Estimated Economic Impacts of Utility Scale Wind Power in Iowa

Sandra Halvatzis and David Keyser
National Renewable Energy Laboratory

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Technical Report
NREL/TP-6A20-53187
November 2013

Contract No. DE-AC36-08GO28308

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

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Executive Summary

Iowa is ranked second (after Texas) in terms of cumulative wind energy capacity with 4,524 MW of capacity installed (AWEA 2012). The scale of wind energy deployment in Iowa has spurred in-state supply chain development and various activities that contribute to a diversified energy economy. State and federal policies, market conditions, and economic development priorities support the addition of wind energy capacity.

It is important to better understand the economic development impacts of wind energy in Iowa. This report analyzes the jobs and economic impacts of the first 1,000 MW of wind power generation in the state. The impacts highlighted here can be used in policy and planning decisions and can be scaled to get a sense of the economic development opportunities associated with other wind scenarios. The analysis can also inform stakeholders in other states about the potential economic impacts of this scale of new wind power development.

According to this analysis, the first 1,000 MW of wind power development in the State of Iowa (projects built between 1999 and 2008):

- Generated employment totaling nearly 2,300 full-time-equivalent (FTE) jobs within the State of Iowa during the construction periods
- Supports approximately 270 permanent Iowa jobs
- Supported nearly $290 million in economic activity for Iowa during the construction periods
- Supported and continues to support nearly $38 million in annual Iowa economic activity during operating periods
- Generates more than $6 million in annual property taxes[1]
- Generates nearly $4 million annually in income for Iowa landowners who lease their land for wind energy projects.

Results above are provided in 2010 real (inflation adjusted) dollars.

[1] Because tax payments vary every year, the annual property tax calculation is based on the average annual payment over a 20-year period and later deflated using a rate of inflation of 3%. See Section 3.3 for more information.

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1 Introduction

A growing population, increasing demand for energy, and energy price uncertainty have created public support for wind power development in several states. Iowa has sought to diversify its energy mix with wind energy, which can also address some economic development and environmental priorities.

Numerous conditions drive wind energy development in Iowa. Iowa has excellent wind resources (see Appendix), supportive state and energy market policies, robust transportation infrastructure, and a trained workforce. As a result, utility-scale wind projects bolster jobs and generate tax revenue that is used to improve schools and provide other public services, which in turn improve the quality of life in rural areas. In addition, landowners receive income in the form of land-lease payments for wind turbines located on their land.

Estimating the economic development impacts of power plants allows policymakers and decision makers to assess impacts on jobs and state economic growth (Lantz and Tegen 2008). This study captures the economic impacts of the first 1,000 MW of wind energy in Iowa. Specifically, we examine the impact of seven of the first utility-scale wind energy projects on the Iowa economy during construction and operation. We use 1,000 MW as a baseline because it can be scaled to get a sense of the economic development opportunities associated with other wind scenarios. It also represents an important threshold because at 1,000 MW the nascent in-state wind industry has demonstrated viability.

For the purposes of this study, state-level economic impacts include jobs, land-lease payments, property tax revenue, payroll, and business activity from wind project development. Results from this study do not include manufacturing impacts because during most of the period analyzed (1999-2008), utility scale wind component manufacturing did not exist in Iowa or was at an initial stage of development. However, a separate section of this report analyses manufacturing potential, particularly in light of the recent manufacturing development in the state. This section includes a sensitivity analysis of manufacturing activity in the state, with the purpose of informing policymakers of how purchases from in-state producers and suppliers could affect impact results.

2 Methodology

2.1 The Jobs and Economic Development Impact Model

This study utilizes the Land-Based Wind Jobs and Economic Development Impact (JEDI) model. The model is one element of a suite of JEDI input-output (I-O) models. JEDI models provide estimated economic impacts that are supported by investment in a number of different energy technologies. NREL and MRG & Associates developed the offshore wind JEDI model to incorporate the unique aspects of offshore wind development in to an economic impact tool that can be accessed and used by the public. [2]

I-O models are widely recognized tools that are used to estimate economic impacts associated with investments or expenditures. These models map how sectors in an economy such as businesses, households, workers, capital and governments interact with one another via purchases and sales at a single point in time. Because sectors are related to one another, an increase in demand for one can lead to an increase in demand for another. An increase in demand for steel towers, for example, results in increased demand for iron ore.

JEDI and other I-O models estimate economic impacts that are supported by changes in demand for goods and services produced by industries and households. [3] Goods or services produced by households include labor and property (such as land) that is sold or leased to industries. JEDI estimates changes in demand for these goods and services with data from the project scenario.

The JEDI project scenario is a set of data that describes a project. Each project contains two sets of line item expense categories such as equipment (blades, towers, turbines), materials and services, and labor. One set covers the construction of the project, the other covers operation and maintenance of a project. JEDI models contain default project scenario and cost data, but analysts with knowledge of project details can edit these defaults to better represent the scenario being analyzed.

The JEDI model also allows a model user to specify what portions of expenditures are made within the region of analysis. For example, the model allows users to specify whether wind turbine blades were manufactured in the state where the project is being built, or outside the state (assuming the state is the region of analysis). JEDI uses expenditures made within the region of analysis, or "local expenditures," to estimate economic impacts. The JEDI model does not estimate economic impacts outside the particular region of analysis (e.g., generator parts from China).

Economic impact estimates from JEDI take the form of a number of different variables at different times. Each data point represents a specific metric, that metric's relationship to the project, and the phase of the project in which it occurs.

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[2] The Land Based Wind JEDI model can be downloaded at http://www.nrel.gov/analysis/jedi/download.html. Accessed May 2012.

[3] JEDI currently uses the IMPLAN input-output model. More information about IMPLAN can be found at http://www.implan.com.

JEDI reports economic impact estimates for two phases: construction and operations and maintenance (O&M). Construction phase results are one-time totals that span the equivalent of one year. [4] O&M results are annual and ongoing for the life of the facility.

All impacts are based on expenditures and local content data contained within the project scenario worksheet. JEDI organizes these effects in to different categories based on how the user-specified project scenario supports the impact. The workers who install a wind turbine, for example, are onsite. The workers who manufactured that turbine are part of the supply chain. Installers and manufacturers earn wages and spend money within the region of analysis, which supports further economic activity (e.g., the construction workers eat lunch at local sandwich shops). The three categories of impacts used by JEDI are[5]:

- **Project development and onsite labor impacts** represent economic activity that is either directly involved with a project's development and implementation or that occur onsite. These impacts typically occur in the construction, maintenance, engineering and professional services, and port staging sectors. These do not include impacts that arise from expenditures for inputs used in a project.
- **Turbine and supply chain impacts** represent economic activity that is supported by inputs purchased for a project or business to business services. These include locally manufactured inputs such as blades and locally procured inputs used to manufacture those blades such as resin and fiberglass.
- **Induced impacts** accrue as money circulates in an economy. Households spend earnings from project development and onsite labor impacts as well as turbine and supply chain impacts. The portion of these earnings spent within the region of analysis supports induced impacts. These effects commonly occur in retail sales, child care, leisure and hospitality, and real estate sectors.

Figure 1 shows a graphical representation of the three types of impacts from JEDI.

[4] If, for example, JEDI reports a construction phase impact of 50 workers to build a project that takes two years to complete, this is the equivalent of an average of 25 workers per year (50 / 2 = 25). If the same project took 3 years, the average would be 17 (rounded) workers per year.

[5] Typically, I-O models organize impacts in to direct, indirect and induced effects. JEDI categories differ from these. Project development and onsite labor impacts include less than direct effects from project expenditures and turbine and supply chain impacts are more broad than the indirect effects from project expenditures. The Offshore Wind JEDI User Reference Guide (http://www.nrel.gov/analysis/jedi) contains more information about these differences.

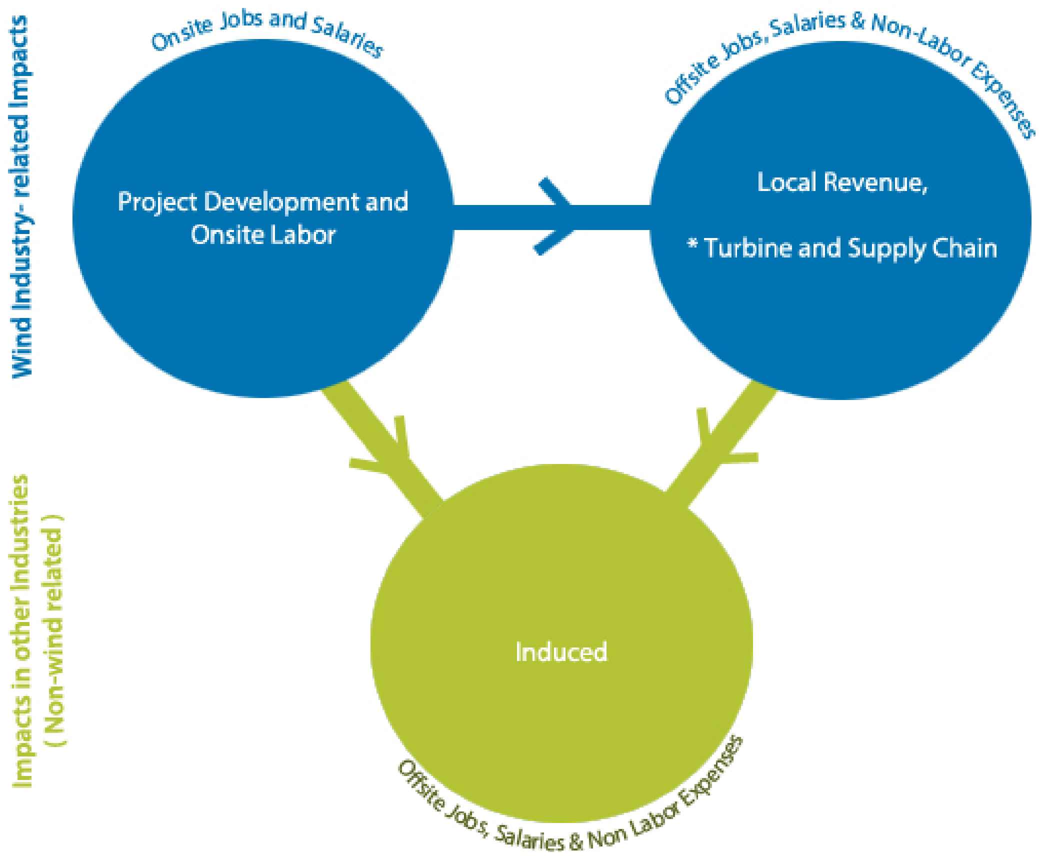

Figure 1. JEDI wind model economic development impact categories

JEDI reports three different metrics for each type of impact: jobs, earnings, and gross output. JEDI utilizes intuitive labels when reporting these metrics such as "jobs" and "earnings." Each metric, however, has a specific definition that informs how it should be interpreted.

- **Jobs** are expressed as full time equivalent (FTE). One job is the equivalent of one person working 40 hours per week, year-round. Two people working full-time for six months equal one FTE. Two people working 20 hours/week for 12 months also equal one FTE. An FTE could alternately be referred to as a person-year or job-year. Jobs, as reported by JEDI, are not limited to those who work for an employer – they could include other types of workers such as sole proprietors (self-employed).
- **Earnings** include any type of income from work, generally an employee's wage or salary and supplemental costs paid by employers such as health insurance and retirement. It could also be other non-wage compensation for work performed such as proprietor earnings.
- **Gross output** is the total amount of economic activity that occurs within an economy (within the region of analysis). It is the sum of all expenditures. A scenario in which a developer purchases a locally manufactured $500,000 blade that utilized $100,000 of locally procured fiberglass represents $600,000 in gross output.

As with all economic models, there are caveats and limitations to the use of JEDI. Input-output models in general utilize fixed, proportional relationships between sectors in an economy. This means that factors that could change this, such as price changes that lead households to change consumption patterns, are not considered.

JEDI provides estimates of economic impacts given the user-specified expenditures and economic conditions when input-output data were compiled. Impacts that extend in to the future (such as O&M impacts) are assumed to do so if all else is constant. There can be any number of changes in a dynamic economy that JEDI does not consider, so these future results should not be considered to be a forecast. They simply reflect how a project might look if it was completed in the current economy under the user-specified cost and local content assumptions.

JEDI results are based on project inputs, and these inputs can change from project to project. This is especially true of nascent technologies or technologies that have not yet been widely deployed in the United States. If an analyst wishes to estimate impacts from a specific project, tailoring inputs to that project should produce more accurate results. JEDI does not evaluate whether or not inputs are reasonable, nor does it determine whether a project is feasible or profitable.

Results from JEDI models are gross, not net. JEDI only calculates what economic activity would be supported by demand created by project expenditures. Other changes in an economy may take place that JEDI does not consider. These include supply-side impacts such as price changes, changes in taxes or subsidies, utility rate changes, or changes in property values. JEDI also does not incorporate far reaching affects such as greenhouse gas emissions, displaced investment, or potential side effects of a project such as changes in fishing, recreation, or tourism.

2.2 Research Data and Assumptions

Lists of Iowa wind power projects were obtained from the American Wind Energy Association (AWEA) and DNV (Det Norske Verita)[6] databases. These lists contained information regarding wind project location, completion status, project size, turbine manufacturer, project owner, number of turbines, and turbine size. Using these lists, the first 1,000 MW (nameplate capacity) of utility-scale wind projects (those larger than 50 MW) developed in Iowa were selected for this study. These projects were chosen based on information obtained from public sources as well as from interviews with developers and other wind industry stakeholders. These wind projects are listed in Table 1.

[6] Formerly Global Energy Concepts (GEC).

Table 1. Utility-Scale Wind Energy Projects Selected for this Study

Project Name	Storm Lake I & II	Top of Iowa	Hancock	Intrepid I	Century	Victory	Pomeroy I & II
Year of Construction	1999	2001	2002	2004	2005	2006	2007; 2008
Nameplate Capacity (MW)	188.3	80.1	97.7	161	185	99	198
Turbine Size (kW)	750	900	660	1,500	1,000; 1,500	1,500	1,500
Number of Turbines	251	89	148	107	135	66	132

Iowa reached its first 1,000 MW of installed wind capacity in 2007 (Figure 2), but given that not all the data for all those projects was available, we decided to include data and parameters pertaining to the second phase of the Pomeroy wind farm, built in 2008.

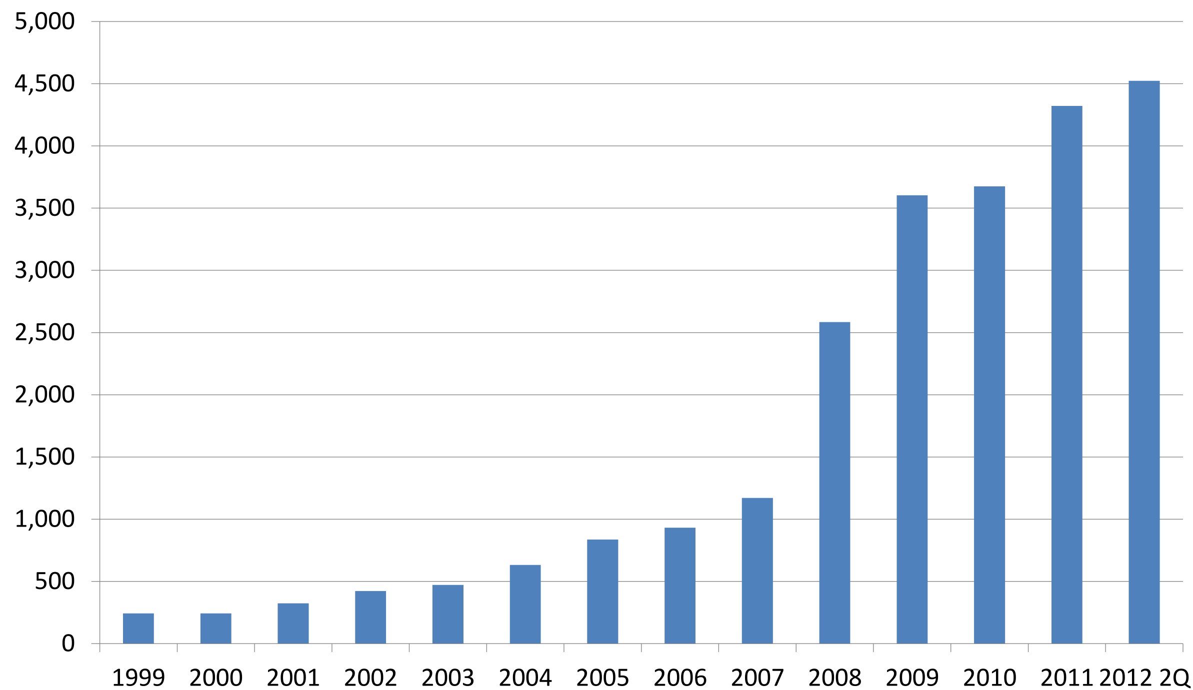

Figure 2. Wind powered electricity generation capacity in Iowa

Preliminary research for each project consisted of collecting media information and corporate press releases. This information provided an initial indication of the magnitude of the construction costs and the economic impacts of these projects in Iowa. This effort was complemented by a literature review. Extensive interviews were then conducted with developers, manufacturers, construction company workers, lawyers, county commissioners, farmers, farmer's union members, industry experts, and other stakeholders to provide further depth to the analysis. Data obtained from interviews included construction cost, operation and maintenance (O&M) cost, percentage of goods and services acquired in state, job generation during the construction period, job generation during the operation period, land-lease payments, tax information, payroll parameters, and cost breakdown of different installation and operation categories.

Utilizing the information derived from the sources noted above we developed specific assumptions including project cost (Table 2), detailed construction cost (Table 3), operating cost (Table 4), local share, and other relevant parameters (Table 5), which were used in the JEDI model to perform the analysis.

Table 2. Overall Cost Assumptions

Overall Cost Assumptions	
Installed Project Cost ($/kW)	$1200–$1,725[7]
Operations and Maintenance Cost ($/kW-year)	$16–$25[8]

[7] Range is provided in 2010 dollar figures
[8] Range is provided in 2010 dollar figures

Table 3. Construction Cost Assumptions

Construction	% of Total Cost	Local Share
Equipment Costs		
Turbines (excluding blades and towers)	44.9%	0%
Blades	10.5%	0%
Towers	11.6%	0%
Transportation	8.0%	0%
Equipment Subtotal	*75.1%*	
Materials		
Construction (concrete, rebar, equip, roads, site prep)	10.8%	60%
Transformer	1.2%	0%
Electrical (drop cable, wire)	1.3%	45%
HV Line Extension	2.4%	20%
Materials Subtotal	*15.7%*	
Labor		
Foundation	0.6%	70%–80%
Erection	0.6%	75%
Electrical	0.9%	25%
Management/Supervision	0.5%	25%–50%
Misc.	3.8%	0%
Labor Subtotal	*6.4%*	
Other Costs		
HV Sub/Interconnection Materials	0.7%	5%–10%
HV Sub/Interconnection Labor	0.2%	65%
Engineering	1.0%	50%
Legal Services	0.6%	50%
Land Easements	0.0%	100%
Site Certificate/Permitting	0.3%	100%
Other Subtotal	*2.8%*	
Total	**100.0%**	

Table 3 presents average calculations for the projects analyzed. Local share refers to the percentage of resources (e.g., labor, materials, supplies, and equipment) purchased or acquired in Iowa. As we can see from the above table, this analysis assumes that all wind turbine equipment (turbines, towers, blades) was manufactured outside of Iowa and imported into the state. According to this table, wind manufacturing (Equipment costs) and related transportation represent about 75% of total project cost.

Figure 3 provides a graphical representation of the assumed average cost breakdown used for this study.

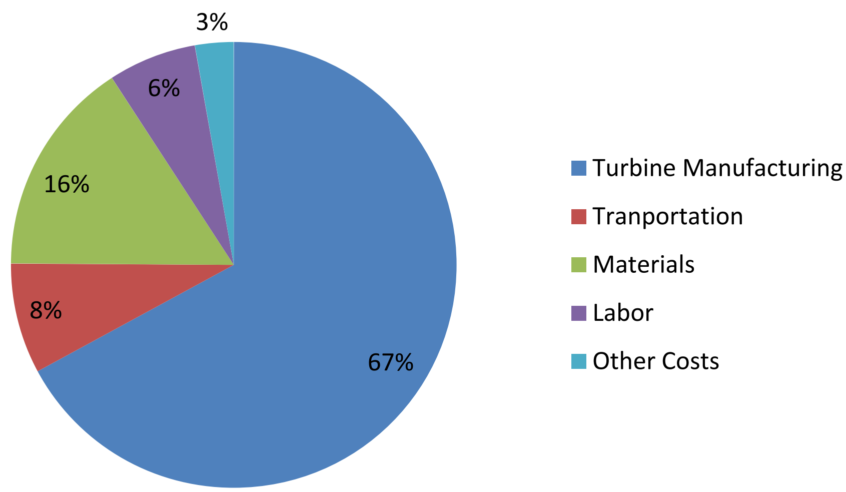

Figure 3. Assumed breakdown of construction cost

Table 4. Operating Cost Assumptions

Wind Farm Annual Operating and Maintenance Costs	**% of Total Cost**	**Local Share**
Labor		
Field Salaries	12.1%	100%
Administrative	1.6%	100%
Management	4.1%	100%
Labor/Personnel Subtotal	*17.9%*	
Materials and Services		
Vehicles	2.4%	100%
Site Maintenance/Misc. Services	0.9%	80%
Fees, Permits, Licenses	0.5%	100%
Utilities	1.9%	100%
Insurance	18.0%	0%
Fuel (motor vehicle gasoline)	0.9%	100%
Consumables/Tools and Misc. Supplies	6.9%	100%
Replacement Parts/Equipment/Spare Parts	50.6%	20%
Materials and Services Subtotal	*82.1%*	
Total O&M Cost	**100.0%**	

Table 5. Other Parameters

Other Parameters	
Financial Parameters	
Percentage Financed	80%
$ Years Financed (term)	10
Interest Rate	10%
Percentage Equity	20%
Corporate Investors (percent of total equity)	100%
Return on Equity (annual interest rate)	16%
Tax Parameters	
Average Taxes Per MW	$6,000 per year
Land Lease Parameters	
Average Lease Payment Per MW	$4,000 per year
Payroll Parameters (per hour)	
Construction Labor	
Foundation	$16–$22 per hr.
Erection	$18–$20 per hr.
Electrical	$25–$28 per hr.
Management/Supervision	$35–$45 per hr.
O&M Labor	
Field Salaries (technicians, other)	$22–$24 per hr.
Administrative	$14–$16 per hr.
Management/Supervision	$35–$45 per hr.

3 Results

We used the JEDI model to estimate the economic impacts of each of the Iowa wind power projects included in this study. Individual economic impacts were then aggregated to reflect combined impacts from 1,000 MW of wind energy development in Iowa.

Study results show significant economic impacts (see Figure 4). Impacts reported are centered on JEDI model results, which include employment, property taxes, landowner revenue, and local economic activity during the construction and operation periods (see Table 6). Although estimating all wind related impacts was beyond the scope of this analysis, it is important to note that new wind power installations provide many other tangible (e.g., use tax generation, sales tax generation, water savings, vendor profits, transmission line impacts, etc.) and intangible impacts (e.g., electricity price stability, and environmental benefits).

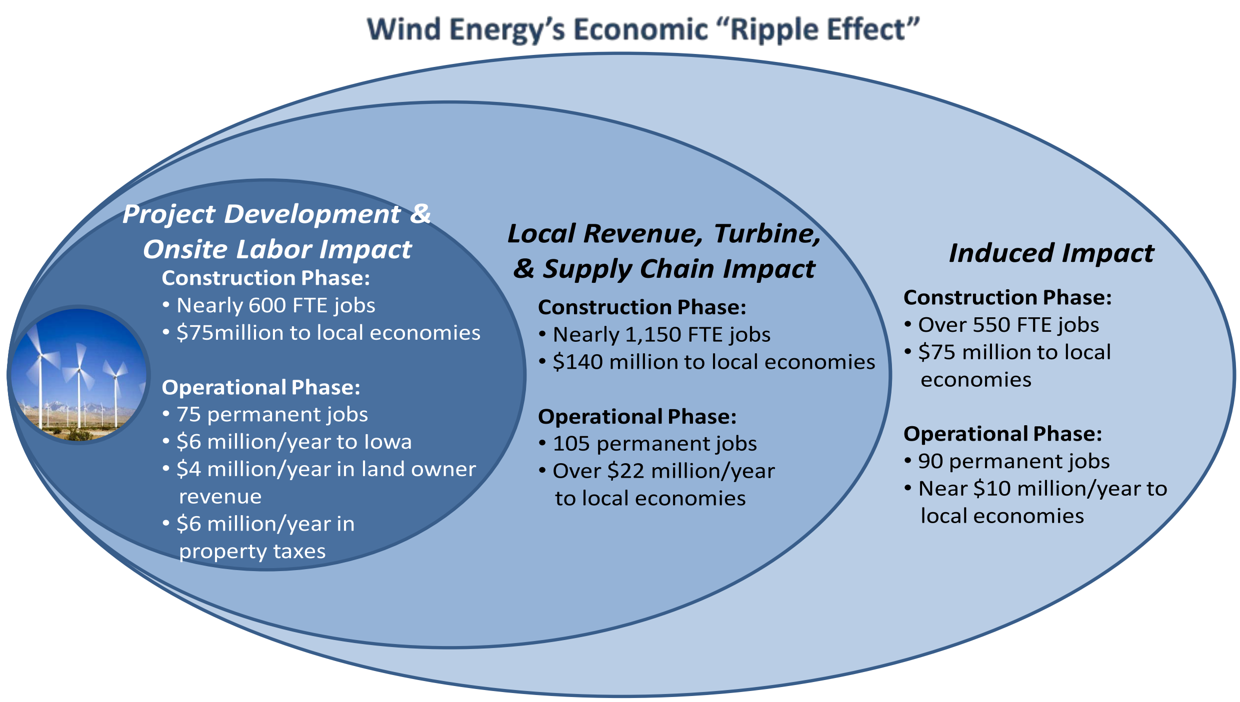

Figure 4. Economic ripple effect from 1,000 MW of wind energy in Iowa

Table 6. Iowa Summary Impacts[9] from 1,000 MW of Wind Energy Development

Iowa Economic Impacts	
During Construction	• Supported approximately 2,300 full-time-equivalent jobs (FTE) within the State of Iowa during construction periods • Supported over $290 million in economic activity for Iowa during the construction period
During Operating Periods	• Currently supports approximately 270 Iowa jobs annually • Annually supports nearly $38 million in gross economic activity in Iowa • Generates more than $6 million in annual property taxes[10] • Generates nearly $4 million annually in income for Iowa landowners who lease their land for wind energy projects

3.1 Gross Economic Activity

The construction and operation of wind power facilities can be a catalyst for much economic activity in Iowa. From rented accommodations that host the influx of construction workers to the suppliers and transportation companies that provide services to the wind farm, wind power development supports a significant impact to the state economy.

> *One thousand megawatts of wind power developed in Iowa generated approximately $290 million in economic activity during the construction phase and nearly $38 million in annual recurring local economic activity.*

The impacts noted above include only the portion of transactions that took place in Iowa. For example, equipment and components that were purchased from other states or other countries are treated as monetary leakages and are not included in these estimates. This study assumes that 1,000 MW of wind energy represents approximately $1.5 billion[11] in investment, which supports over $290 million at the state level (assuming no in-state manufacturing of wind system equipment). This represents approximately $75 million in on-site project labor, $140 million in construction materials and supply chain equipment, and $75 million in induced activities during the construction period (Figure 5).

[9] Results are provided in 2010 real dollars.
[10] See Section 3.3 for more information.
[11] 2010 dollars.

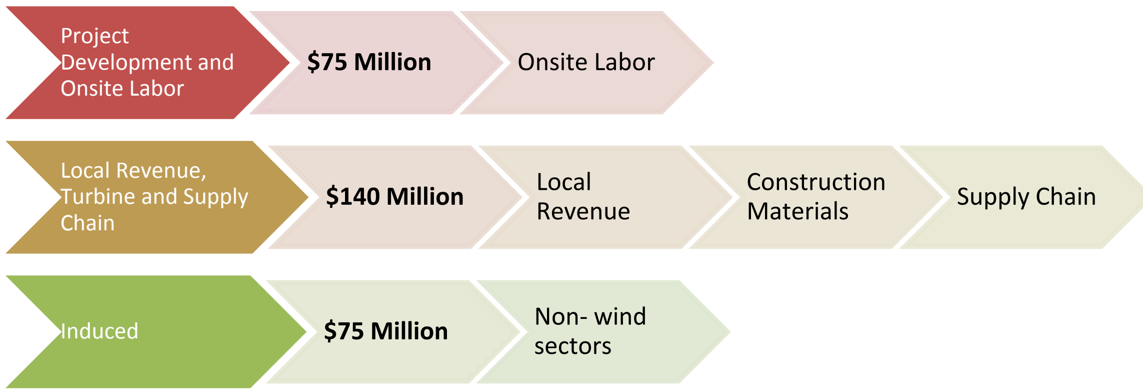

Figure 5. Estimated local spending supported by 1,000 MW of wind energy in Iowa during project construction

3.2 Employment Impacts

3.2.1 Construction Jobs

During the construction period[12] construction workers, engineers, surveyors, turbine installers, electrical contractors, administrative employees, and managers move to town boosting local economic activity. Local workers may be employed directly on the new wind project, depending on the talent pool and skill set in the area. According to this research, approximately 65%–70% of construction workers for the projects studied were Iowa residents. These workers boost Iowa economic activity by spending their earnings on mortgage payments, insurance, childcare, education, utilities, tax payments, family entertainment and recreation, clothing, etc. Workers from out of state generate a different set of economic impacts to the state. These temporary workers support a smaller ripple effect in the Iowa economy because most of their earnings are spent outside of Iowa and thus do not circulate through the Iowa economy. Most of their impacts are limited to spending on lodging, food, beverages and transportation, which is often subsidized by the construction company. Because it is difficult to track the spending of out-of-town workers' earnings, they have not been included in this analysis.[13]

The number of employees building a wind farm depends on the stage of construction of the project. The peak construction phase may require a significantly higher number of workers than the initial and final stages. Data were obtained on the number of employees and hours worked, and these data were translated into FTE units.

> *This research suggests that the construction of Iowa's first 1,000 MW of wind power development during 1999–2008 supported employment totaling approximately 2,300 FTE jobs in the state during the construction period.*

During the construction period, approximately 600 jobs were held by onsite workers (project development, engineering, construction, and electrical). Over 1,150 jobs were supported by

[12] The JEDI model assumes that construction period takes a year. In fact, the construction period could take more or less than a year depending on the project size, location, and weather conditions.
[13] By not including earnings from out of state workers in the analysis we avoid the risk of overestimating the impacts in Iowa.

supply chain and turbine impacts (including providers of construction materials, supplies, and transportation) and over 550 jobs were supported by induced effects.

3.2.2 Operation and Maintenance Jobs

Over the wind farm's anticipated 20- to 30-year operating life, permanent employees operate and maintain the facility. Technicians can service approximately two to three wind turbines per day replacing components, troubleshooting electrical and mechanical malfunctions, repairing the hydraulic system, and changing fluids. The majority of these positions are filled by Iowans or by people who relocate to Iowa.

> *According to this study, 1,000 MW of wind energy capacity in the State of Iowa supports approximately 270 permanent jobs*[14].

Of the 270 permanent jobs, approximately 75 were onsite positions, 105 were equipment and supply chain sector jobs, and nearly 90 were positions in other sectors (e.g., restaurants, hotels, and retail stores) resulting from the induced activity.

3.3 Property Tax Revenue Impacts

Wind energy projects also increase the property tax revenue base in local counties. This revenue in turn is used to fund and improve local schools, parks, recreational facilities, community programs, fire departments, and other public services.

The State of Iowa provides several tax incentives for wind energy projects. Wind farm owners may opt to have their wind farm properties centrally assessed (at the state level) or locally assessed (at the county level). Estimating the tax revenue generated by a wind project over its lifetime requires county specific rates, detailed cost data, and an assessment of other project and location specific information. For instance, it is impossible to know with certainty what a given county's mill levy will be 10 years from now. To discount future tax revenue cash flows to current dollars also requires an estimate of the inflation rate. To assess the tax revenue generated by the projects analyzed in this report, we relied on input from county tax assessors, project developers, and assumptions based on experience from other projects. This analysis assumes that the wind farm projects were assessed at the local level. Local tax assessors calculate wind farm property taxes based on a percentage of the net acquisition cost[15] per tower. During the first year of wind farm operation, the assessed value of the property is calculated at 0% of the net acquisition cost, which means that the wind farm owner does not pay any taxes that year. During the second year of operation, the wind farm owner pays property taxes on 5% of the net acquisition cost, and this percentage increases 5% every year until it reaches 30%, at which point it stays the same for the life of the project (Iowa Code 427B.26). Table 7 provides an example of

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[14] Unlike the construction period, in which several temporary workers are hired, during the operations and maintenance period, permanent workers are hired at the state level. Thus the number of jobs reported during this period remains constant for every year that the wind farm is operating. In other words, 1000MW of wind project development in Iowa supports 270 jobs every year that the wind farms are in operation – approximately 20 years. Although in some cases temporary jobs were reported as part of the maintenance and repairs needed, in most of the cases, these were out-of-state workers, and thus these small numbers were omitted from this study.

[15] According to Iowa Code 427B.26, "net acquisition cost" means the acquired cost of the property including all foundations and installation cost less any excess cost adjustment. http://coolice.legis.state.ia.us/cool-ice/default.asp?category=billinfo&service=iowacode&ga=83&input=427B#427B.26. Accessed May 2012.

the methodology used to calculate the tax revenue stream for the wind farm projects. In this example, the net acquisition cost per tower is assumed to be $1.5 million, and the mill levy is held constant at 2.56%.

Table 7. Property Tax calculation

Acquisition Cost (per tower)	Year	Assessment	Assessed Value	Mill Levy	Tax Payment (per tower)
$ 1,500,000	1st	0%	$ -	0.0256	$ -
	2nd	5%	$ 75,000		$ 1,920.00
	3rd	10%	$ 150,000		$ 3,840.00
	4th	15%	$ 225,000		$ 5,760.00
	5th	20%	$ 300,000		$ 7,680.00
	6th	25%	$ 375,000		$ 9,600.00
	7th - up	30%	$ 450,000		$ 11,520.00

To ensure a consistent analysis, we held the county mill levy constant over a 20-year period and future cash flows were deflated using an assumed inflation rate of 3% to obtain an estimate of all future cash flows in 2010 real dollars. Based on these assumptions and methodology, we estimated that:

> *One thousand megawatts of wind energy (nameplate capacity) generates over $6 million in property tax revenue per year.*

3.4 Landowner Revenue Impacts

There are different types of legal agreements and payment schemes to reward those who give developers access to their land and wind resources. Most of the payments in Iowa are based on a percentage of revenue (royalty) from the electricity generated, and could range from $2,500/MW to $5,500/MW annually. This provides a stable source of income for the duration of the lease, which could last up to 20 or 30 years.

> *According to this study[16], one thousand megawatts of wind energy in Iowa generate more than $4 million annually in income for farmers and ranchers who lease their land to wind developers.*

Generally, a utility-scale wind farm requires approximately 60 acres of land per MW installed (Shoemaker, et al 2007), but the actual footprint of land that is disturbed for wind power projects ranges from 2% to 5% of total land needed by the project (U.S. DOE 2008). Since the rest of the land remains free, farmers can usually continue to grow their crops and ranchers can graze their cattle while the turbines are in operation.

There are other economic opportunities for landowners in the form of road access payments (land easements), permits, licenses, and land-lease revenues for O&M buildings and substations. These could be one-time payments or annual payments, but are not accounted as part of this study given the wide range of possibilities and lack of reliable information.

[16] Based on interviews to stakeholders

4 Manufacturing Potential

Although there are currently seven utility-scale wind manufacturing facilities in Iowa, as shown on Table 8, prior to 2007 there were not many wind manufacturing facilities in the state. Thus, given the period of projects selected for review, this analysis assumes the seven projects imported their turbines, blades, and towers from other states and other countries. Consequently, the results from this study do not account for local turbine manufacturing.[17] Nevertheless, analysis of the potential economic impacts associated with the local production of wind turbines and components provides further insight into the wind industry in Iowa. Future projects may utilize this Iowa-based manufacturing, resulting in an increase in jobs and other economic development impacts.

4.1 Iowa Wind Turbine and Component Manufacturing

Iowa is now a leader in wind energy manufacturing in the US, with wind turbine component suppliers supporting more than 2,000 manufacturing jobs in the state (Iowa Office of Energy Independence 2010). Table 8 provides information on some Iowa wind manufacturing facilities and their estimated number of employees. This is an example of how wind power is expanding businesses and attracting companies to relocate to Iowa.

Table 8. Iowa Utility-Scale Wind Manufacturing Facilities (Not Exhaustive)

Company	Component	Category	City	Jobs
Clipper Windpower	Turbines	Turbine	Cedar Rapids	310 (2009)[18]
Acciona	Turbines	Turbine	West Branch	130 (2009)[19]
TPI Composites	Blades	Blade	Newton	581 (2011)[20]
Trinity Structural Towers	Towers	Tower	Newton	90 (2009)[21]
Goian North America	Elevation Systems	Other	Ankeny	10–12 (2008)[22]
Sector 5 Technologies	Components	Other	Oelwein	12–50 (2008)[23]
Siemens	Blades	Blade	Fort Madison	600 (2010)[24]

Data provided by Frank Oteri, NREL

In addition, Iowa is home to more than 200 turbine supply chain manufacturers (Iowa Office of Energy Independence 2010), producing bearings, mountings, bolts, switches, etc. These local manufacturing companies also benefit other in-state businesses that provide goods and services to them, thus boosting economic activities even further.

[17] Only material manufacturing (e.g., cement for foundations and electrical equipment) for wind plant construction was considered part of in-state impacts. Another reason that this analysis does not incorporate the manufacturing activities into the economic impacts is because it is difficult to attribute changes in in-state manufacturing activity to in-state project development if Iowa manufacturers also sell their products in other states.
[18] Franzman 2009
[19] Norfleet 2009
[20] Hussmann 2011
[21] Elliot and Glover 2009
[22] Bzdega 2008
[23] Kunkle 2008
[24] Siemens Energy, Inc. 2010

Local manufacturing incentives and the state's recognition of the economic development opportunities from wind energy have boosted wind energy and manufacturing development in Iowa. (Lantz and Tegen 2008).

Economic Development impact depends in part, on the extent by which goods and services are acquired at the local level. Since wind turbines and component manufacturing frequently constitutes 65% to 85% of the total construction cost for a new wind farm (Lantz and Tegen 2008), it offers the largest potential source of economic development benefits at the local level. Furthermore, it supports permanent jobs during construction and operating periods.

4.2 Iowa Manufacturing Sensitivity Analysis

Because this analysis assumes zero local wind turbine manufacturing for the first 1,000 MW of wind energy development in Iowa, we developed a sensitivity analysis that compares three manufacturing scenarios with the results from this study (Figure 6). All three manufacturing scenarios assume cost parameters indicated in Table 3, with the exception of equipment local share information, which we varied based on the manufacturing scenario. The first manufacturing scenario assumes that Iowa suppliers provide 25% of turbine parts and components needed to support the installation of 1,000 MW of wind energy in the state. This scenario also assumes 25% of local transportation. The second and third scenarios assume 50% and 75% of local turbine manufacturing and transportation services, respectively.

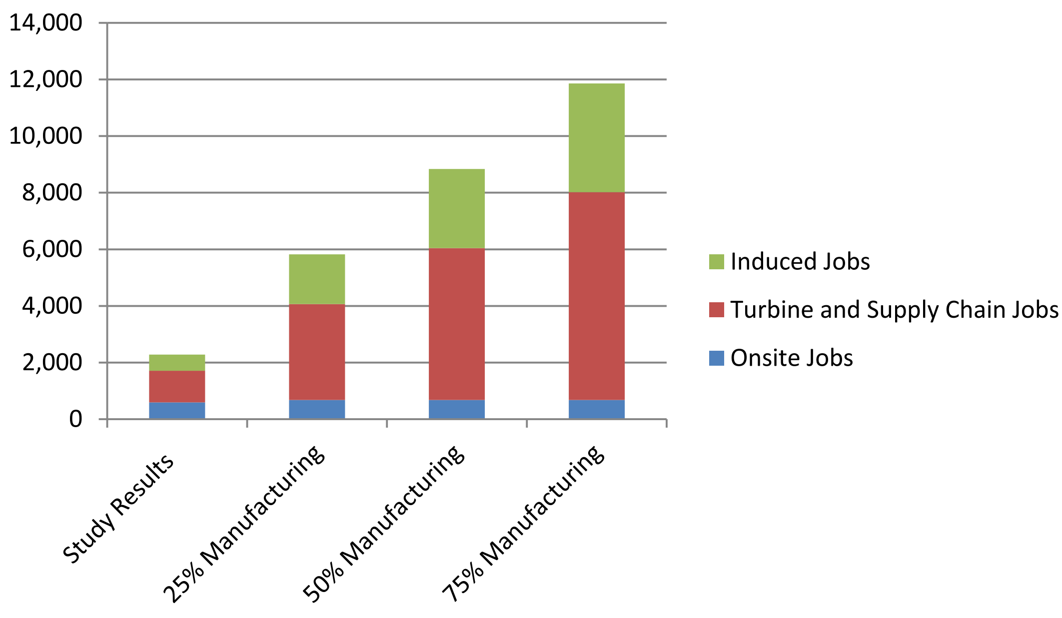

Figure 6. Manufacturing scenarios and associated job impacts during construction

As Figure 6 indicates, even a 25% level of in-state manufacturing can have a significant impact on potential job generation. This level of manufacturing not only increases the number of turbine manufacturing and supply chain jobs, but it also supports a higher number of induced jobs because more wind manufacturing workers spend their income on activities that generate and support additional employment throughout the economy. Hence, this first scenario more than doubles the magnitude of construction period jobs estimated in this study to approximately 5,800. A 50% in-state wind manufacturing scenario more than triples the total number of jobs reported in this study during the construction period to more than 8,800 jobs, and a 75% in-state manufacturing scenario more than quadruples our initial job results, providing job opportunities to almost 11,800 Iowa residents.

Wind development in Iowa has led to more in-state manufacturing, but a stronger wind manufacturing base could provide further economic opportunities.

5 Conclusion

One thousand megawatts of new wind power generation has myriad effects on the Iowa economy. Economic impacts ripple through the state economy providing jobs, tax revenue, and land-lease payments to communities. Based on this analysis, the first 1,000 MW of wind energy development in Iowa supported 2,300 FTE jobs over the 1999-2008 period, and 270 ongoing, annual jobs to-date. It also supported nearly $290 million in gross economic activity for Iowa during the construction period and approximately $38 million per year during the operating period.

The rapid turbine and component manufacturing development in Iowa in 2008-2010, following the construction of 1000MW of wind energy capacity installed, contributed to a healthier and more diversified business climate in the state. It also marked the beginning of a strong wind manufacturing industry, which now supports more than 2000 jobs.

Wind energy manufacturing is the largest economic development driver in the wind industry. It has the potential to provide significantly more jobs and associated economic impacts compared to other wind activities. Supporting local ownership of manufacturing facilities, as well as use of local labor and materials, can provide further opportunities for economic diversification and economic growth.

The burgeoning wind sector also stimulates a secondary supply chain ripple effect as wind industry participants (developers, service providers, manufacturers, etc.) start up or relocate to the state. While outside the scope of this analysis, this second wave carries with it additional economic impacts associated with training workers, exporting goods outside of the state, fostering research and development facilities, and developing leading-edge technologies and capabilities.

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Appendix

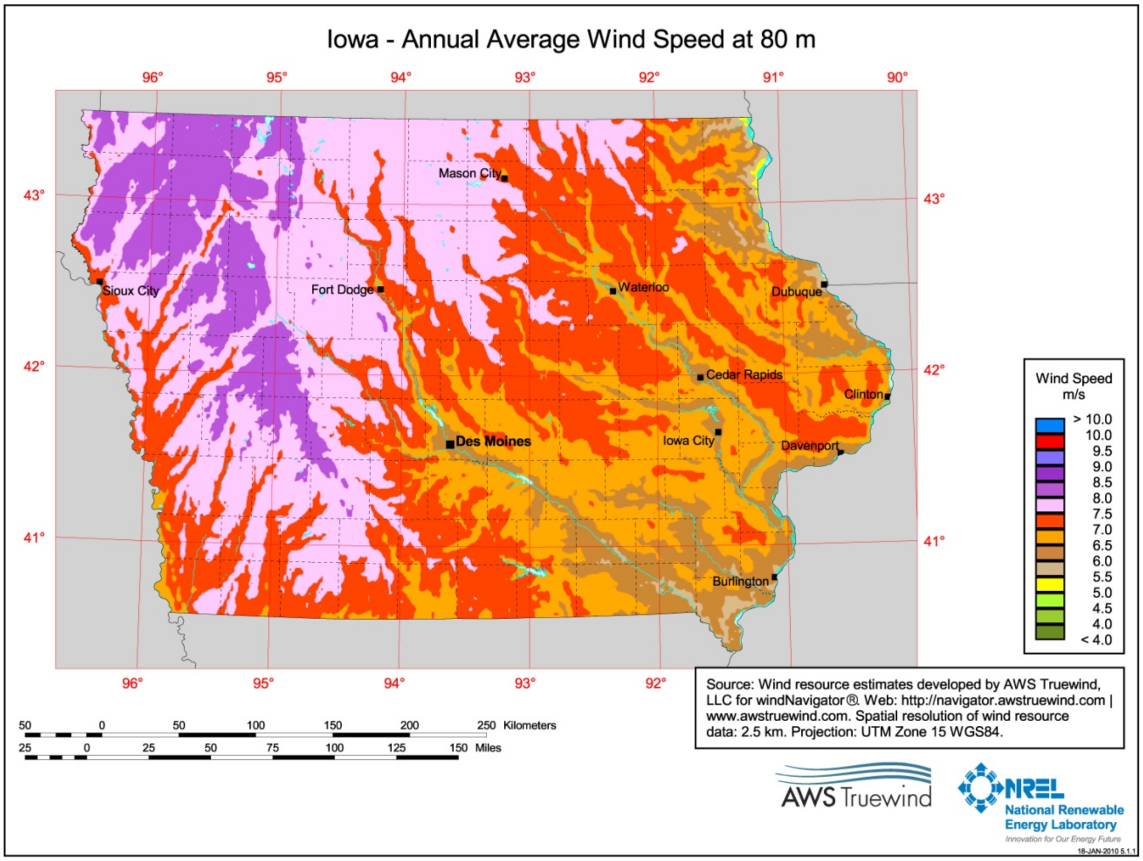

Figure A-1. Iowa average annual wind speed at 80 m

Source: Wind Powering America 2010