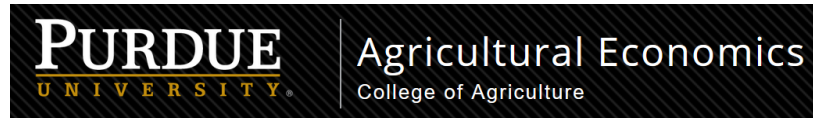




Extension
COMMUNITY DEVELOPMENT



Agricultural Economics
College of Agriculture



Center for Regional Development

AN EXAMINATION OF THE COMMUNITY LEVEL DYNAMICS RELATED TO THE INTRODUCTION OF WIND ENERGY IN INDIANA

Executive Summary

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INTRODUCTION

Wind power, electricity created by capturing the kinetic energy of wind by modern wind turbines, is an attractive, clean, and one of the lowest-cost renewable electricity alternatives currently available. Wind energy is not new to Indiana. The utility-scale wind generation of electricity has been part of the Indiana landscape since 2008.

Most of the wind projects are built in rural areas, and they represent a source of revenues for counties, lease payments for rural landowners, short and long-term job growth, and much needed rural economic development. While these advantages provide compelling evidence for supporting wind power expansion, wind power has experienced community-level opposition in numerous communities in Indiana.

Renewable energy, including wind energy, deserves closer examination given the inherent advantages and disadvantages, and, most importantly, it is potential for becoming a critical element in Indiana's community development and energy portfolio.

Although many studies have examined the benefits and costs associated with wind power introduction and expansion, there is still not an overall consensus at the local, state, or national level. Our project tries to find a coherent way to address the variety of assets and challenges that the communities are facing in terms of wind energy farm's construction and use.

This report examines the wind energy sector in Indiana and selected counties and includes information gathered via two different replicable approaches: rigorous secondary data analysis and primary data collection using an on-line survey and on-line listening sessions. The goal was to assess the socio-economic impacts of the wind energy sector in Indiana.

Trying to capture the multi-dimensional nature of community development, we identified the following key assets of wind energy in White County and Benton County: natural, cultural, human, social, political, financial, financial, and built capitals.

Wind energy represents a huge investment in Indiana communities. The wind farms bring geographically diverse and long-lasting benefits, including millions of dollars in property tax revenue and annual lease payments for Indiana's farmers and well-paying manufacturing and construction jobs. But wind energy is associated with skepticism, suspicion, and opposition. We provide a couple of suggestions that might help in the effort to support the development of wind

farms: (a) awareness of key assets and challenges in counties supporting or declining wind farms that are related to the wind energy, (b) legislative instruments, (c) technology development, (d) awareness-raising capacity building and education, (e) fostering positive relationships between the commercial wind energy company and local communities.

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 Later 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 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

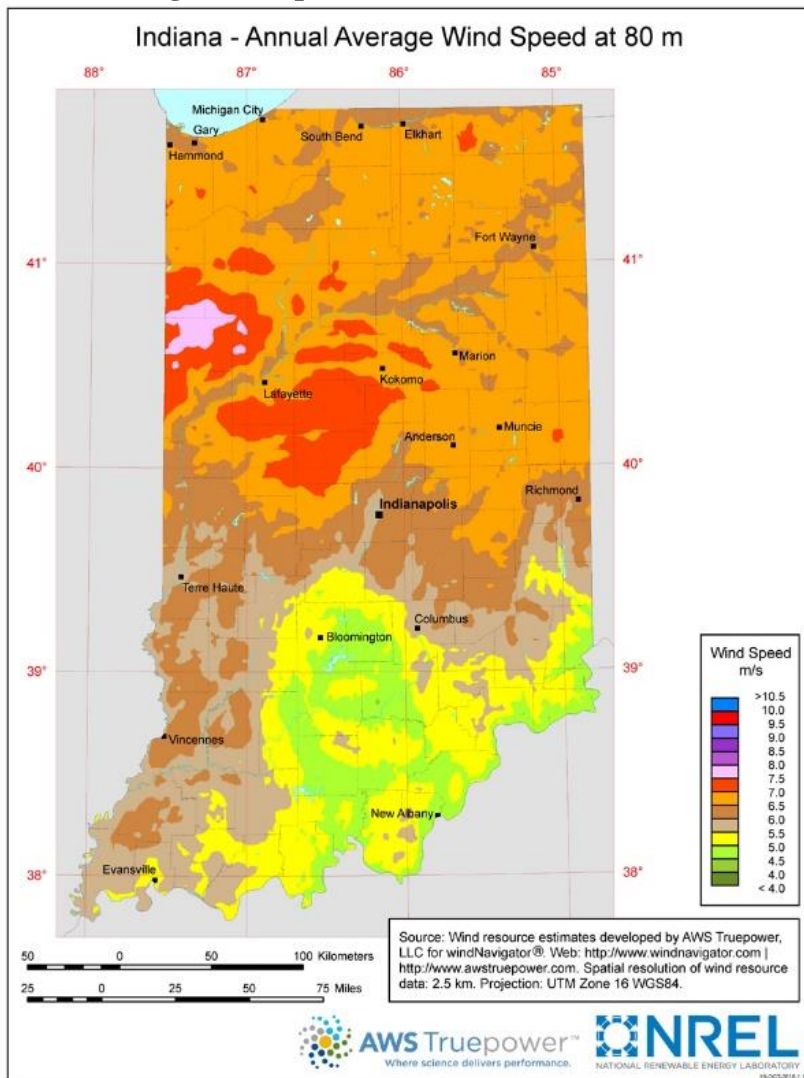
¹ The arrival of the wind power sector in Indiana coincides with a national boom in the construction of such facilities – a boom that was made possible by the American Recovery and Reinvestment Act, the federal stimulus designed to offset the effects of the global financial crisis. See Johnson (2009)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

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. Average wind speeds in Indiana at 80 meters



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

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

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>.

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 critical 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.

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

Project name	County	Nameplate Capacity (M.W.)	Turbine count	Year on-line	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 U.S. Wind Turbine Database. Retrieved from <https://eerscmap.usgs.gov/uswtodb/viewer/#6.3/37.778/-87.597>, <http://gis.awea.org/arcgisportal/apps/webappviewer/index.html?id=eed1ec3b624742f8b18280e6aa73e8ec>

In recent years, the industry has adopted taller turbines. 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.

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 on-line 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.

The wind industry as a source of income

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 electricity show that the purchase and installation of the turbines themselves represent a significant share of the total cost of generating wind-powered electricity.⁴ 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.

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.

⁴ 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.

Indiana’s total nameplate capacity of utility-scale wind turbines is just over 2300 MW. Using the \$3000-\$6000 per M.W. range quoted in the news article, this means that landowners in Indiana are paid somewhere in a 7.5 to the 15-million-dollar range for hosting turbines.

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%.⁵ 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.

Employment

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. 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.

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

⁵ 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.

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)	On-line 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.

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.

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 wider 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 residents of Indiana. In contrast, 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.

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.⁶ 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.

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. 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.

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

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

⁶ 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.

the sector 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.

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.

Policy

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.

One of the lessons to take from the policy analysis 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.

COUNTIES SELECTED AS CASE STUDIES

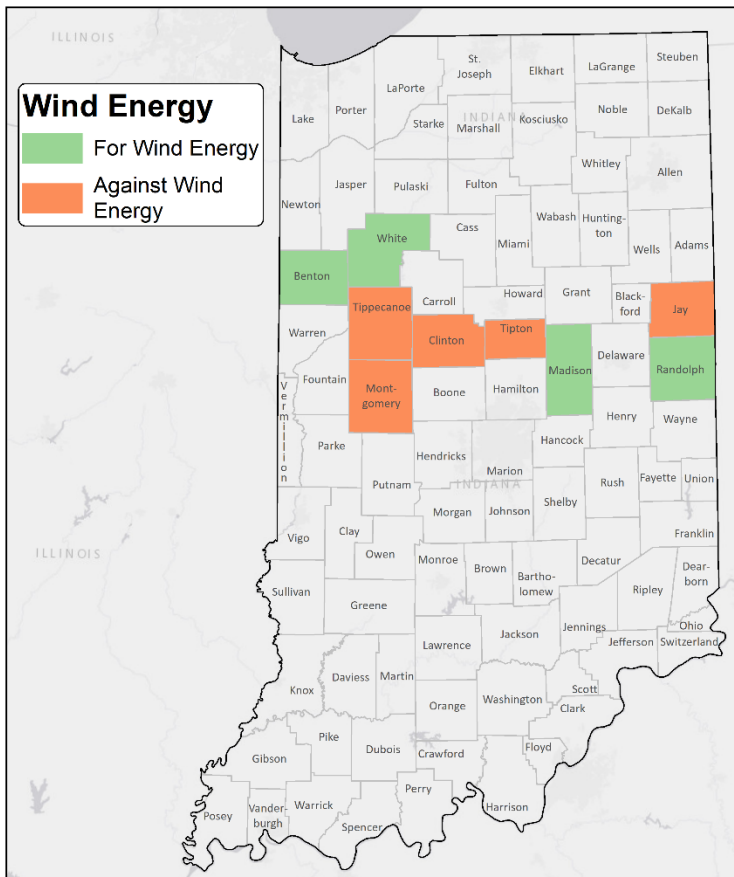
While advantages resulting from the wind energy industry provide compelling arguments for supporting wind power expansion and the number of wind farms in Indiana has increased steadily, many wind power projects have experienced community-level opposition in the proposed wind farm area.

Different public opinions related to the wind farm projects led us to divide counties selected as case sites into two groups (Figure 2):

Group 1 – For wind energy counties: Benton, White, Randolph, and Madison

Group 2 – Against wind energy counties: Tippecanoe, Clinton, Montgomery, Jay, and Tipton

Figure 2. Selected counties in Indiana



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 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.

LOOKING FORWARD

Wind energy represents a huge capital investment in Indiana communities. Wind farms bring geographically diverse and long-lasting benefits, including millions of dollars in property tax revenues and annual lease payments for Indiana's farmers and well-paying manufacturing and construction jobs. But wind energy is associated with skepticism, suspicion, and opposition. We

provide a couple of suggestions that might help in the effort to support the development of wind farms.

I. Awareness of key assets and challenges in counties supporting or declining wind farms that are related to the wind energy

- The statistical analysis of studied counties revealed a set of characteristics that are common for the counties supporting the development of the wind energy industry (Benton, White, Randolph, and Madison counties). Those counties
 - are more dependent on agriculture;
 - suffer from decreasing population;
 - have lower population density;
 - are more consistent in terms of educational attainment levels (compared to the counties that are against the wind energy);
 - have a higher relative labor participation rate (compared to the counties that are against the wind energy);
 - have a higher relative inflow of earnings (compared to the counties that are against the wind energy);
 - are net exporters of labor to neighboring counties.
- The statistical analysis of studied counties uncovered a set of features that are common for the counties declining development of the wind energy industry (Tippecanoe, Clinton, Montgomery, Jay, and Tipton). Those counties
 - are more manufacturing-oriented;
 - two counties experienced an increase in population during 2010-2018;
 - vary widely in educational attainment across each county.
- Counties with wind energy benefit financially from the development of utility-scale farms. The industry pays local landowners – primarily those who host turbines on their land - but also others that are affected by its presence.
- In For Wind Counties the public receives positive messages about wind energy from local officials in Benton and White counties. That presumably explains why there are not partisan or ideological differences in support for wind energy. In Against Wind Counties, some of the local government members and community stakeholders oppose wind energy on the grounds of its cost or other characteristics. The attitudes toward wind power become more biased, which could cause support for wind power to decline.

- Wind energy expansion can be accepted differently. Some people can see the expansion as beneficial for county development and are positive. Others may express a lot of concerns and negativity.
- The new wind energy technologies are better and possibly can use the existing infrastructure in the counties that want to expand the wind energy sector.
- Road use agreements and decommissioning agreements are designed to offset other potential burdens the industry might place on the county.
- Wind energy has been changing the landscape that challenges many people.
- The constraint on the expansion can be due to a setback requirements, such as a small airport (because of radar at the airport, it is not allowed to build wind turbines in a certain radius around the airport) and different kinds of easements such as electrical transmission line, utility easements, and agricultural drainage easements.
- It is going to be harder to find areas for wind farm expansion that stay away from municipalities and large populations or areas with receptive communities.

II. Legislative instruments

There is a 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 the federal and state 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.

A possible step to improve an effective legislative system to promote the implementation of wind energy is reclaiming siting and planning authority for large scale wind projects.

County governments that have allowed the development of utility-scale wind farms have benefitted financially from the decision. A number of documents and agreements secure benefits from the wind farms and offset potential burdens the industry might place on the county: Decommissioning Agreements, Road Agreements, Good Neighbor Agreement, Adjustments of the Good Neighbor Agreement, and Economic Development Agreement.

III. Technology development

Wind power is capital-intensive, and the purchase and installation of the turbines themselves represent a significant share of the total costs.

Utilization of the existing infrastructure – sections and towers - in the counties that want to expand the wind energy sector might decrease the total cost of generating wind-powered electricity.

Subsequent technological innovations, especially the development of taller turbines, have expanded the potential for other parts of Indiana to host utility-scale wind farms.

Also, it is important to identify appropriate public/private partnerships for the promotion of wind energy technology development and implementation.

IV. Awareness-raising capacity building and education

The following steps might help to raise public awareness of the benefits and opportunities of wind energy:

- Implement training and education programs with regard to wind energy.
- Awareness-raising and marketing campaigns aimed at all stakeholders.
- Development and dissemination of a “benefits case for wind energy.”
- Improve communication and interaction between national, state, and county government institutions on wind energy policies.
- Receiving positive messages about wind energy from local officials and work closely with the community.

V. Fostering positive relationships between the commercial wind energy company and local communities

There are always individuals and groups within the local community who had benefited from the community fund and considered these benefits to be valuable. However, other community members can be suspicious of the developers from the earliest stages of the planning process.

Involving the public in planning and development process may help to reduce suspicions and skepticism, give members of the local community a sense of ownership over this aspect of the development, and can lead to positive outcomes. County and community benefits provide an excellent illustration of how increasing participation in early decision-making processes may, in turn, increase local acceptance of wind farms.