The State of the Energy Industry in Ohio: Job Trends and Projections

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A Research Project Conducted by Ohio University's U.S. Economic Development Administration University Center

George V. Voinovich School of Leadership and Public Affairs

October 2017

This project was funded in part by the U.S. Commerce Department's Economic Development Administration

Voinovich School of Leadership and Public Affairs

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LIST OF ABBREVIATIONS

AEP – American Electric Power

AWEA – American Wind and Energy Association

BEA – Bureau of Economic Analysis

BTUs – British Thermal Units

CPP – Clean Power Plan

EIA – Energy Information Administration

EPA – Environmental Protection Agency

HB – House Bill

IMPLAN – Impact Analysis for Planning software

JEDI – Jobs and Economic Development Impact Model (National Renewable Energy Laboratory)

kW – Kilowatts

MMcf – Million Cubic Feet

MW – Megawatts

MWh – Megawatt Hours

NAICS – North American Industry Classification System

NREL – National Renewable Energy Laboratory

O&M – Operations and Maintenance (Jobs)

PUCO – Public Utilities Commission of Ohio

PV – Photovoltaics

QCEW – Quarterly Census of Employment and Wages (U.S. Bureau of Labor Statistics)

RPS – Renewable Portfolio Standard

SB – Senate Bill

TSF – The Solar Foundation

EXECUTIVE SUMMARY

This paper investigates the status of four specific energy industries in the State of Ohio: coal, oil & gas, solar, and wind. This research was conducted as part of Ohio University's portion of the Rural Universities Consortium, a U.S. Economic Development Administration University Center, housed within the George V. Voinovich School of Leadership and Public Affairs. This piece broadly examines Ohio's energy industry trends and changes, including the recent increase in natural gas production, the Renewable Portfolio Standard freeze, and others. The overarching purpose of this research was to delineate the current condition of energy-related jobs in the state juxtaposed with projections for the future.

To accomplish this task, we first outline Ohio's energy generation and consumption data, and then discuss the state's policy incentives and relevant organizations working in the state's energy arena. After a brief literature review, we discuss our data sources and methodology, including assumptions and data limitations. We used data from the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages and North American Industry Classification System codes to gather employment data for the coal and oil & gas industries in the state, while relying on secondary sources for solar and wind employment figures. Using linear regression techniques with year-by-year energy industry growth rates, we present baseline employment projections for each of the four core industries (i.e., coal, oil & gas, solar, and wind) covering a six-year period, respectively. We do not cover nuclear, biomass, or hydroelectric due to data limitations, as well as the fact that employment, by nature, does not fluctuate in these industries as frequently.

We find that Ohio's oil & gas and solar industry employment has been increasing at steady rates in recent years, while coal and wind have been decreasing. With the revival of the state's renewable energy mandates, as well as public commitments by electric utilities to integrate more renewable sources as part of their generation portfolios, solar energy shows promise in the state. Wind energy has suffered Ohio-specific impediments, such as the setback law which increased the minimum distance required between a wind turbine and the nearest property line for all newly-zoned projects. Nevertheless, it may grow in the future, especially as more utilities install large-scale wind capacity in the northern and eastern parts of the states, in part spurred by technological advancements and state generation mandates. With advancements in hydraulic fracturing techniques, and access to the Marcellus and Utica shale plays in the eastern part of the state, Ohio has seen noteworthy shale oil & gas development in recent years, but the historic boom and bust cycle of this industry has put many on alert. Finally, the coal industry has been steadily declining for years in Ohio and nationally despite being a historically important player. Overall, understanding the trends and projections for Ohio energy jobs has numerous implications for policymakers and economic development practitioners alike, which we highlight in our conclusions.

1. INTRODUCTION

The State of Ohio can be divided into three key geographic regions: the coastal plains in the north, the Till Plains in the west, and the Appalachian plateaus in the southeast.[1] In the two plains-related regions of the state, particularly in the rural areas, the agricultural industry dominates the economy. However, the Appalachian Ohio region is not well-suited for agriculture, as its hilly terrain limits the size of farms. Instead, this region has historically depended on the coal industry and other resource extraction activity (e.g., timber) as key economic drivers. Overall, the state's economy is more diverse in the urban areas, with a mix of manufacturing, research, and service employment, though the rural areas still play a key role in several resource-based industries.

According to the U.S. Bureau of Economic Analysis (BEA), Ohio had a state gross domestic product of $610.9 billion in 2015, ranking 7th overall in the country.[2] While Ohio was once a leading 'rust belt' state, it has since shifted away from manufacturing and is now defined by its contributions in the health, scientific, and intelligence industries. This is reflected by its largest employers, such as the Cleveland Clinic, which has the greatest overall employment headcount in Ohio, and the Wright Patterson Air Force Base, which has the greatest headcount among single-site employers in the state, both as 2016.[3]

One of the most important and growing industries in Ohio is the energy industry, particularly as the state consumed 3,810 trillion British Thermal Units (BTUs) of total energy in 2014, the 7th highest total in the U.S.[4] Of this total, 27.7% came from coal, 27.4% from natural gas, 4.5% from nuclear energy, and only 4% from renewable energy resources such as solar and wind.[5] Ohio's historic reliance on coal is attributable to the low cost and abundance of coal in Appalachian Ohio and the surrounding region, which allow for it to be cheaply mined and distributed across the state, and to the dependence on coal-fired power plants, many of which are approaching the end of their life cycle. In fact, 14% of the total net summer generating capacity that is retired or will be retired

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[1] Cover page images from Andres (2016); Hangela (2015); and Skeeze (2011a; 2011b). Found at Pixabay.com.

[2] U.S. Bureau of Economic Analysis. (2016). *GDP for Ohio*. Retrieved from https://www.bea.gov/regional/bearfacts/action.cfm?geoType=3&fips=39000&areatype=39000

[3] Ohio Development Services Agency. (2016b). *Ohio major employers-section 1*. Retrieved from https://development.ohio.gov/files/research/B2001.pdf

[4] U.S. Energy Information Administration. (2016d). *Energy consumption overview: Estimates by energy source and end-use sector, 2014* [Data file]. Retrieved from http://www.eia.gov/state/seds/data.cfm?incfile=/state/seds/sep_sum/html/sum_btu_1.html&sid=US

[5] Ibid.

from 2012 to 2025 is located in Ohio.[6] However, due to continuously declining coal prices, increased federal regulations (such as from the U.S. Environmental Protection Agency (EPA)), and the cost competitiveness of alternative energy sources, several coal mines and generating stations in the state have fallen into debt. Further, power producers are looking toward lower cost, and often cleaner, fuel sources such as natural gas facilities to replace decommissioned and soon-to-be decommissioned coal-fired power plants. In turn, this has led to falling coal employment and a destabilization of the already-struggling Appalachian Ohio economy.[7]

This report investigates the State of Ohio's energy industry trends and changes, particularly in light of this recent shift away from coal. Conducted by Ohio's University's portion of the Rural Universities Consortium University Center, a joint partnership between Ohio University and Bowling Green State University,[8] we first discuss trends such as the increase in natural gas production in the eastern part of the state, as well as the growing and widespread deployment of renewable energy resources. We define the energy industry as all businesses that are involved in the production and sale of energy, including fuel extraction, manufacturing, refining, and distribution. We specifically focus this research on the coal, oil & gas,[9] solar, and wind industries, outlining the current status of jobs in each. We do not cover the nuclear, biomass, or hydroelectric industries due to data limitations, among other reasons. We develop baseline employment projections for each of the four covered industries, as well as estimate future projections using secondary estimates of increased energy capacity in each of the industries, for the years 2013–2018. Finally, our report concludes with a summary of these projections, policy implications, and suggestions for future research.

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[6] Appalachian Regional Commission. (2016a). Appalachian coal industry, power generation and supply chain. Retrieved from https://www.arc.gov/assets/research_reports/CoalIndustryPowerGenerationandSupplyChainReport.pdf

[7] Appalachian Regional Commission. (2016b). Appalachia's Economy. Retrieved from https://www.arc.gov/appalachian_region/AppalachiasEconomy.asp

[8] Ohio University's George V. Voinovich School of Leadership and Public Affairs was first established as an U.S. Department of Commerce Economic Development Administration University Center in 1996. The Voinovich School University Center is a joint project with Bowling Green State University which collectively serves 59 rural Ohio counties: 32 Appalachian counties and 27 counties in northwestern Ohio. About the U.S. Economic Development Administration: The mission of the U.S. Economic Development Administration (EDA) is to lead the federal economic development agenda by promoting innovation and competitiveness, preparing American regions for growth and success in the worldwide economy. An agency within the U.S. Department of Commerce, EDA makes investments in economically distressed communities in order to create jobs for U.S. workers, promote American innovation and accelerate long-term sustainable economic growth.

[9] In this paper, the oil & gas industry is defined as the combination of the natural gas, petroleum, and other various gases industries.

2. OHIO'S ENERGY INDUSTRY

Numerous forecasts show Ohio's coal industry to decline in both production and profitability in the coming years, akin to the overall recent contraction of the U.S. coal industry. To illustrate, between 2013 and 2015, Ohio's coal employment fell by 23%,[10] and the U.S. Energy Information Administration (EIA) projects that, over the next 25 years, broader U.S. coal production will drop by 26%.[11] While the EPA's Clean Power Plan (CPP) targets are often anecdotally cited as a reason for this growing decline, an EIA analysis determined that, of the factors contributing to the drop in production, the CPP actually has the least impact.[12] Rather, a key factor is the fact that Appalachian coal is relatively expensive, hurting its competitiveness with coal from other United States (U.S.) regions.[13] Moreover, international demand for metallurgical coal, where Appalachia still has a regional comparative strength, has also declined. American Electric Power (AEP) Ohio, the state's largest investor-owned electric utility, has recently announced plans to phase out 1,500 megawatts (MW) of production from three coal-burning units located in their Conesville and Cardinal plants, with total retirement occurring by 2030.[14] Overall, the natural gas boom in the state, energy efficiency programs, and the increasing cost-effectiveness of renewable energy resources have resulted in a decreased reliance on coal.[15]

Natural gas production in Ohio has continued to grow despite falling production throughout the rest of the country. This may be attributed to the continued extraction of the Utica Shale formation, which began in earnest in 2012. In fact, the Utica may soon match the Marcellus Shale formation in terms of production, the latter of which is the largest formation in the U.S. Both the Utica and Marcellus Shale booms in Ohio were, in part, caused by advances in hydraulic fracturing (i.e., 'fracking') technology which allowed previously-untapped natural gas to be extracted more easily. To illustrate, in 2012, Ohio withdrew roughly 7,041 million cubic feet (MMcf) of natural gas per month, a

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[10] See Section 6. Findings, 6.1 Coal.

[11] Kearney, D. (2016, July 8). *Clean power plan reduces projected coal production in all major U.S. supply regions*. Retrieved from http://www.eia.gov/todayinenergy/detail.php?id=26992

[12] Ibid.

[13] Ibid.

[14] Walton, R. (2016, November 11). Ohio regulators approve AEP plan to retire 1,500 MW of coal generation. *Utility Dive.* Retrieved from http://www.utilitydive.com/news/ohio-regulators-approve-aep-plan-to-retire-1500-mw-of-coal-generation/430244/

[15] Board, G. (2016, August 26). Power play: Experts say killing Clean Power Plan won't revive coal. *Ohio Valley ReSource*. Retrieved from http://ohiovalleyresource.org/2016/08/26/power-play-experts-say-killing-clean-power-plan-wont-revive-coal/

figure that rose to 42,698 MMcf in 2014 and 121,430 MMcf in 2016.[16] As of August 2016, Ohio accounted for 5% of the U.S.' natural gas supply, and new wells continue to be brought online.[17] [18] Six new midstream gathering and processing facilities recently finished construction, while two new pipelines, the Rover and Nexus pipelines, are being worked on which will collectively transport 4,800 MMcf of gas per day.[19] The Rover and Nexus pipelines are estimated to cost $4.3 billion and $2 billion, respectively, and are expected to be operational by the end of 2017.[20] Additionally, there are 11 new natural gas plants currently in the planning or construction phase, which will cost an estimated $9.8 billion, and are predicted to produce power nearly twice as efficiently as current coal facilities.[21] This surge in natural gas production has resulted in the state GDP contribution from oil and gas activity to nearly triple over the last four to five years.[22]

After coal and natural gas, nuclear energy is the third leading energy sector in the state in terms of generation capacity. [23] There are currently two active nuclear power plants located in Ohio, and, as of June 2017, they were responsible for more than one eighth of the state's overall electricity generation, an estimated 1,510 thousand megawatt hours (MWh).[24] However, due to the growing cost-competitiveness of alternate energy sources and negative popular opinion, among other reasons, there are

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[16] U.S. Energy Information Administration. (2016g). *Ohio natural gas gross withdrawals, monthly* [Data file]. Retrieved from http://www.eia.gov/opendata/qb.php?sdid=NG.N9010OH2.M

[17] Lendel, I., Thomas, A., Townley, B., & Dick, J. (2015). Mapping the opportunities for shale development in Ohio. *Urban Publications*. Retrieved from http://engagedscholarship.csuohio.edu/cgi/viewcontent.cgi?article=2332&context=urban_facpub

[18] Buurma, C. (2016, November 7). One U.S. state where natural gas output is still going strong. *Bloomberg Markets*. Retrieved from https://www.bloomberg.com/news/articles/2016-11-07/one-u-s-state-where-natural-gas-output-is-still-going-strong

[19] Ohio Manufacturers' Association Energy Guide. (2017, February 2). *5 game changing Ohio energy projects.* Retrieved from http://energyguide.ohiomfg.com/5-game-changing-ohio-energy-projects/

[20] Ibid.

[21] Ibid.

[22] U.S. Bureau of Economic Analysis. (2014). *Real GDP, OH - Oil and gas extraction 1997-2014*. Retrieved from http://www.bea.gov/iTable/iTable.cfm?reqid=70&step=1&isuri=1&acrdn=2#reqid=70&step=10&isuri=1&7003=900&7035=-1&7004=naics&7005=7&7006=39000&7036=-1&7001=1900&7002=1&7090=70&7007=-1&7093=levels

[23] U.S. Energy Information Administration. (2017). *Ohio net electricity generation by source, Jun. 2017.* Retrieved from http://www.eia.gov/state/?sid=OH#tabs-4

[24] Ibid.

no current efforts to expand nuclear energy in the State of Ohio.[25] Regardless, in 2015, the nuclear power plant in Oak Harbor had its license renewed for another 20 years, allowing the state's two plants to continue to provide power.[26] However, FirstEnergy Corporation, the investor-owned electric utility which owns the Oak Harbor plant, has stated that the plant is unprofitable under current state regulations, and is considering selling or closing it.[27]

Ohio produces most of the remainder of its energy through wind, solar photovoltaics (PV),[28] hydroelectric, and biofuels.[29] The state specifically has strong potential for wind in its Till Plains region, as well as offshore at Lake Erie. As of 2016, there were 13 operational or planned wind farms in the state, and the majority of Ohio's wind capacity comes from the Blue Creek Wind farm, which has an installed capacity of 304 MW.[30] In the third quarter of 2016, Ohio ranked 26th among U.S. states with 444 MW of installed wind capacity,[31] and, in 2015, 27th in the nation with 1,203,008 total

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25 Kowalski, K. M. (2016, April 11). Ohio 'bailout' plan part of larger debate over nuclear's future. *Midwest Energy News.* Retrieved from http://midwestenergynews.com/2016/04/11/ohio-bailout-plan-part-of-larger-debate-over-nuclears-future/

26 FirstEnergy. (2015, December 8). *FirstEnergy's Davis-Besse nuclear power station receives license renewal from Nuclear Regulatory Commission*. Retrieved from https://www.firstenergycorp.com/content/fecorp/newsroom/news_releases/firstenergy-s-davis-besse-nuclear-power-station-receives-license.html

27 Berry, D. (2016, December 30). Area residents worried over possible closure of Davis-Besse, activists say it's overdue. *WTOL*. Retrieved from http://www.wtol.com/story/34156628/area-residents-worried-over-possible-closure-of-davis-besse-activists-say-its-overdue

28 Solar PV systems are the most well-known solar energy form. They convert sunlight directly to electricity without the need to generate steam or utilize any external fuel source.

29 Wind and solar PV generation is often referred to as 'distributed generation.' This phrase is used to describe smaller-scale electricity generation at or near the point of consumption, as opposed to the more conventional 'centralized generation.' Centralized generation signifies large-scale electricity generation located away from consumers yet connected to the grid network via transmission lines. Centralized electricity generating facilities are typically owned and operated by large electric utilities or independent power producers, and include fossil-fuel fired power plants (e.g., coal), nuclear power plants, natural gas plants, and large hydro-electric dams.

30 Sautter, E. (2016, May 16). *Ohio wind farm update*. Retrieved from http://www.greenenergyoh.org/wp-content/uploads/2016/05/15_Wind-News_Ohio-Wind-Farm-Update.pdf

31 State of Nebraska. (2016, November 30). *Wind facilities' installed capacity by state*. Retrieved from http://www.neo.ne.gov/statshtml/205.htm

MWh[32] of wind-based electricity generation.[33] This will be further boosted by a new 189 MW wind farm that Amazon plans to construct in Hardin County to power its numerous data centers, which will supplement its 100 MW wind farm currently being constructed in Paulding County.[34] Ohio also has a relatively strong solar energy industry, with the northwest portion of the state being regarded as a national PV manufacturing hub known as the 'Solar Valley.' Solar PV deployment in the state has grown steadily since 2010, when construction was completed on the 12 MW solar farm in Upper Sandusky, the first large solar farm in the state.[35] Further development has included a 20 MW array in Bowling Green[36] and a 3 MW array in Minster.[37] These projects have resulted in Ohio being ranked 12th nationally in installed solar capacity in 2016.[38]

With the recent rise of solar, hydroelectric fell to the third largest renewable industry in Ohio in 2015, accounting for roughly 12.5% of the total renewable energy in the state, while solar accounted for roughly 14.5%.[39][40] However, due to environmental

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[32] Energy generating systems are often sized by their installed power-generating capacity in kilowatts (kW) or MW. This power measurement refers to how much electricity the system can produce under ideal conditions, or how 'large' the system is. Conversely, 'energy' integrates a time component to measure the actual electricity being delivered by the system, particularly in kilowatt hours (kWh) or MWh. These measurements are the means by which electric utilities bill consumers, with 1 kWh being the amount of energy used at 1000 watts for one hour.

[33] U.S. Energy Information Administration. (2016f). *Net generation for wind, annual* [Data file]. Retrieved from http://www.eia.gov/electricity/data/browser/

[34] Williams, M. (2016, November 1). Amazon to build second wind farm in Ohio. *The Columbus Dispatch*. Retrieved from http://www.dispatch.com/content/stories/business/2016/11/01/amazon-to-build-second-wind-farm-in-ohio.html

[35] Funk, J. (2010, August 19). 80-acre solar farm in Wyandot County offers glimpse at Ohio's energy future. Cleveland. Retrieved from http://www.cleveland.com/business/index.ssf/2010/08/post_62.html

[36] Henry, T. (2016, August 26). State's largest solar project to be in B.G. *Toledo Blade*. Retrieved from http://www.toledoblade.com/Energy/2016/08/26/State-s-largest-solar-project-to-be-in-B-G.html

[37] Trabish, H. K. (2016, July 5). Inside the first municipal solar-plus-storage project in the US. *Utility Dive*. Retrieved from http://www.utilitydive.com/news/inside-the-first-municipal-solar-plus-storage-project-in-the-us/421470/

[38] Solar Energy Industries Association. (2016). *State solar policy: Ohio solar*. Retrieved from http://www.seia.org/state-solar-policy/ohio

[39] For more information, see: U.S. Energy Information Administration. (2016b). *Electric power industry capability by primary energy source, 1990 through 2015* [Data File]. Retrieved from http://www.eia.gov/electricity/state/Ohio/state_tables.cfm

[40] All references to the capability listed in the Ohio State Electric Profile report consist of the combination of the capability and net metering statistics, as this page covers on both utility and distributed energy generation.

concerns and a lack of viable locations, Ohio has not experienced much recent hydroelectric growth, despite the proximity of the Ohio River. [41] Finally, biofuels have long been a fixture in the state's green energy generation portfolio, with 20 currently-operating biomass generation plants.[42] Ohio currently has the 8th largest biofuels production capacity in the nation, and universities across the state are actively involved in furthering biofuel research.[43] It should be noted that although the renewable industries of Ohio have experienced large growth over the last decade, they still account, taken as a whole, for less than 3% of total energy capability. [44]

2.1. ENERGY GENERATION AND CONSUMPTION IN OHIO

This section highlights the current energy capacity or capability, generation, and consumption in Ohio per resource. Here, capability is defined as the maximum output an electricity generator can produce under peak conditions, measured in direct current MW.[45] Generation is defined as the amount of electricity a generator actually produces over time. Finally, consumption is defined as the total energy used.[46] For coal and oil & gas, this is defined as the total heat energy content of fuel consumed in facilities measured in BTUs, while the consumption for solar and wind consist of the generation converted to BTUs.

[41] Northey, H & Nelson, G. (2012, May 4). Utilities squeeze Ohio River for a few more drops of energy. *E&E News.* Retrieved from https://www.eenews.net/stories/1059963923

[42] U.S. Energy Information Administration. (2016i). *Profile analysis: Renewable energy*. Retrieved from https://www.eia.gov/state/analysis.cfm?sid=OH

[43] U.S. Department of Energy. (2015). *Benefits of biofuel production and use in Ohio*. Retrieved from https://energy.gov/sites/prod/files/2015/10/f27/ohio_biofuels_benefits.pdf

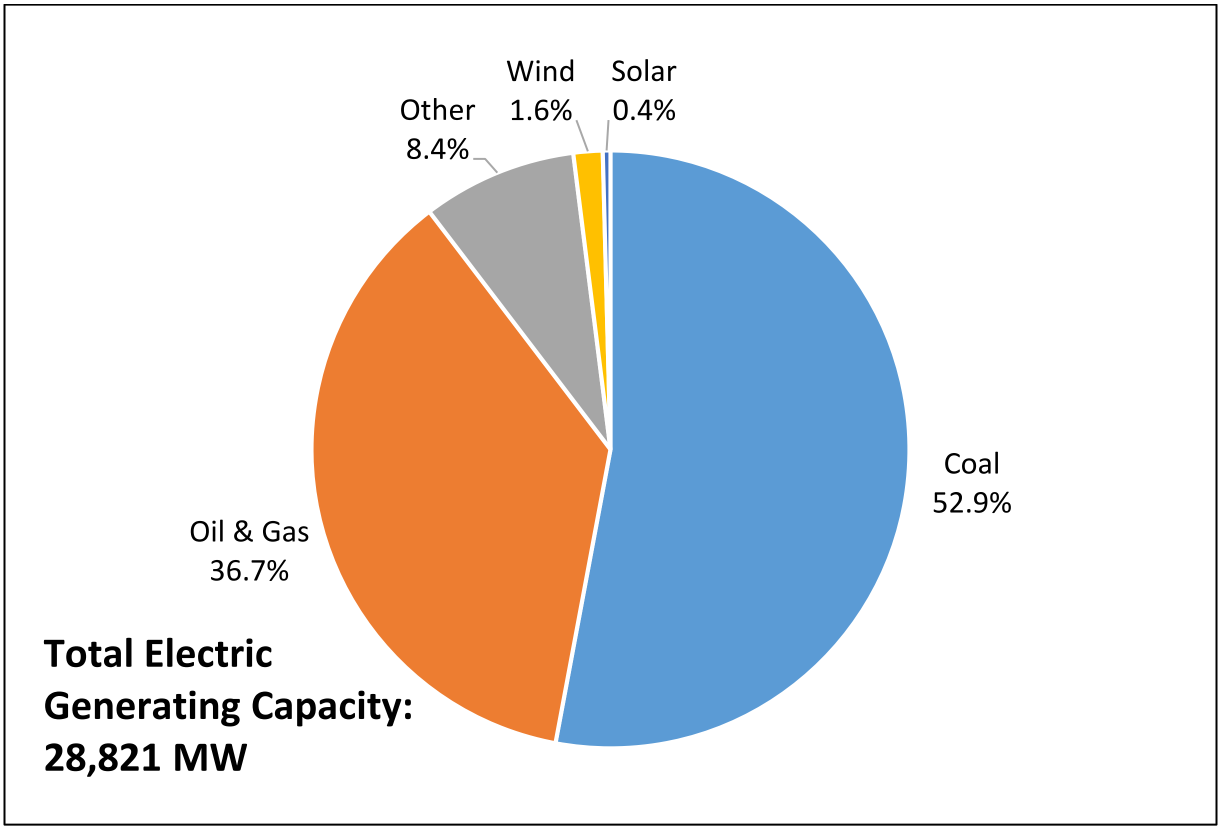
[44] For more information, see: U.S. Energy Information Administration. (2016b). *Electric power industry capability by primary energy source, 1990 through 2015* [Data file]. Retrieved from http://www.eia.gov/electricity/state/Ohio/state_tables.cfm

[45] U.S. Energy Information Administration. (2016e). *Frequently Asked Questions*. Retrieved from https://www.eia.gov/tools/faqs/faq.php?id=101&t=3

[46] U.S. Energy Information Administration. (2016c). *Electric power industry generation by primary energy source, 1990 through 2015* [Data file]. Retrieved from http://www.eia.gov/electricity/state/Ohio/state_tables.cfm

Figure 1.

Ohio Electricity Capability Distribution, 2015



Note. Developed by authors from the United States Energy Information Administration (2016b)[47] [48]

Figure 1 shows the total electric generating capacity of Ohio in 2015, the most recent year of publicly available data. In 2015, Ohio had a total generating capacity of 28,821 MW, which consisted of 15,260 MW from coal (52.9%), 10,575 MW from oil & gas (36.7%), 455 MW from wind (1.6%), 120 MW from solar PV (0.4%), and 2,413 MW from other sources, such as nuclear, biomass, and hydroelectric (8.4%).

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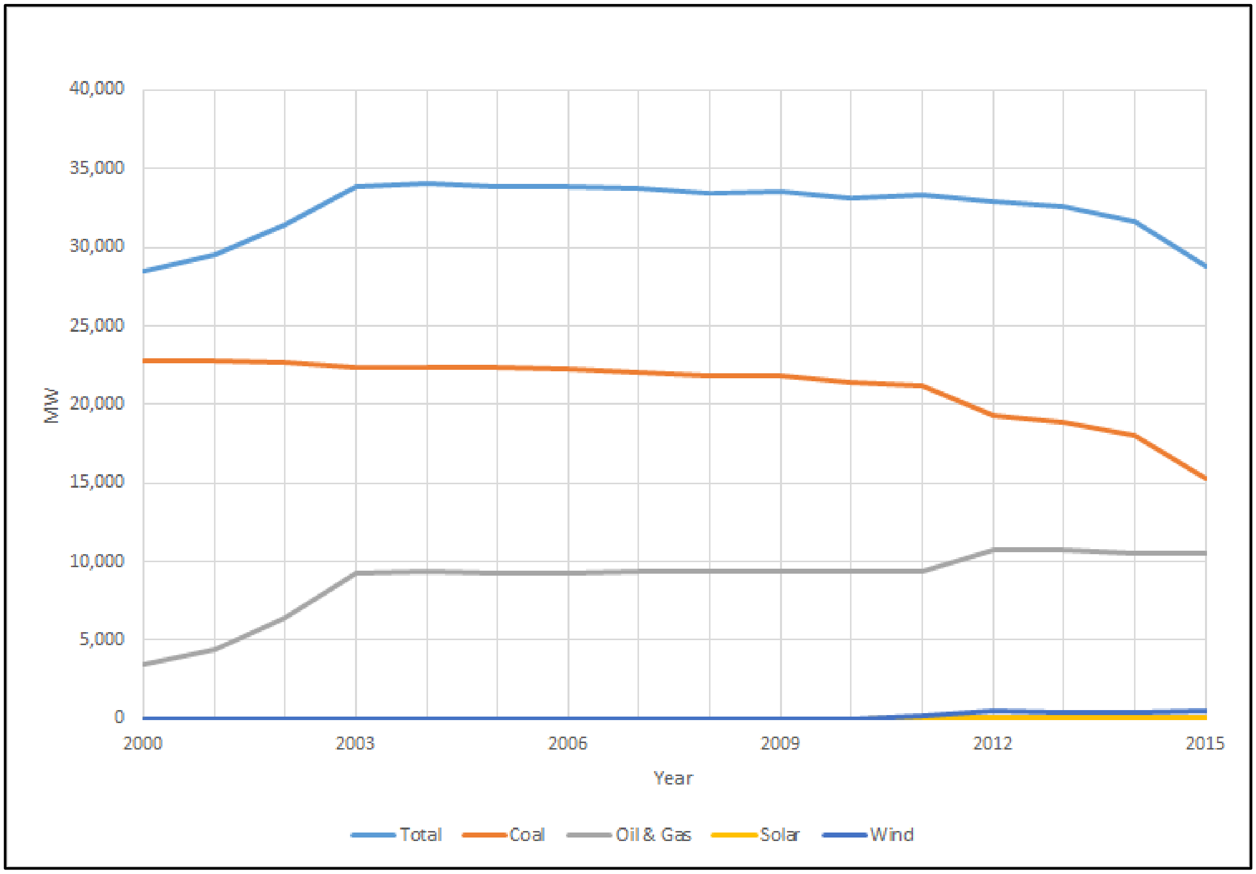
[47] For more information, see: U.S. Energy Information Administration. (2016b). *Electric power industry capability by primary energy source, 1990 through 2015.* Retrieved from http://www.eia.gov/electricity/state/Ohio/state_tables.cfm

[48] Of the aggregate numbers presented for the renewables, 23 MW of wind and 77 MW of solar were distributed, net-metered generation.

Figure 2.

Ohio Net Capability, 2000–2015



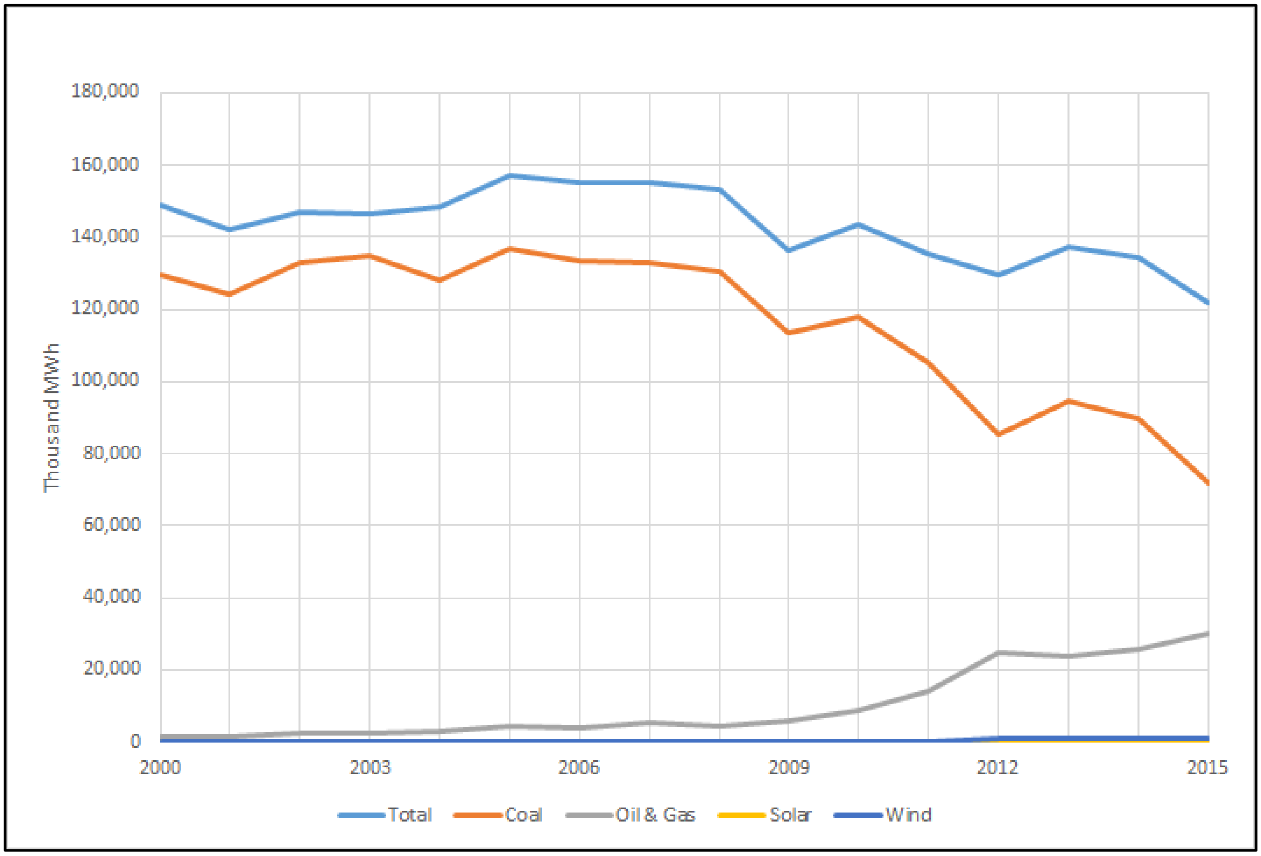
Note. Developed by authors from the United States Energy Information Administration (2016)[49]

Next, Figure 2 displays the net installed capability of each respective industry, as well as Ohio's total, from 2000 to 2015. This presentation method incorporates a time series analysis to show that coal has been consistently declining since 2000, with the most extreme reduction beginning in 2011 and continuing until 2015, with an average annual negative growth rate of 6.2%. Alternatively, oil & gas has been consistently growing over this timeframe, with the most intense growth occurring from 2000 to 2003 (39.3% average growth rate) and also 2011 to 2012 (14.1% growth). Both solar and wind did not experience much growth in Ohio until 2010, where the average annual growth rates jumped to 41.7% for solar, and 278.5% for wind, with 87.4% of that collective growth occurring from 2010 to 2011.

[49] Ibid.

Figure 3.

Ohio Net Annual Generation, 2000–2015



Note. Developed by authors from the United States Energy Information Administration (2016).[50]

Finally, as shown in Figure 3, Ohio generated a total of 121,893 MWh of electricity in 2015. This total consisted of 71,709,530 MWh from coal, 30,295,764 MWh from oil & gas, 1,203,008 MWh from wind, and 56,072 MWh from solar. From 2010 to 2015, coal generation declined somewhat steadily at an average rate of 9.5% per year, while oil & gas, solar, and wind generation grew at average rates of 27.9%, 34.3%, and 148.9% per year, respectively.

In 2014, Ohio consumed an estimated 917 trillion BTUs of coal, 182.5 trillion BTUs of oil & gas, 10.6 trillion BTUs of wind energy, and 0.5 trillion BTUs of solar energy.[51] As expected, the previously covered growth rates of generation for each

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[50] U.S. Energy Information Administration. (2016c). *Electric power industry generation by primary energy source, 1990 through 2015* [Data file]. Retrieved from http://www.eia.gov/electricity/state/Ohio/state_tables.cfm

[51] U.S. Energy Information Administration. (2016j). *State energy consumption estimates, 1960-2014.* Retrieved from http://www.eia.gov/state/seds/sep_use/notes/use_print.pdf

industry from 2011 to 2014 match the growth rates of the consumption for each industry, with a decline of 5.9% per year in coal, and a growth of 21.5%, 35.7%, and 77.4% for the oil & gas, solar, and wind industries, respectively.

3. OHIO ENERGY POLICIES, PROGRAMS, AND ORGANIZATIONS

3.1. PUBLIC POLICY FRAMEWORK

This section highlights the key policies, incentives, programs, and organizations working in the energy arena in Ohio. For renewable energy technologies such as solar and wind, most U.S. states, including Ohio, have implemented public policies to encourage investment and deployment, such as net metering laws, renewable mandate programs, and a variety of financial incentives. However, their respective lucrativeness to investors and businesses varies greatly. Sometimes, local policies or programs exist to regulate or incentivize energy generation and decision making, such as how localities can offer property tax exemptions or abatements for residents or businesses who invest in certain energy forms. However, these are not highlighted in this state-level analysis report.

3.1.1. RENEWABLE PORTFOLIO STANDARD

In 2008, Ohio enacted a renewable portfolio standard (RPS), which refers to a legislative mandate requiring a state's electric utilities to generate a certain amount of energy from renewable sources by an identified date (e.g., 15% by 2025). Sometimes, an RPS may specify 'carve-out' or 'set-aside' totals that require a specific sector to contribute a set proportion to the grander renewable portfolio. For instance, Ohio's RPS requires 0.5% of its final 12.5% renewable energy goal to come from solar energy by 2027.[52]

Relatedly, like several states with RPS programs, Ohio has a solar renewable energy credit (SREC) system which allows owners of PV systems to sell credits for every MWh of electricity generated. Electric utilities can subsequently purchase these SRECs to meet the solar carve-out mandated in the RPS.[53] In essence, the program incentivizes solar investment by allowing generators to recover upfront costs by selling these tradeable commodities.

Nevertheless, in 2013, Ohio passed Senate Bill (SB) 310, which effectively froze its RPS program. As a result, the Ohio SREC market became oversupplied and

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[52] Database of State Incentives for Renewables & Efficiency. (2014a). *Alternative Energy Portfolio Standard*. Retrieved from http://programs.dsireusa.org/system/program/detail/2934

[53] Database of State Incentives for Renewables & Efficiency. (2015). *Solar Renewable Energy Certificates Program (SRECs)*. Retrieved from http://programs.dsireusa.org/system/program/detail/5668

investors could only sell these credits in the Pennsylvania market,[54] gaining negligible returns, at best. Nevertheless, the RPS freeze did not seem to significantly harm the state's solar energy industry, as it continued to grow, both in terms of deployment figures and jobs. This may be attributed to declining soft costs for solar installations and supportive policies such as the 30% Investment Tax Credit at the federal level. Moreover, the installed cost of solar PV modules has continued to decrease year-by-year, exemplified by the 50% drop (from an average of over $8 per watt to roughly $4 per watt) from 2009 to 2015.[55] Still, Ohio's solar PV deployment and jobs figures may have grown at a faster rate without the freeze.

Ohio's wind industry has been more heavily affected by the state RPS freeze and other legislation. For instance, in 2014, Ohio enacted House Bill (HB) 483, which increased the minimum distance required between a wind turbine and the nearest property line from 550 feet to 1,125 feet from the tip of a turbine's blades for all newly-zoned wind projects.[56] Collectively, SB 310 and HB 483 created additional barriers for new wind energy deployment in the state, leading to a slight decline and overall stagnation in the wind industry over the past few years. Recent estimates by the American Wind and Energy Association (AWEA) have shown that these limitations on the construction of eight already approved wind farms in Ohio will cost $1.6 billion over 30 years, and could cost another $2.67 billion if another nine additional planned or proposed wind farms would be approved, resulting in a loss of more than $4.2 billion over 30 years.[57]

On December 27, 2016, Governor John Kasich vetoed HB 554, which would have rendered participation in the RPS voluntary until 2021.[58] This move effectively ended the RPS freeze enacted by SB 310. While it is too early to assess the economic impact of the veto, a report from the National Renewable Energy Laboratory (NREL)

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[54] SRECTrade. (2017). *Ohio*. Retrieved from http://www.srectrade.com/srec_markets/ohio

[55] Barbose, G., & Darghouth, N. Lawrence Berkeley National Laboratory. (2016). *Tracking the sun IX: The installed price of residential and non-residential photovoltaic systems in the United States*. Retrieved from https://emp.lbl.gov/sites/all/files/tracking_the_sun_ix_report_0.pdf

[56] Kowalski, K. M. (2014, June 19). Industry: Setback changes will end new wind farms in Ohio. *Midwest Energy News*. Retrieved from http://midwestenergynews.com/2014/06/19/industry-setback-changes-will-end-new-wind-farms-in-ohio/

[57] Funk, J. (2017, May 24). Ohio wind law crippling wind development, $4.2 billion boost to Ohio economy. *Cleveland*. Retrieved from http://www.cleveland.com/business/index.ssf/2017/05/ohio_wind_law_crippling_wind_d.html

[58] Andorka, F. (2016, December 28). Ohio governor temporarily saves solar from RPS freeze. *PV Magazine*. Retrieved from https://pv-magazine-usa.com/2016/12/28/ohio-governor-temporarily-saves-solar-from-rps-freeze/

suggests that RPS adherence is generally a net gain for Ohio's economy.[59] In particular, it predicts that adhering to a state RPS would cost $31 billion nationwide while generating $97 billion in health and environmental benefits and $161 billion from reductions in greenhouse gas emissions.[60]

3.1.2. NET METERING

State net metering programs allow customers to have bidirectional meters and sell electricity to their utility provider (most often at the retail rate) and receive credit on their bill. Essentially, the energy produced by a renewable energy system is used directly by the building on which it is installed, yet excess energy produced beyond the building's needs is returned to the greater electricity grid. When the building's needs surpass the production of the system, the building draws the power it needs from the grid. Thus, customers only pay the net amount of energy consumed from the electricity grid per month, effectively reducing the amount of electricity purchased from the utility.

Currently, 41 of the 50 states have authorized net metering programs, including Ohio. Ohio's net metering program allows customers to generate electricity from solar, gas, wind, biomass, hydroelectric, among other sources. Moreover, unlike other states, there are no capacity limits, and utility companies provide credit toward future bills when customers generate more than they consume. Due to these factors, Freeing the Grid, an annual report which examines each state's net metering policies, grades Ohio's net metering as an A on an A–F scale.[61]

3.1.3. ENERGY LOAN FUND

The Energy Loan Fund encourages energy efficiency and renewable energy by offering low-cost loans to small businesses, manufacturers, nonprofits, and public entities. The loans must be spent on energy efficiency measures or renewable energy development. To qualify, the applicant's proposed improvements must cut their energy use by 15%.[62]

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[59] Ferris, D. (2017, January 9). Report: Benefits of state renewable energy policies far outweigh costs. *Midwest Energy News*. Retrieved from http://midwestenergynews.com/2017/01/09/report-benefits-of-state-renewable-energy-policies-far-outweigh-costs/

[60] Ibid.

[61] Freeing the Grid. (2017). *State grades: Ohio*. Retrieved from http://freeingthegrid.org/#state-grades/ohio

[62] Database of State Incentives for Renewables & Efficiency. (2014c). *Energy loan fund*. Retrieved from http://programs.dsireusa.org/system/program/detail/5069

3.1.4. QUALIFIED ENERGY PROJECT TAX EXEMPTION

Ohio offers permanent tax exemptions for some energy projects through its Qualified Energy Project Tax Exemption. To qualify, the project must generate energy from renewables, clean coal, advanced nuclear, or cogeneration. Small projects of less than 250 kilowatts (kW) are qualified without additional regulation. However, projects of greater than 5 MW must agree to train and equip local emergency responders and cover the project's infrastructure costs.[63]

3.2. RELEVANT AGENCIES, PROGRAMS, AND DEPARTMENTS

Ohio has several agencies and programs focused on job development related to energy. The five most prominent ones are listed below, in no particular order.

3.2.1. OHIO DEVELOPMENT SERVICES AGENCY

The Ohio Development Services Agency presides over a variety of job development programs in the state. In particular, the agency contributes to job growth in Ohio's energy industry through a multitude of advanced energy and efficiency programs. Such programs include the Alternative Fuel Transportation Program, the Energy Efficiency Program for Manufacturers,[64] and the Ohio Coal Research and Development Program.[65] These programs are funded, in part, through the federal government's State Energy Program.

3.2.2. JOBSOHIO

JobsOhio is a nonprofit organization that encourages business development in Ohio, resulting in job creation and other positive economic development impacts. In 2015, JobsOhio helped attract 330 new projects to the state, which created 23,602 jobs and $6.7 billion in capital.[66] The organization's strategy centers around nine industries where Ohio has a regional competitive strength, one of which is the shale energy and petrochemical industry.

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[63] Ohio Development Services Agency. (2017). *Qualified energy project tax exemption*. Retrieved from https://development.ohio.gov/bs/bs_qepte.htm

[64] Database of State Incentives for Renewables & Efficiency. (2014b). *Energy efficiency program for manufacturers*. Retrieved from http://programs.dsireusa.org/system/program/detail/5587

[65] Ohio Development Services Agency. (2016a). *Advanced energy programs*. Retrieved from http://development.ohio.gov/bs/bs_renewenergy.htm

[66] JobsOhio. (2016). *2015 annual report*. Retrieved from http://jobs-ohio.com/images/JO_Annual_Report_15-16_FA_spreads.pdf

3.2.3. OHIO ENERGY PROJECT

The Ohio Energy Project, founded in 1984, works with K–12 teachers to create interactive programs which teach students about responsible energy use.[67] The curriculum includes sources and forms of energy, energy efficiency conservation, and economic and environmental impacts. By educating young people, the project aims to ensure that energy is used efficiently in the future. The program has received numerous awards, from organizations such as the Ohio Association of NonProfit Organizations and the Environmental Education Council of Ohio.

3.2.4. GREEN ENERGY OHIO

Green Energy Ohio is a 17-year-old nonprofit organization that advocates for renewable energy use by educating and distributing information to Ohioans. The organization has contributed to news articles related to sustainable energy, hosted tours of homes and businesses that use renewables (i.e., Green Energy Ohio Tours), among other efforts. Green Energy Ohio also serves as the Ohio chapter of the American Solar Energy Society.[68]

3.2.5. PUBLIC UTILITIES COMMISSION OF OHIO

The Public Utilities Commission of Ohio (PUCO) is a government agency that regulates the rates and services of public electric utilities. The PUCO also settles disputes between utility companies and consumers through both formal (i.e., requiring interference by the PUCO) and informal (i.e., requiring no interference) means. They further assist consumers through their *Apples to Apples* reports, which compare the costs and contract terms of various energy services.[69]

4. PRIOR LITERATURE

There is not an abundance of literature that specifically addresses Ohio's coal, oil & gas, solar, and wind industries, especially as it relates to capacity trends, employment, and economic impact metrics. In one of the most relevant studies, the Greenlink Group developed three scenarios for energy industry development in Ohio: one where Ohio focuses on energy efficiency, one focused on renewables, and one 'intermediate' scenario. The modeling suggests that, of these options, the first, the

[67] Ohio Energy Project. (2017). *About OEP*. Retrieved from https://www.ohioenergy.org/about

[68] Green Energy Ohio. (2017). *About GEO*. Retrieved from http://www.greenenergyoh.org/about-geo/

[69] Public Utilities Commission of Ohio. (2017). *How the PUCO works for you*. Retrieved from http://www.puco.ohio.gov/puco/index.cfm/how-the-puco-works-for-you/#sthash.kyMnXITa.dpbs

'accelerated efficiency' scenario, is the most beneficial to Ohio's economy. [70] This scenario projects that, by 2030, Ohio's energy efficiency and renewable energy industries could comprehensively employ 82,300 to 136,000 individuals. The affiliated payroll boost was estimated at $4.6 billion to $7.6 billion, contributing $6.7 billion to $10.7 billion to Ohio's GDP.[71] While these metrics do incorporate efficiency focused employment, the report did primarily attribute the boost to labor-intensive wind energy development in the state.

Specific to solar, the national Solar Energy Industries Association found that, as of 2016, $467.13 million has been invested in the solar industry of Ohio.[72] It also projects that Ohio will install 607 MW of solar capacity over the next 5 years.[73] For wind, the AWEA claims that there have been $1.1 billion invested in the Ohio wind industry as of 2016, and that there are 172 MW of wind currently under construction, with an additional 210 MW in advanced development. These investment and deployment figures show that the solar and wind industries both contribute a large amount to the Ohio economy, and the projections imply that renewables will continue to experience increasing growth, which will lead to even more employment and greater economic contributions in Ohio.

The literature on coal employment in Ohio is mixed. A 2014 study examined mining dependence from 2000–2011 and found a positive relationship between mining dependence and employment and income growth in Ohio and other rural counties in the eastern United States.[74] Later, in a 2015 study focused on Ohio, researchers found that coal employment may have short-term employment benefits for Appalachian communities, but appears to have negative long-term effects on comprehensive employment figures.[75] To exemplify, Dayton Power & Light claimed that it will begin to shut down two coal-fired power plants in Southern Ohio, which will decrease both direct and ancillary employment figures, as well as eventually reduce coal capability in the

[70] Cox, M., Sun, X., Seryak, J., & Nader, J. (2016, October 19). *Grounds for optimism: Options for empowering Ohio's energy market*. Retrieved from http://www.thegreenlinkgroup.com/ohio

[71] Ibid.

[72] Solar Energy Industries Association. (2016). *State solar policy: Ohio solar*.

[73] Ibid.

[74] Deller, S. (2014). Does mining influence rural economic growth? *Journal of Regional Analysis & Policy*, *44*(1), 36–48. Retrieved from http://jrap-journal.org/pastvolumes/2010/v44/v44_n1_a3_deller.pdf

[75] Betz, M. R., Partridge, M. D., Farren, M., & Lobao, L. (2015). Coal mining, economic development, and the natural resources curse. *Energy Economics*, *50*, 105–116. Retrieved from http://www.sciencedirect.com/science/article/pii/S0140988315001279

state by an additional 3,000 MW.[76] For the oil & gas industry, the American Petroleum Institute recently published a study that found that the natural gas and oil industry supports more than 262,800 jobs nationally, with more than $14.7 billion in wages and $37.9 billion in economic impact added to the economy.[77] However, it should be noted that this study defines natural gas and oil jobs very broadly, and it does not offer specific figures for Ohio. Regardless, natural gas capability is expected to continue to grow in the state, illustrated by the recent approval of a 1,105 MW natural gas facility in Columbiana County.[78] These figures show that the coal industry is expected to contract as facilities continue to be retired and employment continues to fall. Conversely, recent literature has shown that the oil & gas industry is currently thriving, and is expected to experience growing employment and large contributions to the Ohio economy as long as the extraction boom continues.

No prior literature has specifically and comprehensively addressed the jobs and economic impact metrics/trends within Ohio's energy sectors. Ohio serves as an interesting and relevant case study due to its relatively diverse population and variations in political ideologies. The southeastern part of the state has a historic coal mining presence and now natural gas boom, while the northwestern part has been recognized as a strong base for both solar and wind development. Therefore, taken as a whole, further research is needed to determine the employment projections and best path(s) forward for the energy industries in Ohio given its unique political, regulatory, and industrial landscape.

5. METHODOLOGY

5.1. TREND ANALYSIS

This research used secondary data sources for energy industry employment in Ohio, which we used as the inputs to our trend analysis and economic impact modeling. We first utilized the U.S. Bureau of Labor Statistics' Quarterly Census of Employment and Wages (QCEW) data for coal and oil & gas employment figures. The QCEW data comes from quarterly tax reports from employers and represents 97% of all wage and civilian employment in the country. Further, QCEW data is organized using the North American Industry Classification System (NAICS), the standard for all federal statistics bureaus. By determining appropriate NAICS codes to represent the coal and oil & gas industries, we retrieved the associated employment from QCEW for 2013 through 2015.

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[76] Walton, R. (2017, March 21). DP&L to retire 3,000 MW of coal generation in Ohio. *Utility Dive*. Retrieved from http://www.utilitydive.com/news/dpl-to-retire-3000-mw-of-coal-generation-in-ohio/438556/

[77] American Petroleum Institute. (2017). *Natural gas and oil: Fuel Ohio*. Retrieved from http://www.api.org/~/media/Files/Policy/Jobs/Economics-Nat-Gas-Oil/API_OilEconomy_%20Ohio.pdf

[78] Carson, E. (2016, October 5). *Ohio approves 1,105 MW natural gas-fired power plant adding to list of projects replacing coal*. Retrieved from https://enerknol.com/wp-content/uploads/2016/10/EKR-FF-Ohio-Natural-Gas-Fired-Plants-Replacing-Coal-10-5-2016.pdf

However, the solar and wind industries did not have sufficiently concise NAICS industries or appropriate data due to suppression and other issues, so this method could not be used to quantify the employment for these two sectors. Instead, survey data was used from prior industry reports that covered each year. With the employment from 2013 to 2015, we then performed a simple linear regression on each industry to generate a baseline, or status quo, employment projection for 2016 through 2018.

5.1.1. COAL

The direct coal-related employment was defined as all jobs falling under the NAICS codes listed below. It should be noted that coal-fired power plants are not included under these codes, as they fall under the general NAICS code for fossil fuel powered plants, and, thus, cannot be analyzed separately from natural gas powered facilities. However, job losses in this industry are still mentioned throughout this report, as its losses will have a negative impact on the rest of the coal industry.

- 212111: Bituminous Coal & Lignite Surface Mining
- 212112: Bituminous Coal Underground Mining
- 213113: Support Activities for Coal Mining
- 423520: Coal and Other Mineral Merchant Wholesalers

5.1.2. OIL & GAS

Oil & gas jobs were all jobs associated with the following NAICS codes. Here, we used the same selection of NAICS codes as in the Ohio Department of Job and Family Services' 2015 Ohio Shale Report's definition of core shale-related industries.[79]

- 211111: Crude petroleum and oil & gas extraction
- 211112: Natural gas liquid extraction
- 213111: Drilling Oil and Gas Wells
- 213112: Support Activities for Oil and Gas Operations
- 237120: Oil and Gas Pipeline and Related Structures Construction
- 486210: Pipeline Transportation of oil & gas

5.1.3. SOLAR

The solar employment data used in this report comes from the annual solar industry report released by The Solar Foundation (TSF), a nonprofit organization dedicated to advancing solar energy through funding research on solar markets, economics impacts, and workforce.[80] It arrives at its annual figures by surveying

[79] For more information, see: Ohio Department of Job and Family Services. (2016). *2015 Annual Ohio shale report*. Retrieved from http://ohiolmi.com/OhioShale/2015AnnualShale.pdf

[80] The Solar Foundation. (2016a). *About The Solar Foundation*. Retrieved from http://www.thesolarfoundation.org/about-the-solar-foundation/

hundreds of thousands of known and potential energy establishments, resulting in completed surveys from more than 2,000 solar establishments.[81]

5.1.4. WIND

The wind employment figures used in this study come from reports from two different organizations. Our 2013 data comes from Green Energy Ohio.[82] Both the 2014 and 2015 data points come from surveys sponsored by Environmental Entrepreneurs, a national group of business leaders and investors that promotes economic and environmental policies. The 2014 survey, Clean Jobs Ohio, was released in 2015 and detailed the economic potential of the green energy industry of Ohio, largely in response due to the passing of SB 310.[83] The 2015 survey, Clean Jobs Midwest, performed a comprehensive survey of clean energy industries in 12 Midwestern states, including Ohio.[84]

5.2. MODELING SOFTWARE

Beyond employment projections, we also estimated the impact of the four energy industries on the economy of Ohio. For this, we used, separately, NREL's Jobs and Economic Development Impact (JEDI) and the Impact Analysis for Planning (IMPLAN) software. This method provided an approximation of the economic impacts effects of future changes in these industries.

5.2.1. JEDI

The NREL's JEDI tool is a model that estimates the economic impacts of constructing and operating power generation and plants at the state level. In our analysis, we did not have access to any data other than the expected installed capacity of new solar and wind projects in MW, and, thus, default values (i.e., industry averages) were used in place of information such as construction cost, equipment costs, and financing parameters. Given these limitations, the results of the JEDI model should strictly be taken as rough estimates, not precise results. Further, JEDI's approximations of input-output relationships reflect gross impacts and not net impacts. The JEDI model

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[81] The Solar Foundation. (2016b). *National solar jobs census 2015*. Retrieved from http://www.thesolarfoundation.org/wp-content/uploads/2016/10/TSF-2015-National-Solar-Jobs-Census.pdf

[82] Green Energy Ohio. (2014). *Wind energy fact sheet*. Retrieved from *http://www.greenenergyoh.org/wp-content/uploads/2015/08/Wind-Energy-Fact-Sheet-2014.pdf*

[83] Clean Jobs Ohio. (2015). *Sizing up Ohio's clean energy jobs base and its potential*. Retrieved from https://members.e2.org/ext/doc/CleanJobsOhio_FINAL_HiRes.pdf

[84] Clean Jobs Midwest. (2016). *Clean jobs Midwest.* Retrieved from http://www.cleanjobsmidwest.com/wp-content/uploads/2016/03/CJM-Full-Story-Final-1.pdf

also assumes a linear relationship between input data and the resulting output impacts. Despite these deficiencies, the JEDI tool allowed us to develop approximations of employment, wages, and economic impact metrics.

5.2.2. IMPLAN

The IMPLAN software is, similar to JEDI, an input-output analysis model that estimates economic impact, tax impacts, and a number of other figures. We used IMPLAN to measure the direct effects of energy industry development without overstating economic results. IMPLAN data is based on the U.S. Bureau of Labor Statistics' QCEW (ES-202) and the BEA's Regional Economic Information System. For this research, we used 2015 data, as this was the most recent data available at the time of reporting. The key input used was employment per industry, as derived from secondary sources as described in sections 5.1.1–5.1.4. With this, we then generated an approximation of the average wage and value of production, which we refer to as economic impact, of each industry.

Though the employment figures come from secondary sources, it is important to understand that IMPLAN defines it as the annual average of monthly jobs in that industry for its modeling. In other words, one job lasting 12 months equals two jobs lasting 6 months each equals three jobs lasting 4 months each. A job can be either full-time or part-time. Output is defined as the value of industry production. In IMPLAN, these are annual production estimates for the year of the data set and are in producer prices. For manufacturers, this would be sales plus or minus the change in inventory. For service sectors production, it is sales. For retail and wholesale trade, output is gross margin and not gross sales.

5.3. LIMITATIONS AND ASSUMPTIONS

The largest inherent limitation of this study is the use of only three data points to make linear projections about future employment figures. Unfortunately, the wind and solar industries do not correspond well to the NAICS code data, which resulted in a heavy reliance on previous work that generates such estimations. Thus, the span of years for the job estimations depend entirely on the years that such work was produced. Since TSF started its state employment survey process in 2013 and no extensive wind employment surveys were found prior to 2013, it was chosen as the initial year.

Further, since this report relies heavily on the use of NAICS codes, it contains the same limitations that correspond with the NAICS system. While a majority of the energy industry jobs that utilized NAICS codes are directly found in the respective 6-digit NAICS codes, there are also jobs related to those industries (i.e., indirect and induced jobs) that are classified under other codes, and are, thus, not included in the given figures. Similarly, there are jobs not related to those sectors found in the listed industries, which will result in unrelated jobs being included in the figures.

Moreover, the secondary data for coal sector employment in the industry corresponding to NAICS code 212111 (i.e., Bituminous Coal and Lignite Surface Mining) became unavailable in 2014, and would have resulted in a significant, unexplainable drop in coal jobs for that year (i.e., 1,049). To overcome this, we computed the trends from the previous two years to estimate the employment of 2014 and 2015.

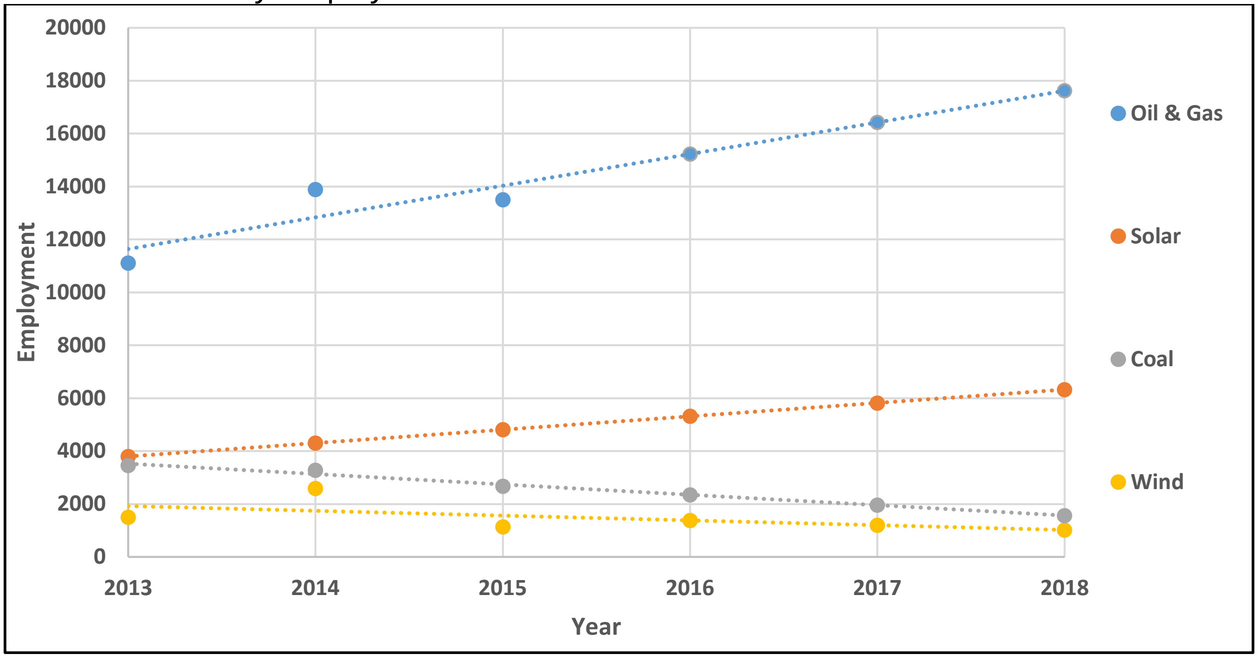
Finally, due to the reliance on the data from TSF's annual national solar jobs census, must rely on the accuracy of their findings. Similarly, since there was a lack of available data on the wind industry, multiple different sources of census data was used, leading to possible inconsistencies in definition of employment in the wind sector. Finally, the figure used in 2013 was originally a range from 1,000–2,000, and, therefore, to make the figure comparable with the other years, the average was taken.

6. FINDINGS

This section details our report findings, including energy industry employment projections based on prior years' data. We first cover the year-by-year growth rates as percentage increases or decreases, and then project the 2016–2018 trend with a linear regression method based on the 2013–2015 employment data. Our projected employment change rates are calculated by using the aggregate 2013 figure to the 2015 figure, meaning that the projected rates do not always fit within the expected parameters of the year-by-year growth or decline rates.

Figure 4.

Ohio Four Industry Employment



Note. Developed by authors from the United States Bureau of Labor Statistics.[85] [86]

Figure 4 shows annual industry employment in Ohio from 2013 to 2015 derived from the sources listed in the previous section, along with a projected status quo scenario (i.e., current trend line) for the following three-year period of 2016 to 2018. This figure shows that while the oil & gas and solar industry's employment have grown, both coal and wind employment have declined. Further, it shows that oil & gas accounts for the majority of employment with solar quite far behind.[87]

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[85] Bureau of Labor Statistics. (2016a). *Quarterly census of employment and wages, NAICS 6-digit industries, one area.* Retrieved from https://data.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables

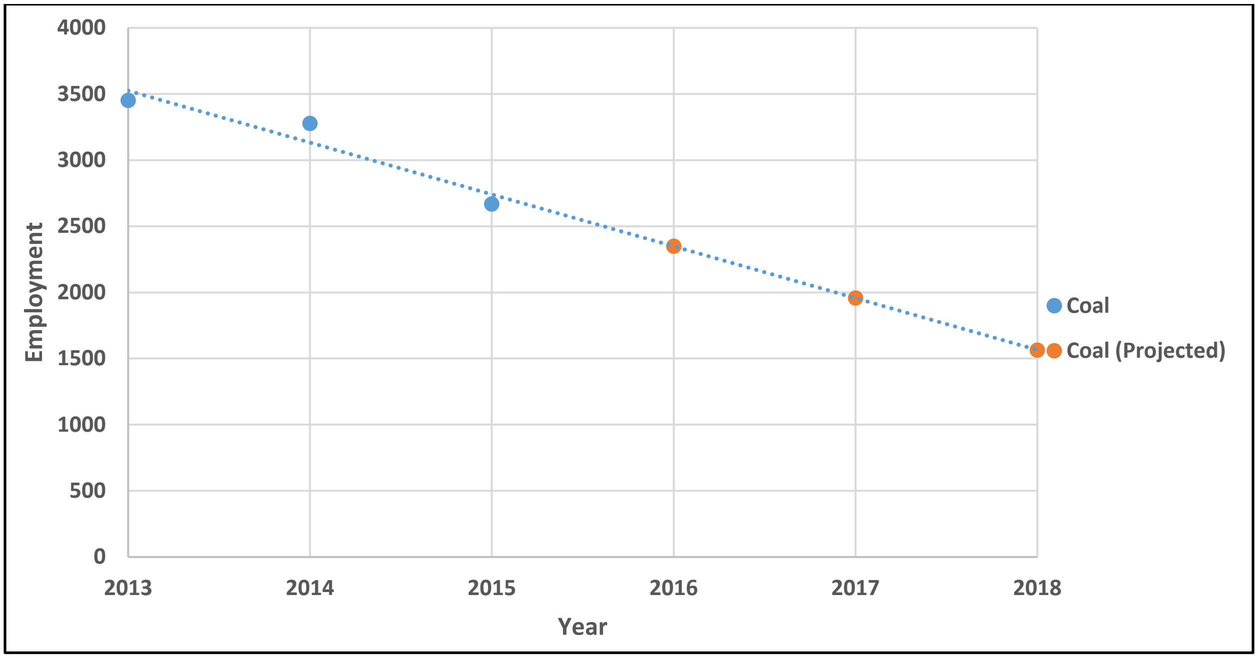
[86] As mentioned in Section 5.1.3 and Section 5.1.4 respectively, the Solar and Wind industries used different sources. For more information, see Figures 7 and Figures 8.

[87] For exact employment figures for these four industries, see Appendix B. For renewable energy employment per Ohio Metropolitan Statistical Area (MSA), see Appendix A.

6.1. COAL

Figure 5.

Ohio Coal Industry Employment



Note. Developed by authors from the United States Bureau of Labor Statistics. [88]

Figure 5 shows that coal employment in the state has declined, with 5.1% of coal jobs lost from 2013 to 2014 and an additional 18.6% lost from 2014 to 2015. Using this, we calculated a total employment decline of 16.7% per year, which outpaces the national decline of 12% reported in EIA's most recent Annual Coal Report.[89] By 2018, our projected coal employment in Ohio figure is 1,565. Although the total employment of the designated coal industries declined over this period, not all sectors decreased during this period. For instance, the Bituminous Coal and Lignite Surface Mining industry consistently grew over this period.

Major rebounds from this declining coal economy trend are unlikely, especially as renewables and oil & gas become greater contributors to Ohio's energy portfolio, energy companies retire coal power plants, and companies further automate coal mining. However, loosened coal-related regulations, such as those mandated by EPA's CPP, may cause a temporary rebound in employment due to lowered costs.

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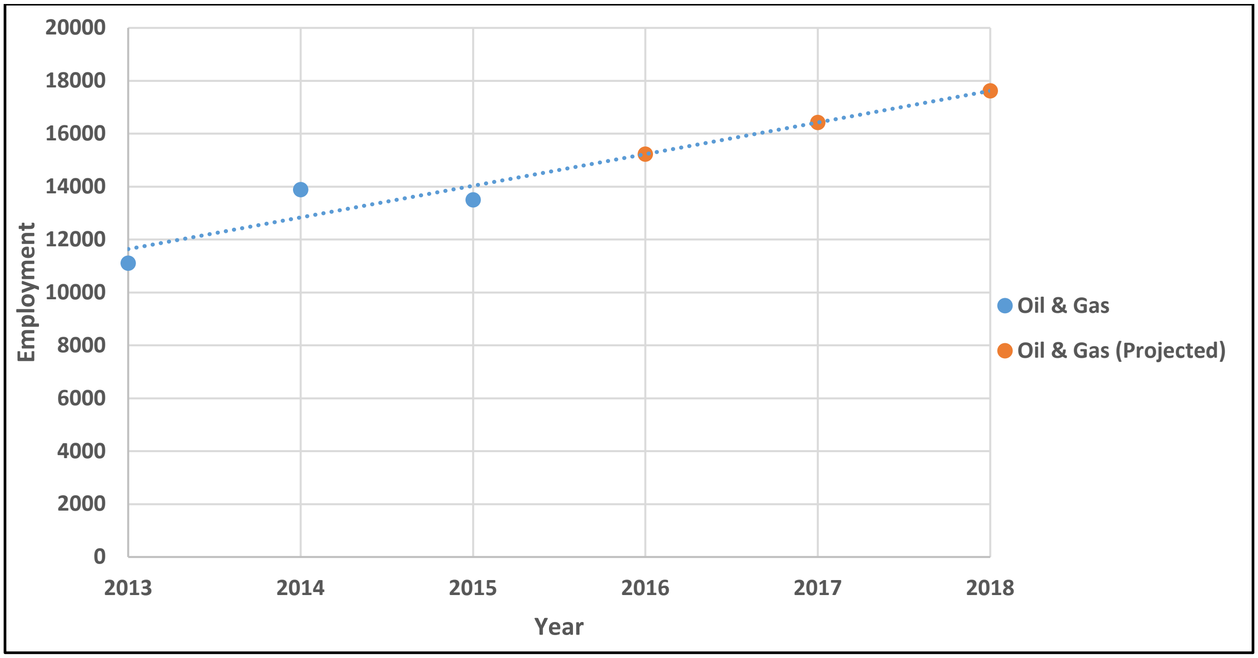
[88] Bureau of Labor Statistics. (2016a). *Quarterly census of employment and wages, NAICS 6-digit industries, one area.* Retrieved from *https://data.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables*

[89] United States Energy Information Administration. (2016a). *Average number of employees by state and mine type, 2015 and 2014* [Data file]. Retrieved from http://www.eia.gov/coal/annual/pdf/table18.pdf

6.2. OIL & GAS

Figure 6.

Ohio Oil & Gas Industry Employment



Note. Developed by authors from the United States Bureau of Labor Statistics.[90]

Similar to Figure 5, Figure 6 displays current and trend projections of the annual employment of Ohio's oil & gas industry. This shows that oil & gas employment surged from 2013 to 2014, with 25% growth, before a 2.8% retraction from 2014 to 2015. Collectively, this averaged growth rate of 7.9% places Ohio in stark contrast with the rest of the U.S., which experienced a 26% reduction in oil and gas employment from October 2014 to May 2016.[91] Using this growth rate, and all other factors being equal, we project 2018 Ohio oil & gas employment at 17,621, up from 11,111 in 2013 and 13,504 in 2015.

The 2013 to 2014 growth rate is most likely a byproduct of the shale boom, and, thus, may be unsustainable in the long term. Whether oil & gas employment growth will actually continue in this manner will depend on the viability of continued drilling in the Utica and Marcellus shale plays and the presence of demand for oil & gas to match increasing production.

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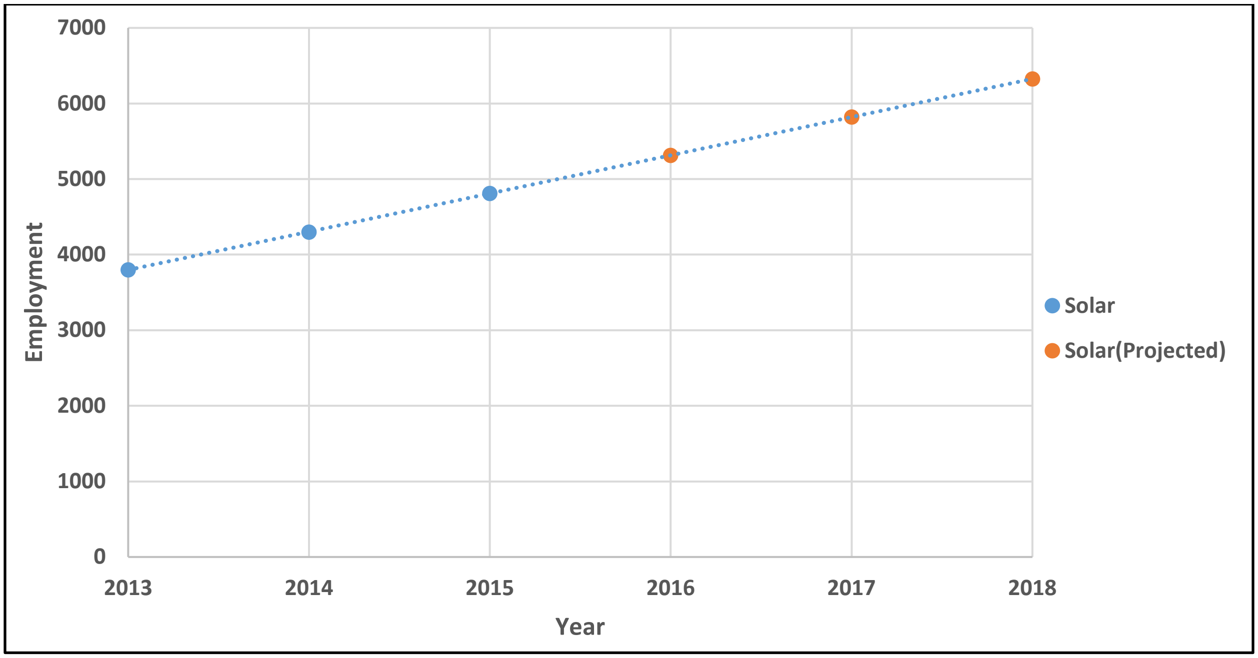
[90] Bureau of Labor Statistics. (2016b). *Quarterly census of employment and wages, NAICS 6-digit industries, one area.* Retrieved from *https://data.bls.gov/cew/apps/data_views/data_views.htm#tab=Tables*

[91] United States Energy Information Administration. (2016h). *Oil and natural gas production jobs in May were 26% lower than in October 2014*. Retrieved from http://www.eia.gov/todayinenergy/detail.php?id=27392

6.3. SOLAR

Figure 7.

Ohio Solar Industry Employment



Note. Developed by authors from The Solar Foundation, (2013)[92]; (2014)[93]; and (2015).[94]

Shown in Figure 7, solar employment grew consistently throughout our study years, with 13.2% growth from 2013 to 2014 and 11.9% growth from 2014 to 2015. From these figures, we project an annual status quo growth rate of 9.5%, resulting in 6,326 Ohio jobs by 2018. The expansion of the state's solar manufacturing sector will mostly likely fuel this growth, a development primarily beneficial to northwest Ohio, where solar manufacturing is well established due to the presence of companies such as First Solar. The reinstatement of the RPS will add to this growth, as well as Ohio

[92] The Solar Foundation. (2014). *State solar jobs census 2013*. Retrieved from http://www.thesolarfoundation.org/wp-content/uploads/2015/01/NSJC-2013-Factsheet_50-States_Final.pdf

[93] The Solar Foundation. (2015). *State solar jobs census 2014*. Retrieved from http://www.thesolarfoundation.org/wp-content/uploads/2015/02/Solar-State-Fact-Sheet_FINAL.pdf

[94] The Solar Foundation. (2016). *State solar jobs census 2015*. Retrieved from http://www.thesolarfoundation.org/fact-sheet-state-solar-jobs-census-2015/

continuing its favorable net metering legislation. Both have been shown in prior literature to enhance solar PV deployment and employment figures.[95] [96] [97]

Moreover, AEP Ohio has publicly announced a plan to install 400 MW[98] of solar capacity in the state over the next five years, with the Appalachian region as a site preference for these installations.[99] [100] We used this conceptual plan to estimate the possible economic impact of such additions by utilizing the JEDI model. To simplify the projection, we assume that the 400 MW will be evenly added over a five year period, resulting in an annual addition of 80 MW. Further, due to AEP proposals for solar farms that are 10 MW or larger,[101] we assume that this figure will be installed separately across eight solar farms at 10 MW each. For this input, the JEDI model projects an estimated 824 construction jobs and 272 operations and maintenance (O&M) jobs.[102] These jobs then result in $100,320,000 in construction wages and $12,160,000 in annual O&M wages. Finally, construction will add $136,720,000 to the Ohio economy,[103] while O&M will annually add $12,160,000.

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[95] Krasko, V., & Doris, E. (2013). State distributed pv policies: Can low cost (to government) policies have a market impact? *Energy Policy, 59*, 172–181.

[96] Burns, J. E., & Kang, J. (2012). Comparative economic analysis of supporting policies for residential solar PV in the United States: Solar renewable energy credit (SREC) potential. *Energy Policy, 44*(1), 217–225.

[97] Michaud, G. (2016). *Net energy metering and community shared solar deployment in the U.S.: Policy perspectives, barriers, and opportunities*. (Doctoral Dissertation). Retrieved from http://scholarscompass.vcu.edu/etd/4627/

[98] Half of this figure can be owned by an AEP affiliate and recovered through a long-term Power Purchase Agreement.

[99] Editors of Power Engineering. (2017, January 5). *AEP Ohio issues RFPs for wind and solar*. Retrieved from http://www.power-eng.com/articles/2017/01/aep-ohio-issues-rfps-for-wind-and-solar.html

[100] In December of 2016, AEP Ohio issued two RFPs for the development of solar and wind energy in the state, explicitly seeking proposals of up to 250 MW of wind and 100 MW of solar PV, with a specified minimum capacity of 10 MW for each.

[101] Cassell, B. (2016, December 22). AEP seeks bids on 250 MW of wind, 100 MW of solar. *Renewable Energy World*. Retrieved from http://www.renewableenergyworld.com/articles/2016/12/aep-ohio-seeks-bids-on-250-mw-of-wind-100-mw-of-solar.html

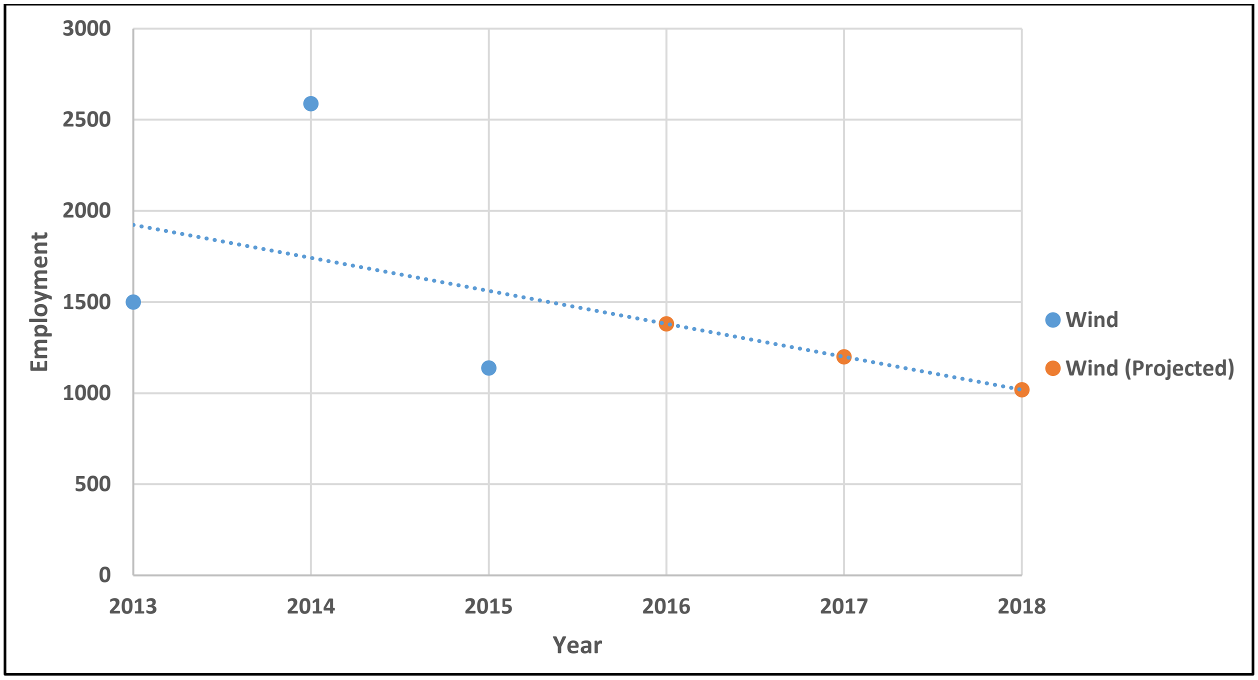
[102] Most of these jobs fall under the categories of engineering, design, and administration.

[103] Economic activity or the value of production in the state or local economy.

6.4. WIND

Figure 8.

Ohio Wind Industry Employment



Note. Developed by authors from Green Energy Ohio (2013)[104] and Energy Entrepreneurs, (2014)[105] & (2015).[106]

The wind data was the most challenging of the energy industries modeled in this analysis. Figure 8 shows that wind employment underwent remarkable shifts during the surveyed years, rising 72.6% from 2013 to 2014 before plummeting by 56% from 2014 to 2015, perhaps in a delayed response to the passing of SB 310 and HB 483. These shifts amount to a 13.1% projected yearly job loss. However, this trend may reverse due to the recent revival of Ohio's RPS and continued improvements in wind turbine technologies, among other reasons. Nevertheless, future wind deployment and jobs will continue to be hindered by the zoning restrictions of HB 483. Using our trend data and historic percentage changes, our model shows 2018 wind employment to be 1,018 by 2018.

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[104] Green Energy Ohio. (2014). *Wind energy fact sheet*. Retrieved from *http://www.greenenergyoh.org/wp-content/uploads/2015/08/Wind-Energy-Fact-Sheet-2014.pdf*

[105] Clean Jobs Ohio. (2015, May). *Sizing up Ohio's clean energy jobs base and its potential*. Retrieved from https://members.e2.org/ext/doc/CleanJobsOhio_FINAL_HiRes.pdf

[106] Clean Jobs Midwest. (2016). *Clean jobs Midwest.* Retrieved from http://www.cleanjobsmidwest.com/wp-content/uploads/2016/03/CJM-Full-Story-Final-1.pdf

Similar to the solar industry, we used JEDI to model AEP Ohio's proposed plan to add an additional 500 MW of wind over the next five years in the state.[107] For ease of analysis, we assumed that AEP will evenly install the 500 MW over a 5-year period, and, thus, modeled one year's economic impact with a single 100 MW farm. Further, we model this assuming 2 MW turbines are used, as this is the size of turbines type used in the largest Ohio wind farm.[108] From this, we found that such a series of installations would provide 648 construction jobs during the installment period which leads to $42,050,225 in construction wages. Furthermore, it would provide 18 O&M jobs, providing an additional $996,528 in annual wages. Finally, construction will add $36,788,479 to Ohio's economy, while O&M will add $1,837,777 annually. As more of these projects are installed, Ohio will likely see wind employment growth that more closely matches 2015's national growth rate of roughly 20%.[109]

6.5. IMPLAN ANALYSIS

Table 1.

Ohio's Energy Industries Economic Impact, 2015

	Employment	*Average Salary*	*Economic Impact*	*Installed Capacity (MW)*	Economic Impact / MW
Coal	2,669	$69,620	$1,683,989,936	15,260	$110,353
Oil & Gas	13,504	$53,539	$2,371,629,056	10,575	$224,268
Solar	4,811	$74,635	$900,777,216	119.561	$7,534,039
Wind	1,138	$68,336	$4,336,450,048	455.103	$9,528,502

Note. Author calculation from IMPLAN Version 3.1.

Table 1 displays the results of the economic impact analysis of each covered energy industry, generated by inputting the 2015 employment of each into an IMPLAN model. We customized the IMPLAN model so that each sector in the analysis made 100% of its primary commodity. This was done so the commodity value would not be changed by another industry that may produce the focus industry's primary product as a byproduct. Trade flows were also customized so that the local use ratio for each sector is 0. This was completed so that no purchases from these industries were allowed beyond the amount specified in the analysis, which is the direct effect of each industry.

The second of column of Table 1 shows that the 2015 average salary of each industry was $69,620, $53,539, $74,635, and $68,336 for coal, oil & gas, solar, and

[107] Editors of Power Engineering. (2017, January 5). *AEP Ohio issues RFPs for wind and solar*.

[108] Krouse, P. (2016, September 13). Ohio's largest wind farm, sprouts cash crop of turbines: Impact 2016: The path to green energy. *Cleveland*. Retrieved from http://www.cleveland.com/metro/index.ssf/2016/09/ohios_largest_wind_farm_sprout.html

[109] American Wind Energy Association. (2016, April 12). *US wind power jobs hit record, up 20 percent in 2016*. Retrieved from http://www.awea.org/MediaCenter/pressrelease.aspx?ItemNumber=8736

wind, respectively. The third column displays the economic impact of each industry. Here, the coal figure seems rather large compared to that of the oil & gas industry, since oil & gas has more than five times the number of employees as coal, and less than 1.5 times the economic impact. However, we believe this figure is reasonable due to the fact that oil & gas has experienced much more contributing support activity, such as pipeline construction and processing and gathering facilities. The difference between the solar and wind economic impacts compared to their employment is even more extreme. However, this difference may be explained by how solar energy deployment is, by nature, much more distributed (i.e., residential and small commercial installations) than wind. This results in many small firms working to install solar PV energy systems, while comparatively less employees work to set up larger, utility-scale wind energy farms, which still, taken as a whole, contribute a lot to the state's economy.

Finally, we calculated the economic impact of each industry with respect to its installed capacity in MW. This offered a per unit measurement which allows for the more direct assessment of economic impact per industry. These data show that coal has the lowest economic impact per MW at $110,353, with oil & gas relatively close at $224,268. However, solar and wind have much higher values, respectively at $7,534,039 and $9,528,502. This large divide between the renewables and fossil fuel industries is relatively expected, as the renewables industries are much smaller with respect to installed capacity and faster in growth in recent years, paralleled by the shrinking fossil fuels industries.

7. CONCLUSIONS AND RECOMMENDATIONS

The energy industry serves as a key driver to the State of Ohio's economy and will continue to serve as an important asset in the future. Based on our trend data, we project annual employment growth in the oil & gas and solar industries of 7.9% and 13.2%, and declines of 12% and 13.1% in the coal and wind industries, respectively. By 2018, under this status quo scenario, employment should rise in Ohio's oil & gas and solar industries to 17,621 and 6,326, and decline to 1,565 and 1,018 in the coal and wind industries, respectively. The net impact of this combination would result in employment growth in these four industries to 26,530 in 2018, up from 22,122 in 2015 (a 19.9% total increase). Though this is a very simplified calculation of Ohio's energy employment future, it provides a palatable forecast via publicly available data and status quo scenarios. Of course, changes in federal or state policy, resource limits, consumer tastes and preferences, and a number of other factors may alter these scenarios one way or the other.

Ohio's energy economy is in a state of rapid evolution, largely due to the rise of renewables. Of course, this trend is not unique to Ohio, but is a nationwide movement driven by technological advancement, economies of scale, best practices during industry maturity, and wider consumer acceptance. Beginning in 2013, the U.S. saw solar and wind capacity additions surge relative to other energy generation sources.

For instance, in 2016, 65% of new generation capacity additions came from wind and solar alone.[110] The 14,626 MW of solar capacity installed nationwide in 2016 nearly doubled the previous record of 7,493 MW, set in 2015.[111] While Ohio's renewables development has surged as well over the last few years, it has undeniably been hindered by the 2013–2016 RPS freeze, which encouraged investment in other, neighboring states.[112]

The oil & gas sector will continue to benefit from Ohio's proximity to the prominent Utica and Marcellus shale plays. Additionally, the installation of new oil & gas infrastructure (e.g., the Rover and Nexus pipelines) will enable Ohio's economy to further capitalize on the state's plentiful natural gas resources while this fracking boom cycle lasts. Ohio's solar energy industry will benefit from the northwest region's comparative strength in solar equipment manufacturing, as well as AEP Ohio's proposal to deploy 400 MW of PV in the state. While wind development faces unfavorable regulations mandated by HB 483, the increasing cost-effectiveness of wind generation, the RPS revival, and AEP's Ohio's wind energy deployment announcement, all combined with Ohio's plains-dominated geography, offers prospects for future success despite recent trends. The increased deployment of these renewable energy technologies will, at least partially, displace the economic losses associated with coal's decline in Ohio.

Ohio's coal jobs are continuing to wane, and those out of work in the industry are needing to find work elsewhere. With continued growth in the oil & gas and solar industries, as well as potential growth in the wind industry, there may be employment opportunities for former coal workers in other Ohio energy sectors. According to O*NET data, solar PV installers typically hold a high school diploma and possess mechanical, construction, and design skills. Gas pumping station operators are primarily high school educated as well, but must be skilled mechanically, mathematically, and in public safety and security. These types of positions may create an opportunity for coal miners, who also possess mechanical skills and are usually educated at the high school level, to find another role in Ohio's energy industry if so desired. Wind project and operations managers are typically college educated, and must possess mechanical, administrative, and public safety skills, perhaps limiting options for former, lower-level coal industry workers.

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[110] Munsel, M. (2017, February 15). *US solar market grows 95% in 2016, smashes records*. Retrieved from https://www.greentechmedia.com/articles/read/us-solar-market-grows-95-in-2016-smashes-records

[111] Ibid.

[112] Kowalski, K. M. (2017, February 9). Despite solar job growth, company officials say Ohio policy prevented more. *Midwest Energy News*. Retrieved from http://midwestenergynews.com/2017/02/09/despite-solar-job-growth-company-officials-say-ohio-policy-prevented-more/

Regardless, workforce development will be essential for Ohio's energy labor force to adapt to the state's rapidly-changing industry. Since several of the new employment opportunities in the renewables industries will require more education and advanced technical skills, job training programs will be essential. As such, we recommend accessible workforce training to prepare, for instance, former Appalachian coal miners for work in other industries. Currently, AEP Ohio plans to retire 6,000 MW of coal-fired power plants and upgrade and install new emissions reduction equipment on another 10,100 MW. AEP Ohio, the Sierra Club, and other signatories to the 900 MW renewables plan have stated their goal to develop Appalachian Ohio into a solar manufacturing hub, presenting an opportunity to alleviate unemployment in this region during this coal phase-out.[113] These types of plans, and other associated programs, will enhance the viability of new energy industry employment in the growing sectors.

With regard to policy, our analysis suggests that current Ohio legislation, such as HB 483, has hindered the growth of the renewable energy industries compared to other U.S. states. If Ohio policymakers have a desire to allow further growth in the state's green energy economy, they should consider repealing the wind setback law, as well as protecting current efforts to repeal the state's RPS laws. Ohio's RPS policy, specifically, has been under great attack since passing as part of a 2008 restructuring bill. Large, investor-owned electric utilities, which had coal-dominated generation sources, were facing stranded asset costs as a result of electricity restructuring,[114] and, thus, pushing against new distributed renewable energy capacity, eventually eradicating the solar carve-out and freezing the RPS altogether. Ohio's RPS has been in limbo for several years, and these two policy fights, among others, have stalled renewable energy development in the state despite cost competitiveness.

The federal government has yet to adopt significant policies or programs to encourage renewable energy deployment nationwide (e.g., a federal RPS). Moreover, the Trump administration introduces a great deal of uncertainty to the energy economy, largely as their energy policy agenda remains unclear. Many have suggested that several of the Obama administration energy policies will be scrapped, most notably the CPP. There may be a revival of favorable regulatory policies for fossil fuels, and a lessened sense of urgency in combating climate change. These federal policy trends may trickle down into Ohio as the state continues to explore and extract oil & gas, as well as navigates the growth of alternative energy sources such as solar and wind.

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[113] Walton, R. (2016, November 11). Ohio regulators approve AEP plan to retire 1,500 MW of coal generation. *Utility Dive*. Retrieved from http://www.utilitydive.com/news/ohio-regulators-approve-aep-plan-to-retire-1500-mw-of-coal-generation/430244/

[114] The restructuring, or deregulation, of state electricity markets began with the 1978 passage of the Public Utilities Regulatory Policies Act (PURPA), which allowed Independent Power Producers to generate and market electricity. Thus, electric utilities in deregulated markets, such as Ohio, are only responsible for distribution, operation, maintenance, and ratepayer billing – not generation and transmission. Such deregulation aimed to expand consumer choice, keep electricity prices low, and increase private sector control and flexibility.

Overall, Ohio's energy industry is an important economic contributor to the state, seeing positive impacts in labor and materials during both development and operations. Many renewables projects also rely on local banks and businesses for financing and loans. Other indirect beneficiaries of energy activity in the state comprises of vendors, such as accountants, feasibility study researchers, and manufacturers of energy related equipment. With the state's coal economy continually declining in production and employment, Ohio will most likely look to oil & gas, solar, and wind industry development to maintain adequate generation resources to meet energy demand. The current Marcellus and Utica shale boom has positively impacted the state's economy, yet has the elements of a future bust, as oil & gas products are not being efficiently extracted, used, or transported, and resource limitations constrain the timeframe on this industry. Ohio may need to employ supportive policy mechanisms for renewables, as well as workforce development initiatives, to mitigate resource extraction negative pollution effects from fossil fuels, and, overall, to strengthen the state's economic opportunities in its energy industry through diversification.

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APPENDICIES

Appendix A.

Renewable Energy Industry Employment by Metropolitan Statistical Area

District	Employment
Canton-Massillon, OH MSA	<250
Dayton, OH MSA	<250
Huntington-Ashland, WV-KY-OH MSA	<250
Lima, OH MSA	<250
Mansfield, OH MSA	<250
Parkersburg-Marietta-Vienna, WV-OH MSA	<250
Sandusky, OH MSA	<250
Springfield, OH MSA	<250
Weirton-Steubenville, WV-OH MSA	<250
Wheeling, WV-OH MSA	<250
Youngstown-Warren-Boardman, OH-PA MSA	<250
Akron, OH MSA	500
Toledo, OH MSA	700
Columbus, OH MSA	1,000
Cleveland-Elyria-Mentor, OH MSA	1,500
Cincinnati-Middletown, OH-KY-IN MSA	2,200
OH NONMETROPOLITAN AREA	2,800

Appendix B.

Industry Employment, Current and Projected, 2013–2018

	Year (Actual)			Year (Projected)		
Industry	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Coal	3,453	3,277	2,669	2,349	1,957	1,565
Oil & Gas	11,111	13,890	13,504	15,228	16,425	17,621
Solar	3,800	4,300	4,811	5,315	5,820	6,326
Wind	1,500	2,589	1,138	1,380	1,199	1,018