural gas industry has doubled since 2005, from 11,089 jobs to 22,781 jobs. Jobs are forecast to increase an additional 46 percent over the next ten years, although the outlook for employment will be weaker if the recent drop in oil prices is sustained.

¹ This analysis is a contribution analysis, not a net economic impact analysis. Even with the removal of the oil and natural gas industry from Michigan's economy, some of those employed by the industry would remain in the state and work in other fields. The resulting indirect and induced impacts from their purchases would still be added to the economy.

² The severance tax figure is for 2014. This report uses 2015 figures when available. If 2015 figures were not available, the report uses totals for 2014.

Michigan's oil and natural gas industry has:

- Supported over \$1 billion in grants to local governments and state agencies from royalty payments deposited in the Michigan Natural Resources Trust Fund (MNRTF).
- Deposited more than \$153 million in the Michigan State Parks Endowment Fund (MSPEF) to help provide operating support to Michigan's state park system.

These grants are extremely important in supporting outdoor recreation in Michigan. Since its inception, the MNRTF has made more than 755 local property acquisitions and more than 467 state property acquisitions. The Fund has also supported more than 866 local and 105 state development projects. The MNRTF has supported projects in every county in Michigan. These projects, which are important to placemaking in Michigan, include trail development, restrooms and amenities at parks, ball fields, and many other important recreation assets. The MNRTF also purchases and protects environmentally sensitive areas. The MSPEF, which is supported with oil and natural gas revenues, provided one-third of state support to the state park system in 2014. This park system includes more than 70 state parks and 211 state recreation areas including 145 state forest campgrounds.

Michigan produced 7.1 million barrels (bbl.) of oil in 2014, and has 53 million bbl. of known oil reserves (U.S. EIA 2015a). Ongoing discoveries of new oil have been adding to Michigan's known reserves, and these reserves are actually higher than they were in 1998 (44 million bbl.). Michigan's 2014 natural gas production was 114,950 million cubic feet (mcf), ranking Michigan 18th highest among states. Michigan's known natural gas reserves total 1,845 billion cubic feet, with 10,500 producing wells.

Federal government projections show that oil and natural gas will be an important source of energy for years to come. The U.S. Energy Information Administration has forecast the sources of U.S. energy through 2040. In 2040, the U.S. will meet 29 percent of its energy needs through natural gas and 33 percent through petroleum and other liquids. With over half of U.S. energy needs being met by oil and natural gas in 2040, it is clear that these sources will remain an important part of the country's energy portfolio for decades to come.

Overview

Michigan's oil and natural gas industry is an important part of the state's economy. In 2014, Michigan produced more than 7 million barrels of oil and 115 billion cubic feet of natural gas. The industry not only provides jobs and contributes to the state's overall GDP, but it also supports the state, local governments, and schools through tax payments. Royalties and lease payments to private landowners are an important source of income to thousands of Michigan residents. Local production also helps reduce the United States' reliance on foreign energy sources.

This report estimates the economic contribution of the oil and natural gas industry in Michigan, and it includes detailed statewide- and county-level information. The report focuses on the direct and indirect impacts of oil and natural gas drilling, extraction, transportation, and refining in 2015. Specifically, this report examines industry employment, wages, taxes paid, goods and services purchased by the industry, and the jobs, wages, and taxes resulting from these purchases. Lease payments, bonuses, and royalties paid to state and private landowners, severance tax payments to the state and property tax payments made to local governments, as well as payments to the Michigan Natural Resources Trust Fund and to the Michigan State Parks Endowment Fund are also included.

The report looks at recent growth in oil and natural gas employment and projects future job growth, and finally it provides detail on the training needed for these jobs as well as the Michigan education institutions that provide that training.

This report is divided into the following sections:

- Economic contribution estimates
- Oil and natural gas workforce
- Oil and natural gas funding for recreation in Michigan
- Role in Michigan's energy production
- Conclusion
- References
- Appendix A: Data and methodology
- Appendix B: Educational institutions, by occupation

A separate supplement to this report contains estimates of the contributions of the oil and natural gas industry to each Michigan county. Individual county estimates or the full set of estimates for Michigan's 83 counties will be provided upon request.

Economic Contribution Estimates

OVERVIEW

The oil and natural gas industry has a significant economic impact in Michigan, creating jobs and income in 82 of Michigan's 83 counties. The industry directly employs people in the state through activities like oil and natural gas extraction, pipeline transportation, and refining. The industry also indirectly employs many people through the purchase of goods and services. For example, oil and natural gas companies hire surveyors, attorneys, and accountants. Finally, the spending of employees both directly and indirectly employed by the industry generates additional economic activity in sectors such as retail trade.

The estimates of the economic impact of the oil and natural gas industry in this report were created using the IMPLAN (IMPact analysis for PLANning) economic model—an input-output (I-O) model of the economy. I-O models trace spending as it moves through the economy to show how spending flows through interdependent industries to meet demand. IMPLAN was developed by the U.S. Department of Agriculture in the 1970s and was further developed in the 1980s through a partnership with the University of Minnesota. IMPLAN has been used in thousands of studies since it was first created. Government agencies, universities, and private institutions have used the model to estimate economic impacts, including the Environmental Protection Agency, the Federal Reserve Bank, Booz Allen Hamilton, Ernst & Young, and many others.

IMPLAN is currently owned by IMPLAN Group LLC in Huntersville, North Carolina. IMPLAN uses 536 industry classifications to model the economy, and can be used to model economic activity at the state, county, and zip code level. The software accounts for trade flows between industries in the study area and provides estimates of the multiplier effects of the initial industry spending and employment.

IMPLAN splits the economic contribution into the following categories:

- **Direct effect:** The direct employment and spending of the oil and natural gas industry.
- **Indirect effect:** The employment and spending generated by oil and natural gas industry purchases of goods and services.
- **Induced effect:** The effect on the economy from the household spending of those directly or indirectly employed by the oil and natural gas industry.

This analysis utilized individual county data for estimation of the county-level contributions of the oil and natural gas industry, using an industry-change analysis based on known employment numbers by sector. Each county and the state-level estimates were estimated separately. The statewide total is greater than the sum of the counties because some employment could not be attributed to specific counties and because a conservative approach was used for some counties where data were missing or underreported. Detail on the data utilized as well as the IMPLAN model is provided in Appendix A.

There are a number of studies examining the impact of the oil and natural gas industry at the national, state, or local level for various areas around the country. Most of these studies are economic contribution studies in that they do not identify the net gain resulting from the industries' presence but instead model the effect the overall industry has on the economy. These studies vary in how they define the extent of the oil and natural gas industry, from the very broad to the very narrow.

This report takes a conservative approach to defining the oil and natural gas industry to include only those industries that are related to the development, extraction, production, pipeline transportation, and refinement of oil and natural gas (see Exhibit 1). Subsequent uses for the produced oil and natural gas, such as fuel stations, are not included in the analysis. This model also takes care to modify the model's underlying

assumptions for each county to ensure that the effects are not double counted (see Appendix A for more detail). Finally, this study does not make any assumptions regarding the presence of Michigan’s oil and natural gas industry on the price of oil and natural gas products for Michigan consumers. If the presence of Michigan’s oil and natural gas industry results in lower prices for Michigan consumers, it could have a significant economic impact. For example, approximately 4.5 billion gallons of gasoline are purchased in Michigan each year, and if the presence of Michigan’s oil and natural gas industry lowers this price by even a few cents, it would result in a significant economic impact.

ECONOMIC IMPACT

Exhibit 1 lists the industry sectors that were counted as part of the oil and natural gas industry for this analysis. For each industry the North American Industry Classification System (NAICS) code and the related IMPLAN sector are listed. The NAICS code is an industry classification system used by federal agencies to gather statistical data, and the IMPLAN sectors are the corresponding industries as defined in the IMPLAN model.

EXHIBIT 1. Oil and Natural Gas Sectors

NAICS Code	Related IMPLAN Sector	Description	2015 Employment
211111	20	Oil and gas extraction	13,818
211112	21	Natural gas liquid extraction ³	801
213111	37	Drilling oil and gas wells ³	2,403
213112	38	Support activities for oil and gas operations	2,016
237120	58	Oil and gas pipeline and related structures construction	2,128
324110	156	Petroleum refineries	558
333132	266	Oil and gas field machinery and equipment manufacturing	28
486110	413	Pipeline transportation	40
486210	413	Pipeline transportation of natural gas	881
486910	413	Pipeline transportation of refined petroleum products	108
Total			22,781

Source: Employment-level data from EMSI and IMPLAN Economic Modeling.

Michigan’s oil and natural gas industry directly employed 22,781 people in 2015. The largest category of employment was in oil and gas extraction with industry employment of 13,818. Differences in the industry definitions at the six digit NAICS code level can be somewhat subtle. NAICS codes are also defined at more general levels, for example, the 3 digit NAICS code 211 is categorized as “oil and gas extraction” and encompasses both NAICS codes 211111 and 211112. This may be a more natural way of viewing extraction employment, and this sector has 14,619 jobs. Similarly, NAICS code 213, “support activities for mining” encompasses 213111 and 213112. This combined sector has employment of 4,419. The IMPLAN sectors often correspond to the more detailed six-digit NAICS codes in order to more accurately reflect how economic activity flows through the economy.

³ See Appendix A for employment modifications made to sectors 21 and 37.

In addition to direct employment, the oil and natural gas industry had over \$10 billion in output for 2015. Industry employment and output can fluctuate greatly from year to year due to changing energy prices and availability of resources. The 2015 total depicts the size of the industry at one point in time.

The direct impact of the oil and natural gas industry’s presence further contributes an additional 24,324 induced and indirect jobs, for a total employment of 47,105. Direct labor income is over \$1.5 billion with a total labor income of nearly \$2.8 billion. The industry’s direct output of \$10 billion drives an additional \$3.5 billion in indirect and induced impacts, for a total economic contribution of over \$13.6 billion. When compared to Michigan’s overall GDP for 2014 of \$448.2 billion (BEA 2015), the oil and natural gas industry and its spending represents over 3 percent of Michigan’s annual economy.

EXHIBIT 2. Oil and Natural Gas Industry Economic Contribution—Michigan

Impact Type	Employment	Labor Income (millions of \$)	Output (millions of \$)
Direct Effect	22,781	\$1,540.4	\$10,070.0
Indirect Effect	10,356	\$626.0	\$1,726.5
Induced Effect	13,968	\$590.9	\$1,829.1
Total Effect	47,105	\$2,757.2	\$13,625.7

*Totals may differ due to rounding.

Source: Estimated by PSC using employment-level data from EMSI and IMPLAN Economic Modeling.

The economic contribution of the oil and natural gas industry was run for every county within Michigan and then for the state overall (see Appendix A for a detailed methodology).⁴ Wayne and Oakland County contributed the most to the overall economy by supporting a combined total effect of over 12,000 jobs and over \$7.2 billion in output. For more information, separate report addendum containing one-page summaries of each of the 82 Michigan counties with oil and natural gas economic activity.⁵ Their individual impacts are a snapshot in time using 2015 employment data and economic trade flows, and as with the statewide estimates, these can vary significantly from year to year.

As noted, the oil and natural gas industry creates economic activity in other sectors through its purchase of goods and services and through the purchases of goods and services made by its employees. Exhibit 3 shows the top 20 industries by employment that are not categorized as oil and natural gas industries based on their industry codes. As can be seen in the Exhibit, the oil and natural gas industry creates jobs in construction, wholesale and retail trade, truck transportation, restaurants, and hospitals.

EXHIBIT 3. Top 20 Industries Supported by Oil and Natural Gas Activity by Employment

IMPLAN Sector	Description	Total Employment
62	Maintenance and repair construction of nonresidential structures	2,051

4 The sum of the individual counties does not match the statewide analysis for two reasons: 1) some employment numbers could not be allocated to a specific county, so are only present in the statewide analysis; and 2) due to the need to add sectors or modify the model for several counties where industry data was missing or underreported, the individual county estimates use a conservative estimation methodology.

5 Houghton County has no activity in the oil and natural gas industry for 2015.

IMPLAN Sector	Description	Total Employment
395	Wholesale trade	1,047
482	Hospitals	854
502	Limited-service restaurants	825
501	Full-service restaurants	805
440	Real estate	795
461	Management of companies and enterprises	744
464	Employment services	667
468	Services to buildings	552
449	Architectural, engineering, and related services	548
411	Truck transportation	509
447	Legal services	501
405	Retail - General merchandise stores	492
436	Other financial investment activities	416
503	All other food and drinking places	411
475	Offices of physicians	409
483	Nursing and community care facilities	404
400	Retail - Food and beverage stores	377
407	Retail - Nonstore retailers	372
433	Monetary authorities and depository credit intermediation	349

Source: Estimated by PSC using employment-level data from EMSI and IMPLAN Economic Modeling.

Exhibit 4 shows the industries with the largest output resulting from oil and natural gas activity. The top five industries all involve direct economic activity by the oil and natural gas industry. Not surprisingly, the largest economic impact of the industry is in the refining, extraction, pipeline transport, and drilling sectors. These top five sectors represent over two-thirds of the economic impact relating to the oil and natural gas industry. However, there is also significant economic activity in construction, wholesale trade, management, real estate and other industries.

EXHIBIT 4. Top 20 Industries by Output (millions of \$)

IMPLAN Sector	Description	Direct Output	Indirect/Induced Output	Total Output
156	Petroleum refineries	\$5,120.5	\$0	\$5,120.5
20	Extraction of natural gas and crude petroleum	\$2,478.5	\$0	\$2,478.5
21	Extraction of natural gas liquids	\$683.6	\$0	\$683.6
413	Pipeline transportation	\$600.5	\$0	\$600.5
37	Drilling oil and gas wells	\$575.2	\$0	\$575.2
62	Maintenance and repair construction of nonresidential structures	\$0	\$333.7	\$333.7
58	Construction of other new nonresidential structures	\$313.9	\$0	\$313.9

IMPLAN Sector	Description	Direct Output	Indirect/Induced Output	Total Output
38	Support activities for oil and gas operations	\$282.6	\$0	\$282.6
395	Wholesale trade	\$0	\$254.0	\$254.0
441	Owner-occupied dwellings	\$0	\$230.2	\$230.2
461	Management of companies and enterprises	\$0	\$181.4	\$181.4
440	Real estate	\$0	\$148.4	\$148.4
482	Hospitals	\$0	\$121.3	\$121.3
437	Insurance carriers	\$0	\$86.8	\$86.8
449	Architectural, engineering, and related services	\$0	\$85.8	\$85.8
411	Truck transportation	\$0	\$82.0	\$82.0
447	Legal services	\$0	\$79.3	\$79.3
49	Electric power transmission and distribution	\$0	\$75.9	\$75.9
502	Limited-service restaurants	\$0	\$63.1	\$63.1
475	Offices of physicians	\$0	\$57.3	\$57.3

Source: Estimated by PSC using employment-level data from EMSI and IMPLAN Economic Modeling.

TAX IMPACT

The Michigan oil and natural gas industry's economic activity generates taxes for the state, local governments, and schools in Michigan. In total, tax payments resulting from direct and indirect economic oil and gas activity totaled approximately \$419.5 million, or roughly \$42 per capita.⁶ Estimates for the sales, property, and income taxes were generated using the IMPLAN model. Severance tax estimates were generated using data from the State of Michigan.

EXHIBIT 5. Tax Impacts (millions of \$)

Severance Tax	Sales Tax	Local Property Tax	Income Tax
\$60.3	\$145.7	\$160.1	\$53.4

Source: Tax estimates were produced using data from the Michigan Department of Treasury, IMPLAN, and the oil and gas industry.

Severance Tax

Oil and natural gas companies pay a severance tax to the state on the gross cash value of oil and natural gas severed, or extracted from the ground. The tax rate is 6.6 percent for oil and 5 percent for natural gas. Marginal wells, which are wells near the end of their economic life, pay a tax rate of 4 percent. Oil and natural gas companies paid \$60.3 million in severance tax to the state in FY 2014. Since this tax is based on the price of oil and natural gas, reduction in oil and natural gas prices will reduce the amount this tax generates. Lower oil prices in FY 2015 reduced severance tax collections to \$30.5 million. The severance tax is deposited into the state's general fund. General fund revenues are discretionary and can be used by

⁶ The severance tax estimate is for FY 2014, while the sales, property, and income tax estimates are for FY 2015. FY 2014 severance tax data were used because county-level data were not available for FY 2015.

the legislature for any purpose. In recent years, these funds have been primarily used for higher education, Medicaid, corrections, and the operating budgets of state agencies. This report uses the FY 2014 amount because county-level data were available for FY 2014.

Sales Tax

Michigan levies a 6 percent retail sales tax on the purchase of tangible personal property for use or consumption. Oil and natural gas companies and their employees pay this tax directly on their purchases. Oil and natural gas economic activity generated approximately \$145.7 million in FY 2015. The sales tax is levied by the state, but much of the money is returned to school districts and local governments. Approximately three quarters of Michigan's sales tax is deposited into the state's School Aid Fund, which is used to fund local K–12 schools. In addition, approximately 15 percent of the state's sales tax is returned to local cities, villages, townships, and counties through the state's revenue sharing program.

Local Property Tax

Oil and natural gas companies pay property taxes on the land, structures, facilities, and personal property that they own, including pipelines.⁷ In addition, employees of oil and natural gas companies and firms supported by oil and natural gas activities also pay property taxes on their own personal residences. Property taxes support local governments including cities, villages, townships, counties, and libraries. A small portion of the property tax is remitted to the state as part of the state education tax. The state, however, returns this money to local school districts through appropriations from the state's School Aid Fund. In FY 2015, oil and natural gas economic activity generated an estimated \$160.1 million in property taxes.

Income Taxes

Oil and natural gas companies and the firms that do business with the industry are subject to the state's 6 percent corporate income tax. Income earned by individuals is subject to the state's 4.25 percent individual income tax, and is also potentially subject to city income taxes. Oil and natural gas economic activity generated approximately \$53.4 million in income taxes.

ROYALTY AND LEASE PAYMENTS

The oil and natural gas industry makes significant payments to landowners relating to the leasing of land and for royalties relating to the extraction of oil and natural gas. Landowners generally receive a bonus or lease payment when they reach an agreement with an oil or natural gas company to provide the company with access to the land and the rights to oil and natural gas on the property. Finally, landowners are paid royalties, which is an agreed-upon share of gross revenues from the sale of any oil and natural gas extracted from the land. Oil and natural gas companies make these payments to the government when the oil and gas is on publicly owned land and to private individuals when the oil and natural gas is on privately owned land.

Public Royalties

Oil and gas firms pay royalties to the state for any oil and natural gas related activity on public lands. These royalties are used to support recreation activities in the state through the Michigan Natural Resources Trust

⁷ Michigan's personal property tax is being phased out. Much of oil and natural gas personal property is classified as utility property and will not be subject to the phase-out. For more information see: <http://www.michiganbusiness.org/cm/Files/Fact-Sheets/MIPersonalPropertyTaxReform.pdf>

Fund and the Michigan State Parks Endowment Fund. Royalties are deposited into the Game and Fish Protection Fund if the public land was purchased with Game Fish Protection Fund monies. Funding for recreational activities is discussed in more detail later in the report. In 2014, these royalties totaled \$42.9 million.⁸

Royalties are also paid for oil and natural gas extracted from federal lands. In 2014, these royalties totaled \$1.2 million. Therefore, royalties paid to the state and federal government in 2014 totaled \$44.1 million.

Public Lease Payments

Oil and natural gas leases on state-owned lands originate at public auctions held twice per year by Michigan’s Department of Natural Resources (MDNR). The state has been leasing state-owned oil and natural gas rights through public auction since 1929, and in 2014, the bonus and lease payments from the two auctions totaled \$2.3 million (MDNR 2016). These payments are also made for the leasing rights on federal land, and in 2014 the payments for federal rights totaled \$0.4 million. Therefore, public lease and bonus payments to the state and federal governments totaled \$2.7 million for FY 2014.

Private Royalties

The industry paid an estimated \$214.5 million in royalties to private individuals, consisting of \$124.4 million in oil royalties, and \$90.1 million in natural gas royalties. As part of this research, the private royalty payments were estimated for the 62 Michigan counties with oil and natural gas production. Royalties were estimated by first looking at oil and natural gas production by county. The total value of oil and gas extracted from private lands was estimated using 2014 severance tax payments since these payments are based on the value of extracted resources. Given the share of oil and natural gas produced in each county and the estimated value of production statewide, we estimated the value of private production for each county. Finally, based on information provided by the Michigan Oil and Gas Association, we assumed that the royalty share of production on private land, which includes the royalty that goes directly to the private landowner and the other royalties owed to private individuals as part of the lease, was 22 percent. The estimate of private oil and natural gas royalties paid in each Michigan county is included in the separate report addendum.

Private Lease Payments

The Michigan Oil and Gas Association estimates that the industry paid private individuals \$37.8 million in private lease and bonus payments in 2014.

EXHIBIT 6. 2014 Royalty and Lease Payments (millions of \$)

Public Royalty Payments	Public Lease and Bonus Payments	Private Royalty Payments	Private Lease and Bonus Payments
\$44.1	\$2.7	\$214.5	\$37.8

Source: PSC estimates using production data and the Michigan Oil and Gas Association.

⁸ FY 2014 royalty estimates are used because FY 2015 estimates were unavailable.

Oil and Gas Workforce

INDUSTRY EMPLOYMENT

Between 2007 and 2013, the number of oil and natural gas workers in the U.S. increased 51.2 percent (Polzin 2014). According to the World Economic Forum (WEF), from 2010 to 2011 alone, oil and natural gas industry employment grew by 4.9 percent, directly adding 37,000 jobs to the U.S. economy (2013). From 2005 to 2015, Michigan’s oil and natural gas industry employment grew by over 105 percent, primarily due to larger increases in crude petroleum and natural gas extraction (140 percent increase) and natural gas liquid extraction and drilling of oil and gas wells (181 percent increase) sectors. Significant growth was also seen in the oil and natural gas pipeline and related structures construction as well as support activities for oil and gas operations (see Exhibit 7).

EXHIBIT 7. Oil and Natural Gas Industry Sectors

Description (IMPLAN Code)	2005 Jobs	2015 Jobs	2025 Jobs	2005-2015 Percent Change	2015-2025 Percent Change
Crude Petroleum and Natural Gas Extraction (20)	5,792	13,818	20,351	139.6%	47.3%
Natural Gas Liquid Extraction (21) and Drilling Oil and Gas Wells (37) ⁹	1,142	3,204	5,281	180.6	64.8
Support Activities for Oil and Gas Operations (38)	1,338	2,016	2,570	50.7	27.5
Oil and Gas Pipeline and Related Structures Construction (58)	1,330	2,128	3,469	60.0	63.0
Petroleum Refineries (156)	324	558	598	72.2	7.2
Oil and Gas Field Machinery and Equipment Manufacturing (266)	<10	28	54	>208.0	92.9
Pipeline Transportation of Crude Oil (413)	44	40	25	-9.4	-37.5
Pipeline Transportation of Natural Gas (413)	1,009	881	771	-12.7	-12.5
Pipeline Transportation of Refined Petroleum Products (413)	108	108	105	0.0	-2.8
Total	11,089	22,781	33,224	105.4	45.9

*Totals may differ due to rounding.

Source: Employment-level data from EMSI, 2016.

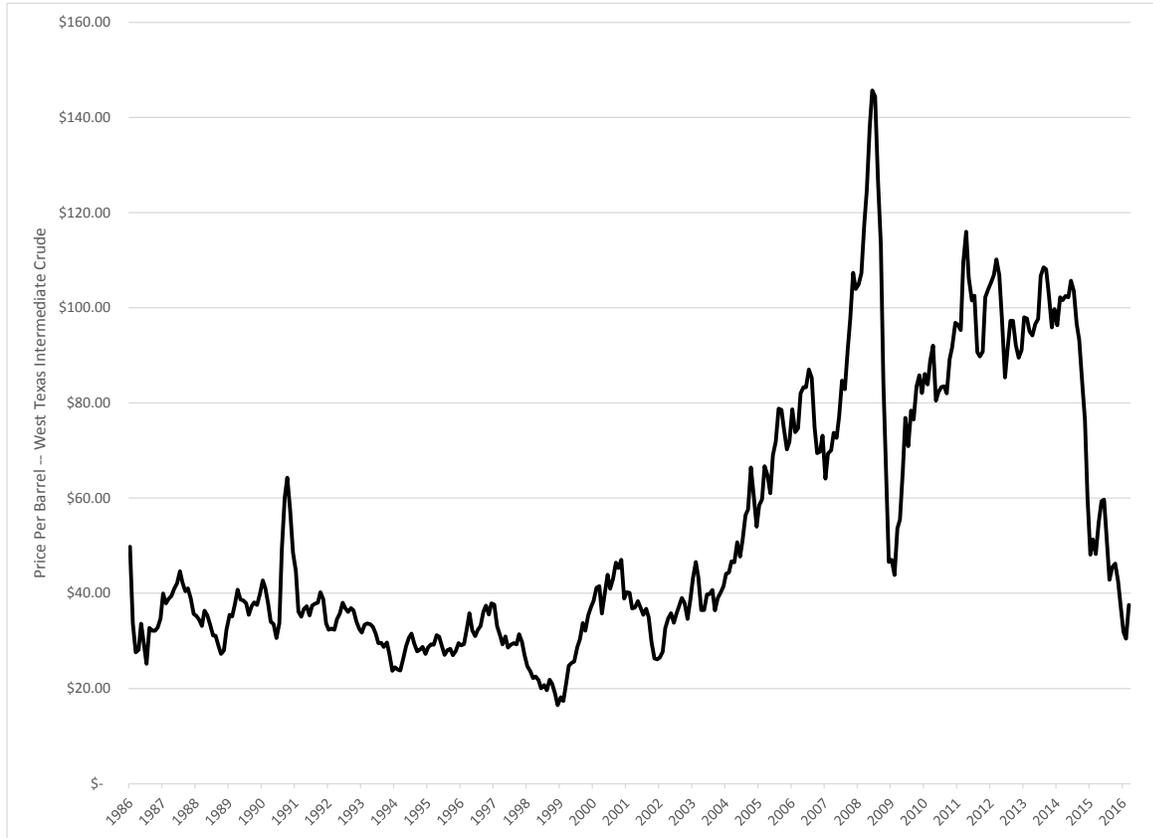
Michigan currently employs nearly 23,000 people directly in the oil and natural gas industry.¹⁰ Using projections from EMSI, we estimate that employment in the oil and natural gas industry will continue to expand in Michigan, adding over 10,000 jobs (45.9 percent) between 2015 and 2025 to bring the total to over 33,000 jobs. These projections are based on the recent activity and past employment changes in oil and natural gas industry. The estimates will be impacted by both the future price of oil and natural gas as well as the availability of oil and natural gas in Michigan. The price of oil is quite volatile and has recently fallen sharply—oil averaged over \$90 per barrel from 2011 to 2014 but is currently around \$40 per barrel

9 See appendix A for a description of the employment modifications to these sectors.

10 This includes employment of those categorized as extended proprietors who are “workers who are counted as proprietors, but classify the income as peripheral to their primary employment” (EMSI 2012). These employees need to be included in an input output analysis for a particular industry/sector.

(see Exhibit 8). If these lower prices persist, employment in oil related industries will likely be significantly lower than these projections. In addition, while new methods for finding and extracting oil and natural gas may offer continued growth, it is uncertain the extent to which Michigan's market can actually expand.

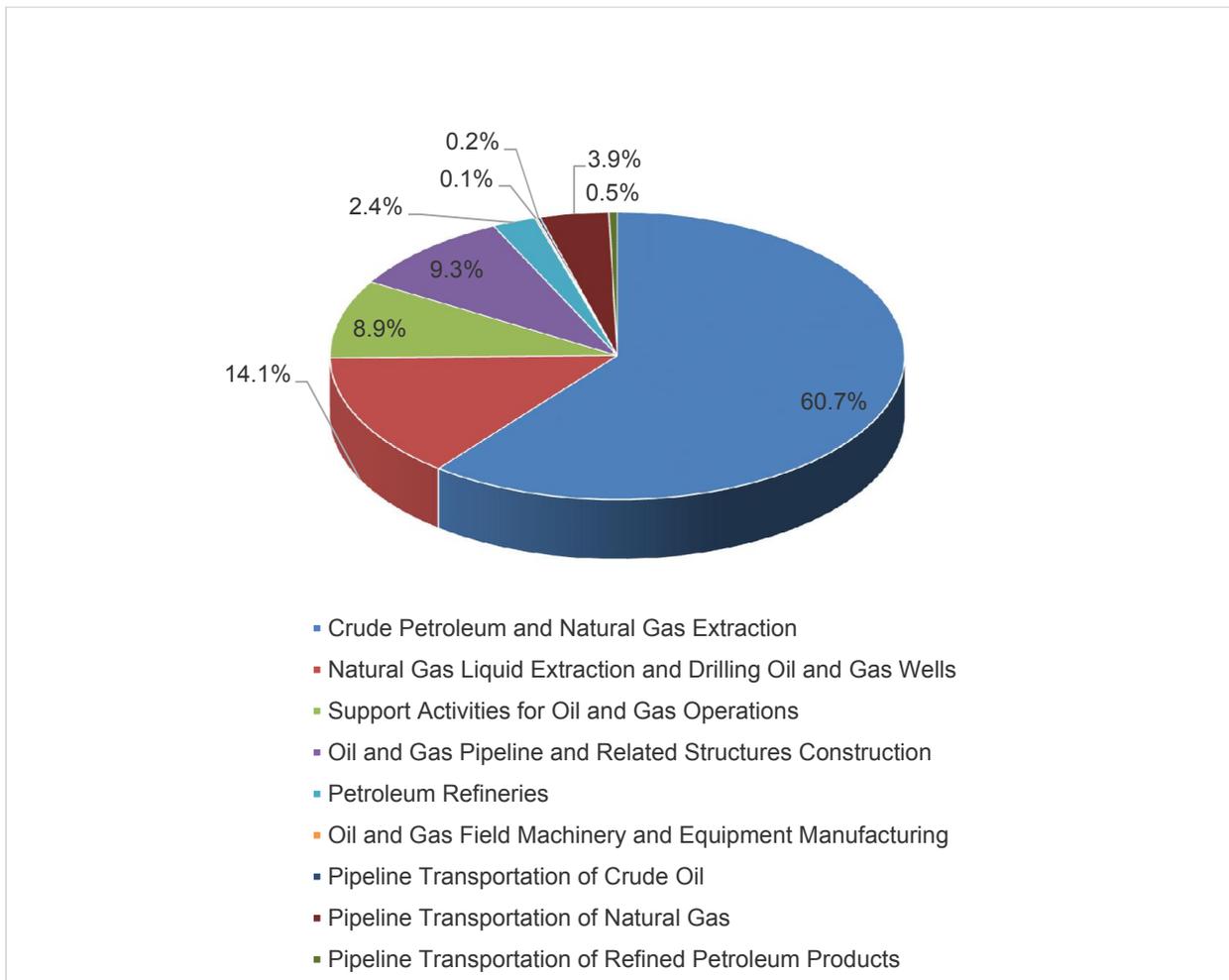
EXHIBIT 8. Price per Barrel of Oil (Adjusted for Inflation)



Source: St. Louis Federal Reserve Bank and PSC calculations. Prices adjusted to 2016 dollars using the U.S. CPI-U for March of 2016.

Most of Michigan's oil and natural gas related jobs are in the crude petroleum and natural gas extraction sector, making up nearly 61 percent of the state's oil and natural gas industry employment. An additional 14 percent of employment is in the natural gas liquid extraction and drilling oil and gas wells sectors, while nearly 9 percent is in the sectors of oil and natural gas pipeline and related structures construction (see Exhibit 9).

EXHIBIT 9. Share of Oil and Natural Gas Industry



Education Requirements

Oil and natural gas jobs are relatively high paying. The Bureau of Labor Statistics (BLS) reports that the U.S. average annual wage in the oil and natural gas industry was about \$108,000 in 2013. This wage is more than double the average of \$49,800 for all workers (Polzin 2014). In Michigan, oil and gas industry employees earned an average of \$105,533 per year, compared to the statewide average of \$56,712 for 2015.¹¹ This average includes compensation for overtime. The industry employs workers at a variety of education levels. The entry level education requirements for the majority of oil and natural gas industry related occupations, from roustabouts to rotary drill operators, is a high school diploma or less. Workers in jobs that do not require a formal education credential often develop significant skills through on-the-job training, including working with more experienced and more highly skilled workers. The occupation of geological and petroleum technicians typically requires an associate's degree, while geoscientists and petroleum engineers require a bachelor's degree.

¹¹ Total earnings for the oil and natural gas industry and the state of Michigan are for 2015, excluding extended proprietors. Extended proprietors may have low or no earnings in a given year, as this is not a primary source of income for this group.

EXHIBIT 10. Oil and Natural Gas Occupations

Standard Occupational Classification (SOC) Code	Description	Entry Level Education	Median Hourly Earnings
17-2171	Petroleum Engineers	Bachelor's degree	\$58.68
19-2042	Geoscientists, Except Hydrologists and Geographers	Bachelor's degree	36.18
19-4041	Geological and Petroleum Technicians	Associate's degree	19.27
47-5011	Derrick Operators, Oil and Gas	Less than high school or GED	19.42
47-5012	Rotary Drill Operators, Oil and Gas	Less than high school or GED	22.87
47-5013	Service Unit Operators, Oil, Gas, and Mining	Less than high school or GED	25.39
47-5041	Continuous Mining Machine Operators	High school diploma or GED	18.79
47-5071	Roustabouts, Oil and Gas	Less than high school or GED	19.84
47-5081	Helpers--Extraction Workers	High school diploma or GED	14.06
47-5099	Extraction Workers, All Other	High school diploma or GED	22.34
51-8093	Petroleum Pump System Operators, Refinery Operators, and Gaugers	High school diploma or GED	26.21
53-7073	Wellhead Pumpers	Less than high school or GED	19.76

Source: Estimated using employment-level data from EMSI, 2016.

Exhibit 10 shows the twelve most common occupations specific to the oil and natural gas industry based on Standard Occupational Classification (SOC) codes. There are many other occupations that are employed by the oil and gas industry, such as managers, truck drivers, accountants, and more. Since these occupations are not specific to the oil and natural gas industry, they are not included in this report. This table notes the entry level education generally required for each occupation. Some people in the oil and natural gas industry, however, choose to get advanced training, such as engineering or geology degrees, from universities and colleges in Michigan. Community colleges that train individuals in oil and natural gas industry trades are difficult to identify because the courses are more general, such as welding programs, and apply to a number of occupations. Appendix B contains a list of occupational degrees related specifically to the oil and natural gas industry and the corresponding institutions in Michigan where those degrees are offered.

Landmen

The oil and gas industry employs individuals known as landmen, who are responsible for the acquisition, administration, and disposition of mineral and surface rights for companies involved directly or indirectly with the oil and natural gas industry. Services provided by landmen include negotiating for mineral rights and determining the ownership of mineral rights through the search of public records.

Many oil and gas attorneys are practicing landmen, but no specific degree is required to be a landman. Professional certification can be obtained through the American Association of Professional Landmen (AAPL). Landmen certifications include registered landman, the initial level of certification; registered professional landman, the midlevel designation; and certified professional landman, the highest level credential offered by the AAPL. Requirements to be a certified professional landman include a bachelor's degree, the equivalent of ten years of experience in landwork, and a passing grade on a certification exam (AAPL 2016). Since landmen can be attorneys, engineers, or other professionals, they cannot be identified separately in the employment data.

Oil and Natural Gas Funding for Recreation in Michigan

Oil and natural gas revenues help to support recreation activities in Michigan by funding the purchase and development of land for state and local parks and recreation projects and by providing revenues for state parks. In 1984, Michigan voters approved Proposal B, which amended the state constitution to create the Michigan Natural Resources Trust Fund. The amendment required that oil and natural gas royalty payments from state lands be placed in the MNRTF to acquire and develop state lands for resource protection and public outdoor recreation (MDNR 2016b).

Since its inception, the MNRTF has appropriated more than \$1 billion in grants to local governments and state agencies to support projects in every county in Michigan. Funded projects include \$196 million for trails, acquisition, and/or development of more than 1,000 parks, and a variety of projects including trailheads, restrooms and amenities, and ball fields (MDNR 2015).

MNRTF acquisitions include:

- 755 local acquisitions totaling \$329.9 million
- 467 state acquisitions totaling \$493.6 million

MNRTF development projects include:

- 866 local development projects totaling \$186.6 million
- 105 state development projects totaling \$33.1 million

The MNRTF currently has a balance of \$578 million, including a corpus of \$500 million. Michigan's constitution directs that when the principal of the MNRTF reaches \$500 million new royalties are to be deposited into the Michigan State Parks Endowment Fund. The MSPEF is used for the operation, maintenance, and capital improvements of Michigan state parks. The MNRTF reached the \$500 million corpus in FY 2011, so royalties are currently being deposited into the MSPEF. At the end of FY 2015, the MSPEF had a fund balance of \$260 million. The MSPEF can receive funding from any source. In the past, it has received funds transferred from the MNRTF, and when the fund was established in 1994, \$40 million was deposited into the fund from the sale of the Accident Fund of Michigan.

Michigan's state park system currently has:

- 70 state parks
- 211 state recreation areas, including 145 state forest campgrounds and 66 nonmotorized forest pathways
- Five state scenic sites
- Five state linear parks (House Fiscal Agency 2013)

From FY 2004 to FY 2015, \$876 million was deposited into the recreation trust funds, averaging approximately \$73 million per year (see Exhibit 8). While some of these royalties are being saved to build up the endowment of the fund, the State Park Endowment Fund has also been providing annual support to the state park system. In FY 2014, the MSPEF spent \$23.7 million on state parks, representing one-third of state park spending for the year (Senate Fiscal Agency 2015). Oil and natural gas royalties earned on lands purchased using funds from the Game and Fish Protection Fund are deposited back into that fund.

EXHIBIT 11. Annual Oil and Natural Gas Lease and Royalty Revenue (millions of \$)

	FY	FY	FY	FY	FY	FY	FY	FY	FY	FY	FY	FY
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Nat. Res. Trust Fund	\$50.1	\$66.5	\$80.0	\$61.1	\$93.2	\$52.7	\$155.0	\$38.9	\$0.0	\$0.0	\$0.0	\$0.0
State Parks Endowment	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0	\$12.0	\$37.9	\$35.7	\$40.6	\$27.3
Game and Fish Prot. Fund*	\$4.7	\$5.9	\$7.9	\$5.9	\$9.8	\$5.7	\$68.8	\$4.9	\$3.7	\$4.5	N/A	N/A
Other	\$0.10	\$0.00	\$0.10	\$0.10	\$0.20	\$0.00	\$0.70	\$0.20	\$1.50	\$0.80	N/A	N/A
Total	\$54.9	\$72.4	\$88.0	\$67.1	\$103.2	\$58.4	\$224.5	\$56.0	\$43.1	\$41.0	\$40.6	\$27.3

* The Game and Fish Protection Fund receives mineral lease revenue from leases entered on land with Game and Fish Protection Fund revenue

Source: FY 2004 to FY 2013 Senate Fiscal Agency 2015; FY 2014 and FY 2015 MDNR 2016c. Game and Fish Protection Fund and other revenues not available for FY 2014 and FY 2015.

MNRTF funds are distributed to communities across the state and nearly every county in Michigan receives these grants. Exhibit 12 shows the distribution of total grants across the counties. The total appropriation value for each county is provided in the county summary documents.

Role in Michigan's Energy Production

One of the greatest benefits of available domestic energy resources is reducing dependence on imported energy (Brown 2013). With Michigan's abundant natural resources, the state utilizes a variety of sources for energy production (LARA 2011). Most of Michigan's electricity generation comes from coal and nuclear sources (43.1 percent and 24.5 percent, respectively). However, natural gas also constitutes a significant portion (22.8 percent) of Michigan's electricity generation. In addition, natural gas is the primary home heating source for nearly 80 percent of Michigan households (U.S. EIA 2015a). Oil (petroleum-fired generation) contributes only 0.1 percent of the state's electricity generation; most of the state's oil consumption is for vehicles. This is similar to the national average of 0.3 percent of petroleum going toward electric power generation. The remainder of Michigan's electric power generation is from hydroelectric or other renewable sources, including bio-mass (U.S. EIA 2015a). In addition to their use in vehicle transportation and power generation, petroleum products are used to create a wide range of products including plastics and fertilizer.

According to the U.S. Energy Information Administration (EIA), Michigan ranked eighteenth among states in the marketed production of natural gas in 2014, and twentieth in crude oil production as of December 2015 (EIA 2015a). Michigan has the most underground natural gas storage capacity in the nation, with 1.1 trillion cubic feet of capacity (EIA 2015a). Michigan's extensive gas storage fields allows the state to store natural gas ahead of the state's cold winters, ensuring access to natural gas no matter how cold the winter.

As of 2014, Michigan has:

- Crude oil production: 7.1 million barrels (bbl.), with an all-time production of 1.3 billion bbl.¹³
- Natural gas production (marketed): 114,950 million cubic feet, with an all-time production of 7,608 billion cubic feet.
- Crude oil reserves: 53 million bbl., 0.1 percent of the U.S. total reserves.
- Natural gas reserves: 1,845 billion cubic feet, 0.5 percent of the U.S. total reserves, with 10,500 producing wells (2.0 percent of the U.S. natural gas wells) (EIA 2015a, Michigan Department of Environmental Quality. Production by county summarized by Michigan Oil and Gas News 2016).

Michigan crude oil production peaked in 1979 (LARA 2011). Michigan does not produce enough petroleum products to meet local demand, and imports most of the needed petroleum products from refineries in Ohio, Indiana, and Illinois (LARA 2011; U.S. EIA 2015a). The Marathon oil refinery in Detroit was recently expanded to increase the refinement capacity within Michigan and to allow for more local production (LARA 2011). Due to Michigan's cold winters and reliance on natural gas for heating, Michigan residents consume a significant amount of natural gas. Even so, the state is able to produce enough natural gas to meet approximately one-sixth of the state's yearly needs (US IEA 2015a). Michigan's production is primarily from the Antrim geological formation located in the northern Lower Peninsula (LARA 2011).

In the U.S., recent technological innovations in natural gas production from shale formations provide a case study of the way domestic production and lower energy prices can benefit the economy as a whole. In 2010, the shale gas industry directly contributed \$76.8 billion to U.S. GDP and supported more than 600,000 jobs. Macroeconomic contributions included a 10 percent reduction in the cost of electricity and lower consumer prices for goods and services due to lower input costs. Increased shale gas production has helped reduce wholesale natural gas prices from \$6.73 per million British thermal units (MMBtu) in 2008 to \$3.50 per

¹³ Oil barrel is abbreviated bbl. and one bbl. is 42 gallons.

MMBtu in 2011 (prices in constant 2010 dollars) (WEF 2013). This has resulted in lower U.S. gas and electricity prices for consumers.

Of Michigan's 83 counties, 62 produced oil and/or natural gas in 2014 and 65 have produced oil and/or natural gas at some time in the past. The industry supports employment in 82 counties.¹⁴ Overall, Jackson County produced the most crude oil (1,679 thousand bbl.) in 2014. However, Hillsdale County has the most all-time production in the state at 124,822 thousand bbl. of crude oil. Otsego County has highest production of natural gas for 2014 (27.6 million mcf), as well as the most all-time production (1,629.7 million mcf).

**EXHIBIT 13. All-Time Michigan Crude Oil and Natural Gas Production by County
(* -through December 2014)**

County	2014 Crude Oil Production (Jan.-Dec.)	Cumulative Crude Oil Production* (in 42-gal. bbl.)	2014 Natural Gas Production (Jan.-Dec.)	Cumulative Natural Gas Production* (in Mcf)
Alcona	-	2,387	5,118,321	100,514,215
Alger	-	-	-	-
Allegan	53,323	21,544,042	49,609	32,174,863
Alpena	-	575,491	8,465,661	249,911,806
Antrim	19,223	2,865,648	19,151,683	429,599,539
Arenac	115,539	55,362,591	145,521	49,268,067
Baraga	-	-	-	-
Barry	13,026	952,809	-	-
Bay	237,841	33,158,914	721,522	72,433,960
Benzie	17,257	6,930,902	550,280	15,901,764
Berrien	-	35,501	-	-
Branch	-	4,207	-	-
Calhoun	279,348	21,902,525	745,824	41,292,480
Cass	2,827	690,292	-	-
Charlevoix	-	-	1,023,851	25,547,497
Cheboygan	43,947	3,381,988	100,779	3,951,327
Chippewa	-	-	-	-
Clare	136,887	40,955,317	86,267	96,675,815
Clinton	-	4,121	-	-
Crawford	252,231	37,158,927	3,167,831	166,284,227
Delta	-	-	-	-
Dickinson	-	-	-	-
Eaton	7,428	6,149,394	-	54,601,179
Emmet	-	-	-	-
Genesee	9,141	705,686	-	486,821
Gladwin	143,836	41,869,523	1,173,284	19,859,877

¹⁴ Houghton County has no activity in the oil and natural gas industry.

County	2014 Crude Oil Production (Jan.-Dec.)	Cumulative Crude Oil Production* (in 42-gal. bbl.)	2014 Natural Gas Production (Jan.-Dec.)	Cumulative Natural Gas Production* (in Mcf)
Gogebic	-	-	-	-
Grand Traverse	304,775	69,233,589	740,146	589,236,360
Gratiot	359	1,251,512	-	15,110,293
Hillsdale	61,727	124,822,359	135,882	230,139,233
Houghton	-	-	-	-
Huron	1,640	97,411	-	-
Ingham	100,108	24,385,294	-	52,361,308
Ionia	-	48,633	-	-
Iosco	-	1,909,281	29,948	11,437,986
Iron	-	-	-	-
Isabella	138,297	46,947,867	5,137	38,182,465
Jackson	1,679,177	21,761,223	2,003,695	34,762,923
Kalamazoo	37,164	74,707	-	-
Kalkaska	184,666	63,508,644	4,850,192	624,530,863
Kent	34,574	19,147,561	-	5,359,902
Keweenaw	-	-	-	-
Lake	3,292	2,873,775	100,900	3,031,805
Lapeer	32,221	5,923,027	-	10,037,353
Leelanau	-	-	-	-
Lenawee	562,007	2,217,145	190,796	567,865
Livingston	36,372	4,769,381	78,868	42,009,966
Luce	-	-	-	-
Mackinac	-	-	-	-
Macomb	7,966	1,136,776	-	18,444,584
Manistee	457,519	115,411,183	4,532,229	747,714,790
Marquette	-	-	-	-
Mason	16,919	8,928,822	24,251	51,066,636
Mecosta	146,109	12,078,510	86,926	66,862,463
Menominee	-	-	-	-
Midland	71,743	85,078,011	-	15,487,870
Missaukee	259,262	38,836,616	227,727	42,489,128
Monroe	12,831	883,718	-	-
Montcalm	15,387	20,359,672	-	72,971,979
Montmorency	16,114	2,258,857	26,209,674	1,062,863,760
Muskegon	31,299	8,869,303	-	9,809,572
Newaygo	32,805	11,564,151	54,880	107,149,472
Oakland	50,584	7,538,670	413,298	52,924,762
Oceana	23,620	3,055,136	122,969	26,124,814

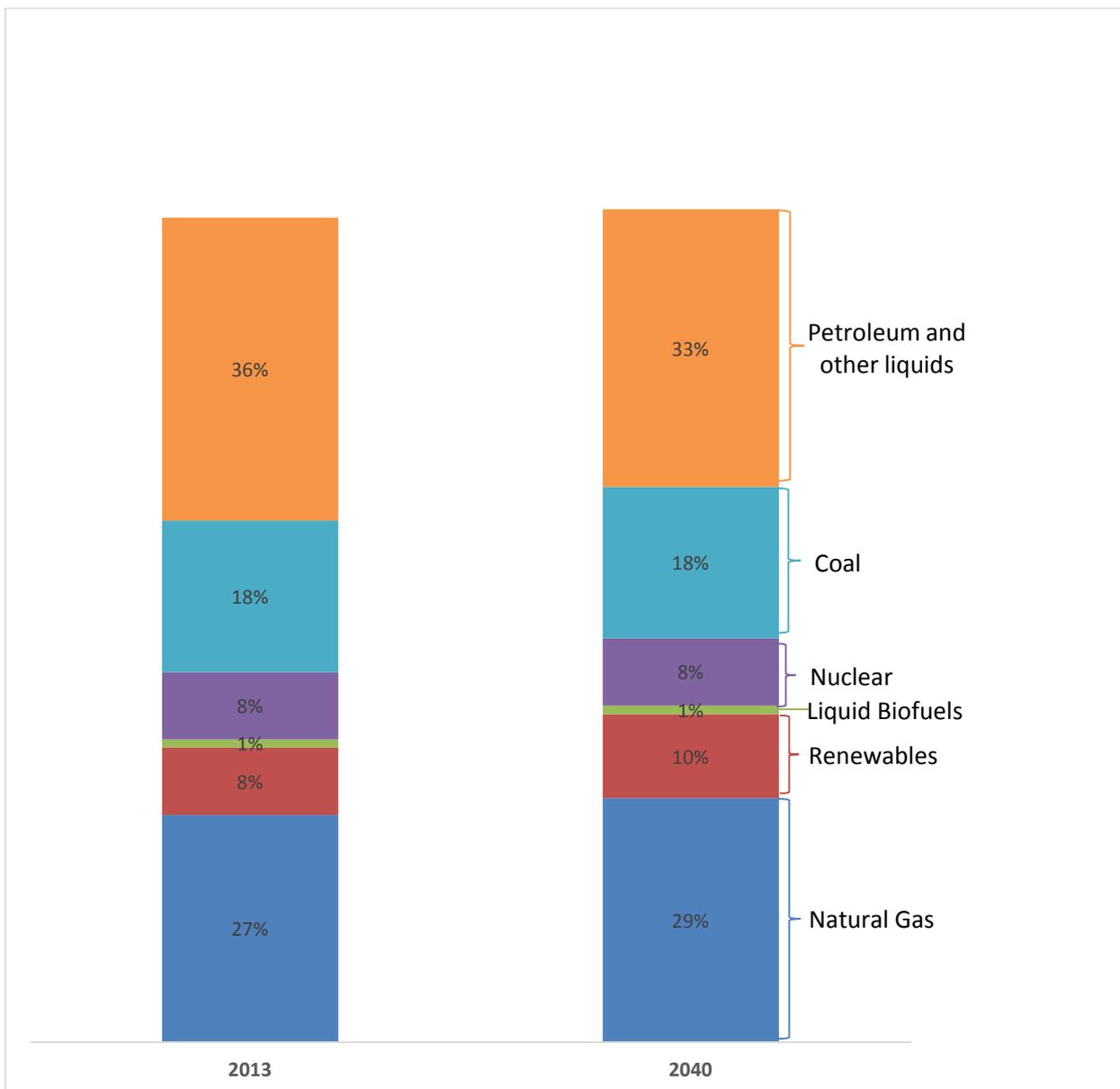
County	2014 Crude Oil Production (Jan.-Dec.)	Cumulative Crude Oil Production* (in 42-gal. bbl.)	2014 Natural Gas Production (Jan.-Dec.)	Cumulative Natural Gas Production* (in Mcf)
Ogemaw	163,794	32,046,321	766,067	75,712,954
Ontonagon	-	-	-	-
Osceola	55,084	63,304,721	1,030,388	122,258,131
Oscoda	12,811	1,800,331	4,985,498	176,689,827
Otsego	578,949	110,186,680	27,578,558	1,629,742,878
Ottawa	21,552	2,271,824	-	5,741,779
Presque Isle	79,788	12,094,904	95,101	38,503,405
Roscommon	50,164	3,638,363	-	2,149,622
Saginaw	15,683	3,741,505	-	6
St. Clair	51,473	21,335,561	107,896	192,045,524
St. Joseph	-	-	-	-
Sanilac	779	779	-	-
Schoolcraft	-	-	-	-
Shiawassee	3,411	325,924	-	-
Tuscola	42,638	4,358,318	-	2,403,838
Van Buren	425	12,269,989	-	-
Washtenaw	289,921	1,447,148	-	19,852,311
Wayne	58,161	2,325,192	17,652	15,289,421
Wexford	9,455	5,731,804	61,553	39,229,970
Total	7,084,479	1,256,100,463	114,950,664	7,608,801,255

Source: Michigan Department of Environmental Quality. Production by county summarized by *Michigan Oil and Gas News*.

Michigan had 53 million bbl. of proven oil reserves in 2014. This is a significant decrease from the peak of 240 million barrels of proven reserves in 1981 (U.S. EIA 2015c). Given that Michigan extracted over 7 million barrels of oil in 2014, this raises the question of whether Michigan is running out of oil. This is a complex question. New oil is continually being discovered and new technologies are making it possible to extract oil that may have previously been inaccessible. Michigan's current proven oil reserves are actually higher than they were in 1998 (44 million bbl.) even though the state has been continually extracting oil over this time period. U.S. oil production appeared to have peaked in 1970 at 3.5 billion bbl. By the mid-2000s, the U.S. was producing less than 2 billion bbl. per year. However, new discoveries, new technologies, and higher oil prices have led to a significant rebound in U.S. oil production. Production in 2015 hit 3.4 billion bbl., roughly the level of 1970 and the highest total since 1972.

Although renewable energy sources will become increasingly important sources of energy, oil and natural gas will remain important parts of the U.S. energy portfolio for decades to come. For example, the EIA produces long-term energy outlooks for the United States, and these illustrate the continuing importance of oil and natural gas for the United States' energy future. Their forecast for 2040 shows that petroleum products will supply 33 percent of U.S. energy needs, while natural gas will supply 29 percent. Therefore, continued domestic production will be important to ensuring a secure energy future.

EXHIBIT 14. Primary U.S. Energy Consumption by Fuel



Source: U.S. EIA 2015d. The 2040 estimate is the EIA reference case forecast.

The process of bringing new oil online is a lengthy one. Exhibit 15 illustrates the oil production lifecycle. It can take 10 to 15 years to go from the exploration stage to the production stage. This, in part, means that the production climate, including price, technology, and regulatory structure, has an impact on the level of production we will see in Michigan years, and perhaps even decades, into the future.

EXHIBIT 15. Oil Production Timeline



Conclusion

While oil and natural gas production does not play as important a role in Michigan's economy as it does in large producing states such as Texas and North Dakota, it does make a significant contribution. Michigan produced 7.1 million bbl. of oil in 2014 and 115.0 million mcf. of natural gas. This production—along with refining, pipeline transport, and other oil and natural gas sectors—created 22,781 direct jobs for Michigan's economy and 47,105 jobs including indirect and induced employment.

In FY 2015, oil and natural gas activity also generated more than \$400 million in tax revenue in Michigan. Royalties on oil and natural gas extracted from state land support recreational activity throughout the state through the MNRTF and the MSPEF. Since its creation, the MNRTF has supported more than \$1 billion in grants to state agencies and local governments to support outdoor recreation. Oil and natural gas royalty payments are an important source of income for many private landowners.

Michigan has seen significant growth in oil and natural gas employment since 2005. Jobs in crude petroleum and natural gas extraction have grown from 5,792 to 13,818 over the last ten years, and forecasts call for continued growth for the next several years. However, these forecasts come with an important caveat—if recent declines in oil prices are sustained, Michigan may see a retrenching in the industry and overall employment may decline.

Finally, when thinking about the oil and natural gas industry in Michigan, it is important to keep in mind the long production timeline. It can take 10 to 15 years to go from the exploration stage to the production stage, and this means that changes in price, technology, and the regulatory structure that happen now can impact production in the industry well into the future.

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Appendix A: Data and Methodology

EMSI DATA

Economic Modeling Specialists International (EMSI) data for the third quarter of 2015 was used to estimate the number of employees and median annual earnings for each of ten (10) industry sectors identified to directly make up the oil and natural gas industry. North American Industry Classification System (NAICS) codes, at the six-digit level, were used to identify each oil and natural gas industry sector. By using such a detailed level of NAICS codes, PSC was able to precisely model oil and natural gas industry related jobs, without including any unrelated sectors.

After identifying these sectors, IMPLAN codes were aligned with each specific NAICS code and industry sector, resulting in eight (8) total IMPLAN sectors for the analysis. This allowed PSC to apply the most specific level of data to IMPLAN software to obtain the most realistic economic impact analysis results. See Exhibit 1 in the report for a full list of the sectors included in the analysis and their respective NAICS codes and IMPLAN codes.

Extended proprietor employment for the natural gas liquid extraction and drilling oil and natural gas wells sectors are estimated differently in EMSI than in IMPLAN. Natural gas liquid extraction often occurs at the site of the drilling, so it can be difficult to separate the extended proprietors in this sector from those working on drilling alone. EMSI applies the extended proprietor jobs in these related sectors to the natural gas liquid extraction, while IMPLAN counts them in drilling oil and natural gas wells. To account for the discrepancy in reporting, the ratio of the employment split between these two industries from IMPLAN (which has the employee compensation and sector output related to this split) was applied to the total EMSI employment so that these sectors would be in line with IMPLAN's industry profile. This was done statewide and for each county.

SURVEY

As part of the study, Public Sector Consultants (PSC) surveyed 1,255 oil and natural gas industry businesses on behalf of MOGA. The survey asked general information of the MOGA members. These questions inquired about the number of employees, percent of revenue received from oil and natural gas activities, the purchase and leasing of oil and natural gas rights and royalties, easement payments, oil and natural gas transportation costs, lease operating expenses, charitable contributions, and volunteer hours. The survey provided a check against EMSI and IMPLAN data to help identify missing pieces to the industries profile. The survey was sent to 1,255 individuals via e-mail by MOGA. Of these, only 383 were opened and viewed by the recipient. There were 56 respondents, making a response rate of 14.6 percent of those viewed requests. The response rate and sample size does not allow for extrapolation of the data from respondents to the larger MOGA member population.

IMPLAN MODEL

Current employment numbers from EMSI were applied within the IMPLAN model (see Exhibit 1). By using the detailed sectors available in EMSI, PSC created more accurate measures of the economic impact of the oil and natural gas industry than would be available utilizing IMPLAN data alone.

To capture the economic impacts of the oil and natural gas industry, a number of changes were made to the IMPLAN model for each county. The following is a description of the steps taken in conducting the county-level and statewide economic contribution analysis:

1. Each county was modeled separately within IMPLAN.¹⁵ Some employment was not attributable to a particular county but was included in the statewide analysis in IMPLAN. Each model was done for 2015 to assure consistency with the year of the data.
2. EMSI employment data for each county and statewide was input for each of the eight IMPLAN sectors identified from six-digit NAICS codes.
3. Some IMPLAN sectors were not present in IMPLAN for every county. However, EMSI identified jobs within those sectors. In these cases, PSC adjusted the IMPLAN model to add the industry sector using Michigan statewide averages for per-worker employee compensation, proprietor income, other property type income, and tax on production and imports. Adding the sector in this manner allowed conservative underlying numbers to inform the modeling of economic impact.
4. Commodity production and trade flows were altered within the IMPLAN model for seven of the eight IMPLAN sectors used in the model.¹⁶ These adjustments made sure that the full employment was accounted for within the identified sectors and not duplicated through indirect or induced impacts from activity in sectors already included in the direct effects of the model.
 - a. Commodity production was customized to change its underlying multipliers by fixing the coefficient for each of the seven altered sectors to 1.000000 such that 100 percent of the commodities from a given sector were contained within itself.
 - b. Trade flows were customized by zeroing out the local use ratio (RSC), meaning that no other sectors were able to make purchases from this sector.

The model adjustments were necessary since the analysis was already fully accounting for the sectors' employment and output, and including additional purchases of the sector from other industries would double count the amounts already used in the model. Many analyses conducted of the impact of the oil and natural gas industry in other states do not make these adjustments to the underlying multipliers. By omitting these alterations to the IMPLAN model, these analyses double count some employment in the industries of interest, and therefore, overestimate the industry's economic impact.

¹⁵ Houghton County was not built because it contains zero employment in the oil and natural gas industry.

¹⁶ IMPLAN Sector 58 was not altered in any way. This sector is very broad and contains a number of other types of construction that may reasonably be impacted through indirect or induced multipliers such that altering its underlying multiplier data would result in an inaccurate representation of that particular sector's impact on wages and employment throughout the counties and Michigan.

Appendix B: Educational Institutions, by Occupation

Occupation	Institution	Degree	Degree Completions (2013)
Construction/Heavy Equipment/Earthmoving Equipment Operation	Lansing Community College	Award of less than 1 academic year	0
		Award of at least 1 but less than 2 academic years	5
		Associates degree	5
Geochemistry	Grand Valley State University	Bachelor's degree	1
	Western Michigan University	Bachelor's degree	1
Geological and Earth Sciences/Geosciences, Other	Albion College	Bachelor's degree	0
	Calvin College	Bachelor's degree	1
	University of Michigan-Ann Arbor	Bachelor's degree	0
		Master's degree	0
	Western Michigan University	Bachelor's degree	0
		Master's degree	10
	Doctors degree	2	
Geology/Earth Science, General	Adrian College	Bachelor's degree	3
	Albion College	Bachelor's degree	12
	Calvin College	Bachelor's degree	2
	Central Michigan University	Bachelor's degree	8
	Delta College	Associates degree	0
	Eastern Michigan University	Bachelor's degree	12
	Grand Rapids Community College	Associates degree	0
	Grand Valley State University	Bachelor's degree	23
	Hope College	Bachelor's degree	1
	Lake Michigan College	Associates degree	0
	Lake Superior State University	Bachelor's degree	1
		Bachelor's degree	19
	Michigan State University	Master's degree	1
		Doctors degree	3
	Michigan Technological University	Bachelor's degree	2
		Master's degree	7
		Doctors degree	2
	Northern Michigan University	Bachelor's degree	3
		Bachelor's degree	29
	University of Michigan-Ann Arbor	Master's degree	9
Doctors degree		4	
University of Michigan-Dearborn	Bachelor's degree	6	

	Wayne State University	Bachelor's degree	8
		Master's degree	1
	Western Michigan University	Bachelor's degree	12
		Master's degree	1
		Doctors degree	0
Geophysics and Seismology	Michigan State University	Bachelor's degree	0
		Bachelor's degree	1
	Michigan Technological University	Master's degree	0
		Doctors degree	1
	Western Michigan University	Bachelor's degree	1
Heavy/Industrial Equipment Maintenance Technologies, Other	Wayne County Community College District	Award of at least 1 but less than 2 academic years	0
	Wayne County Community College District	Associates degree	2
Oceanography, Chemical and Physical	Central Michigan University	Bachelor's degree	0
	Grand Rapids Community College	Associates degree	0
	University of Michigan-Ann Arbor	Bachelor's degree	0
		Master's degree	0
		Doctors degree	0
Operations Management and Supervision	Baker College Center for Graduate Studies	Master's degree	0
	Baker College Corporate Services	Associates degree	0
		Bachelor's degree	0
	Baker College of Auburn Hills	Bachelor's degree	0
	Baker College of Cadillac	Associates degree	0
		Bachelor's degree	0
	Baker College of Clinton Township	Bachelor's degree	2
	Baker College of Flint	Associates degree	0
		Bachelor's degree	2
	Baker College of Jackson	Bachelor's degree	0
	Baker College of Muskegon	Bachelor's degree	0
	Baker College of Owosso	Bachelor's degree	0
	Baker College of Port Huron	Associates degree	0
		Bachelor's degree	0
	Central Michigan University	Bachelor's degree	6
		Master's degree	0
	Davenport University	Bachelor's degree	0
	Davenport University-Eastern Region-Dearborn	Bachelor's degree	0
	Davenport University-Eastern Region-Warren	Bachelor's degree	0
	Delta College	Associates degree	0
	Ferris State University	Award of less than 1 academic year	11
		Bachelor's degree	45
	Kettering University	Master's degree	19
	Lawrence Technological University	Bachelor's degree	0

		Master's degree	12
	Macomb Community College	Award of at least 1 but less than 2 academic years	0
		Associates degree	0
	Michigan State University	Master's degree	0
		Doctors degree	0
	Michigan Technological University	Bachelor's degree	7
	Monroe County Community College	Associates degree	1
	Oakland University	Bachelor's degree	13
		Post-master's certificate	0
	Saginaw Valley State University	Bachelor's degree	2
	Spring Arbor University	Bachelor's degree	138
	University of Detroit Mercy	Bachelor's degree	0
	University of Michigan-Flint	Bachelor's degree	4
	University of Phoenix-Detroit Campus	Bachelor's degree	1
	University of Phoenix-Michigan	Bachelor's degree	0
	University of Phoenix-West Michigan Campus	Bachelor's degree	0
Petroleum Engineering	Wayne State University	Master's degree	0
		Post-master's certificate	0
Petroleum Technology/Technician	Northwestern Michigan College	Award of at least 1 but less than 2 academic years	1

Source: Estimated using occupation-level data from EMSI Economic Modeling, 2016, available at <http://economicmodeling.com/> and IMPLAN Economic Modeling, 2016, available at <http://implan.com/>

Additional institutions identified as providing oil and natural gas industry related training include:

- Andrews University
- Kalamazoo Valley Community College
- Kellogg Community College
- Mott Community College