Report on the

WIND ENERGY TRANSMISSION ECONOMICS ASSESSMENT

South Dakota Wind Energy Association

Project No. 63452

November 2011

Wind Energy Transmission Economics Assessment

prepared for

South Dakota Wind Energy Association
Pierre, South Dakota

November 2011

Project No. 63452

prepared by

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November, 2011

The South Dakota Wind Energy Association (SDWEA) with the sponsorship of the South Dakota Governor's Office of Economic Development (GOED) is pleased to release the enclosed "Wind Market Discovery Project" report. There are two components of this Market Discovery Project, namely the "Wind Energy Transmission Economics Assessment" prepared by Burns and McDonnell Engineering Company, Inc., Kansas City, Missouri, and the "Transmission Input" prepared by Jared Alholinna, Regional Transmission Planning Strategist, CapX 2020, Minneapolis, Minnesota. This Project report offers new tools to assess potential wind export markets and defines transmission assets which are being developed that could deliver South Dakota produced wind to these markets.

This Project report provides a dynamic computer model which can serve as an economic 'screening' tool to evaluate multiple proven wind production sites in South Dakota for competitiveness with wind production in neighboring states. The initial modeling shows South Dakota's wind resources have the potential to be competitive while supporting investment in new transmission assets under certain scenarios. The Transmission Input portion of the Analysis shows opportunity for interconnection into potential markets in states east of South Dakota for almost 1,000 MW of wind export as possible within the next five years.

The challenge for public officials and private interests is to develop the business case to capture these opportunities.

We are committed to working with GOED, state and local interests, and others to apply the findings of this Wind Market Discovery Project to further advance an expanded South Dakota wind industry.

s/ Jeffrey L Nelson

President
South Dakota Wind Energy Association

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LIST OF ABBREVIATIONS AND ACRONYMS

BMcD	Burns & McDonnell Engineering Company, Inc.
DOE	Department of Energy
GCF	Gross Capacity Factor
IEC	International Electrotechnical Commission
ITC	Investment Tax Credit
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
m/s	meters per second
MISO	Midwest Independent System Operator
MW	Megawatt
MWh	Megawatt-hour
NCF	Net Capacity Factor
NREL	National Renewable Energy Laboratory
PTC	Production Tax Credit
SDWEA	South Dakota Wind Energy Association
Study	Wind Energy Transmission Economics Assessment

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EXECUTIVE SUMMARY

ES.0 EXECUTIVE SUMMARY

Burns & McDonnell Engineering Company, Inc. (BMcD) was retained by the South Dakota Wind Energy Association (SDWEA) to perform a Wind Energy Transmission Economics Assessment (Study). The purpose of the Study was to assist the SDWEA with the development of an economic model to assess the viability of transporting wind energy from wind-rich areas in South Dakota to eastern load centers. For purposes of this Study, a one gigawatt wind energy facility was assumed to be physically sited within South Dakota and used to supply load in neighboring states (Project).

It is important to note that the intent of this Study, including the accompanying pro forma economic model, was to be utilized as a screening tool for identification of potential development opportunities; any results derived herein should be used only for justification of further analyses. Moreover, this Study is not meant for comparison, either implicitly or explicitly, of wind resources against other forms of generation; it is intended only for comparing the economic viability of developing wind resources in South Dakota to wind resources in other states. Any use of these tools for reasons beyond these stated objectives may yield erroneous or misguided results.

The Study was completed as three separate tasks. The following sections present an overview of the Study, as well as a summary of the methodology and results of each task.

ES.1 STUDY OVERVIEW

The pro forma economic model produced for this Study enables its user to derive the breakeven amount that can economically be spent on transmission improvements required to move wind energy from one area to another. This breakeven amount, expressed in dollars per kilowatt of incremental power transfer capability, is calculated as the difference in levelized busbar generation cost between a wind farm with a high capacity factor and a similar wind farm in a location with a low capacity factor. The user of the economic model may subsequently assess the economic feasibility of developing remote wind generation by comparing the breakeven cost with their projected cost of providing incremental power transfer capability between the two areas. Note that this Study does not estimate expected congestion cost savings that new transmission facilities would provide at other times.

ES.2 CAPACITY FACTOR CHARACTERIZATION

A significant and underlying assumption of the Project is that wind energy will be harnessed in areas with attractive wind resources (the “source”) and delivered to more modest wind-resource locations (the "sink"). Moreover, perhaps the most influential factor on the economics of a wind energy project is that project's capacity factor. Thus, it is important to characterize the expected capacity factor ranges that are likely to occur between the Project site and various sink locations.

Utilizing publically-available data and industry-standard techniques, average annual capacity factors were estimated for each of the potential source and sink locations. This effort revealed the most efficient source location for the Project to be near Brookings, South Dakota, with a net annual capacity factor of approximately 44.4 percent. Conversely, the sink location with the lowest net annual capacity factor was Detroit, Michigan (27.8 percent).

Table ES-1 presents a summary of the differential in net annual capacity factors between each potential source and sink location. As presented in this table, the greatest disparity exists between the Brookings site and Detroit area, or nearly a 17 percent difference in expected annual NCF. Conversely, less than a five (5) percent differential is observed between the Minneapolis regional sink location and several potential source locations. As expected, the net difference in capacity factor between the potential source and sink locations tends to increase with distance between the sites, particularly moving to the east where lower wind speeds are prevalent.

Table ES-1: Net Capacity Factor Differential between Source and Sink Locations

Sink Name	Source Locations				
	Big Stone	Broadland-Huron	Brookings	Groton	Split Rock
Chicago	-8.5%	-8.5%	-14.8%	-11.8%	-8.5%
Detroit	-10.4%	-10.4%	-16.6%	-13.6%	-10.4%
Indianapolis	-9.1%	-9.1%	-15.4%	-12.4%	-9.1%
Milwaukee	-10.1%	-10.1%	-16.3%	-13.4%	-10.1%
Minneapolis	-4.9%	-4.9%	-11.1%	-8.1%	-4.9%
St. Louis	-9.5%	-9.5%	-15.7%	-12.8%	-9.5%

As clarified within the body of this report, it is important to note that although the major metropolitans in Table ES-1 are identified as the potential sink locations, it is not anticipated that a significant wind energy project would be constructed within the physical boundary of any of these cities. Rather, it is more likely that a project would be constructed at some distance outside of the city (while still in reasonably-close proximity) and power would be imported. Thus, these sink locations are intended only to be representative of regional load centers and not specific project sites.

ES.3 PRO FORMA ECONOMIC ANALYSIS

A pro forma economic model was prepared to evaluate the relative financial viability of developing wind resources in assorted areas of the country. Using the base-case model assumptions (Section 3.1), Figure ES-1 presents the approximate 20-year levelized busbar cost (2014$) as a function of net capacity factor.

ES.4 ELECTRIC TRANSMISSION CAPITAL COST EVALUATION

Utilizing the aforementioned capacity factor ranges and pro forma economic model, BMcD completed an evaluation of electric transmission system breakeven capital costs. The breakeven cost is the electric transmission capital investment that can be economically justified by the differential in capacity factors between potential source and sink locations. Figure ES-2 presents the breakeven cost as a function of capacity factor differential.

Assuming a relatively large capacity factor differential of 17 percentage points between the source and sink locations, the breakeven transmission investment was estimated at $1,100 per kilowatt. Thus, a project sited in a wind-rich area could justifiably spend up to $1,100 per kilowatt of incremental power transfer capability and remain economically competitive with a similar project sited in an area with an annual capacity factor that is 17 points lower.

ES.5 PROJECT EXAMPLE

The amount of transmission investment that an entity could economically justify to provide the required capability to transfer wind energy decreases as the differential in capacity factor narrows. For instance, assuming a differential of 12.8 percent between Groton Substation (South Dakota) and St. Louis (Missouri), the breakeven transmission cost was determined to be approximately $760 per kilowatt. Thus, if an entity was interested in transferring energy from a 1,000-megawatt wind farm near Groton to loads in eastern Missouri, the capacity factor differential between these states would economically justify spending up to $760 million on transmission system improvements ($760/kW x 1,000 MW x 1,000 kW/MW = $760 million). As such, if transmission planning studies indicate that it would cost $2 billion to provide 1,000 megawatts of incremental power transfer capability from South Dakota to Missouri, for example, the Study would show that siting the subject wind generation locally in Missouri would be more economic.

Figure ES-1: Levelized Busbar Cost Variation with Net Annual Capacity Factor

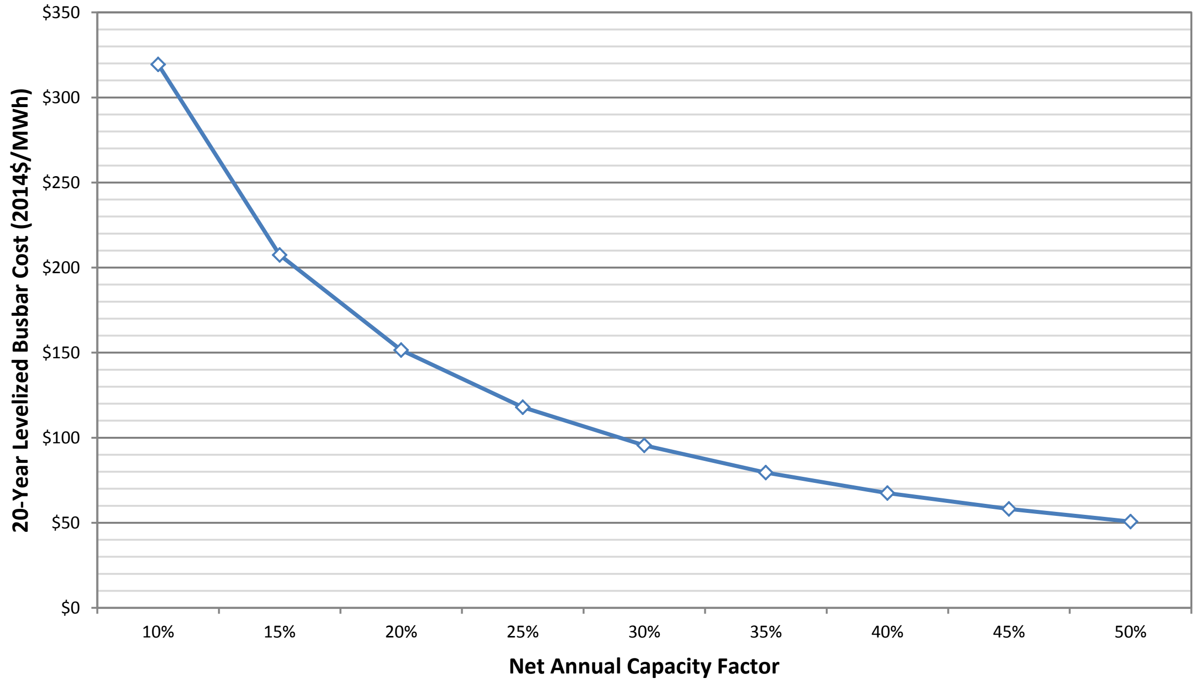
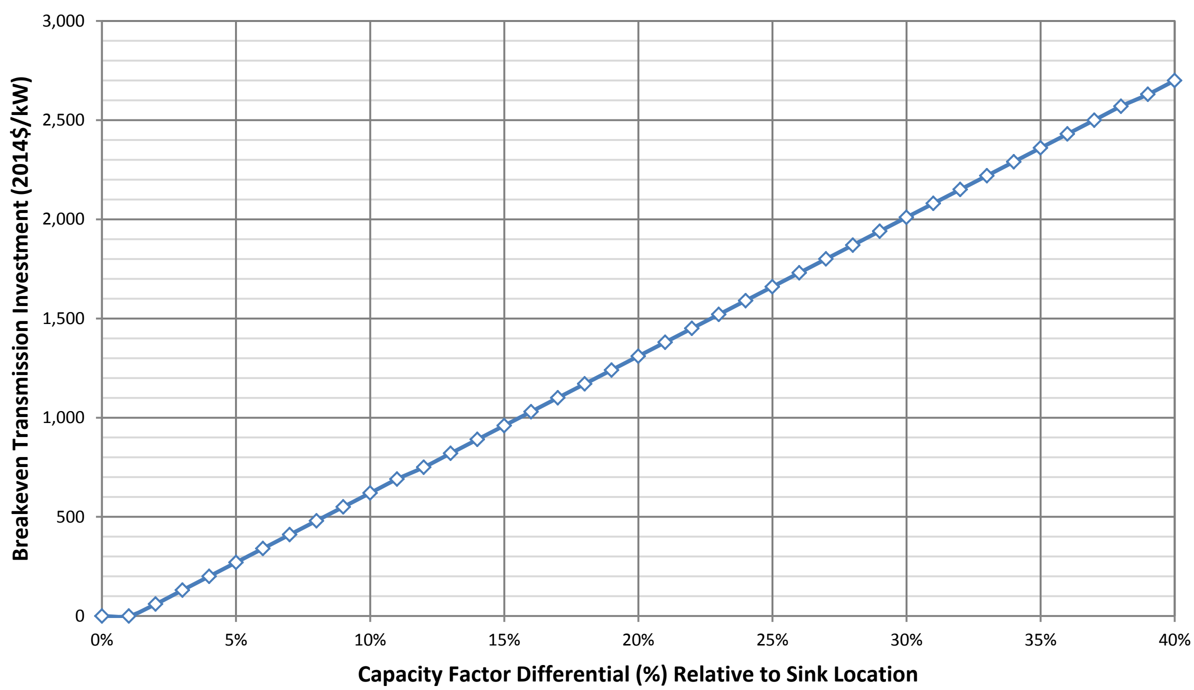


Figure ES-2: Breakeven Transmission Capital Cost by Capacity Factor Differential



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SECTION 1

INTRODUCTION

1.0 INTRODUCTION

Burns & McDonnell Engineering Company, Inc. (BMcD) was retained by the South Dakota Wind Energy Association (SDWEA) to perform a Wind Energy Transmission Economics Assessment (Study). The purpose of the Study was to assist the SDWEA with the development of an economic model to assess the viability of transporting wind energy from wind-rich areas in South Dakota to eastern load centers.

It is important to note that the intent of this Study, including the accompanying pro forma economic model, was to be utilized as a screening tool for identification of potential development opportunities; any results derived herein should be used only for justification of further analyses. Moreover, this Study is not meant for comparison, either implicitly or explicitly, of wind resources against other forms of generation; it is intended only for comparing the economic viability of developing wind resources in South Dakota to wind resources in other states. Any use of these tools for reasons beyond these stated objectives may yield erroneous or misguided results.

1.1 BACKGROUND

The South Dakota Wind Energy Association was formed in January 2009 with the objective of supporting the development of wind energy as a sustainable economic and environmentally-friendly resource for the state of South Dakota. According to the National Renewable Energy Laboratory (NREL), South Dakota has the fourth-greatest potential for generating wind energy when compared to all states [1]. As of mid-2011, nearly 775 megawatts (MW) of commercial wind power had been installed in South Dakota, or approximately 26 percent of the state’s total demand for electricity (assuming all of these wind resources are operating at rated capacity). Thus, the SDWEA has initiated this Study to explore other opportunities and markets for utilizing South Dakota’s massive wind energy potential.

In 2010, the SDWEA and the South Dakota Governor’s Office of Economic Development commissioned the “South Dakota Wind Blueprint” [2], an examination of the economic impacts of exporting 1,000 MW of added wind power from South Dakota (Project). The results of this analysis indicated that the Project would create 5,360 new construction jobs; generate $538 million of total economic activity; and produce a sustained $6.5 million in annual economic benefits. However, to export the energy to neighboring states, the one-gigawatt Project would also necessitate the construction of 83.4 miles of new high-voltage electric transmission lines in South Dakota, costing an estimated $67.5 million, as well as an investment of $1.35 billion into the Midwest Independent System Operator (MISO) transmission system for upgrades and other improvements.

Following the completion of the "South Dakota Wind Blueprint," the SDWEA determined that additional investigation was prudent. A "Market Discovery Project" was commissioned in 2011, the purpose of which was to identify potential markets for exporting wind energy from South Dakota; understand the potential economic hurdles and benefits of this endeavor; and determine the indicative transmission and generation aspects of this project. This Study, along with a coordinated evaluation that was completed in parallel by CapX2020, forms the basis of the "Market Discovery Project".

1.2 ORGANIZATION OF REPORT

This report is organized into several separate chapters and supporting appendices. These individual sections are listed below along with a brief description of their contents.

- **Executive Summary:** An executive summary of the Wind Energy Transmission Economics Assessment.
- **Section 1.0 - Introduction:** A description of the Study's background and objectives.
- **Section 2.0 - Capacity Factor Characterization:** A summary of the methodology utilized to characterize expected annual capacity factors at each potential source and sink location.
- **Section 3.0 - Pro Forma Economic Analysis:** Overview of pro forma financial model developed for this Study.
- **Section 4.0 - Electric Transmission Capital Cost Evaluation:** A summary of the underlying electric transmission economic analysis that forms this basis of this Study.
- **Section 5.0 - Summary and Conclusions:** The conclusions reached during the Study.
- **Section 6.0 - References:** The sources referenced within this report.

1.3 STATEMENT OF LIMITATIONS

BMcD cannot warrant or guarantee the wind energy forecasts presented in this Study. These forecasts are provided on a best-effort basis. Moreover, calculations performed herein are based upon publically-available wind resource information. BMcD has not conducted independent wind measurements and, therefore, cannot be held responsible for the accuracy of the data it was supplied or utilized.

Estimates and projections prepared by BMcD relating to performance, construction costs, and operating and maintenance costs are based on BMcD's experience, qualifications, and judgment as a professional consultant. Since BMcD has no control over weather, cost and availability of labor, material and equipment, labor productivity, construction contractor's procedures and methods, unavoidable delays, construction contractor's method of determining prices, economic conditions, government regulations and laws (including interpretation thereof), competitive bidding, and market conditions or other factors affecting such estimates or projections, BMcD does not guarantee that actual rates, costs, performance, schedules, etc., will not vary from the estimates and projections prepared herein by BMcD.

1.4 STATEMENT OF CONFIDENTIALITY

This report may have been prepared under, and only be available to parties that have executed, a Confidentiality Agreement with the SDWEA. Any party to whom the contents are revealed or may come into possession of this document is required to request of the SDWEA if such Confidentiality Agreement exists. Any entity in possession of, or that reads or otherwise utilizes information herein, is assumed to have executed or otherwise be responsible and obligated to comply with the contents of such Confidentiality Agreement. Any entity in possession of this document shall hold and protect its contents, information, forecasts, and opinions contained herein in confidence and not share with others without prior written authorization from the SDWEA.

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SECTION 2

CAPACITY FACTOR CHARACTERIZATION

2.0 CAPACITY FACTOR CHARACTERIZATION

A significant and underlying assumption of the Project is that wind energy will be harnessed in areas with attractive wind resources (the “source”) and delivered to more modest wind-resource locations (the “sink”). Moreover, perhaps the most influential factor on the economics of a wind energy project is that project’s capacity factor. Thus, it is important to characterize the expected capacity factor ranges that are likely to occur between the Project’s various source and sink locations. The following sections detail the methodology utilized in the characterization of regional capacity factors for the Study.

2.1 POTENTIAL SOURCE LOCATIONS

Five (5) potential sites were identified within South Dakota (Figure 2-2) for siting the Project. These sites were jointly selected by the CapX2020 and SDWEA team as part of the “Market Discovery Project” (see Section 0 for additional detail). These sites were chosen based upon their attractive estimated wind speeds and access to adequate electric transmission resources. Moreover, these sites are intended to represent a geographically-diverse offering within the eastern half of the state. Nevertheless, it is important to note that selection of these sites for analysis in this Study is not intended to construe a final location for the Project. Rather, these sites are only intended to be representative of a typical wind energy project that may be constructed in South Dakota.

A summary of the potential source locations, including the available interconnection voltage(s) and transmission owner(s) at the adjacent substations, is provided in Table 2-1.

Table 2-1: Potential Project Source Location Summary

Site Name	County	Transmission Owner	Interconnection Voltage(s) [kV]
Big Stone	Grant	Otter Tail Power	115-230-345
Broadland-Huron	Beadle	Basin Electric / WAPA	115-230-345
Brookings	Xcel Energy	Xcel Energy	115-345
Groton	Brown	Basin Electric / WAPA	115
Split Rock	Minnehaha	Xcel Energy	115-230-345

2.2 POTENTIAL SINK LOCATIONS

Six (6) potential sink locations were identified for the Project (Figure 2-3 and Figure 2-4). These locations, jointly selected by BMcD and the SDWEA, were intended to include representative locations where wind energy originating within South Dakota may reasonably be expected to be exported. Moreover, they include large, regional load centers within or near the MISO footprint where wind energy may also not be as efficiently captured (i.e., capacity factors will be lower than those realized at the potential source locations).

The following potential sink locations were identified for purposes of this Study:

1. Chicago, Illinois
2. Detroit, Michigan
3. Indianapolis, Indiana
4. Milwaukee, Wisconsin
5. Minneapolis, Minnesota
6. St. Louis, Missouri

It is important to note that while the aforementioned metropolitans are identified as the potential sink locations, it is not anticipated that a significant wind energy project would be constructed within the physical boundary of any of these cities. Rather, it is more likely that a project would be constructed at some distance outside of the city (while still in reasonably-close proximity) and power would be imported. Thus, these sink locations are intended only to be representative of regional load centers and not specific project sites.

2.3 CAPACITY FACTOR ESTIMATES

The following sections present an overview of capacity factor estimates that were derived at the potential source and sink locations.

2.3.1 Wind Resource Data

BMcD relied exclusively upon publically-available data to complete the capacity factor characterization task. More specifically, high-resolution wind resource maps [3] from the Department of Energy’s (DOE) National Renewable Energy Laboratory and Wind Powering America program were utilized to estimate mean annual wind speeds. Additionally, estimates for wind energy potential [1] were utilized to analyze individual states’ abilities to efficiently generate wind energy.

2.3.2 Wind Turbine Technology

A generic wind turbine technology was assumed for this analysis, with a nameplate capacity of 2,000 kilowatt (kW) and a hub height of 80 meters, both typical of industry-standard technology. A composite power curve was utilized for the assumed wind turbine generator by normalizing and averaging the curves from various General Electric, Vestas, and Gamesa International Electrotechnical Commission (IEC) Class II wind turbines. This composite power curve is presented in Table 2-3.

2.3.3 Source Location Capacity Factor Estimates

Wind speeds in most parts of the world can be modeled using a Weibull distribution. This statistical tool indicates how often winds of different speeds will be seen at a location and is characterized by two parameters – shape and scale – that are empirically derived. However, when only a mean wind speed is available for a site, a Rayleigh distribution may be used to estimate the frequency of various wind speeds for a respective site. The Rayleigh distribution is a special case of the Weibull distribution with a shape factor equal to two.

Using the aforementioned publically-available wind resource maps [3], the mean annual hub height wind speed at each potential source location was estimated. Using a Rayleigh distribution and composite power curve described in Section 2.3.2, a gross annual capacity factor (GCF) was subsequently estimated for each site. A summary of these values for each potential source location is provided in Table 2-2.

Annual losses for a wind energy facility were estimated at approximately 15 percent. This is a typical value for the wind industry based on the type and location of the proposed Project. This loss factor was applied to the gross capacity factor estimates denoted in Table 2-2 to derive a net annual capacity factor (NCF) for each potential source location.

Table 2-2: Potential Project Source Location Capacity Factor Summary

Site Name	Wind Speed [m/s]	GCF [%]	NCF [%]
Big Stone	8.0	44.9%	38.2%
Broadland-Huron	8.0	44.9%	38.2%
Brookings	9.0	52.2%	44.4%
Groton	8.5	48.7%	41.4%
Split Rock	8.0	44.9%	38.2%

As a reference, the Rayleigh wind speed distribution for the Groton site is shown in Figure 2-1, along with the expected annual energy output from the representative wind turbine. In Table 2-3, the cumulative energy distribution of approximately 8.5 million kilowatt-hours (kWh) is presented, equivalent to a 48.7 percent GCF.

Figure 2-1: Rayleigh Wind Speed Distribution and Turbine Output

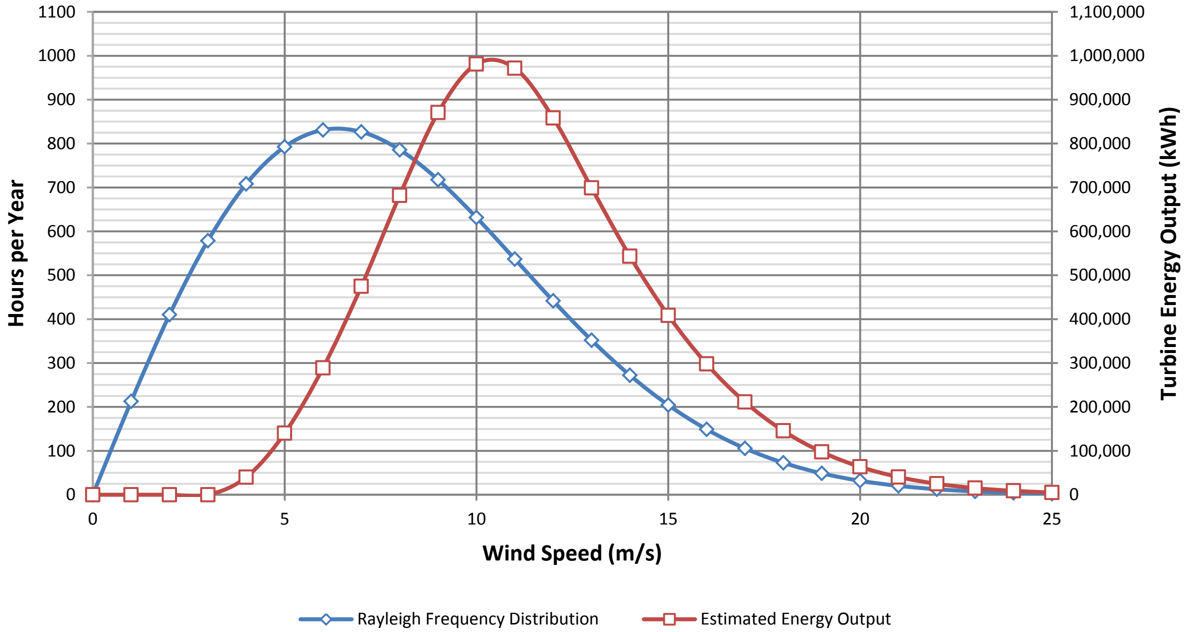

Table 2-3: Estimated Wind Frequency Distribution and Energy Output

Speed [m/s]	Power [kW]	Annual Hours	Energy [kWh]
0	0	40	0
1	0	148	0
2	0	365	0
3	0	518	0
4	57	640	36,302
5	177	726	128,534
6	348	773	269,225
7	575	783	450,532
8	868	760	660,626
9	1,213	711	863,702
10	1,554	642	999,605
11	1,810	562	1,019,575
12	1,943	478	930,053
13	1,985	394	784,307
14	1,996	317	633,164
15	2,000	248	495,902
16	2,000	189	377,711
17	2,000	140	280,346
18	2,000	101	202,900
19	2,000	71	143,247
20	2,000	49	98,683
21	2,000	33	66,354
22	2,000	22	43,558
23	2,000	14	27,921
24	2,000	9	17,479
25	2,000	5	10,689
		Total [kWh]:	**8,540,414**

2.3.4 Sink Location Capacity Factor Estimates

In February 2010, NREL completed a study to identify all "windy land area" within the United States [1]. These areas included locations with an estimated gross capacity factor of at least 30 percent, which was determined to be a baseline below which a wind project would likely not be pursued. Further, by excluding land areas unlikely to be developed – such as wilderness areas, parks, urban areas, and water features – the potential megawatts of rated capacity that could be installed on the available windy land area were estimated for each state.

A summary of the wind energy potential from the NREL study for each sink location state, including statewide installed capacity and annual generation, is provided in Table 2-4. Based on these annual generation estimates, BMcD calculated gross annual capacity factor and net annual capacity factor (using 15 percent losses as described in Section 2.3.3) for each state.

As expected, mean annual capacity factors are typically highest in the northern and upper-Midwest states whereas these values decrease to the east.

Table 2-4: NREL Wind Energy Potential and Capacity Factor Estimates by State

Sink Name	State Name	Wind Energy Potential [1]		BMcD Capacity Factor Estimates	
		Installed Capacity [MW]	Annual Generation [GWh]	Estimated GCF [%]	Estimated NCF [%]
Chicago	Illinois	249,882	763,529	34.9%	29.6%
Detroit	Michigan	59,042	169,221	32.7%	27.8%
Indianapolis	Indiana	148,228	443,912	34.2%	29.1%
Milwaukee	Wisconsin	103,757	300,136	33.0%	28.1%
Minneapolis	Minnesota	489,271	1,679,480	39.2%	33.3%
St. Louis	Missouri	274,355	810,619	33.7%	28.7%

It is important to note that the estimated capacity factors presented in Table 2-4 are intended to represent a statewide average. As such, it is reasonable to claim that more attractive capacity factors may be obtained from wind energy projects in these states (although a similar statement regarding the presence of less-attractive sites is also valid). However, based on the pragmatic assumption that the Project's wind energy would be delivered to regional load centers without access to local and efficient wind resources, it was determined that these averages should be representative.

2.4 SUMMARY

Table 2-5 presents a summary of the differential in gross capacity factors between each potential source and sink location. As seen in this table, the greatest disparity exists between the Brookings site and Milwaukee, or nearly a 17 percent difference in expected annual GCF. Conversely, less than a six (6) percent differential is observed between the Minneapolis sink location and several potential source locations. As expected, the net difference in capacity factor between the potential source and sink locations tends to increase with distance between the sites, particularly moving to the east where lower wind speeds are prevalent.

Table 2-5: Gross Capacity Factor Differential Between Source and Sink Locations

Sink Name	Source Locations				
	Big Stone	Broadland-Huron	Brookings	Groton	Split Rock
Chicago	-8.5%	-8.5%	-14.8%	-11.8%	-8.5%
Detroit	-10.4%	-10.4%	-16.6%	-13.6%	-10.4%
Indianapolis	-9.1%	-9.1%	-15.4%	-12.4%	-9.1%
Milwaukee	-10.1%	-10.1%	-16.3%	-13.4%	-10.1%
Minneapolis	-4.9%	-4.9%	-11.1%	-8.1%	-4.9%
St. Louis	-9.5%	-9.5%	-15.7%	-12.8%	-9.5%

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Figure 2-2: Potential Project Site and South Dakota Wind Resource Map

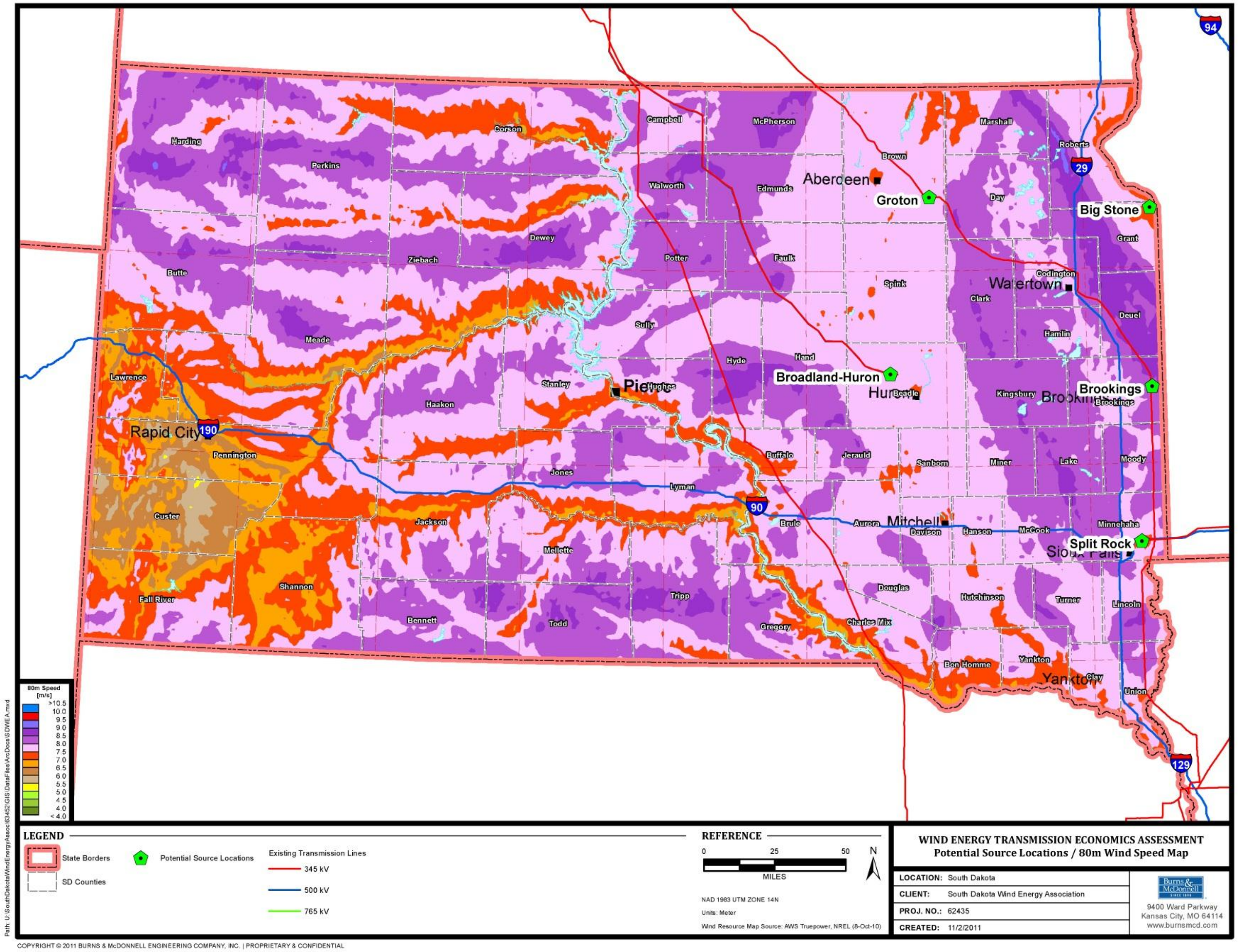


Figure 2-3: Potential Sink Locations and MISO Footprint

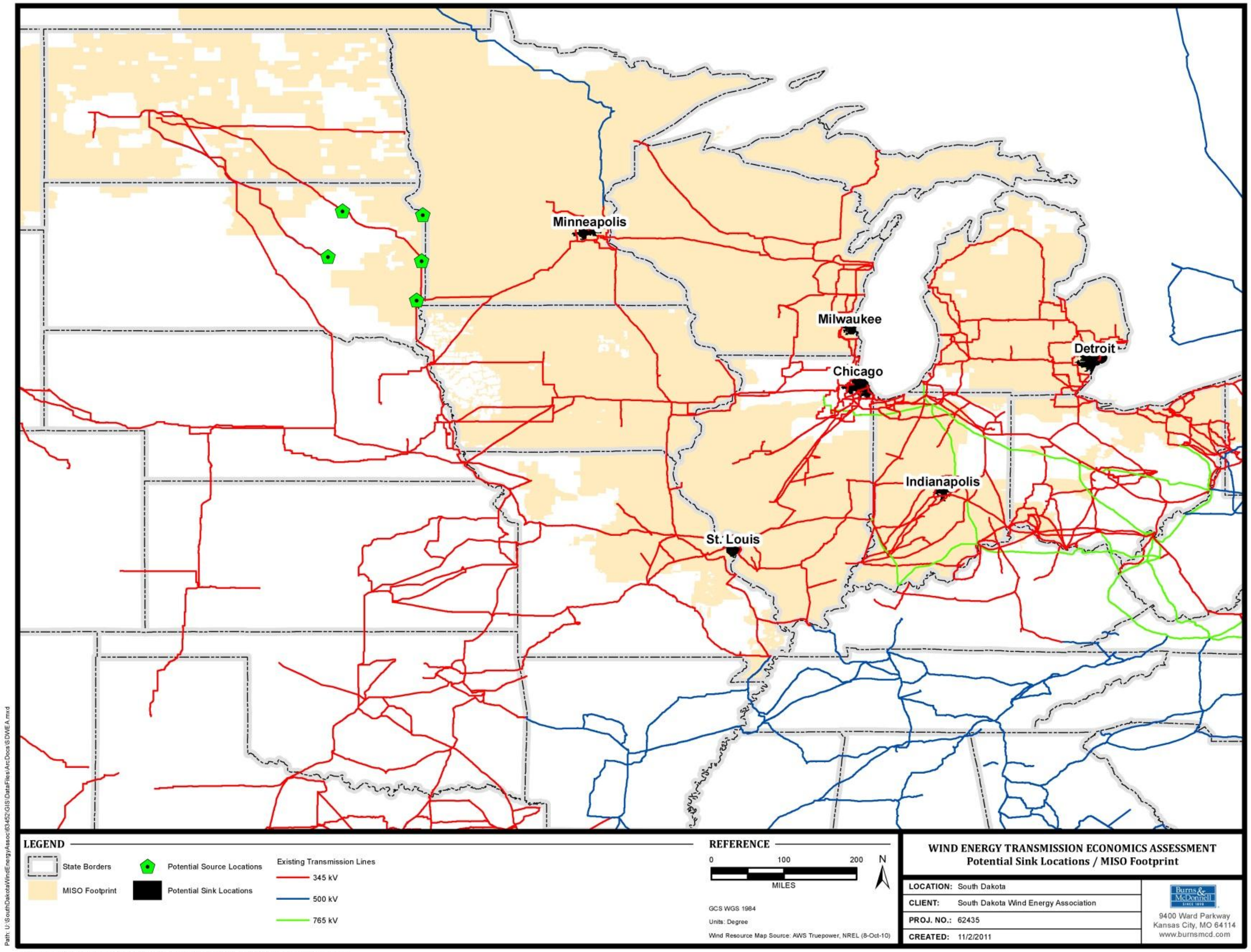
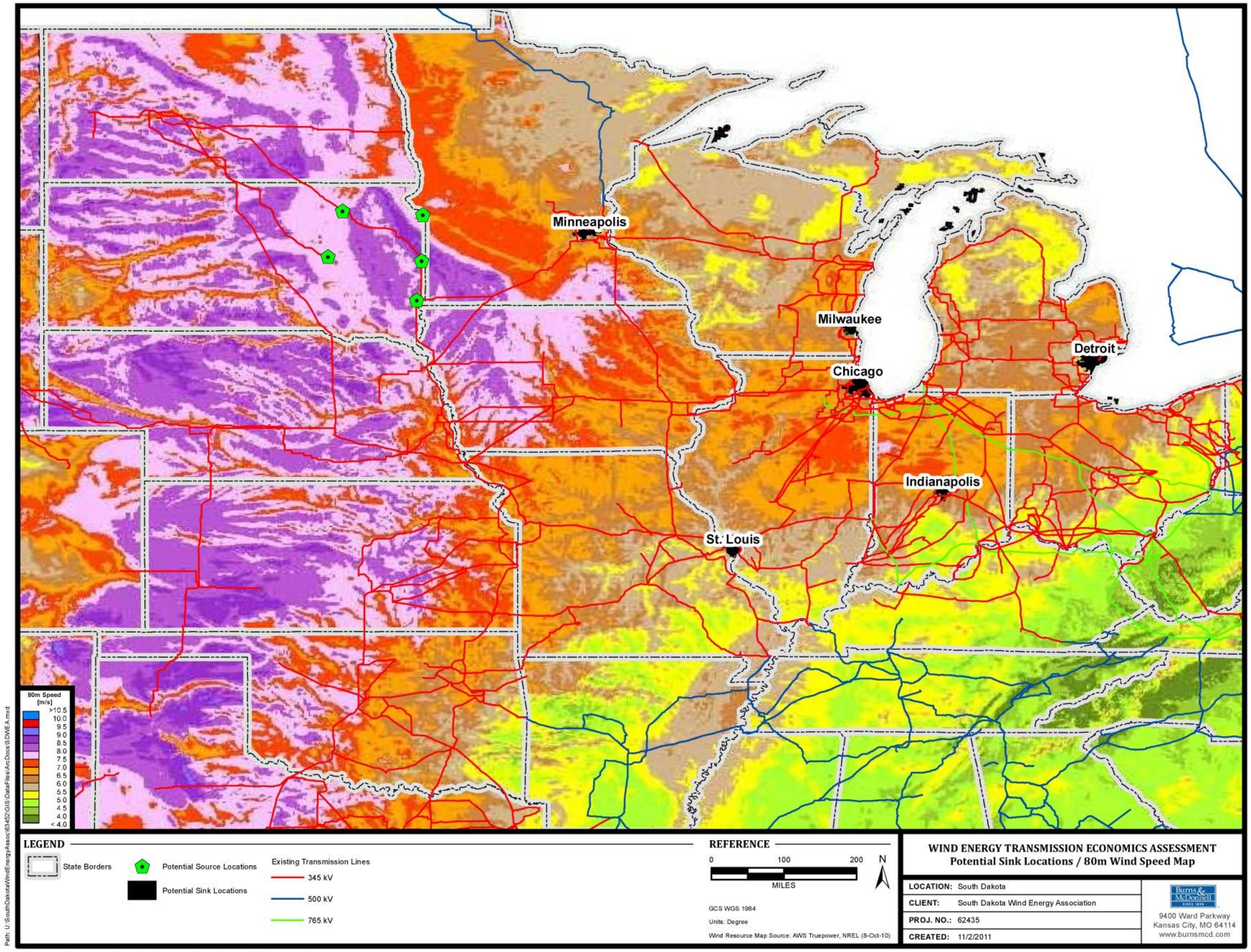


Figure 2-4: Potential Sink Locations and 80-Meter Wind Resource Map



SECTION 3

PRO FORMA ECONOMIC ANALYSIS

3.0 PRO FORMA ECONOMIC ANALYSIS

BMcD prepared a pro forma economic analysis to evaluate the 20-year levelized busbar cost of the Project. The levelized busbar cost represents the fixed energy cost that would be equivalent to an annually escalated busbar cost over a 20-year period, the design life of a typical wind project. The pro forma model is based on a generic Project site and incorporates expected costs for a utility-scale wind farm, including typical capital costs, debt service expenses, tax liabilities and credits, and operating expenses.

3.1 PRO FORMA INPUTS

The pro forma model was designed and delivered to the SDWEA with the intention of allowing for the modification of all model inputs. The following represents the key estimates and economics assumptions that were utilized as base-case values in the model. A full listing of all model inputs is provided in Appendix A for future reference.

- Operational Assumptions
  - Rated Capacity (kW) 1,000,000
  - Annual Net Capacity Factor 41.30%
  - Commercial Operation Date 2014
- Financing Assumptions
  - Debt Interest Rate 7.00%
  - Debt Financing Term (years) 20
  - Capital Structure - Debt 70.00%
  - Capital Structure - Equity 30.00%
  - Required Return on Equity 12.00%
  - Construction Financing Fees 0.50%
  - Permanent Financing Fees 1.00%
- Economic Assumptions
  - General Escalation Rate (per annum) 2.00%
  - Discount Rate 8.50%
  - Income Tax Rate 40.00%
- Depreciation Assumptions
  - Straight-Line Book Depreciation Term (years) 20

- Capital Cost Assumptions
  - Capital Cost Estimate (2011$/kW) $1,800
- Operating Expense Assumptions
  - Fixed O&M Costs (2011$/kW-year) $40.00
  - Variable O&M Costs (2011$/MWh) $0.00
  - Insurance Rate 0.05%
  - Gross Receipts Tax Rate 2.00%
  - Nameplate Tax ($/kW) $3.00
- South Dakota Contractor Taxes Assumptions
  - Contractor Excise Tax Rate 2.041%
  - Sales and Use Tax Rate 4.00%
- Renewable Tax Credits
  - Production Tax Credit Value (2011$/MWh) $22.00
  - Investment Tax Credit Value 30.00%

These assumptions are based upon typical values observed for utility-scale wind farms and BMcD's experience with developing comparable projects. The following highlights a few of the most important pro forma inputs and the methodology used to derive these numbers:

- **Commercial Operation Date:** A date of 2014 was assumed as the earliest and most aggressive date available to become commercially operable for a wind project not currently under development.
- **Property Taxes:** South Dakota's Alternative Taxes were utilized in lieu of a flat property tax rate.
- **Alternative Taxes:** Estimates for South Dakota's Alternative Taxes (i.e., Nameplate Capacity Tax, Gross Receipts Tax) are based upon a September 2011 presentation to the South Dakota Wind Energy Facility Task Force [4].
- **Contractor Taxes:** Estimates for South Dakota's front-end wind energy taxes (i.e., Contractor Excise Tax, Sales and Use Tax) are based upon a September 2011 presentation to the South Dakota Wind Energy Facility Task Force [4].
- **Capital Cost Estimate:** The capital cost estimate of $1,800/kW is based upon evaluation of several recent turbine supply agreements by BMcD. These costs represent the all-in Project capital costs, including turbine supply, delivery, installation, and commissioning activities, as well as construction of balance-of plant infrastructure (e.g., power collection system, access

roads, foundations) and owner's costs. For the avoidance of doubt, the estimated capital costs exclude the applicable cost of transmission upgrades beyond the high-side of the interconnection substation.

- **Renewable Tax Credits:** The pro forma model allows for the production tax credit (PTC) or investment tax credit (ITC) to be utilized by the Project. These credits cannot be used simultaneously nor is either tax credit required to be utilized. However, the model does assume that both credits will be available at the Project's commercial operation date. Moreover, as part of the American Recovery and Reinvestment Act of 2009, a cash grant of up to 30 percent of the cost of building a new facility is available for certain renewable energy projects built in 2009 or 2010. The pro forma model assumes that this grant will not be available beyond these years.

3.2 PRO FORMA RESULTS

Utilizing the base assumptions noted above, the 20-year levelized busbar cost of the Project was estimated to be approximately $65 per megawatt-hour (MWh) (2014$), or roughly $61 per MWh in current (2011) dollars. This cost is considered to be conservatively high, based on BMcD expectations and experience with recent market transactions.

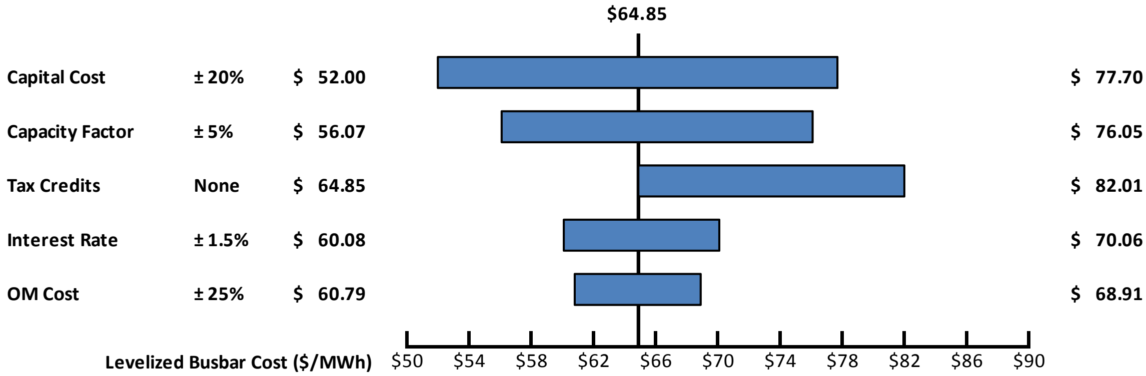
3.3 BUSBAR COST SENSITIVITY ANALYSIS

To understand the impacts of the economic inputs on the results of the busbar cost evaluation, a sensitivity analysis was prepared for the following cases:

- Capital Cost ± 20%
- O&M Costs ± 25%
- Capacity Factor ± 5%
- Interest Rate ± 1.5 percentage points
- No Federal Tax Incentives (PTC, ITC)

The results of the sensitivity analyses are presented in the tornado diagram in Figure 3-1. A tornado diagram illustrates the range of results for each sensitivity case and its impact on the levelized busbar cost, and ranks the results from greatest impact to least impact. The sensitivity analysis indicates that capital cost and capacity factor are by far the most significant factors affecting the economics of a wind energy facility. Similarly, the production tax credit is providing a nearly $17 per MWh subsidy to the levelized busbar cost, or approximately 28 percent relative to the total project cost. As such, the Project economics may be significantly impacted if the renewable tax credits are not extended past the expected commercial operation date.

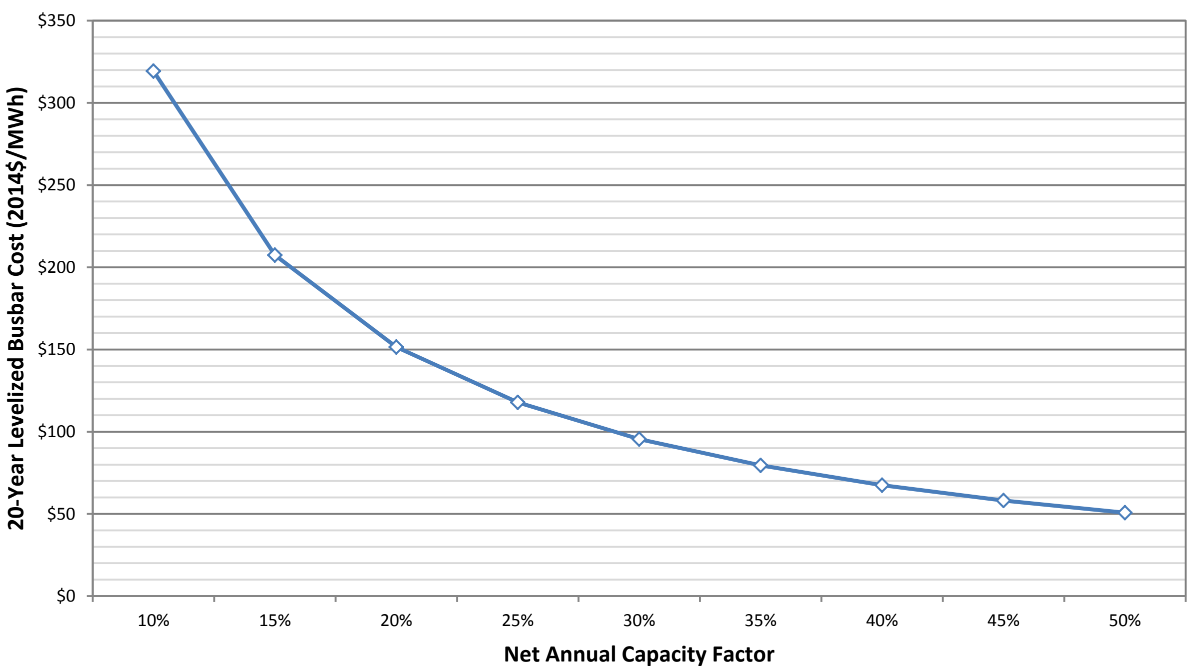
Figure 3-1: Base Case Sensitivity Analysis Tornado Diagram



3.4 CAPACITY FACTOR SENSITIVITY ANALYSIS

BMcD further evaluated the sensitivity of the Project’s levelized busbar cost to net annual capacity factor. Figure 3-2 below demonstrates the impact on levelized busbar cost as capacity factor is varied. As expected, the Project’s busbar costs drop significantly as capacity factor increases.

Figure 3-2: Levelized Busbar Cost Variation with Net Annual Capacity Factor



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SECTION 4

ELECTRIC TRANSMISSION CAPITAL COST EVALUATION

4.0 ELECTRIC TRANSMISSION CAPITAL COST EVALUATION

BMcD completed an evaluation of electric transmission system capital cost investments required to move wind energy between the Project's potential source and sink locations. To perform this analysis, a net annual capacity factor was assumed for each location, along with both the expected electrical losses likely to occur when moving wind energy between these Project locations and the expected annual, levelized carrying charge factor for the electric transmission infrastructure. Based on these inputs, as well as the base pro forma assumptions noted previously, a breakeven capital investment cost was calculated. This cost, expressed in total capital cost per kilowatt of incremental transfer capability realized, represents the maximum allowable investment in electric transmission infrastructure that can be expended before the source location's busbar cost would exceed the busbar cost of a similar project at the sink location.

4.1 BASE CASE BREAKEVEN CAPITAL COSTS

As a base case scenario, the following assumptions were utilized in the calculation of the breakeven transmission investment (note that the selected capacity factors represent the maximum range expected for the source and sink locations evaluated herein):

- Source Location Capacity Factor 44.00%
- Sink Location Capacity Factor 27.00%
- Electrical Losses 5.00%
- Transmission Carrying Cost 15.00%

Based on these assumptions, a 17 percent capacity factor differential between the source and sink location yields a breakeven capital cost of approximately $1,100/kW. Thus, a project sited in a wind-rich area could justifiably spend up to $1,100 per kilowatt of incremental power transfer capability on transmission infrastructure and remain economically competitive with a similar project sited in an area with an annual capacity factor that is 17 points lower than the source location. Note that breakeven transmission investment costs are expressed in 2014 dollars.

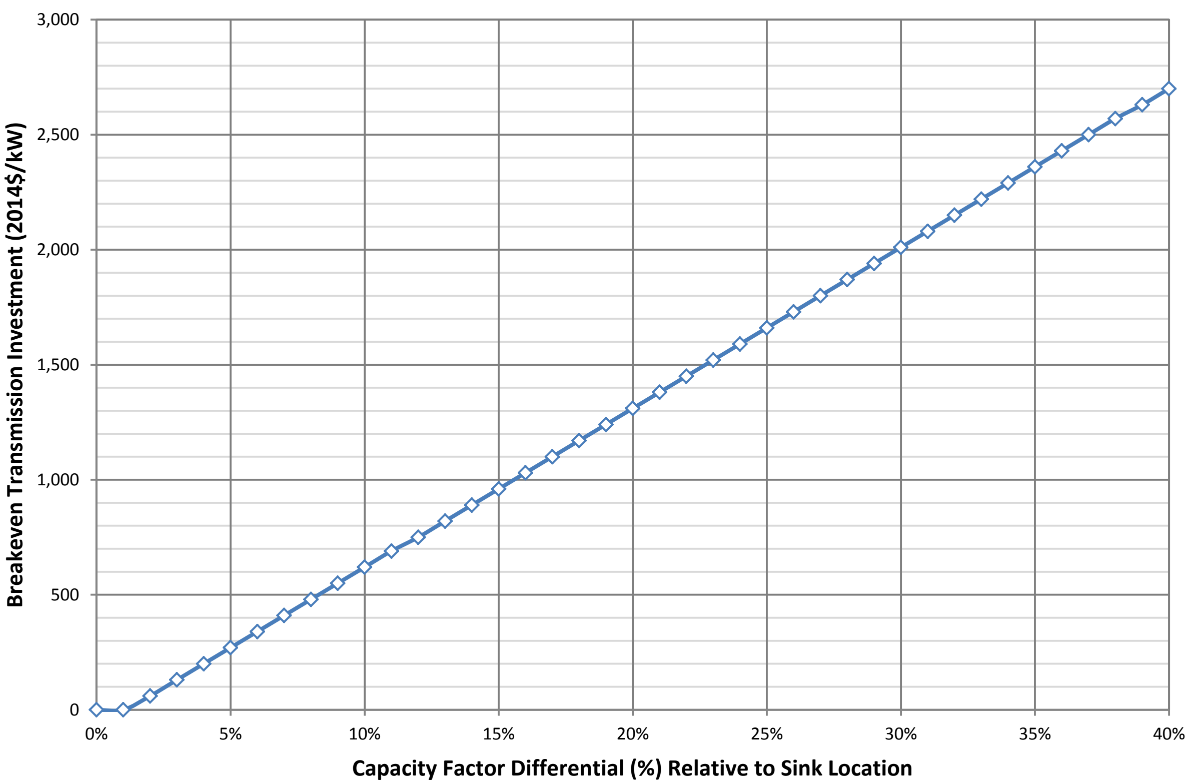
Although the breakeven capital cost of $1,100 per kW is calculated on a unit basis, making it generally independent of Project size, the overall financial investment will vary significantly as the Project capacity increases. For example, a 100-MW wind farm could justifiably spend up to $110 million on electric transmission infrastructure under the base case scenario ($1,100/kW x 100 MW x 1,000 kW/MW = $110 million). If this wind farm were scaled up to 1,000 MW, the breakeven capital cost would remain constant on a unit ($/kW) basis, but the overall financial investment would increase ten-fold to $1.1 billion.

4.2 CAPACITY FACTOR DIFFERENTIAL SENSITIVITY ANALYSIS

As noted in Table 2-2, the highest average annual capacity factor of any potential Project location is 44.4 percent (Brookings); the lowest average annual capacity factor of any potential Project location is 27.8 percent (Michigan). Thus, a capacity factor differential of approximately 17 percent, as utilized in the base case breakeven capital cost evaluation, represents a best-case scenario in terms of the capacity factor differential between potential source and sink locations.

A sensitivity analysis was completed on the breakeven transmission investment to examine the impact of variations in capacity factor differential. As seen in Figure 4-1, the breakeven transmission investment drops as capacity factor differential decreases. Thus, the smaller the gap in capacity factor between the Project's source and sink locations, the smaller the justifiable investment in electric transmission infrastructure to move the wind energy between the two locations.

Figure 4-1: Breakeven Transmission Capital Cost by Capacity Factor Differential



4.3 PROJECT EXAMPLE

The following example is intended to illustrate a specific Project scenario. Under this example, a 1,000-MW wind farm is developed at the Groton site in South Dakota. Energy from the wind farm is transferred on a high-voltage transmission line to an off-take location in another state. All potential Project sink locations were evaluated as off-take points.

Based on information derived from the Capacity Factor Characterization task (Section 2.0), the average net annual capacity factor expected at the Groton site is approximately 41.4 percent. The average net annual capacity factors at the potential sink locations, along with the corresponding capacity factor differential from the Groton source location, are summarized in Table 4-1 below. From these differentials, a breakeven transmission investment was calculated for each off-take location to assess the maximum investment that could justifiably be made in electric transmission infrastructure.

Table 4-1: Breakeven Transmission (From Groton)

Sink Location	Avg Annual NCF [%]	NCF Differential [%]	Breakeven Cost [$/kW]
Chicago	29.6%	11.8%	$670
Detroit	27.8%	13.6%	$840
Indianapolis	29.1%	12.4%	$720
Milwaukee	28.1%	13.4%	$820
Minneapolis	33.3%	8.1%	$380
St. Louis	28.7%	12.8%	$760

Notes:
1. Assumes source location near Groton, South Dakota
2. Assumes project with 1000 MW nameplate capacity
3. Assumes electrical losses of 5.0 percent
4. Assumes transmission carrying cost factor of 15.0 percent

Based on the information in Table 4-1, if the Project were constructed near the Groton site and used to export energy to the St. Louis sink location, up to $760 per kW would be available as capital to invest in transmission infrastructure before the source location’s busbar cost would exceed the cost of the same project at the sink location. For the 1,000 MW example project, this equates to approximately $760 million to make necessary improvements and additions to the electric transmission system between the sites, covering approximately 620 miles (point to point).

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SECTION 5

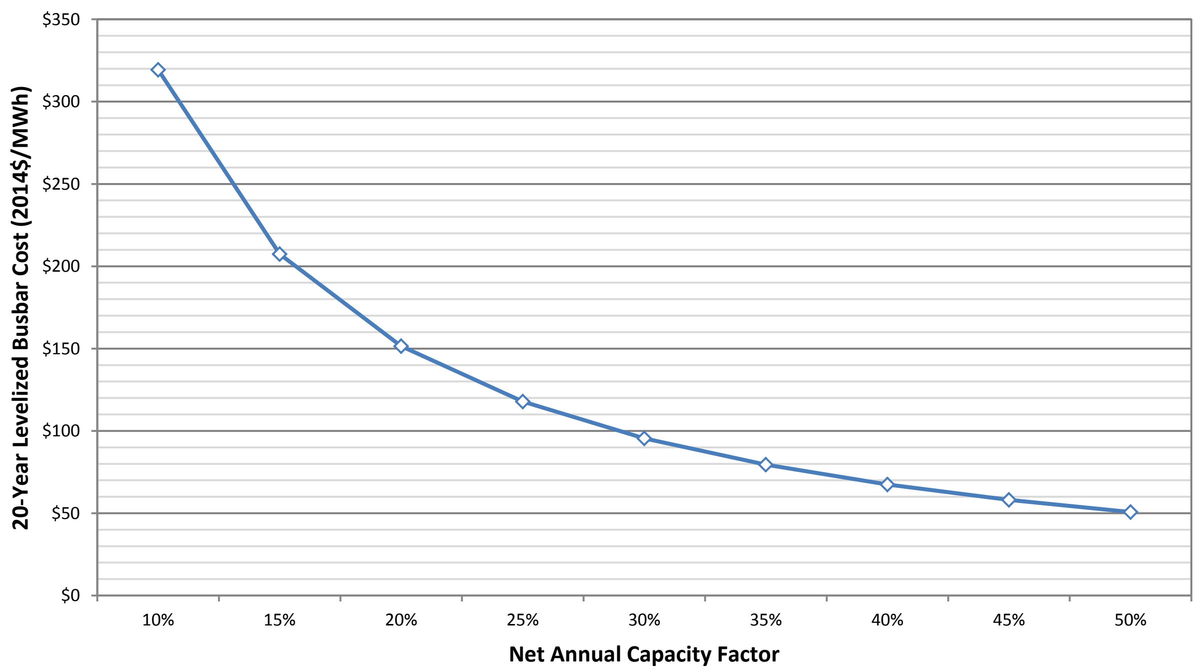
SUMMARY AND CONCLUSIONS

5.0 SUMMARY AND CONCLUSIONS

The purpose of this Study was to create an economic model to assess the viability of transporting wind energy from wind-rich areas in South Dakota to eastern load centers. This model was designed to evaluate the 20-year levelized busbar cost of energy from the Project based on several base-case assumptions and economic inputs. These assumptions may be modified at the user's discretion to evaluate any combination of Project options.

Utilizing the base assumptions in the pro forma economic model, the 20-year levelized busbar cost of the generic 1,000-MW Project was estimated to be $65 per MWh (2014$). In current (2011) dollars, this would be approximately $61 per MWh. Figure 5-1 below demonstrates how the levelized busbar cost of wind generation varies with capacity factor.

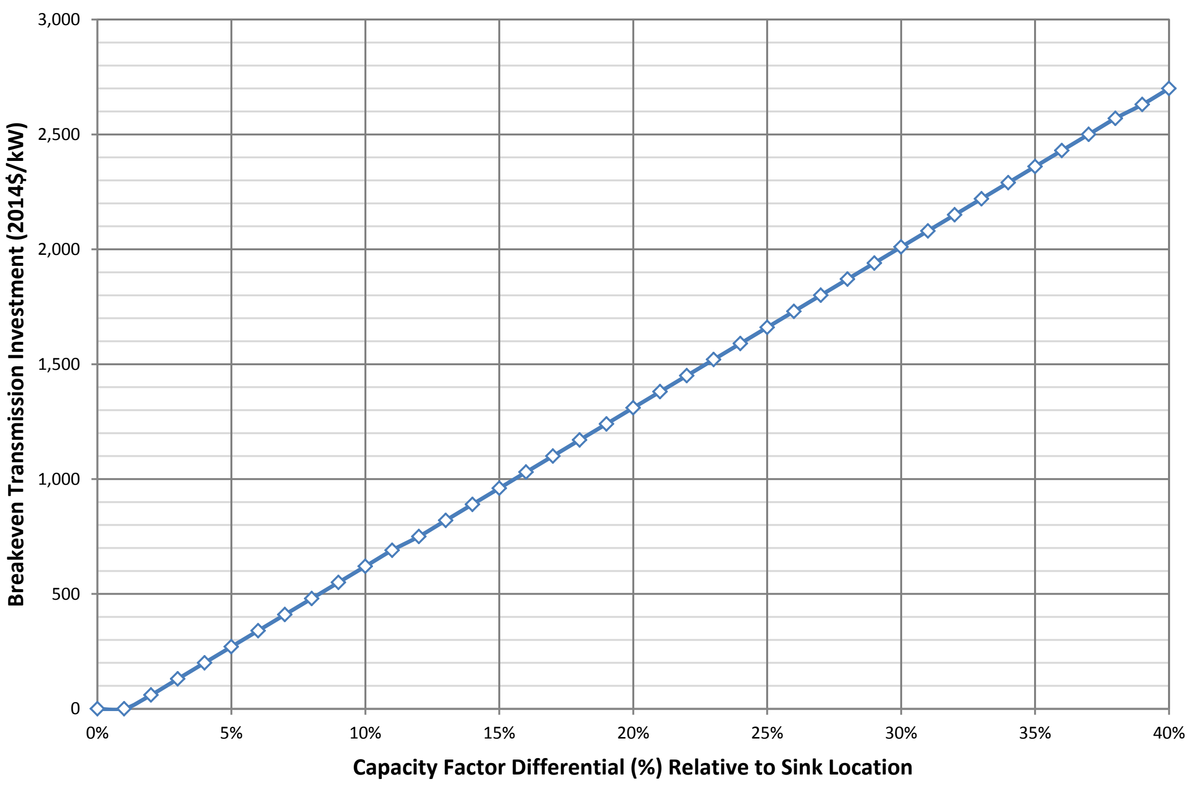
Figure 5-1: Levelized Busbar Cost Variation with Net Annual Capacity Factor



BMcD also characterized the expected capacity factor ranges that are likely to occur between various Project locations. This task, completed entirely with publically-available data and using industry-standard techniques, revealed the most attractive source location for the Project to be near Brookings, South Dakota, with an average net annual capacity factor of approximately 44.4 percent. Conversely, the sink location with the lowest average net annual capacity factor was Detroit, Michigan (27.8 percent).

Finally, utilizing the pro forma economic model and capacity factor ranges noted above, BMcD determined the breakeven electric transmission system capital cost investments that could be economically justified by a differential in wind generation capacity factors between any two source and sink locations considered in the Study. Based on results of the Capacity Factor Characterization task, the largest differential in capacity factor between any source and sink location is not expected to exceed 17 percent. Assuming that scenario, the breakeven transmission investment was estimated at $1,100 per kilowatt. Thus, a project sited in a wind-rich area of South Dakota could justifiably spend up to $1,100 per kilowatt of incremental power transfer capability and remain economically competitive with a similar project sited in an area with an annual capacity factor that is 17 points lower than the source location. As demonstrated in Figure 5-2 below, the amount of transmission investment that an entity could economically justify to provide the required capability to transfer wind energy decreases as the differential in capacity factor narrows.

Figure 5-2: Breakeven Transmission Capital Cost by Capacity Factor Differential



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SECTION 6

REFERENCES

6.0 REFERENCES

The following sources were referenced within this report.

[1] National Renewable Energy Laboratory (NREL). “Estimates of Windy Land Area and Wind Energy Potential, by State, for Areas >= 30% Capacity Factor at 80m”. April 13, 2011. <http://www.windpoweringamerica.gov/docs/wind_potential_80m_30percent.xlsx>. Accessed October 4, 2011.

[2] Stuefen Research, LLC. “The South Dakota Wind Blueprint”. September 2010. < http://www.stuefenresearch.com/SD%20Wind%20Blueprint%20Economic%20Impact%20Analysis%202011.pdf>. Accessed October 20, 2011.

[3] Wind Powering America. “80-Meter Wind Maps and Wind Resource Potential.” April 2011. <http://www.windpoweringamerica.gov/wind_maps.asp>. Accessed October 4, 2011.

[4] Alison Jares and Matt Fonder. Presentation for the (South Dakota) Wind Energy Task Force. “South Dakota Taxation: How it Applies to Wind Energy Facilities.” Presented September 7, 2011. < https://legis.state.sd.us/interim/2011/documents/WET_09072011_SDTaxation.pdf>. Accessed October 17, 2011.

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APPENDIX A

PRO FORMA BASE CASE VALUES

The following represent the estimates and economic assumptions in the base-case pro forma economic model provided to the SDWEA:

Tab: Assumptions

- Wind Project Assumptions
  - Rated Capacity (kW) 1,000,000
  - Net Annual Capacity Factor 41.30%
  - Commercial Operation Date 2014
- Renewable Tax Credits
  - Renewable Tax Credit Type PTC
  - Investment Tax Credit Amount 30.00%
  - PTC Inflation Adjustment Factor (2011) 1.4459
  - Production Tax Credit Value Year 2011
  - PTC Escalation Rate 2.00%
- Rate Assumptions
  - General Escalation Rate 2.00%
  - Property Tax Rate 0.00%
  - Insurance Rate 0.05%
  - Income Tax Rate 40.00%
- South Dakota Alternative Taxes
  - Nameplate Tax ($/kW) $3.00
  - Gross Receipts Tax Rate 2.00%
  - Base Tax Rate ($/kWh) $0.0499
  - Base Tax Rate Escalation Rate 2.50%
  - Base Tax Rate Year 2011
  - Rebate Amount, Years 1-5 90.00%
  - Rebate Amount, Years 6-10 50.00%
- South Dakota Contractor Taxes
  - Ratio of Total Cost Subject to CET 100.00%
  - Contractor Excise Tax to Collect 2.041%
  - Ratio of Total Cost to Sales / Use Tax 70.00%
  - Sales / Use Tax Rate 4.00%

- Wind Farm Financing Assumptions
  - Debt, % Financed 70.00%
  - Debt Interest Rate 7.00%
  - Required Return on Equity 12.00%
  - Construction Financing Fees 0.50%
  - Permanent Financing Fees 1.00%
  - Debt Financing Term (years) 20
  - Book Depreciation Term (years) 20
  - Tax Depreciation Type 5-Year MACRS
  - Tax Partner Risk Discount 0.00%
- Wind Farm Operations and Maintenance Expenses
  - Forecast Effective Date 2011
  - Fixed O&M ($/kW-year) $40.00
  - Variable O&M ($/MWh) $0.00
  - Annual O&M Contingency 20.00%
- Wind Farm Capital Cost Estimates
  - Forecast Effective Date 2011
  - Capital Cost Estimate $1,800/kW
  - Midpoint of Construction 2013
- Sensitivities
  - Capital Cost Variance 20.00%
  - Interest Rate Variance 1.50%
  - Capacity Factor Variance 5.00%
  - O&M Cost Variance 25.00%
  - Tax Credit Variance 100.00%
- General Workbook Assumptions
  - Rounding Accuracy -3

<u>Tab: Transmission</u>

- Gross Capacity Factor, Source 40.00%
- Gross Capacity Factor, Sink 30.00%
- Electrical Losses 5.00%
- Transmission Annual Levelized Carrying Charge Factor 15.00%

Tab: Project Example

• Project Source Location	Groton
• Project Size (MW)	1,000
• Electrical Losses	5.00%
• Transmission Carrying Cost	15.00%

Tab: IDC

• Drawdown, Month 1	1.00%
• Drawdown, Month 2	1.00%
• Drawdown, Month 3	1.00%
• Drawdown, Month 4	1.00%
• Drawdown, Month 5	1.00%
• Drawdown, Month 6	5.00%
• Drawdown, Month 7	0.25%
• Drawdown, Month 8	0.25%
• Drawdown, Month 9	0.25%
• Drawdown, Month 10	0.25%
• Drawdown, Month 11	0.50%
• Drawdown, Month 12	0.50%
• Drawdown, Month 13	15.00%
• Drawdown, Month 14	1.00%
• Drawdown, Month 15	1.00%
• Drawdown, Month 16	20.00%
• Drawdown, Month 17	0.75%
• Drawdown, Month 18	0.75%
• Drawdown, Month 19	20.00%
• Drawdown, Month 20	7.50%
• Drawdown, Month 21	7.50%
• Drawdown, Month 22	7.50%
• Drawdown, Month 23	3.50%
• Drawdown, Month 24	3.50%

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