PROFILE OF THE WIND ENERGY SECTOR IN INDIANA

In 2008, Indiana's first utility-scale wind farm went into operation near the small town of Earl Park in Benton County. Spurred on by generous federal subsidies, a number of subsequent wind farms in Benton County and neighboring White County came on-line in 2009 and 2010.[1] Subsequent technological developments have led to further growth of the industry in Indiana, even as the size and scope of federal subsidies have been substantially reduced. Indiana's wind power generation sector has since grown through further large investments in Benton and White Counties, and through the introduction of three more large farms with footprints in Tipton, Madison, Jay and Randolph counties.[2]

Recent technological developments - notably the development of much taller turbines - have made much of northern Indiana viable for hosting utility-scale wind power generation, even as geographic spread of the industry has fostered local resistance. Many Indiana county governments have taken explicit and/or implicit actions to impede the utility-scale wind power in their localities.

In this section of the report, we offer some descriptive background on the utility-scale wind sector in Indiana. We describe Indiana's wind resource, technological developments that have improved the economic viability of utility-scale investments, as well as the industry's footprint in the state. We describe the form and approximate value of the industry's payments to the local governments and residents. Finally, we summarize state, local and federal policies towards the development of the wind industry.

[1] The arrival of the wind power sector in Indiana coincides with a national boom in the construction of such facilities – a boom that was made possible by the American Recovery and Reinvestment Act, the federal stimulus designed to offset the effects of the global financial crisis. See Johnson (2009) for a contemporary account linking the stimulus to the wind power boom at that time.

[2] The American Wind Energy Association has produced a comprehensive and detailed map of U.S. wind facilities, which is available here: http://gis.awea.org/arcgisportal/apps/webappviewer/index.html?id=eed1ec3b624742f8b18280e6aa73e8ec. Detailed information on Indiana's wind energy production facilities can be found by scaling the US map.

I. Indiana's wind resource

In order to be economically viable, wind farms should be located in places with winds that are sustained and of sufficient speed. Wind conditions vary across locations, but stronger and more stable winds are generally found at higher altitudes. One of the most significant technological innovations in the wind-energy generation sector - particularly as it relates to the issues relevant to this report - is the development over time of ever taller turbines that can access the more favorable winds that occur at higher heights. Most of Indiana's earliest utility-scale turbines have their "hubs" located 80 meters (approx. 262 feet) above the ground.

Figure 1 is a map illustrating average wind speed at this 80-meter height for the whole of Indiana.[3] The figure shows that average wind speeds in the west north-central portion of the state - especially Benton and White Counties - average more than 7.5 meters per second 80 meters above the ground. Other locations, mostly in the state's north-central region, have wind speeds of more than 7 meters per second at the 80-meter height. 80-meter wind speeds in other parts of the state are substantially lower, especially in south-central Indiana. The key lesson taken from Figure 1 is that higher quality wind resources in Benton and White Counties are a crucial reason that the industry's earliest investments occurred there.

In recent years, the industry has adopted taller turbines. This development has meant that much larger portions of Indiana are now viable as hosts for utility-scale wind farms. Figure 2 shows a map of wind speeds for the United States at the height of 100 meters (328 feet). At 100-meter heights, much of the northern two-thirds of the state have average wind speeds of more than 8 meters per second. These speeds are higher than Benton and White county winds at 80 meters and are typically strong enough to make utility-scale wind energy generation economically viable.

While average wind speeds offer a useful guide to understanding spatial and vertical variation in the quality of Indiana's wind resource, an indicator known as the *capacity factor* is more helpful in understanding the implications of technological progress for wind energy generation in Indiana. The capacity factor for a given wind turbine or wind farm is calculated as the annual amount of power produced, divided by the nameplate capacity (the theoretical maximum amount of power that the turbine or farm would produce under ideal circumstances).[4] Technical analysts can

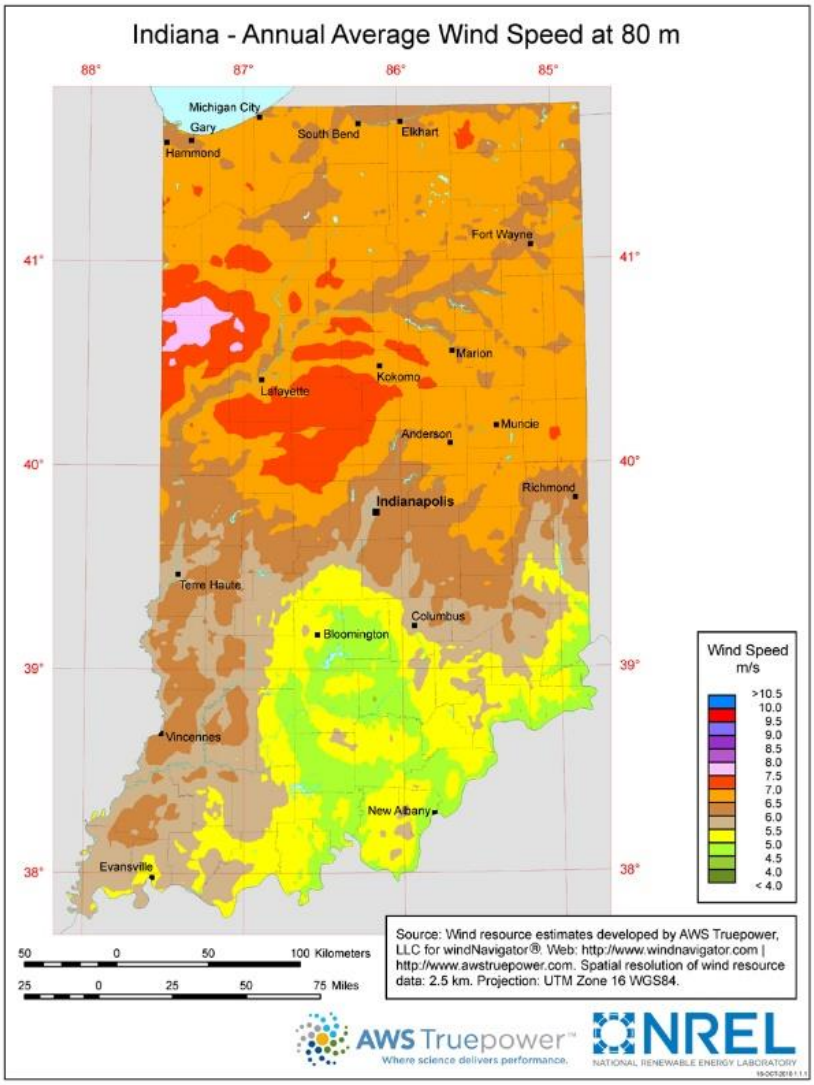
[3] The map focuses on Indiana's on-shore wind capacity, which is the focus of the issues studied in this report. Indiana also has offshore generating potential in Lake Michigan, which can be viewed at https://windexchange.energy.gov/maps-data/171.

[4] Capacity factors for wind energy are affected by the intermittency of sufficiently strong winds, but also by down time for maintenance and repairs. Other generation technologies also have down times, and therefore have capacity

combine information on wind conditions in a given location with the capabilities of a given turbine technology to predict the capacity factor of a turbine of that type if it were to be installed in that location. Experts at the U.S. National Renewable Energy Laboratory (NREL) have done these calculations, and their estimates help to explain why the production of wind-generated electricity is now viable in locations outside the west-north central region.

factors below the theoretical maximum of 100. EIA (2020d) reports annual average capacity factors for existing installed capacity of various generation technologies in 2019. Some examples are: Coal (47.5), Combined Cycle Natural Gas (56.8), Hydroelectric (39.1), Nuclear (93.5), Photovoltaic Solar (41.5) and Wind (34.8).

Figure 1. Average wind speeds in Indiana at 80 meters

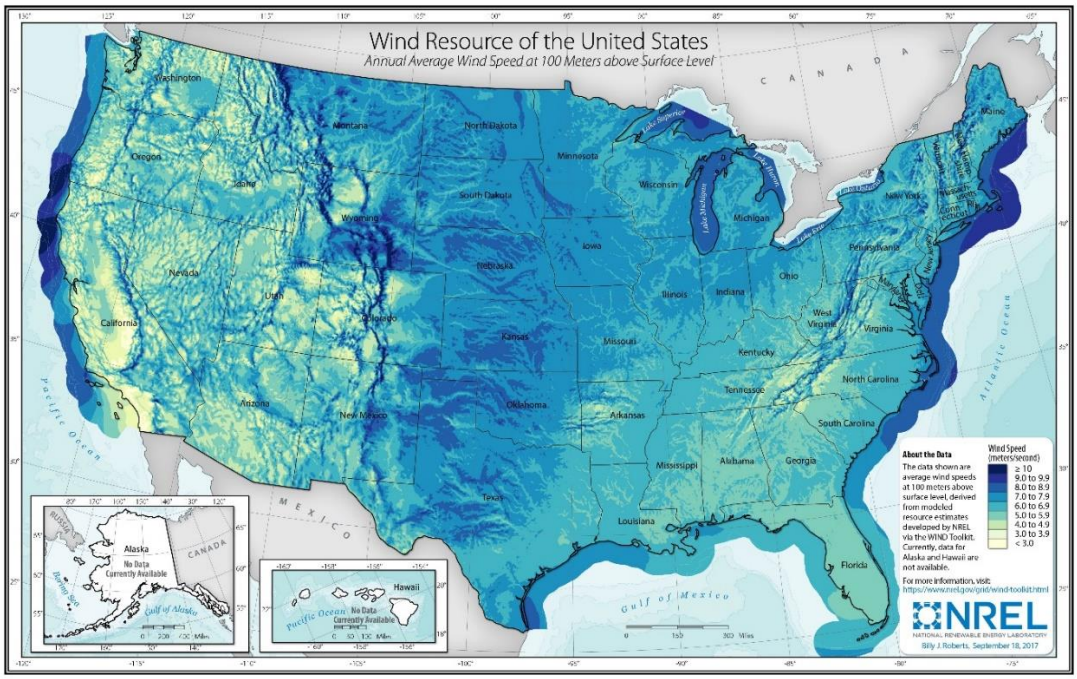


Source: https://windexchange.energy.gov/maps-data/40 using data from NREL

The NREL analysts began their calculations by screening outlands that are not suitable for development for legal or other reasons (populated areas, state and national parks, wildlife refuges,

airfields, etc.).[5] These exclusions leave approximately 60,000 of Indiana's 23 million acres as potential hosts of wind turbines. The question the NREL analysts then asked was, "how productive would each of three different generations of wind turbines be if they were sited on each of these 60,000 acres?" The analysts considered this question for three different technologies, the leading technology in 2008 (with 80-meter hub heights), in 2014 (with 110-meter hub heights), and the technology that is expected to be available in the *near future* (with 140-meter hub heights).

Figure 2. Wind resources of the United States at the height of 100 meters



Source: https://windexchange.energy.gov/maps-data/324 using NREL data.

The results of this analysis are reproduced in Figure 3. The bottom axis of the figure measures (gross) capacity factors.[6] The left-hand axis indicates the cumulative number of acres with a

[5] The analysis does not appear to have taken into account access to the electrical grid, which is another important factor in siting decisions.

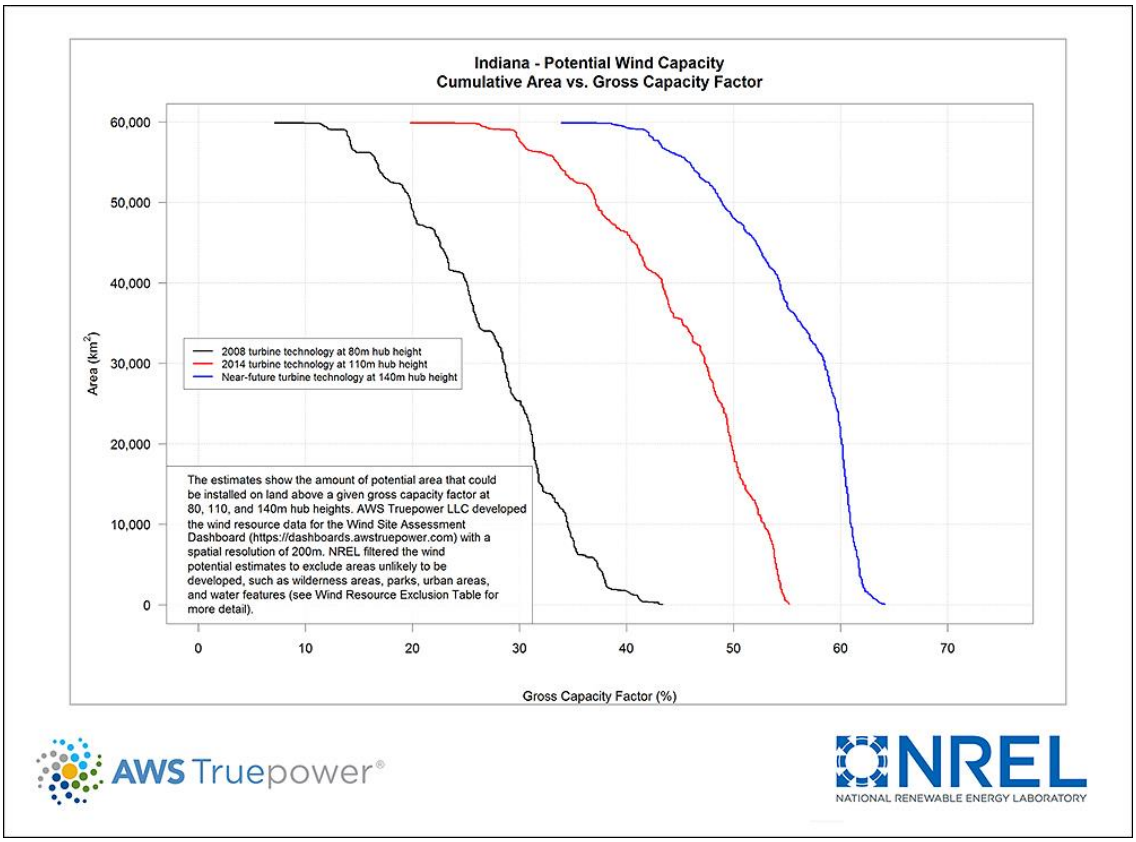
[6] The *gross* capacity factor uses the amount of electricity produced by the turbine it its location as the numerator in the capacity factor calculation. A related concept is the *net* capacity factor, which is lower than the gross capacity

capacity factor that exceeds a given level. The first line on the figure, the black line, shows the cumulative number of modeled Indiana acres that are capable of achieving each level of a capacity factor with the 2008 technology. The distribution of capacity factors across suitable acres in Indiana with the 2008 technology is broad, ranging from less than 10 to over well over 40. More importantly, with the 2008 technology, there are relatively few acres (approximately 8,000) with gross capacity factors that exceed 35, the level that is generally understood to be necessary for utility-scale wind energy production to be economically viable. The relatively small share of Indiana acres with capacity factors of 35 or higher using the 2008 technology reflects much the same information as appeared in Figure 1; a relatively small portion of Indiana (primarily the west-North central part) has wind conditions that are favorable to production at 80-meter hub heights.

Technological progress between 2008 and 2014 substantially enhanced the productivity of Indiana's wind resource, making new areas of Indiana economically viable as locations for wind energy generation. The second line in Figure 3, the red line, shows the cumulative number of modeled Indiana acres that achieve a given capacity factor with the 2014 technology, a technology with 110-meter hub heights. Under the 2014 technology, capacity factors range from 20 to approximately 55. With the technological improvement, nearly 53,000 of the 60,000 modeled Indiana acres meet the threshold for viability, a gross capacity factor of 35.

factor because the quantity of output in this calculation is reduced by losses that occur in the transmission of electricity over space.

Figure 3. The distribution of capacity factors across suitable acres in Indiana at different hub heights



Source: https://windexchange.energy.gov/maps-data/42 using NREL data.

The third line in the figure, the blue line, illustrates the same calculations assuming a near-future generation technology, a technology with 140-meter hub heights. Capacity factors with this technology vary from the mid-30s to the mid-60s. Virtually all of the modeled acres have capacity factors of 35 or more. Figure 3 thus shows how advancing technology in the sector makes ever larger parts of Indiana viable as hosts for wind energy generation.

Estimates of economic viability implicit in the above figures consider only technological variables and show that steady increases in wind energy production go along with increases in turbine size. Larger turbines, are, however, more expensive to build and install. Recent modeling efforts have moved beyond simple technological analysis, asking instead which hub heights are likely to be most profitable, after taking into account the costs of construction and operation at several different

hub heights. Lantz *et al.* (2019) estimate that, for the vast majority of locations in Indiana, 110-meter hub heights produce lower "levelized costs of energy" (LCOE) when compared with turbines at 140- and 160-meter hub heights. The publication offers caveats, however, noting that the cost estimates across different hub heights are not very different. Using the assumed cost variables, 110-meter turbines would be more profitable than 140-meter turbines, but not by a large margin.[7]

II. The footprint of utility-scale wind energy generation in Indiana

Table 1 provides a listing of operational wind farms in Indiana, the dates in which they became operational, and other key characteristics. Projects are sorted by year of entry-into-operation and host county. The table reports nameplate capacity, the amount of electricity each farm can produce under optimal conditions. Hub heights are also included in order to illustrate the trend of increasing hub heights.

Table 1 shows that the first burst of investment activity in Indiana occurred in Benton and White Counties. Initial exploration of these counties' wind resources began in 2006-7, and the first set of projects came online in 2008-2010. The first set of projects still account for more than one half of the state's total operational nameplate capacity. However, more recent projects use better technologies and produce more electricity per unit of nameplate capacity. More recent projects have tended to consist of turbines with higher hub heights. These more recent projects include new projects in Benton and White counties as well as others in the central part of the state. The latest project to come on-line - in White County - has turbines with 105-meter hub heights.

[7] The very low interest rate environment that arrived with the COVID-19 virus may enhance the viability of larger, more costly turbines, relative to calculations that were done in an environment with somewhat higher interest rates.

Table 1. Operational utility-scale wind farms in Indiana and their characteristics.

Project name	County	Nameplate Capacity (MW)	Turbine count	Year online	Hub Height (m)
Benton County Wind Farm (Goodland I)	Benton	130.5	87	2008	80
Fowler Ridge	Benton	301.3	162	2009	80
Fowler Ridge	Benton	99	60	2009	80
Fowler Ridge	Benton	200	133	2009	80
Hoosier	Benton	106	53	2009	80
Meadow Lake Wind Farm	White	199.65	121	2009	80
Meadow Lake Wind Farm	White	98.7	47	2010	80
Meadow Lake Wind Farm	White	99	66	2010	80
Meadow Lake Wind Farm	White	103.5	69	2010	80
Wildcat I	Madison, Tipton	202.5	125	2012	100
Headwaters	Randolph	200	100	2014	95
Amazon Wind Farm (Fowler Ridge)	Benton	149.5	65	2015	80
Bluff Point	Jay, Randolph	119.7	57	2017	94
Meadow Lake Wind Farm	White	100	50	2017	95
Meadow Lake Wind Farm	White	200.4	61	2018	105

Source: Science for a Changing World, AWEA Wind Project Mapping Portal, the US Wind Turbine Database. Retrieved from https://eerscmap.usgs.gov/uswtdb/viewer/#6.3/37.778/-87.597, http://gis.awea.org/arcgisportal/apps/webappviewer/index.html?id=eed1ec3b624742f8b18280e6aa73e8ec

II.a. Electricity produced by the utility-scale wind sector in Indiana

There appears to be no publicly available information on the levels of annual production for individual Indiana wind farms. But annual production at the state level is tracked by both private and public entities. The U.S. government's Energy Information Agency (EIA) reports in EIA (2019) that the total quantity of electricity produced in Indiana in 2018 was 113.5 million megawatt-hours. The same source put Indiana's net generation of electricity from wind power in 2018 at 5.4 million megawatt-hours, or 4.8% of Indiana's total.[8] Comparable figures for 2019 are not yet available from the EIA, but the American Wind Energy Association (AWEA), the wind industry's trade association, reports total output of 6.2 million megawatt-hours in Indiana in 2019, or 6.0 percent of Indiana's total electricity production. The change in output from 2018 to 2019 represents a 14.8 percent increase in the amount of electricity produced by wind in Indiana.

It is difficult to put a precise dollar value on Indiana's wind industry output. Many of Indiana's wind farms have contracted to sell their energy to corporate and institutional buyers at a fixed price. These fixed prices are the prices that matter for the profitability of the wind farms themselves, but spot prices are more useful in representing the economic value of their output. Spot prices vary substantially over time (and throughout the day), so it is difficult to establish a precise best estimate for valuing the industry's electricity output. We were able to obtain spot price data for the "Indiana hub" of the Midcontinent Independent System Operator for 2018. These prices ranged from $3/MW to $524/ MW during 2018.[9] The median spot price in 2018 was $27.12 per megawatt-hour. Applying that figure as a rough proxy for the price of electricity produced in the state, we estimate that the market value of the electricity produced by wind power in Indiana in 2018 was $147.5 million.

We were unable to obtain comparable data on spot prices from 2019, but note that EIA (2020c) reports that wholesale electricity prices were 15-30% lower in 2019 than in 2018, mainly as a result of lower 2019 prices for natural gas.[10] In terms of valuing the 2019 value of Indiana production, a

[8] "Net generation" adjusts gross generation figures by the estimated amount of electricity lost in transmission.

[9] These figures are indicative of all sales of electricity at the Indiana hub, not only electricity produced by wind power. Hourly price data downloaded from LCG consulting (2020).

[10] See EIA (2020c).

15 percent reduction in the price of wholesale electricity would just offset the 15 percent increase in production. The EIA report thus suggests that the dollar value of Indiana's wind-generated electricity output was roughly stable from 2018 to 2019, though possibly somewhat lower.

II.b. Investments in Indiana's wind energy production capacity

Figures that offer another perspective on the economic value of the sector are the size of investments made in wind energy capacity in Indiana. A rough rule of thumb is that each kilowatt of nameplate capacity installed requires an investment of $1000-$2000. By this calculation, a 2MW turbine costs between $2 and $4 million to install. The $1000-$2000 rule of thumb implies that the dollar values of investment required to install the capacity recorded in Table 1 lies between $2.3 and $4.6 billion. The AWEA - with access to more detailed data that include investments not completed or not yet completed - estimates that the cumulative value of investments in Indiana's wind sector is $5.0 billion.[11]

III. The wind industry as a source of income

Although the possibility of broader economic benefits of the wind sector should be considered (and will be, elsewhere in the report), the most important local economic benefits are those that flow from direct payments made by the industry to local actors. Unlike coal- and gas-powered electricity generation, the wind generation industry does not pay for purchases of fuel. This means that the vast majority of operation and maintenance costs involve payments to local economic actors. These payments accrue to local governments through tax and other payments to workers at local establishments that perform maintenance on the turbines and to the owners of the land where turbines are sited. In this section of the wind profile, we discuss the industry's payments to private entities. The next section discusses payments to local governments.

Before documenting these payments, it is essential to understand that among electricity-producing technologies, wind power is one of the most capital-intensive. An installed turbine like those in Indiana represents an investment of as much as $4 million. In marked contrast to coal and gas-powered turbines, operators of wind-generated power need not pay for ongoing purchases of fuel. Relatively low operation and maintenance costs are a key reason that the sector can be cost-competitive with other generating technologies. Estimates of the total "levelized" costs of

[11] See AWEA (2020).

electricity show that the purchase and installation of the turbines themselves represent a significant share of the total cost of generating wind-powered electricity.[12] A large share of industry revenues must, therefore, go to compensating the owners of the turbines for their investments in installed capacity. A much smaller share of revenues goes to operation and maintenance, and this share is the primary source of payments to local entities.

III.a. Lease payments

One of the most significant direct payments by the wind sector to local entities is lease payments paid to landowners for the use of their land. The most common of these payments are those made to owners of the land on which a turbine is located, though there are a number of other reasons that the industry makes payments to landowners. In some cases, additional infrastructure is needed to facilitate the transmission of the electricity, and the affected landowners would be paid to host this infrastructure.

Detailed information on the magnitudes of each of these types of payments is not readily available, but we were able to collect some information on the value of payments made to landowners who host the turbines. Information on aggregate payments is reported by the AWEA. We consider each of these in turn.

In a news report about the situation in Ohio, an AWEA spokesperson said that the landowners were paid between $3,000 and $6,000 per megawatt of nameplate capacity installed on their land.[13] Knowledgeable residents suggested that payments per MW of nameplate capacity in Benton and White Counties lie near the middle of this range. One local resident told us said that the level of compensation is quite consistent across landowners when measured on the basis of megawatts of nameplate capacity. Landowners do receive different payments on a *per turbine* basis. Recently installed turbines have nameplate capacities of approximately 3 MW, and the owners of land with these turbines would be paid twice as much as the landowners who have the earliest generation of turbines (with approximately 1.5 MW of nameplate capacity each).

[12] Table 1a in EIA (2020b) estimates that the levelized capital cost of installed wind capacity in 2025 will represent $23.51/MW out of a total levelized system costs of $34.10/MW. In other words, roughly 70 per cent of costs of generating electricity relate to the costs of purchase and installation.
[13] See Kowalski (2019).

Indiana's total nameplate capacity of utility-scale wind turbines is just over 2300 MW. Using the $3000-$6000 per MW range quoted in the news article, this means that landowners in Indiana are paid somewhere in a 7.5 to 15-million-dollar range for hosting turbines. AWEA (2020), an annual report by a wind industry trade association, indicates that payments to landowners in Indiana totaled $20 million in 2019. The gap between the AWEA figure and the bottom-up estimate that we calculate here probably reflects the inclusion of other types of payments to local landowners in the AWEA figure.

An understudied issue that matters for understanding the distribution of lease income and possibly the effects of such income on the local economy relates to the distinction between landowners and farmers. Forty-five percent of farmed land in Indiana is rented.[14] This share is considerably higher in areas with grain crops, the primary crop in areas of Indiana where utility-scale wind turbines operate. Counties hosting wind power in Indiana typically have high shares of rented farmland. Estimates from the Census of Agriculture (2017) put the share of rented farmland acres in Benton County at 74%, White County at 64%, Madison County at 59%, Tipton County at 59%, Randolph County at 46%, and Jay County at 37%.[15] A key question for analysis of the local economic impact of the lease payments is the degree to which the lessors receiving payments recirculate these funds in the local economy. There is anecdotal evidence that some portion of the land hosting turbines is owned by non-resident owners (who would be less likely than local residents to use the lease payments to purchase local goods and services), but we were not able to establish that non-resident land ownership is common.

III.b. Employment

Although wind-powered generation is a capital-intensive industry, it employs workers engaged in a wide variety of activities. Since 2012, the US Bureau of Labor Statistics (BLS) has tracked employment within a well-defined wind energy generation sector, which is defined as code 221115 in the North American Industry Classification System (NAICS). The national figures offer a detailed breakdown of the occupations of workers employed directly by the sector. Data for Indiana lack the occupational detail available in the national statistics but are more directly informative about the industry's relationship to Indiana. We first review employment data from the national data, discuss shortcomings of these data for our purposes, and then provide another

[14] USDA (2016). This compares against a 40% share for the United States as a whole.
[15] Census of Agriculture (2017). Data drawn from https://www.nass.usda.gov/Publications/AgCensus/2017/Online_Resources/Ag_Census_Web_Maps/Data_download/index.php, Feb 25, 2020.

set of estimates based on publicly available information on ongoing local employment. We also review a study that quantified short-run employment tied to the construction of Indiana's first round of turbines. We follow this by reviewing estimates of Indiana employment in activities that are related to those of the wind-energy production sector through up- and down-stream linkages.

III.b.1 National employment in the wind generation sector

The BLS' documentation of national employment in the industry includes information on 25 different occupational categories of the sectors' employees. In addition to employees involved in the construction and maintenance of wind turbines, industry employment includes occupational categories such as management, electrical engineers, lawyers, and more. The BLS estimates that the industry's nation-wide direct employment in 2017 was 5,240 workers.[16] The mean annual wage across all these workers was $73,720.[17] Employees in some of the smaller employment categories (such as "Top Executives" or "Operations Research Analysts"), likely do most if not all of their work outside of Indiana, and the average wage for Indiana might, therefore, be expected to be somewhat lower than the reported national average.

It is the larger occupational categories in the BLS classification that include employees who do work in Indiana. The BLS estimates indicate that over half of the employees in the wind generation sector fall under the employment category "Installation, Maintenance and Repair Occupations." This occupational heading has 2730 employees nationally, with an annual average wage of $61,480. 2020 of these employees are "Wind Turbine Service Technicians," a group that has an annual average wage of $60,240. Lam (2016) interviews George Myers, a turbine service technician in Colorado, who describes his work as a turbine service technician. It is employees like Myers, who would comprise the majority of wind-sector employees in the rural Indiana counties that allow wind-powered generation.

As Myers indicates in his interview, there are two distinct phases to the employment of turbine technicians on a wind project. During the construction phase, a project employs a large number of technicians (as well as a broad array of other occupations). The construction phase is temporary, though, and many of these workers will move on to work on the construction of new wind farms

[16] As we note later in the section on Indiana's employment in the sector, these figures are likely an understatement of the number of employees who are active in the construction and operation of utility-scale wind turbines. Some firms that are not classified by the Census Bureau as being primarily in wind generation industry sector have employees who are employed full time in activities that support the activity of wind generated electricity.
[17] BLS estimates from May 2017, downloaded here https://www.bls.gov/oes/2017/may/naics5_221115.htm on February 26,2020.

in other locations. A small number of turbine technicians (and some support staff) remain behind to conduct maintenance throughout the life of the turbines' productive life, which maybe 30 years or more. The different time profiles of the two phases of the project are an important consideration for understanding the industry's payments to labor. In our documentation of industry employment in Indiana, we first report available statistics on long-term employment at or near the wind farms and then discuss the differences between employment in the construction and maintenance phases of a project.

III.b.2 Wind Industry employment in Indiana

The official data for wind industry employment dates from 2012 when the Census Bureau first began to track employment in the sector. The official U.S. statistics for the sector's employment in Indiana are reported in Table 2. Official estimates of the industry's employment in Indiana rose by more than a factor of three during the period in which data is available. In 2010, the industry itself employed 19 full-time workers; in 2018, the sector employed 67 full-time workers.

Table 2. BLS estimates of wind-industry employment in Indiana, 2010-2018.

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018
Employment	19	24	44	50	56	59	56	60	67

Notes: Data reported by the Indiana Department of Workforce Development. Original data from the BLS Quarterly Census of Employment and Wages. These figures exclude self-employment and owner-operators. They also exclude employment by firms that are classified outside the wind-power generating sector, even though some parts of those firms' businesses in the State may include participating in the installation or maintenance of turbines. For this reason, official figures are almost certainly an underestimate of total employment in the sector.

The official employment figures for NAICS 221115 are likely to understate total employment in the sector within Indiana in any given year. Employees of firms that are not identified by the Census Bureau as firms whose primary activities are in the wind sector would not be included in these data. Some firms that are classified as belonging to other industries may be involved in the installation of turbines during the construction phase. Other firms from different sector classifications might employ workers who help to maintain the turbines. In neither case would

these workers appear in Table 2 estimates because the parent firm's primary activity is in another sector.[18]

In order to offer a different perspective, we use publicly available information on local employment to provide an unofficial estimate of total employment linked to wind farms in Indiana. Table 3 reports estimates of permanent wind farm employment taken from publicly available web sites. While these figures are unofficial, the employment estimates in each location appear reasonable and correlate well with the number of turbines in each location. We view these figures as a good estimate of the level and distribution of full-time employment in rural Indiana that is linked directly to the presence of wind farms. Taking the individual estimates as given, we calculate that approximately 185 permanent full-time jobs in Indiana are linked directly to the operation and maintenance of the wind farms.

Table 3: Estimated employment linked to the ongoing operation of wind farms, by location.

County or wind farm project	Source	Estimated permanent full-time employment
Benton County	Benton County Economic Development Corporation	95
Meadow Lake Wind Farm (White County)	Meadow Lake Wind Farm	63
Wildcat Windfarm I (Madison/Tipton Counties)	E.on Climate & Renewables	8-12
Headwaters Wind Farm (Randolph County)	Headwaters Wind Farm	12
Bluff point wind farm (Randolph/Jay Counties)	Online news article	5
Total for Indiana Wind counties		Approx. 185

Notes: Publicly available information on full-time employment at Indiana wind farms. Source information: Benton County (https://benton4business.com/benefits),
Meadow Lake Wind Farm (https://meadowlakewindfarm.com/),
Wildcat Wind Farm (https://www.madisoncounty.in.gov/assets/wwf_madison_sep_tab_0d.pdf),
Headwaters Wind Farm (https://headwaterswindfarm.com/),
Bluff Point Wind Farm (https://www.power-grid.com/2017/12/07/aep-nextera-energy-open-200-million-indiana-wind-farm/#gref). All web sites accessed June 23, 2020.

[18] For example, a firm that is primarily in the business of providing engineering services might be engaged in the maintenance of turbines, and its employees would be attributed to NAICS 541330 rather than to 221115.

III.b.2.i Wind turbine technician employment in Indiana

Wind turbine technicians are the primary category of employees working in the wind industry in Indiana. These jobs offer high salaries, relative to others in rural Indiana, and there are numerous positions available. The website Indeed.com – which produces its estimates by combining local information on salaries with other industry reports from across the country – estimates that the annual salary for wind technicians in Indiana of $52,964 per year, with an estimated $8,250 in annual overtime pay.[19] Indeed.com is also a website with job listings, and the same web search that produced these salary estimates revealed two openings for web technicians in Indiana (one in Fowler and one in Chalmers), and one in nearby Hoopeston, Illinois. All three of these job listings had been posted within seven days of the web search.

One advertisement – for a position of Wind Technician II in Chalmers, Indiana - lists a range of physical, technical, communication, and problem-solving skills that are required for the position.[20] Technical skills involve knowledge related to working with electricity, with cranes and rigging equipment, Microsoft Office skills, and more. This position asks for 1+ years of college or technical education, or equivalent experience. Prospective employees may spend 10% of their time on work-related travel, but would presumably be able to live and work primarily in Chalmers. The employee should be prepared to work on holidays and weekends and to be willing to respond to emergencies. The employee should also be able to lift up to 50 lbs. of weight, and to climb turbine towers above 100 meters in height. This advertisement did not discuss salary or benefits, but another advertisement (for an entry-level wind technician position) indicates that compensation includes a variety of benefits including Medical, Dental, Vision and Life Insurance, and a 401K with a company match.[21]

III.b.2.ii Employment in the development and construction of wind farms

Maintenance positions represent the primary source of ongoing employment once the wind turbines have been installed. At the development and construction stage, the sector employs a large number of workers with a broader variety of skills, but does so over a relatively short period. Some of the employees engaged in the development and construction phases of the project would be

[19] Source information https://www.indeed.com/salaries/wind-turbine-technician-Salaries,-Indiana. Downloaded February 26, 2020.
[20] Job advertisement for position with EDP Renewables, listed on the employment website GlassDoor on February 10, 2020.
[21] Indeed.com advertisement for "Wind Service Technician – Level 1" at Sky Climber Renewables in Fowler, Indiana. Posted on February 19, 2020.

residents of Indiana, while others would only reside here during the projects' development and construction stages. During the construction phase, the industry also provides short-term employment of local residents for a variety of temporary tasks.

The short-term nature of work in the development and construction stages means that employment in these sectors may not be represented in official statistics. Perhaps the best source of the division between employment in the development and construction phases is Tegen *et al.* (2014). They attempt to estimate the economic impacts of Indiana's first 1000 MW of wind capacity. We review the analytical approach of the study in the section of the report that examines studies of economic impact. In this section, we relay information from that report on direct employment by the sector during the construction phase of the project. The authors of the study conducted extensive interviews with the industry and are therefore likely to have produced the best estimates of direct employment in the two stages of activity.

Tegen *et al.* (2012) explain that a typical wind farm requires a 6- to 12-month construction period. This period entails the employment of a wide variety of employees, including managers, engineers, construction workers, administrative staff, and more. During the construction of the first seven Indiana projects, Tegen *et al.* estimate that the developers spent $553 million in Indiana during the construction phase. They report that 50 to 75 percent of the construction workers were Indiana residents. Approximately 930 workers were employed on-site in the process of developing Indiana first seven utility-scale wind projects.

In a subsection of the more extensive report, Tegen et al. (2012) describe qualitative aspects of the local employment consequences of the construction phase via an interview with the owner of a small business in Earl Park, Bennet's Garage. The developers employed this local garage to do maintenance on vehicles used in construction. In addition to the local workers hired to work on the project itself, the garage also expanded its workforce in order to support the construction phase. For example, the garage owner hired local teens who were hired at $10 per hour to do flagging in support of the transportation of construction materials to the site. Hotels and local residents were also paid to house construction workers, and the industry purchased local materials such as concrete. Construction of the wind farm was also accompanied by road construction and repair to support the movement of heavy turbines to their destination. These activities also generated a temporary boost in local employment.

III.b.3. Related employment outside the wind-energy generation sector

Wind turbines are difficult to transport over long distances, so turbine manufacturers that are proximate to the locations of turbine installation offer a significant cost advantage.[22] Wind turbines are also exceptionally complicated pieces of machinery. The manufacturers of the finished elements of the turbines require large numbers of inputs, some of which are produced near final-stage producers of pieces of the turbine. Indiana's history as a location of sophisticated manufacturing facilities, together with its proximity to sites of wind energy generation, has meant that the state's manufacturing industry has participated in this complex supply chain.

The AWEA identifies 15 manufacturing facilities engaged in the production of turbines components or of upstream inputs.[23] The NREL Wind Prospector identifies three wind-related manufacturing facilities in Indiana, one each in Bloomington, Lafayette, and Bedford.[24] The smaller number of manufacturing facilities identified in the NREL data presumably represents a much narrower definition of wind-related manufacturing than the AWEA uses.

Direct estimates of employment in wind-related manufacturing in Indiana are not practical, as many of the manufacturing facilities identified by AWEA would also be engaged in activities not linked to producing wind-turbines. Using input-output analysis, Tegen *et al.* attribute 3770 jobs in the upstream supply chain that arise from the construction of Indiana's wind power.[25] In the context of this report, which focuses on the local dynamics within counties that are considering whether to allow wind farms and under what conditions, it is important to note that these supply chain impacts arise almost entirely outside the affected counties, even when they do occur within the state.

Employment outside the wind sector itself is not exclusively limited to upstream suppliers. Tegen *et al.* note that a small "wind tourism" industry has arisen in Benton County, where a large number of turbines are present. Moreover, local community colleges have also developed programs to train workers for the industry. Some wind-related services in Benton County serve the wind industry

[22] Using Danish and German data, Cosar, *et al*, (2015) estimate that a 1% increase in distance reduces by 0.36% to 0.54% the probability that a manufacturer will supply a given wind project.
[23] AWEA (2020)
[24] https://maps.nrel.gov/wind-prospector/.
[25] It is important to understand that the 3770 figure is an imputed number that does not take into account opportunity costs, or the switching of manufacturing outputs across downstream buyers. The analysis assumes that manufacturers respond to an order for materials from the wind sector by hiring new workers to produce for that order. Upstream manufacturing firms might see this instead as one order in a flow of orders from multiple buyers, and not respond to each order with new hiring. On the other hand, it is likely that wind-related manufacturing in Indiana also produces inputs into turbines that are located in other states, and construction in other states is not considered in the analytical exercise. It would be better to say that the construction of Indiana's first seven large wind farms *temporarily supported* as many as 3770 jobs, during the period of construction, rather than to imply, as Tegen, *et al.* do, that the 3770 new jobs were created by these investments.

outside of Indiana.[26] These "exports" by local Indiana firms to other states would not have arisen if the large-scale presence of the industry in this state had not first arrived here.

IV. Payments to local governments

The industry's payments to landholders and employees are paid to private citizens. The industry also makes payments to local governments, both in the form of taxes and in the form of additional payments associated with designated purposes. Payments to local governments are the most direct way that the industry benefits communities as a whole. In Indiana, siting and planning authority is allocated to county governments, and payments made to these and other local governments are part of the county governments' decision-making process. It is therefore helpful to review available information about payments made to these and other local governments. Conceptually it is useful to divide payments into those that are collected in the form of assessed taxes and other payments that are not made as tax payments. We report some publicly available estimates for state-wide totals for tax revenues and other payments, and then provide some detail on the size and timing of payments made to Benton and White Counties.

IV.a. Tax payments

AWEA estimates that annual tax payments from the wind industry to state and local governments in Indiana total $12 million per year.[27] While detailed information on the form and geographic distribution of these tax revenues across Indiana does not appear to be available publicly, the relevant officials in Benton and White counties make some information available. State and local governments in Indiana have sometimes offered property tax abatements to attract investment. A news report on the Amazon Wind Farm Fowler Ridge project in Benton County notes that the wind farm was offered an abatement for the first 10 years of the project's life.[28] The same report quoted the Benton County Local Economic Development Officer as saying that once the abatement period ends, the property tax revenues are "fantastic," though the article does not provide specific figures for property tax revenues.

One rationale for property tax abatements is that at the beginning of a wind project's life, the assessed value of the turbines is very high, by local standards, and immediate taxation would

[26] The owner of Bennet's Garage interviewed in Tegen, *et al.* (2014) now serves out-of-state wind projects, for example.
[27] AWEA (2020)
[28] Douglas (2019)

impose a substantial financial burden. A case study of Benton County notes that the assessed value of the Amazon Wind Farm Fowler Ridge was $150 million.[29] With local property tax rates in Benton County of just over 1 percent, this would have generated an annual local tax bill of $1.5 million.[30] This is only a single project; others would have similar assessments and large associated property tax bills. The ten-year abatement period allows the owners of the wind turbines to depreciate their investment substantially before it becomes taxable.

The Benton County Assessor's office and the White County Auditor's office collect information on taxes collected from the wind industry in their respective counties and make this information available to the public. In order to provide some sense of the scale of these payments, and the way in which they vary over time, we reproduce those figures here. Annual estimated property tax revenues the two counties receive from the industry are reported in Table 4. These vary over time, but the most recent (2019) figures were $4.3 million for Benton County and $2.3 million for White County.

One striking aspect of the tax revenue collections is their growth over time. An increase in county revenues is mostly attributable to the gradual phase-out of tax abatements given to the industry when it first arrived. Both counties have also seen additional construction of turbines over time, which also raises their ability to collect taxes now and in the future. One factor that limits the growth of property tax revenues is the depreciation of the value of the assessed value of each turbine over time. Absent further construction in the two counties, and the tax revenue collections will peak, eventually, and diminish as the value of the turbines gradually depreciates.

[29] IUERI (undated)
[30] Information on local tax rates taken from http://www.stats.indiana.edu/web/profiles/tax_rates_2016/Benton.html, downloaded February 27, 2020.

Table 4. Property tax revenue paid by the wind generation industry in Benton and White Counties

	Estimated property tax receipts from the wind sector	
Tax year	**Benton County**	**White County**
2009 (payable 2010)	$135,847	-
2010 (payable 2011)	$565,124	-
2011 (payable 2012)	$1,022,809	$274,383
2012 (payable 2013)	$1,356,638	$607,036
2013 (payable 2014)	$1,817,621	$695,287
2014 (payable 2015)	$2,109,964	$985,148
2015 (payable 2016)	$2,624,256	$1,330,060
2016 (payable 2017)	$3,085,724	$1,563,636
2017 (payable 2018)	$3,646,631	$1,829,141
2018 (payable 2019)	$4,304,694	$2,260,411
Totals, to date	**$20,669,308**	**$9,545,102**

Notes: Publicly available information on property tax collections provided by the Benton County Assessor's office and the White County Auditor's office

A second striking aspect of the revenues reported in Table 4 is their scale. The scale of these figures is perhaps best understood in terms of their relationship to the population of each county. U.S. Census Bureau estimates for the 2019 population of Benton County was 8,748. This means that Benton County collected approximately $492 per person in property taxes from the wind industry in 2019. The Census Bureau estimates that the White County population in 2019 was 24,102. White County collected approximately $94 per person in property taxes paid by the wind industry.

Both Benton and White counties use tax revenues collected from the wind industry to reduce the burden of property taxes on their residents. Much of this property tax relief occurs in the particular townships where the turbines are located. Data from the White County Auditor reports the total tax levy for each township, and the share of each township's property taxes that is paid by the wind industry. In West Point Township, which has two taxing districts associated with the Frontier and Tri-County School Corporations, 51 and 41 percent of the property tax revenues are paid by the

wind industry, respectively. In Round Grove Township, 45 percent of property tax revenue that is collected is paid by the wind industry.

Data from the Benton County Assessor reports tax rates for townships and towns in Benton County over the period in which the wind generation industry has been active in the county (2006-2019). Although average tax rates fell in both towns and townships, most of the tax relief associated with the wind industry occurred in the townships. Table 5 reproduces a table from the Assessor's office that documents average property tax rates over the period.[31] From 2006 to 2019, the average tax rate in Benton County's townships fell from 2.20 to 1.05 percent of assessed value. The scale of the tax reduction is quite stable across Benton County's individual townships. In Benton County towns, the average property tax rate fell from 3.01 to 2.77 percent of assessed value over the 2006-2019 period.[32]

Table 5. Average property tax rates for Benton County towns and townships, 2006- 2019

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Avg all	**2.49**	**2.87**	**2.64**	**2.05**	**2.10**	**1.96**	**1.81**	**1.60**	**1.68**	**1.57**	**1.56**	**1.61**	**1.61**	**1.66**
Avg tws	**2.20**	**2.53**	**2.31**	**1.59**	**1.58**	**1.44**	**1.30**	**1.12**	**1.07**	**0.97**	**0.99**	**0.99**	**1.00**	**1.05**
Avg towns	**3.01**	**3.49**	**3.25**	**2.90**	**3.05**	**2.92**	**2.75**	**2.49**	**2.79**	**2.67**	**2.63**	**2.77**	**2.73**	**2.77**

Notes: Average property tax rates for all Benton County tax units, for townships (tws) and for towns. Data is publicly available from the Benton County Assessor's office. Property tax rates rounded to two decimal places here for the purpose of brevity.

IV.b. Economic Development Agreement payments

In addition to tax revenues, the industry typically negotiates additional payments to local governments under the terms of an "economic development agreement." In the initial years of a project's life, property tax revenues are often delayed by tax abatement agreements. Payments from the economic development agreements are typically made nearer the beginning of the project's life. In news reports, these payments are typically reported in the aggregate. For example, Douglas (2019) writes, "the Amazon Wind Farm Fowler Ridge project is expected to make $5

[31] Tax rates are rounded to two decimal points, from four, for brevity and clarity.
[32] The property tax changes at the town level are considerably more variable than across townships, and probably reflect other developments in the towns.

million in economic development payments to Benton County over 17 years." It is also useful to understand the level and timing of annual payments under the agreements.

The White County Auditor graciously provided us with publicly available information on payments made to the county as part of economic development agreements with the Meadow Lake Wind Farm. Each of the five phases of construction of the farm generated two or three annual payments. In the first year, 2009, White County received $1.92 million of economic development funds, with somewhat larger payments in the following years. In 2011, Meadow Lake Wind farm-made scheduled payments early; these payments amounted to almost $3.3 million. As of September 2019, Meadow Lake Wind Farm had made payments amounting to more than $12.5 million to White County. These payments were linked to each of the five distinct phases of the project.

The White County government itself retained just over half of the economic development agreement payments, disbursing the rest to other local government institutions and organizations. The largest recipients of the disbursements were the Frontier and Tri-County School corporations, which by September 2019 had received more than $2.6 million and $3.3 million, respectively, of these funds. Other recipients of distributions included five different townships, the town of Chalmers, and the Brookston and Wolcott public libraries.

IV.c. Road Use and Decommissioning Agreements

Two other kinds of negotiated agreements govern relations between the industry and the county governments – road use agreements and decommissioning agreements. Both agreements require the industry to post a bond to ensure that the industry's presence does not impose a financial burden on the county.

One local government official said that road use agreements are probably the most important and most difficult agreements to negotiate with the industry. The agreements specify which roads will be used to move heavy equipment, and outline conditions under which these roads will be left. Under the terms of the agreement, the industry is responsible for funding preparation of the roads for their use and repair of the roads should any damage be caused. In some cases, the industry leaves roads in better conditions than they were before construction (because the paving of rural roads outlasts the construction period, for example). IUERI (undated) discusses the road use agreement between Benton County and Pattern Energy Group – the developer of the Amazon Wind Farm Fowler Ridge project – and explains that the project allowed the county to spend an additional $35 million over ten years on county roads.

Decommissioning agreements are designed to ensure that the turbines and other materials such as concrete will be removed at the end of the project, regardless of unforeseen circumstances. Developers post a bond with the county to cover the costs of turbine removal. Even if the wind farm were to be in financially distressed circumstances near the end of the project, these funds would be available to finance the removal of the turbines and other materials.

V. Policy

Finally, we turn to a characterization of government policies that have facilitated or impeded the growth of the utility-scale wind-energy generation sector in Indiana. The governments that are most relevant for this report are county governments, whose control over planning and siting authority gives them an effective veto on the development of large-scale wind energy production capacity. These authorities are, however, given by state law, and so a comparison of Indiana state law with those of other states is also useful. For context, it is also helpful to consider other policies at the local, state, and federal levels that are relevant to an understanding of the industry's development and footprint. The broad lesson of this summary is that federal policy, and - to a degree - state policy has been supportive of further investments in utility-scale wind energy capacity. The majority of Indiana counties that have considered the issue have, however, used siting and planning authorities to substantially limit the scale of the sectors' investments in the state. The tension between local policy decisions and policy goals at the state and federal level bears further scrutiny.

V.a. State policies towards wind energy generation

Analyses of state government policies towards renewable energy often focus on so-called *renewable portfolio standards* (RPS), policies that require regulated utilities in a state to increase their purchases of electricity that is produced by renewable sources. Illinois, for example, mandates that renewable sources will produce 25 % of the states' energy by 2025.[33] Indiana is the only state bordering the Great Lakes without a binding RPS. Instead, 2011 legislation provides financial incentives to utilities to increase their 2010 clean energy production by 2025. Indiana's law defines

[33] Illinois further mandates that 75% of these purchases should be generated by wind. See Mills *et al*. (2014) for a discussion of state policies related to wind power in the Great Lakes region. The discussion of Indiana's policies also relies on Mills, *et al.* (2014).

a large number of energy types as "clean," meaning that the policy is far less oriented towards increasing wind production than are policies in other states.

Mills *et al.* (2014) argue that the rapid growth of wind-energy production in Indiana - even in the absence of an RPS - can be attributed to two factors. First, siting authority in Indiana falls exclusively to counties, rather than to other local governments such as townships. This eases the permitting process for developers in Indiana, relative to other states, especially for projects that cross-city/township borders.[34] Second, wind equipment installed after December 31, 2011, earns a tax exemption from state and local property taxes, a law that reduces the tax burden on capital-intensive wind projects.[35]

One piece of state law that affects how local governments relate to wind energy developers is the restrictions that the state places on local governments' use of development impact fees. Development impact fees are "a monetary exaction other than a tax or special assessment that is charged by a local governmental agency to an applicant in connection with the approval of a development project to defray all or a portion of the cost of public facilities related to the development project."[36] Indiana's legislation limits the purposes for which impact fees can be collected, and imposes constraints on the ability of local governments to impose impact fees on developers. The financial arrangements between developers and local governments have, therefore, more often taken the form of negotiated agreements, notably *economic development agreements, road use agreements,* and *decommissioning agreements*.[37]

V.b. County-level policies

The most important policy levers that are available to county governments - with respect to wind power development - are the planning and siting authorities given to them by state law.[38] In the case of utility-scale wind-power in Indiana, these authorities are spelled out in county-level wind ordinances. Wind ordinances typically define a set of parameters that regulate the size and location

[34] While the number of local units that have authority over a project is typically smaller in Indiana than in other states, in recent years Indiana counties have shown themselves willing and able to use siting and planning authorities to restrict utility-scale wind production in their localities. The advantages that Mills cites in 2014, seem to have dissipated over time.
[35] For details on the tax exemption, see https://programs.dsireusa.org/system/program/detail/54 (downloaded February 29, 2020).
[36] See Brown and Lyons (2003), p.2.
[37] See, for example, the discussion of economic development payments made in IUERI (undated).
[38] For a comprehensive discussion of zoning issues as they relate to wind energy systems, see Schindler, *et al.* (2017). This discussion relates to Michigan in particular, but is useful for understanding the issues more broadly.

of turbines. Other provisions may impose limits on the level of sound emitted by the turbines, and on the shadows that the turbines cast on other properties.

Developers of wind power see combinations of these regulations as either favorable or unfavorable to wind energy investment. Of particular importance are limitations on the height of the turbines as well as the "set-back" provisions that require a turbine to be a given distance from the properties of adjacent landowners/ and or an adjacent dwelling place. Height restrictions and/or setback provisions can effectively rule out economically viable turbines, because - as discussed earlier - turbines in most of Indiana must be 100 meters high or more to be economically viable. The following discussion of Indiana county ordinances is based on information provided by Indiana Conservative Alliance for Energy (ICAE), the sponsor of this research. A comprehensive database of Indiana county wind ordinances is available on-line.[39]

The most common setback provision in Indiana is a requirement that turbines be located inside the property at a distance of at least 1.1 lengths of the turbine tip from the nearest property line. This regulation appears in the Benton County wind ordinance, among others, so this regulation does not appear to be binding on utility-scale investments. More substantial set-backs can discourage investments. Cass County requires that turbines be set-back a distance equaling the greater of 2.5 times the height of the turbine or 1,500 feet. This is a regulation that can deter investment; for example, the 1500-foot setback rules out the use of a quarter-section of land that has neighbors on two sides.

The second form of set-back provision is the allowable distance of the turbine to the nearest dwelling. It is common for Indiana counties to require that turbines are located at least 1000 feet from the nearest residence, a regulation that does not appear to be particularly binding on Indiana wind investments. Several counties impose more substantial setback provisions for dwellings. Wabash County, for example, requires that turbines be located at least 3,960 feet from residences owned by landowners not participating in the project, while Tipton County requires turbines to be set back 2,640 feet from non-participating residences.[40] Other counties impose set-backs relative to dwellings as multiples of tip-heights. Steuben County requires that turbines should be located at a distance from dwellings that is at least three times the height of the turbine's tip.

Some counties impose direct limits on turbine height. Hamilton County requires that the tip of the turbine be no larger than 300 feet; Delaware County requires turbines to be no larger than 150

[39] https://windexchange.energy.gov/policies-incentives?state=in. Downloaded March 3, 2020.
[40] Both counties have still large, but somewhat smaller set-backs from dwellings owned by landowners participating in the project.

feet.[41] The 100-meter turbines that can access strong and stable winds in most of Indiana have their hubs at 328 feet, and the tips of these turbines would be even higher. A restriction of 300-feet would thus discourage most large-scale investments, and a 150-foot limit would rule them out altogether.

County wind ordinances include a range of other restrictions that the industry sees as inhibiting or precluding investment. Some counties impose noise limits. Wabash and Montgomery counties limit the sound emitted from the turbine to no more than 32 decibels. For comparison purposes, the Occupational Safety and Health Administration estimates that a human whisper, heard at a distance of 5 feet away, is approximately 40 decibels.[42] Other counties allow somewhat higher levels of admissible sound and measure the sound at the nearest physical structure rather than at the tower itself.

Finally, several Indiana counties have imposed moratoria on investments in large-scale turbines. At current writing, 11 counties have moratoria on further investments: Allen, Boone, Clinton, Fulton, Grant, Jay, Marshall, Pulaski, Rush, Wayne, and Wells Counties.[43] A moratorium in Posey County was pending as of October 2019.

For counties without a moratorium, it is not always clear to the outsider which restrictions effectively limit investment and which do not. Technological change happens rapidly, and regulations may become more or less binding as technology changes. As of October 2019, ICAE judged nine Indiana counties to be open to further investments in the sector, while 29 counties had wind ordinances that substantially limit or effectively prohibit further investment in utility-scale wind energy capacity.[44] ICAE estimates that more than $30 million of past investments had been stranded as a result of restrictive county ordinances and that the potential investment in Indiana that had been precluded by restrictive ordinances was at least $5.08 billion.[45]

V.c. Relevant federal subsidies

[41] Tippecanoe County's ordinance also imposes effective restrictions on tower height, but restricts the height of the tower not the tip of the turbine. Turbine towers in Tippecanoe County may be no larger than 140 feet high, a level well below the heights necessary for economic viability of utility-scale generation.
[42] https://www.osha.gov/SLTC/noisehearingconservation/loud.html, downloaded March 3, 2020.
[43] Jasper County's moratorium is partial, applying only to areas north of County Road 1200.
[44] Benton, Blackford, Carroll, Fountain, Gibson, Huntington, Madison, Randolph and White Counties were seen as open to further investment. Allen, Boone, Cass, Clinton, Dekalb, Delaware, Fulton, Grant, Hamilton, Hendricks, Henry, Howard, Jasper, Jay, Kosciusko, LaPorte, Marshall, Miami, Montgomery, Noble, Pulaski, Rush, Steuben, Tippecanoe, Tipton, Wabash, Warren, Wayne, Wells and Whitley Counties had ordinances or moratoria that were judged to be restrictive. Posey County's wind ordinance was pending, and expected to be restrictive.
[45] Communication from the Land and Liberty Coalition, December 4, 2019.

The U.S. federal government has used a variety of subsidies and tax credits designed to encourage the production of renewable energy. The structure of these programs and their generosity has varied in response to economic conditions and to technological developments in the industry. A comprehensive discussion of existing federal incentives is taken from OEERE (2020). In this survey, we review both the existing federal incentives and the incentives applied to past investments in Indiana's wind capacity.

The most well-known and most well-used subsidy in the industry is the renewable energy production tax credit (PTC). The PTC provides a federal tax subsidy for each unit of electricity produced by qualifying renewable technologies. Turbines that begin construction in 2020 receive 1.5 cents per kilowatt-hour of production in the first ten years of their productive life.[46] This amounts to $15 per Megawatt hour. To put this into a local perspective, a 2 MW turbine working at 1/3 capacity (a rough approximation of the typical turbine in Indiana) would earn about $10 per hour of under the current PTC. Most of Indiana's existing turbines would still be earning revenues under the PTC, though Indiana's oldest turbines have already finished their ten-year period of receiving the tax credit.

One longstanding alternative to the production tax credit is the Business Energy Investment Tax Credit (ITC). OEERE (2020) explains that the ITC is a one-time credit taken at the beginning of the project and is taken in place of the PTC. In general, it is understood that projects that expect to see higher production will earn more after-tax revenues with the PTC, while more marginal projects earn more through the ITC. There does not appear to be any data available on the choice of ITC vs. PTC for Indiana projects.

Another federal program that has been important for the development of wind energy in Indiana is section 1603 of the American Recovery and Reinvestment Act of 2009. Conceived at a time when financial markets were in turmoil, the program was designed to bring forward the PTC to the then-present time, encouraging investment in wind technologies and potentially providing economic stimulus to areas of rural America with wind energy resources. The program is a grant, and firms were to receive - upfront - the expected value of the PTC that they would have otherwise earned over the lifetime of their project. A federal website documenting the program lists projects that were funded under section 1603, along with the levels of funding each received. The program

[46] See OEERE (2020). The PTC was not planned to be extended to projects constructed after 2019. The "Taxpayer Certainty and Disaster Relief Act of 2019" extended the PTC to wind projects that begin in 2020 (National Law Review, 2020).

led $346 million of federal funds to be paid to support investments in utility-scale wind projects in Indiana in the years 2009-2012.[47]

V.d. Policy-tension between different levels of government

One of the lessons to take from section V is the tension that exists between state and federal policies on the one hand, and, on the other hand, the policies of counties that have limited the growth of wind power investments. While state - and especially federal - policies encourage investments in the sector, the ultimate decision about whether to allow a given project rests with the county government where the project is to be located. This situation is the result of Indiana's granting of full siting and planning authority to local county governments. Other states - notably Minnesota, Ohio, and New York in the Great Lakes Region - have responded to similar tensions by reclaiming siting and planning authority for large scale wind projects.[48] Minnesota and Ohio have reclaimed state-level decision-making authority for wind projects that are over 5MW in nameplate capacity. New York has state-level decision-making for projects of over 25MW of nameplate capacity.

VI. Conclusion

The utility-scale wind generation of electricity has been part of the Indiana landscape since 2008. The earliest projects were concentrated in the west-North Central part of the state, the area that had the most favorable wind conditions for the technology of the time. Subsequent technological innovations, especially the development of taller turbines, have expanded the potential for other parts of Indiana to host utility-scale wind farms. While the large-scale generation of electricity from wind power is now viable in many counties of Indiana, county governments have used their legal authorities to inhibit or preclude development. Understanding how and why counties come to such decisions is the primary question of interest for this report.

County governments that have allowed the development of utility-scale wind farms have benefitted financially from the decision. The counties that allowed the first turbines – Benton and White Counties – collected $4.3 million and $2.3 million, respectively, in 2019, property taxes from their local wind farms. The industry also makes substantial payments to the counties under

[47] Authors' calculations based on data downloaded from https://www.treasury.gov/initiatives/recovery/Documents/Website%20Awarded%20as%20of%203.1.18.xlsx on March 2, 2020.
[48] Mills, et al. (2014), Appendix A.

the terms of economic development agreements. Road use agreements and decommissioning agreements are designed to offset other potential burdens the industry might place on the county.

The wind-generated electricity industry is capital intensive, which means that a large share of the industry's revenues must go to compensate those who financed the large investments made at the time of construction. But the industry also makes payments to local citizens. The industry pays local landowners – primarily those who host turbines on their land - but also others that are affected by its presence. In the short periods of construction, there is an intense economic activity in the local areas and numerous short-term employment opportunities. In the operation phase, the employment numbers are smaller, but the jobs are more stable.

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