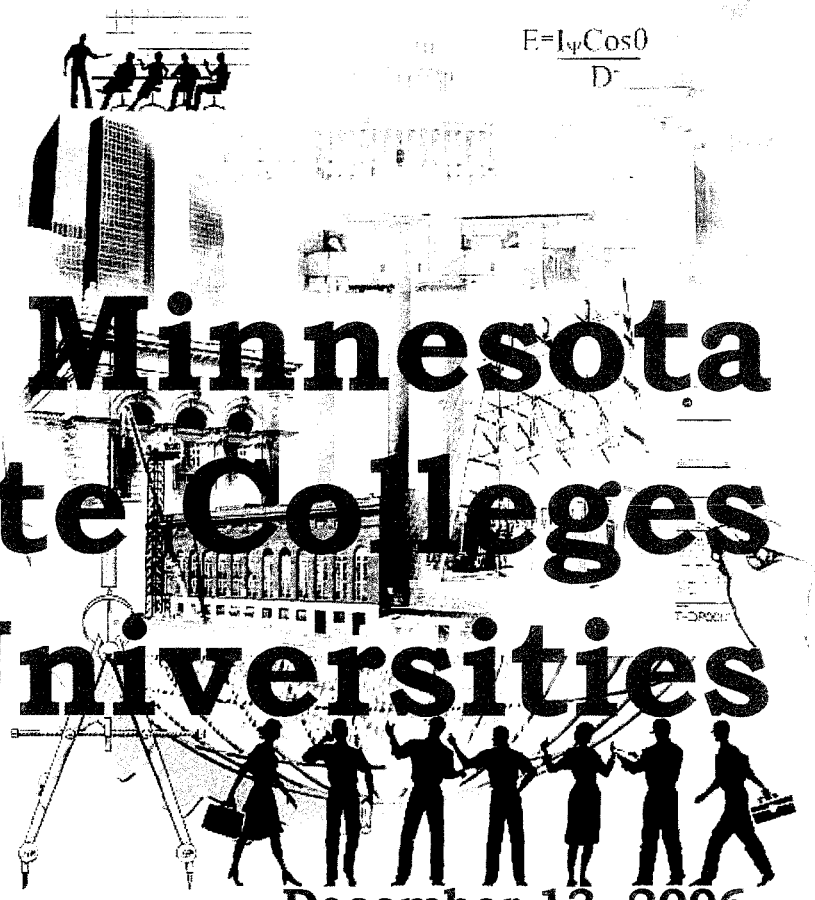
Sebesta Blomberg

Wind Screening Study



Minnesota State Colleges & Universities

December 13, 2006

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APPENDIX A

RETScreen Energy Model **Suzlon S64 1.25 MW**

- East Grand Forks
- Mankato
- Willmar

APPENDIX B

RETScreen Energy Model **Suzlon S88 2.1 MW**

- East Grand Forks
- Mankato
- Willmar

Executive Summary

The Wind Energy Project Analysis Model was used to evaluate the economic viability of installing wind turbines at three system campuses:

East Grand Forks	Northland Community and Technical College
Willmar	Ridgewater College
Mankato	Minnesota State University Mankato

The model incorporates databases on weather, system performance, and system cost to evaluate energy production and life-cycle cost of potential wind energy projects. However site specific weather conditions and wind system performance curves can be loaded into the model, facilitating a less generic evaluation of system performance and economics. Wind data collected by WindLogics and MnSCU has been used to provide site specific evaluation of wind turbine performance. The evaluation period of the model has been set at twenty years.

Two wind turbines manufactured by Suzlon have been used in this evaluation: Suzlon S64 with a rated capacity of 1.25 MW and Suzlon S88 with a rated capacity of 2.1 MW. Wind speed and the performance curve of the wind turbines are the critical factors of system performance. The performance curve establishes the relative capacity available and annual generation from the turbine for a given wind speed.

	East Grand Forks	Mankato	Willmar
Wind Speed (meters/second) and Hub Height			
Hub Height: 65 meters Suzlon S64 1.25 MW	7.4	7.8	6.2
Hub Height: 80 meters Suzlon S88 2.1 MW	7.7	8.11	6.4
Annual Electric Generation (MWh)			
Suzlon S64 1.25 MW	3,016	3,563	1,465
Suzlon S88 2.1 MW	6,447	7,452	3,382

The electricity generated by the 1.25 MW wind turbine in Mankato is assumed to be used by the campus, with a value of $0.056/kWh. Otherwise all generated electricity is assumed to be sold to the grid. Electricity sold to the grid has been assigned an average value of $0.03447/kWh in all instances, with an escalation rate of 3% per year. The grid value of electricity is the average rate paid to windfarms by Xcel, taken from the FERC Form 1 report for 2005.

The value of the generated electricity must be sufficient to support the annual operating expense of the wind turbine. Annual operating expense includes annual and major periodic maintenance and debt service. Annual maintenance expense of the wind turbines is $71,500 for the S64 and $82,500 for the S88. Major periodic maintenance is assumed to occur in years 10, 15 and 20 of the evaluation period.

Turbine Model	Drive Train	Blades
Year, Occurrence	10, 20	15
Suzlon S64	$150,000	$275,000
Suzlon S88	$250,000	$400,000

These costs are expressed in present dollars. An annual inflation rate of 2.5% is used to determine the future cost of these maintenance allowances.

The estimated project cost of installing the S88 2.1MW turbine at any of the campuses is $3,682,397. The estimated cost of the S64 1.25 MW turbine is $2,230,594. Project debt is assumed to 85%, financed over a term of 20-years with an interest rate of 6%. The annual debt service associated with installation of the S88 is $272,931, and $165,302 with the installation of the S64.

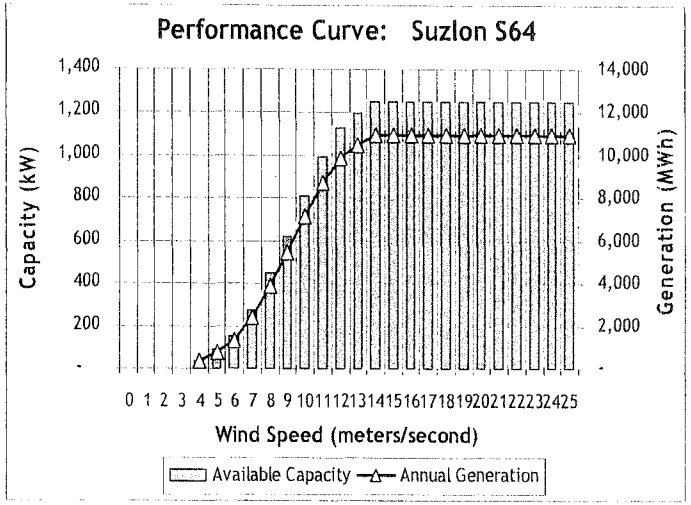
The wind resource as quantified in the project data and anticipated energy payments are not adequate to support the capital investment for installing wind turbines at Ridgewater College in Willmar or the 1.25 MW wind turbine at Northland Community and Technical College in Grand Forks. Installing a 1.25 MW wind turbine to offset the campus electric load of Minnesota State University Mankato does show a positive cash flow and payback, but may not be justifiable exclusively on the basis of economic considerations.

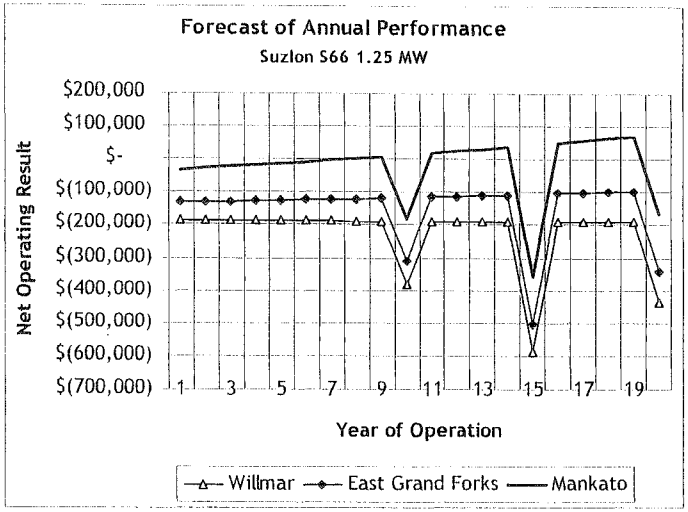
The wind resources do provide significantly greater generation with the 2.1 MW wind turbine if installed in East Grand Forks or Mankato. In these instances the anticipated energy payment of $34.47/kWh does not provide enough revenue for the capital investment and operating expenses.

Based on the foregoing parameters and evaluation, wind turbines financed by conventional debt and absent production credits are not a prudent capital investment for MnSCU. The C-BED tariff in conjunction with innovative financing mechanisms such as Clean Renewable Energy Bonds can significantly improve the economic forecast of wind turbines, revealing potentially viable projects: 2.1 MW Suzlon S88 wind turbines in Mankato and East Grand Forks.

The municipal utility in Willmar has expressed interest in developing a wind turbine installation on the campus property of Ridgewater College. Given the results of this analysis, MnSCU should continue to explore mechanisms for leasing the affected property to the local municipal utility. As part of the lease terms, MnSCU should seek permission to state that Ridgewater College is host of a Green Energy facility in its promotional materials.

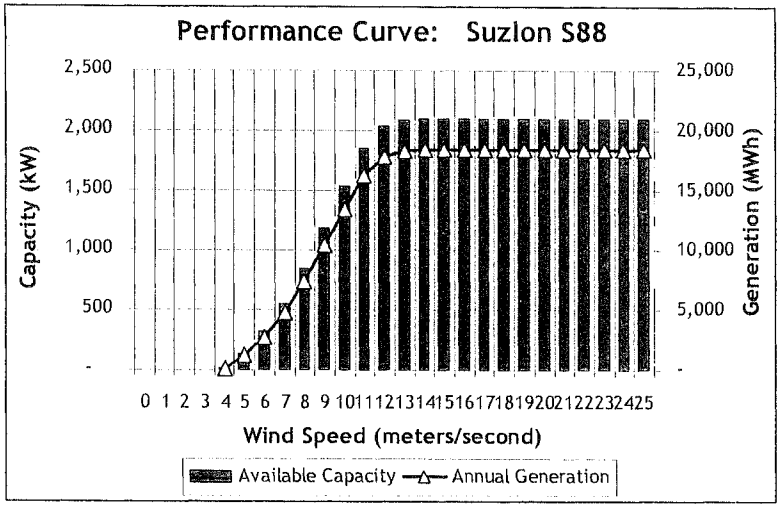
Summary of Economic Forecast: Suzlon S64 1.25 MW

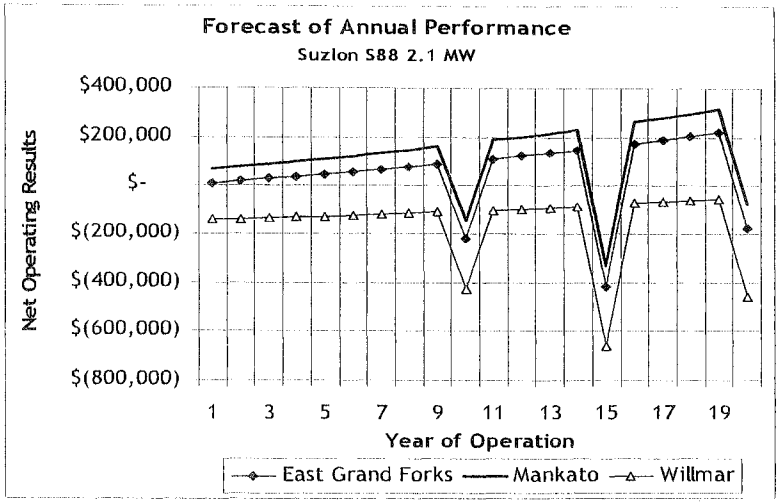




	East Grand Forks	Mankato	Willmar
Wind Speed at 65 M hub	7.4 m/s	7.8 m/s	6.2 m/s
Generation (MWH)	3,016	3,563	1,465
Value of Electric Generation	$ 107,073	$ 238,528	$ 52,013
Annual Maintenance	$ 73,288	73,288	$ 73,288
Debt Service	$ 165,302	165,302	$ 165,302
First Year Savings	-$ 131,517	-$ 33,088	-$ 186,577
Project Cost	$ 2,230,594	$ 2,230,594	$ 2,230,594
Project Debt	$ 1,896,005	$ 1,896,005	$ 1,896,005
Project Equity	$ 334,589	$ 334,589	$ 334,589
Years to Positive Cash Flow	>20	>20	>20
Simple Payback Period (years)	>20	17.4	>20
Internal Rate of Return	Negative	Negative	negative

Summary of Economic Forecast: Suzlon S88 2.1 MW





	East Grand Forks	Mankato	Willmar
Wind Speed at 80 M hub	7.7 m/s	8.1 m/s	6.4 m/s
Generation (MWH)	6,447	7,452	3,382
Value of Electric Generation	$ 228,898	$ 264,570	$ 120,084
Annual Maintenance	$ 84,563	84,563	$ 84,563
Debt Service	$ 272,931	272,931	$ 272,931
First Year Savings	- $ 128,596	-$ 92,924	- $ 237,410
Project Cost	$ 3,682,937	$ 3,682,937	$ 3,682,937
Project Debt	$ 3,130,496	$ 3,130,496	$ 3,130,496
Project Equity	$ 552,441	$ 552,441	$ 552,441
Years to Positive Cash Flow	>20	>20	>20
Simple Payback Period (years)	>20	>20	>20
Internal Rate of Return	negative	negative	negative

Resources and Assumptions for Modeling

Development Sites

Higher average annual wind speed is one relative measure of potential wind energy system performance and economic viability. Table 1 lists the potential MnSCU wind development sites on the basis of average annual wind speed. Data compiled in Table 1 has been taken from 2006 wind speed and capacity factor maps. This feasibility study, in accordance with directives from MnSCU, involves four campuses: Minnesota State University Mankato, Riverland Community College, Northland Community and Technical College at East Grand Forks, and Ridgewater Community College in Willmar. The campuses will be referred to generically as Mankato, East Grand Forks and Willmar[1].

Table 1
Potential MnSCU Wind Development Sites
(2006 50 meter wind speed and capacity factor maps)

Campus	Average Annual Wind Speed (meters/second)
MN West Community & Technical College – Pipestone	8.1-8.5
MN West Community & Technical College – Worthington	8.1-8.5
MN West Community & Technical College – Jackson	8.1-8.5
Northland Community & Technical College - Thief River Falls	8.1-8.5
MN State University – Mankato	**8.1-8.5**
Riverland Community College - Albert Lea	7.7-8.1
MN West Community & Technical College – Canby	7.7-8.1
Northland Community & Technical College - East Grand Forks	**7.3-7.7/7.7-8.1**
Southwest MN State University – Marshall	7.3-7.7/7.7-8.1
Alexandria Technical College – Alexandria	7.3-7.7/7.7-8.1
MN State Community & Technical College - Fergus Falls	7.3-7.7/7.7-8.1
MN State University – Moorhead	7.3-7.7/7.7-8.1
MN State Community & Technical College - Moorhead	7.3-7.7/7.7-8.1
Ridgewater College – Willmar	**7.3-7.7/7.7-8.1**
Riverland Community College - Austin	7.3-7.7/7.7-8.1

[1] Riverland Community College was not included in this evaluation because of proximity to the airport. Height restrictions would preclude installation of large capacity wind turbine generators. A separate evaluation will be developed for this campus upon receipt of capital costs for a 40 kW wind turbine system.

Analysis Model and Data

Projections of wind energy system performance and relative economic viability for the selected campuses are determined by the Wind Energy Project Analysis Model developed by RETScreen International2. The model incorporates databases on weather, system performance, and system cost to evaluate energy production and life-cycle cost of potential wind energy projects. However site specific weather conditions and wind system performance curves can be loaded into the model, facilitating a less generic evaluation of system performance and economics.

Average annual wind speed and atmospheric pressure are two site specific input variables of the RETScreen model. The WindLogics data from a previously completed study was used for the Mankato site. Wind data provided by MnSCU was used for the Willmar and East Grand Forks sites (Grand Forks being the actual location of the weather station that provided data for East Grand Forks). An average atmospheric pressure of 100 kPa was used for all locations.

Table 2
Ambient Conditions and System Losses

	East Grand Forks	Mankato	Willmar
Atmospheric Pressure, kPa	100	100	100
Average Annual Temperature, °C	5	7	6
Array Losses	0%	0%	0%
Airfoil Soiling/Icing Losses	1%	1%	1%
Other Downtime Losses	2%	2%	2%
Miscellaneous Losses	2%	2%	2%

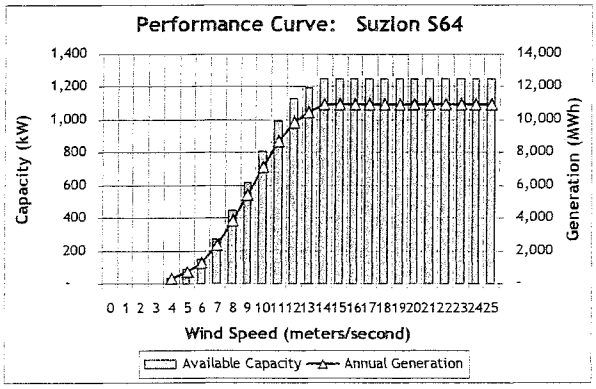
The energy output level is calculated by RETScreen based on the actual turbine power curve, the climatology data for the specific site, and expected losses. The losses used in this model are airfoil soiling and/or icing losses (1%), other downtime losses (2%), and miscellaneous losses (2%). Array losses are eliminated from consideration as there is no array. Only a single turbine is modeled for each campus.

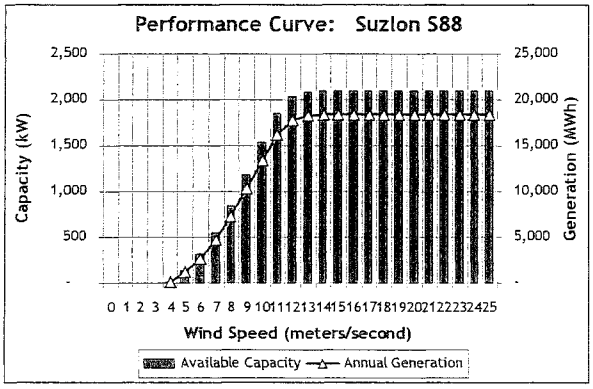
The power curves of two turbines are used: Suzlon S64 and Suzlon S88. The rated capacity of the turbines is 1.25 MW and 2.1 MW, respectively. The hub height of the Suzlon S64 is 65 meters, and the corresponding height of the Suzlon S88 is 80 meters.

Table 3
Wind Speed (meters/second) and Hub Height

Hub Height: 65 meters	7.4	7.8	6.2
Hub Height: 80 meters	7.7	8.11	6.4

[2] RETScreen International is a collaboration of governments and multilateral organizations to provide models for the evaluation of clean energy systems. Participants of the collaboration include Natural Resources Canada Renewable Energy Deployment Initiative, National Aeronautics & Space Administration's Langley Research Center, United Nations, and World Bank.





The capital cost of the respective systems is summarized in the Table 3, and is also included in the RETScreen models for each campus (contained in Appendix A).

Table 4
Summary of Project Capital Costs

Project Cost		
Feasibility Study	$ 75,000	$ 75,000
Project Development		
Legal Services	$ 10,000	$ 10,000
Interconnection Study	$ 10,000	$ 10,000
MISO Study	0	$ 50,000
Local Permits	$ 15,000	$ 15,000
Site Development	$ 30,000	$ 40,000
Engineering	$ 70,000	$ 85,000
Energy Equipment		
Turbine with delivery	$ 1,250,000	$ 2,349,900
Spare parts (3%)	$ 37,500	$ 70,497
Interconnection	$ 150,000	$ 175,000
Balance of Plant		
Labor-erection	$ 55,000	$ 65,000
Crane	$ 100,000	125,000
Foundation	$ 250,000	325,000
Commissioning	$ 10,000	$ 10,000
Miscellaneous		
Contingencies (5%)	$ 103,125	$ 170,270
Interest during Construction	$ 64,969	$ 107,270

Project development costs provide a budget for costs and expenses related to legal services, interconnection studies and review of purchase power agreements, local permits and site development (i.e., roads and grading). It has been assumed that no land lease will be required as the turbines will be

installed on MnSCU campus property. Since all of the potential projects are below 5 MW, only local permitting is required. The cost of obtaining the local permitting was estimated to be $15,000, with allowance for attending local community and zoning meetings. It is further anticipated that the smaller Suzlon turbine will not require a MISO coordination study. Total project development cost is estimated to be $65,000 for the installation of the Suzlon S64 and $125,000 for the Suzlon S88. The differential in project development cost is attributable to the MISO study and higher site development cost for the larger system.

The estimate of engineering fees includes for the design of the interconnection plus an allowance, $10,000, for non-interconnection design services related to the system installation.

The cost of the turbines, including delivery to the respective sites, is based on a budgetary quote from Suzlon. However, note that prices are dynamic and will be heavily influenced by the price of copper and steel. The interconnection cost for the 1.25 MW system is based on a 1.5 MVA transformer and related equipment (i.e. metering, protective relays, switchgear, etc.). The corresponding cost for the 2.1 MW system reflects the use of a 2.5 MVA transformer. The cost of the energy equipment, including turbines deliver to site, allowance for spare parts (3%) and interconnection is $1,437,500 for the 1.25 MW system and $2,595,297 for the 2.1 MW system.

The balance of plant costs includes allowances for labor, crane rental, tower foundation and system commissioning. These costs are estimated to be $415,000 for the 1.25MW system and $525,000 for the 2.1 MW system, recognizing higher costs for labor, crane rental and foundation associated with a larger capacity installation.

The miscellaneous cost allocation is intended to provide a budget to account the cost of interest during construction (6% over a 12 month construction period) and a 5% allowance for project contingencies.

On this basis, the total project cost of the 1.25 MW Suzlon S64 turbine is $2,230,594 or about $1,785/kW. The total cost of the 2.1 MW Suzlon S88 turbine is $3,682,937 or about $1,754/kW.

Results

The RETScreen model forecasts annual performance of a wind turbine using the weather data for the site and performance curve of the turbine. Ultimately the economic viability of a turbine installation is evaluated by comparing the value of generated electricity with the capital cost of the system and annual expense of operating the system over a specified period of time. The time period used in these analyses is 20 years.

Electricity generated by the wind turbines can be used to displace retail service or sold to the grid as a wholesale provider. Upon review of electrical data provided for the campuses it appears that the electricity generated by a 1.25 MW wind turbine if installed in Mankato can be used by the campus, and therefore has been assigned an average retail value of $0.056/kWh. The data for the campus indicate a

minimum demand of only 205 kW. However upon further review, the minimum demand of the campus is less than 1.25 MW for less than 30 hours per year. Given the growth in electric demand experienced by virtually all campuses, it seemed a prudent assumption that generation from the 1.25 MW turbine can be used entirely by the Mankato campus.

Maximum kW	400	2800	1,600
Average kW	160	1756	475
Minimum kW	65	205	285

For the other campuses the capacity of the wind turbines considered by this evaluation is significantly greater than the respective campus demand profiles. So the electricity generated in these instances is assumed to be sold to the grid. Electricity sold to the grid has been assigned an average value of $0.03447/kWh in all instances, with an escalation rate of 3% per year. The grid value of electricity is the average rate paid to windfarms by Xcel, taken from the FERC Form 1 report for 2005.

Annual operating expense includes debt service and maintenance expense. Debt service is based on 85% of capital cost with a 6% interest over a 20-year term. The annual maintenance expense of the wind turbines is $71,500 for the Suzlon S64 and $82,500 for the Suzlon S88. Maintenance expenses at inflated at the rate of 2.5% per year over the 20 year evaluation period.

Additional major maintenance costs are scheduled for the drive train in years 10 and 20 of the evaluation period, and for the blades in year 15. The cost of this major maintenance is:

Turbine Model	Drive Train	Blades
Suzlon S64	$150,000	$275,000
Suzlon S88	$250,000	$400,000

These costs are expressed in present dollars. An annual inflation rate of 2.5% is used to determine the future cost of these maintenance allowances.

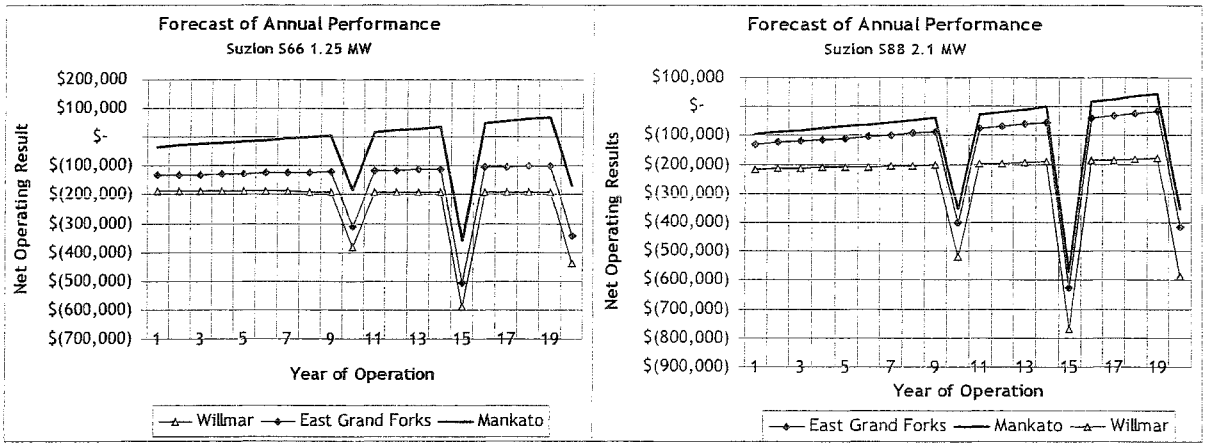
The annual savings, or the differential between the value of generated electricity and operating expense of the turbine, is used to determine the number of years necessary to recover the equity in the wind energy project (15% of total project cost), as one measure of viability. Other gauges of economic viability include internal rate of return and years to positive cash flow.

The results of the economic forecasts for the Suzlon S64 1.25 MW at East Grand Forks and Willmar, and the Suzlon S88 2.1 MW system at East Grand Forks, Mankato and Willmar are summarized in the following tables and graphs.

Table 5
RETScreen Wind Model
Summary of Economic Forecast: Suzlon S64 1.25 MW

	East Grand Forks	Mankato	Willmar
Wind Speed at 65 M hub	7.4 m/s	7.8 m/s	6.2 m/s
Generation (MWH)	3,016	3,563	1,465
Value of Electric Generation	$ 107,073	$ 238,528*	$ 52,013
Annual Maintenance	$ 73,288	73,288	$ 73,288
Debt Service	$ 165,302	165,302	$ 165,302
First Year Savings	-$ 131,517	-$ 33,088	- $ 186,577
Project Cost	$ 2,230,594	$ 2,230,594	$ 2,230,594
Project Debt	$ 1,896,005	$ 1,896,005	$ 1,896,005
Project Equity	$ 334,589	$ 334,589	$ 334,589
Years to Positive Cash Flow	>20	>20	>20
Simple Payback Period (years)	>20	17.4	>20
Internal Rate of Return	negative	Negative	negative

*Retail offset of campus electric requirements at $0.056/kWh. Other installations reflects sale of electricity to grid: $0.034/kWh.



Based on the parameters of the evaluation, the Suzlon S64 1.25 MW turbine does not appear to be a viable investment for any of the campuses with forecasts of significant operating deficits in the first year and subsequent years of operation. Only Mankato shows positive cash flow and payback of equity within the 20-year evaluation period. However, the internal rate of return is not sufficient to justify a capital investment. For the other campuses the value of the generated electricity is not sufficient to support annual operating expenses and recover the project equity. Positive cash flow is not achieved within the 20-year evaluation period.

Similarly, the 2.1 MW turbine does not appear to be a viable capital investment if installed at any of the campuses. The average wind speed from the Willmar data does not provide sufficient generation to

support the capital investment and operating expenses. Project equity is not recovered nor is positive cash flow realized within the evaluation period. The internal rate of return on project equity is negative.

Table 6
RETScreen Wind Model
Summary of Economic Forecast: Suzlon S88 2.1 MW

	East Grand Forks	Mankato	Willmar
Wind Speed at 80 M hub	7.7 m/s	8.1 m/s	6.4 m/s
Generation (MWH)	6,447	7,452	3,382
Value of Electric Generation	$ 228,898	$ 264,570	$ 120,084
Annual Maintenance	$ 84,563	84,563	$ 84,563
Debt Service	$ 272,931	272,931	$ 272,931
First Year Savings	- $ 128,596	-$ 92,924	- $ 237,410
Project Cost	$ 3,682,937	$ 3,682,937	$ 3,682,937
Project Debt	$ 3,130,496	$ 3,130,496	$ 3,130,496
Project Equity	$ 552,441	$ 552,441	$ 552,441
Years to Positive Cash Flow	>20	>20	>20
Simple Payback Period (years)	>20	>20	>20
Internal Rate of Return	negative	negative	negative

The wind resource of East Grand Forks and Mankato affords more annual generation, nearly twice the MWh of Willmar. However, the relatively low payment for electricity is not sufficient to support operating expenses and provide a yield on project equity.

Considerations Affecting Results

Production Credit

An installation needs to be operational prior to December 31, 2007 to be eligible for the production tax credits (IRS Section 45). Given the present lead time for manufacture and delivery of wind turbines, it seemed unlikely that the installations being evaluated would be in operation prior to the eligibility deadline. It also seemed reasonable to exclude the production credits because of the uncertainty of continuing the production credits program or the magnitude and term of the credits if reauthorized. On this basis, the production credits were not included in the economic forecasts of the wind turbines.

Value of Generated Electricity and Capital Cost

Capital cost and value of electricity are fundamental to the financial projections. The debt service associated with capital cost is the predominant component of annual operating expense. The value of generated electricity establishes the gross potential revenues for the wind turbine.

The expected value of electricity sold to the grid is based on the average per kWh payment Xcel made to wind turbine generators in 2005, $34.47/MWh. The payment reflects the capital investment, operating

expenses and production credits when the respective contracts were negotiated. As shown in the table below, to realize a nominal internal rate of return of 12%, the value of the electricity delivered to the grid would need to be increased to compensate for present capital costs and operating expenses (and the absence of production credit):

Energy Payment Adjustment for Improved Rate of Return

Campus and Model	Energy Payment	Internal Rate of Return
Suzlon S64 1.25 MW		
East Grand Forks	$0.085/kWh	12.6%
Mankato	$0.072/kWh	12.7%
Willmar	$0.175/kWh	12.6%
Suzlon S88 2.1 MW		
East Grand Forks	$0.060/kWh	12.4%
Mankato	$0.052/kWh	12.6%
Willmar	$0.114/kWh	12.1%

The energy payment rates as adjusted for Willmar are symptomatic of the modest wind resource relative to the other Campus. It should be noted that with the exception of the 2.1 MW wind turbine in Mankato and East Grand Forks, the energy payment necessary to support an internal rate of return of about 12% is significantly higher than the average payment rate derived from FERC Form 1 plus nominal production credit payment of $0.018/kWh ($0.03447/kWh + $0.018/kWh = $0.05247/kWh).

A funding mechanism to subsidize the capital cost of the wind turbine would also improve the respective financial results. With the exception of Willmar, the value of generated electricity is $34.47/MWh or the average 2005 Xcel payment for wind energy. Because the annual operating expense is projected to be less than the potential energy payments at $34.47/MWh, the value of electric generation has been arbitrarily set of $65/MWh. Without such an adjustment, the wind turbines would operate at a deficit even with a total subsidy of capital cost.

Capital Cost Subsidy for Improved Rate of Return

Campus and Model	Capital Subsidy % and Value	Internal Rate of Return
Suzlon S64 1.25 MW		
East Grand Forks	81.3%: $2.49 million	12.6%
Mankato	71.3%: $2.19 million	12.7%
Willmar	86%*: $2.64 million	12.8%
Suzlon S88 2.1 MW		
East Grand Forks	53.5%: $2.67 million	12.3%
Mankato	42%: $2.10 million	12.1%
Willmar	45%*: $2.70 million	12.0%

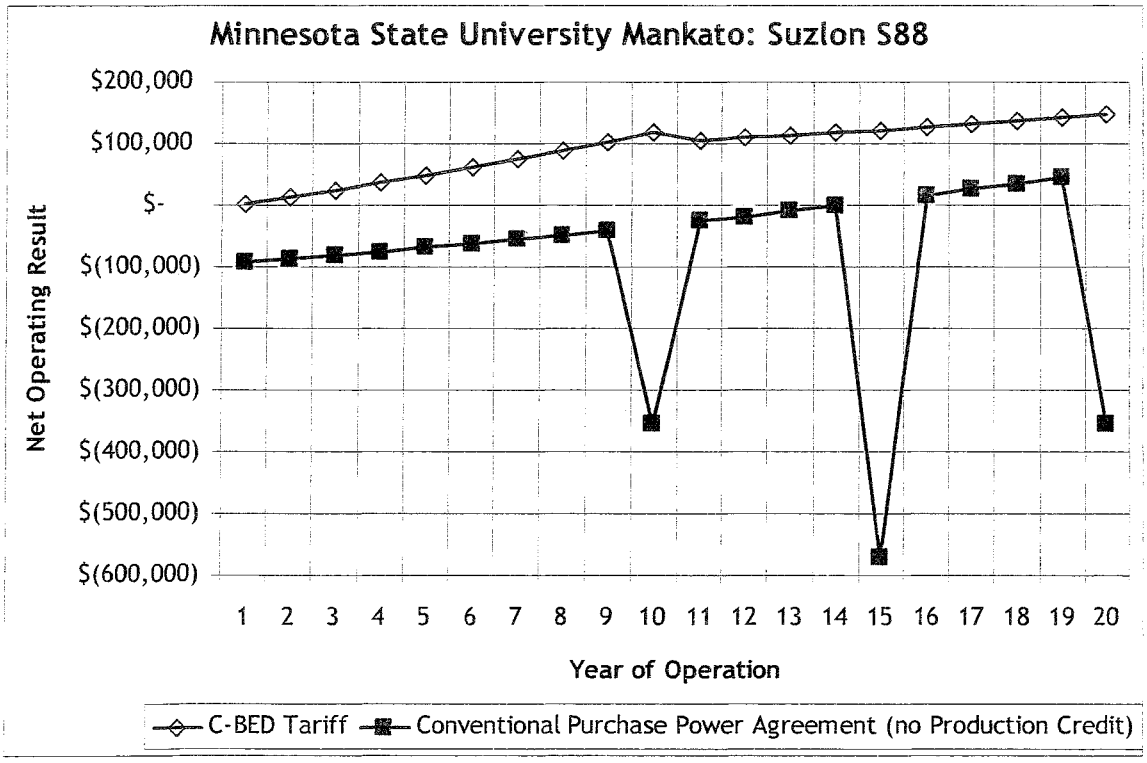
**Value of generated electricity is $65/MWh. For all other cases electric generation is valued at $34.47/MWh.*

The capital subsidy necessary to realize an internal rate of return of about 12% is significant, ranging from 42% to over 85%, or approximately $2.10 million to $2.70 million depending on model and location. The subsidy applies to initial capital cost and periodic maintenance of blades and drive train.

Community Based Energy Development Tariff and Clean Renewable Energy Bond

The Community Based Energy Development (C-BED) Tariff was enacted by the State Legislature to facilitate locally owned energy projects. Public utilities in Minnesota are required to file a tariff with the Public Service Commission for community based projects. The tariff must have a rate schedule that results in a $27.00/MWH net present value over the 20-year term of a purchase power agreement. The tariff must also permit a higher rate during the first 10 years of the purchase power agreement with a lower rate during the remainder of the agreement. The discount to be used in the present value determination must be the utility's normal discount rate used for its other business activities. The two-tier rate structure simulates the affect of the aforementioned production credit, resulting in a higher revenue stream during the initial years to help service start-up costs.

The following chart demonstrates the potential affect of the C-BED tariff on the installation of a S88 in Mankato. The initial evaluation based on $34.47.MWH and 85% debt financed at 6% over a term of 20



years, had a negative internal rate of return and simple payback period greater than 20 years.

With the C-Bed Tariff, the project is financed over 10 years, and project debt is reduced to 70%3 with an interest rate of 6%. Periodic capital maintenance items (blades and drive train) are not included4. With these parameters a positive cash flow is realized every year. The simple payback period on project equity (30% of project cost) is 17.4 years with an internal rate of return of 3.5%. However, the C-Bed tariff does not substantively improve the forecast of economic viability for the other wind turbine installations.

Entities or qualified owners eligible to submit projects to utilities under the C-Bed tariff include: Minnesota residents; limited liability corporations organized under the laws of Minnesota and that is made up on members who are Minnesota residents; Minnesota non-profit organizations; Minnesota cooperative associations (other than a rural electric cooperative of a generation and transmission cooperative); Minnesota political subdivision or local government (other than a municipal electric utility or municipal power agency) including but not limited to county, statutory or home rule charter city town school district, or public or private higher education institution or any other local or regional governmental organization such as a board, commission or association; or a tribal council. Given this eligibility list, the campus or possibly the alumni association could take the lead in developing a wind turbine project based on the C-BED tariff.

Clean Renewable Energy Bonds (CREB) provide a new financial incentive to invest in new renewable electric generation projects. The holder of the bond receives a federal tax credit in lieu of interest paid by the issuer, typical of conventional bonds or debt. Through this financing option, the issuer of the bond may borrow project capital at a 0% interest rate. The maximum maturity of these bonds is term that will be determined by the Secretary of the Treasury, but is expected to be 11 to 14 years.

The effect of CREB financing is illustrated above as applied to a Suzlon S88 if installed in Mankato. With a 0% interest rate applied to 70% debt, the net operating result (electric sales minus operating expense) increases by approximately $92,000 per year when compared to the C-Bed tariff scenario with conventional debt and interest. The internal rate of return increases to 10.1%. CREB financing and C-BED tariff result in a 3.8% internal rate of return on a Suzlon S88 in East Grand Forks.

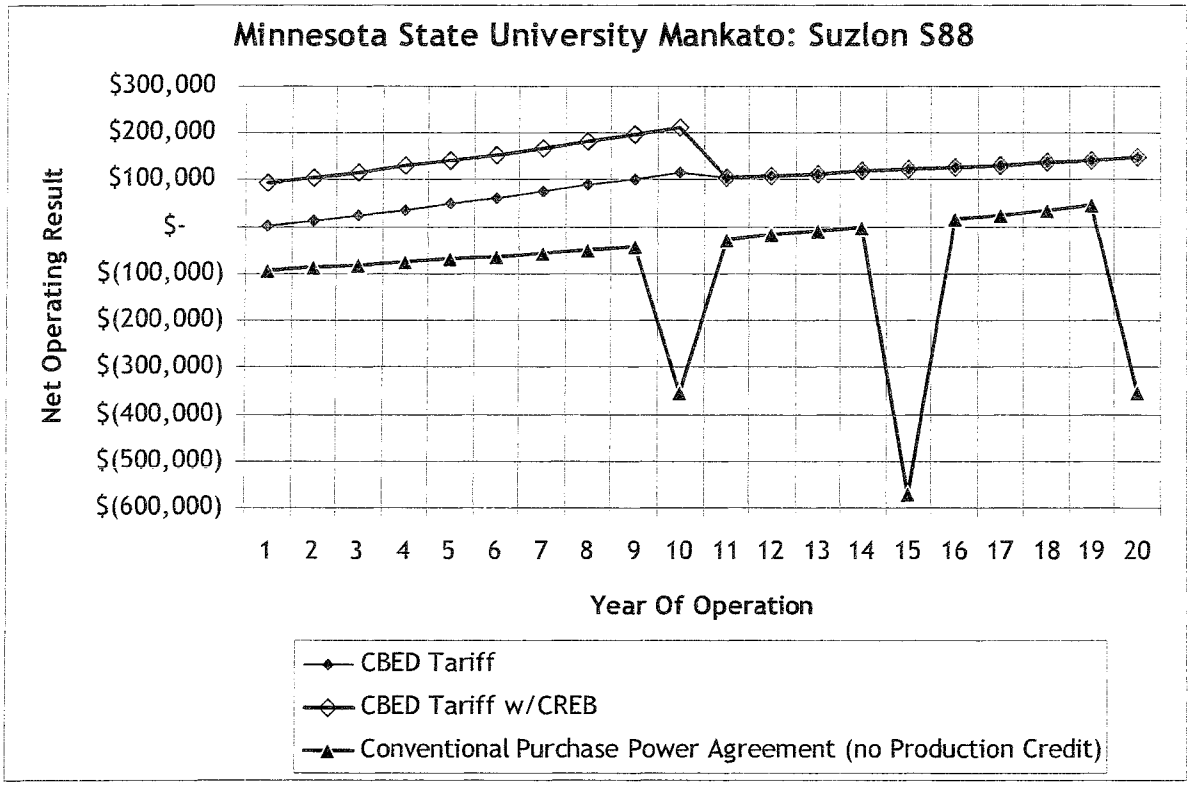
Eligible issuers of Clean Renewable Energy Bonds include state and local governments, U.S. territories and possessions, the District of Columbia, Indian tribal governments, CoBank, Cooperative electric companies and the National Rural Utilities Cooperative Finance Corporation.

CREB financing does not by itself result in viable or attractive payback periods and internal rates of return for any of the projects considered in this evaluation.

[3] A lower percentage of project debt is used to accommodate the shorter debt term associated with the two-tiered tariff structure.
[4] Removing these capital costs from the initial evaluation still results in negative internal rate of return and payback period greater than 20 years.

Conclusions

The wind resource as quantified in the project data and anticipated energy payments are not adequate to support the capital investment for installing wind turbines at Ridgewater College in Willmar or the 1.25 MW wind turbine at Northland Community and Technical College in Grand Forks. Installing a 1.25 MW wind turbine to offset the campus electric load of Minnesota State University Mankato does show a positive cash flow and payback, but may not be justifiable exclusively on the basis of economic considerations.



The wind resources do provide significantly greater generation with the 2.1 MW wind turbine if installed in East Grand Forks or Mankato. In these instances the anticipated energy payment of $34.47/kWh does not provide enough revenue for the capital investment and operating expenses.

Based on the foregoing parameters and evaluation, wind turbines financed by conventional debt and absent production credits are not a prudent capital investment for MnSCU. The C-BED tariff in conjunction with innovative financing mechanisms such as Clean Renewable Energy Bonds can

significantly improve the economic forecast of wind turbines, revealing potentially viable projects5: 2.1 MW Suzlon S88 wind turbines in Mankato and East Grand Forks.

The municipal utility in Willmar has expressed interest in developing a wind turbine installation on the campus property of Ridgewater College. Given the results of this analysis, MnSCU should continue to explore mechanisms for leasing the affected property to the local municipal utility. As part of the lease terms, MnSCU should seek permission to state that Ridgewater College is host of a Green Energy facility in its promotional materials.

[5] The Mankato campus is also within the service territory of Northern State Power and the potential location in East Grand Forks is near an interconnection with Northern States Power. This utility has a greater regulatory incentive than other utilities in the state.

APPENDIX A

RETScreen Energy Model Suzlon S64 1.25 MW

- East Grand Forks
- Mankato
- Willmar

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		MNSCU Wind Feasibility Study	See Online Manual
Project location		East Grand Forks, MN	
Wind data source		Wind speed	
Nearest location for weather data		East Grand Forks, MN	See Weather Database
Annual average wind speed	m/s	7.7	
Height of wind measurement	m	80.0	3.0 to 100.0 m
Wind shear exponent	-	0.16	0.10 to 0.40
Wind speed at 10 m	m/s	5.5	
Average atmospheric pressure	kPa	100.0	60.0 to 103.0 kPa
Annual average temperature	°C	5	-20 to 30 °C

System Characteristics		Estimate		Notes/Range
Grid type	-	Central-grid		
Wind turbine rated power	kW	1250	➡	Complete Equipment Data sheet
Number of turbines	-	1		
Wind plant capacity	kW	1,250		
Hub height	m	65.0		6.0 to 100.0 m
Wind speed at hub height	m/s	7.4		
Array losses	%	0%		0% to 20%
Airfoil soiling and/or icing losses	%	1%		1% to 10%
Other downtime losses	%	2%		2% to 7%
Miscellaneous losses	%	2%		2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	1,250	1,250	
	MW	1.250	1.250	
Unadjusted energy production	MWh	3,081	3,081	
Pressure adjustment coefficient	-	0.99	0.99	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	3,172	3,172	
Losses coefficient	-	0.95	0.95	0.75 to 1.00
Specific yield	kWh/m²	882	882	150 to 1,500 kWh/m²
Wind plant capacity factor	%	28%	28%	20% to 40%
Renewable energy delivered	MWh	3,016	**3,016**	
	million Btu	10,290	10,290	

Complete Cost Analysis sheet

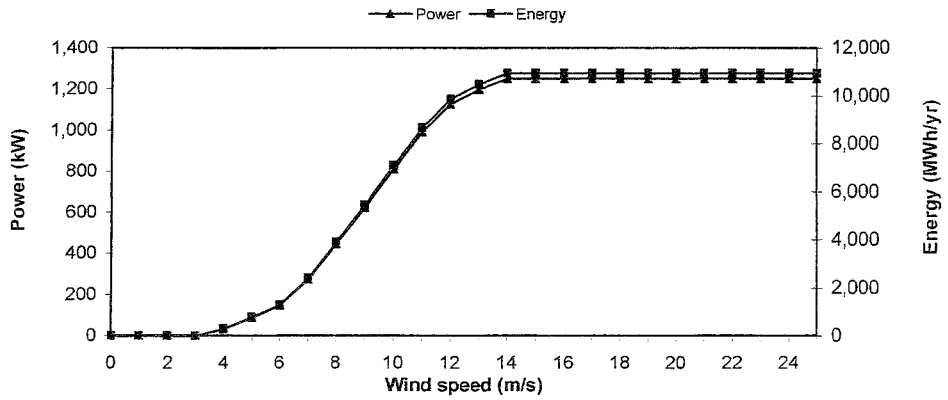
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	1250	See Product Database
Hub height	m	65.0	6.0 to 100.0 m
Rotor diameter	m	64	7 to 80 m
Swept area	m²	3,421	35 to 5,027 m²
Wind turbine manufacturer		Suzlon	
Wind turbine model		Suzlon S66-1.25 MW	
Energy curve data source	-	User-defined	Site specific

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	0.0	0.0
1	0.0	0.0
2	0.0	0.0
3	0.0	0.0
4	35.0	306.60
5	89.0	779.64
6	148.0	1,296.48
7	275.0	2,409.00
8	446.0	3,906.96
9	621.0	5,439.96
10	811.0	7,104.36
11	990.0	8,672.40
12	1,127.0	9,872.52
13	1,198.0	10,494.48
14	1,250.0	10,950.00
15	1,250.0	10,950.00
16	1,250.0	10,950.00
17	1,250.0	10,950.00
18	1,250.0	10,950.00
19	1,250.0	10,950.00
20	1,250.0	10,950.00
21	1,250.0	10,950.00
22	1,250.0	10,950.00
23	1,250.0	10,950.00
24	1,250.0	10,950.00
25	1,250.0	10,950.00

Power and Energy Curves



Return to Energy Model sheet

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Pre-feasibility | Currency: $ | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study							
Feasibility study	Cost	1	$ 75,000	$ 75,000		-	-
Sub-total:				**$ 75,000**	3.4%		
Development							
Development	Cost	1	$ 65,000	$ 65,000		-	-
Sub-total:				**$ 65,000**	2.9%		
Engineering							
Engineering	Cost	1	$ 70,000	$ 70,000		-	-
Sub-total:				**$ 70,000**	3.1%		
Energy Equipment							
Wind turbine(s)	kW	1,250	$ 1,000	$ 1,250,000		-	-
Spare parts	%	3.0%	$ 1,250,000	$ 37,500		-	-
Transportation	turbine	1	$ -	$ -		-	-
Other - Energy equipment	Cost	1	$ 150,000	$ 150,000		-	-
Sub-total:				**$ 1,437,500**	64.4%		
Balance of Plant							
Balance of plant	Cost	1	$ 415,000	$ 415,000		-	-
Sub-total:				**$ 415,000**	18.6%		
Miscellaneous							
Contingencies	%	5%	$ 2,062,500	$ 103,125		-	-
Interest during construction	6.0%	12 month(s)	$ 2,165,625	$ 64,969		-	-
Sub-total:				**$ 168,094**	7.5%		
Initial Costs - Total				**$ 2,230,594**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
O&M	Cost	1	$ 65,000	$ 65,000		-	-
Contingencies	%	10%	$ 65,000	$ 6,500		-	-
Annual Costs - Total				**$ 71,500**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost	Amount	Interval Range	Unit Cost Range
Drive train	Cost	10 yr	$ 150,000	**$ 150,000**	-	-
Blades	Cost	15 yr	$ 275,000	**$ 275,000**	-	-
				$ -	-	-
End of project life	Credit	-	$ -	$ -		*Go to GHG Analysis sheet*

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Wind Energy Project

Use GHG analysis sheet?	Yes	Type of analysis:	Standard
Potential CDM project?	No		

Background Information

Project Information

Project name	MNSCU Wind Feasibility Study	Project capacity	1.25 MW	**Global Warming Potential of GHG**	
Project location	East Grand Forks, MN	Grid type	Central-grid	21 tonnes CO_2 = 1 tonne CH_4	(IPCC 1996)
				310 tonnes CO_2 = 1 tonne N_2O	(IPCC 1996)

Base Case Electricity System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	T & D losses (%)	GHG emission factor (t_{CO2}/MWh)
Coal	50.0%	94.6	0.0020	0.0030	35.0%	12.0%	1.117
Large hydro	50.0%	0.0	0.0000	0.0000	100.0%	12.0%	0.000
Electricity mix	100%	153.6	0.0032	0.0049		12.0%	0.559

Does baseline change during project life? No

Proposed Case Electricity System (Wind Energy Project)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	T & D losses (%)	GHG emission factor (t_{CO2}/MWh)
Electricity system							
Wind	100.0%	0.0	0.0000	0.0000	100.0%	12.0%	0.000

GHG Emission Reduction Summary

	Base case GHG emission factor (tCO2/MWh)	Proposed case GHG emission factor (tCO2/MWh)	End-use annual energy delivered (MWh)	Gross annual GHG emission reduction (t_{CO2})	GHG credits transaction fee (%)	Net annual GHG emission reduction (t_{CO2})
Electricity system	0.559	0.000	2,654	1,482	0.0%	**1,482**

Complete Financial Summary sheet

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name	MNSCU Wind Feasibility Study				
Project location	East Grand Forks, MN				
Renewable energy delivered	MWh	3,016	Net GHG reduction	t_{CO2}/yr	1,482
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 20 yrs	t_{CO2}	29,646

Financial Parameters

Avoided cost of energy	$/kWh	0.0345	Debt ratio	%	85.0%
RE production credit	$/kWh	-	Debt interest rate	%	6.0%
			Debt term	yr	20
GHG emission reduction credit	$/$t_{CO2}$	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	3.0%			
Inflation	%	2.5%			
Discount rate	%	6.5%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	3.4%	$	75,000	O&M	$	71,500
Development	2.9%	$	65,000			
Engineering	3.1%	$	70,000	Debt payments - 20 yrs	$	165,302
Energy equipment	64.4%	$	1,437,500	**Annual Costs and Debt - Total**	**$**	**236,802**
Balance of plant	18.6%	$	415,000			
Miscellaneous	7.5%	$	168,094	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**$**	**2,230,594**	Energy savings/income	$	103,954
				Capacity savings/income	$	-
Incentives/Grants		$	-			
				Annual Savings - Total	**$**	**103,954**
Periodic Costs (Credits)						
Drive train		$	150,000	Schedule yr # 10,20		
Blades		$	275,000	Schedule yr # 15		
		$	-			
End of project life - Credit		$	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	negative			
After-tax IRR and ROI	%	negative	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	68.7			
Year-to-positive cash flow	yr	more than 20	Project equity	$	334,589
Net Present Value - NPV	$	(1,971,877)	Project debt	$	1,896,005
Annual Life Cycle Savings	$	(178,960)	Debt payments	$/yr	165,302
Benefit-Cost (B-C) ratio	-	(4.89)	Debt service coverage	-	(2.06)

Yearly Cash Flows

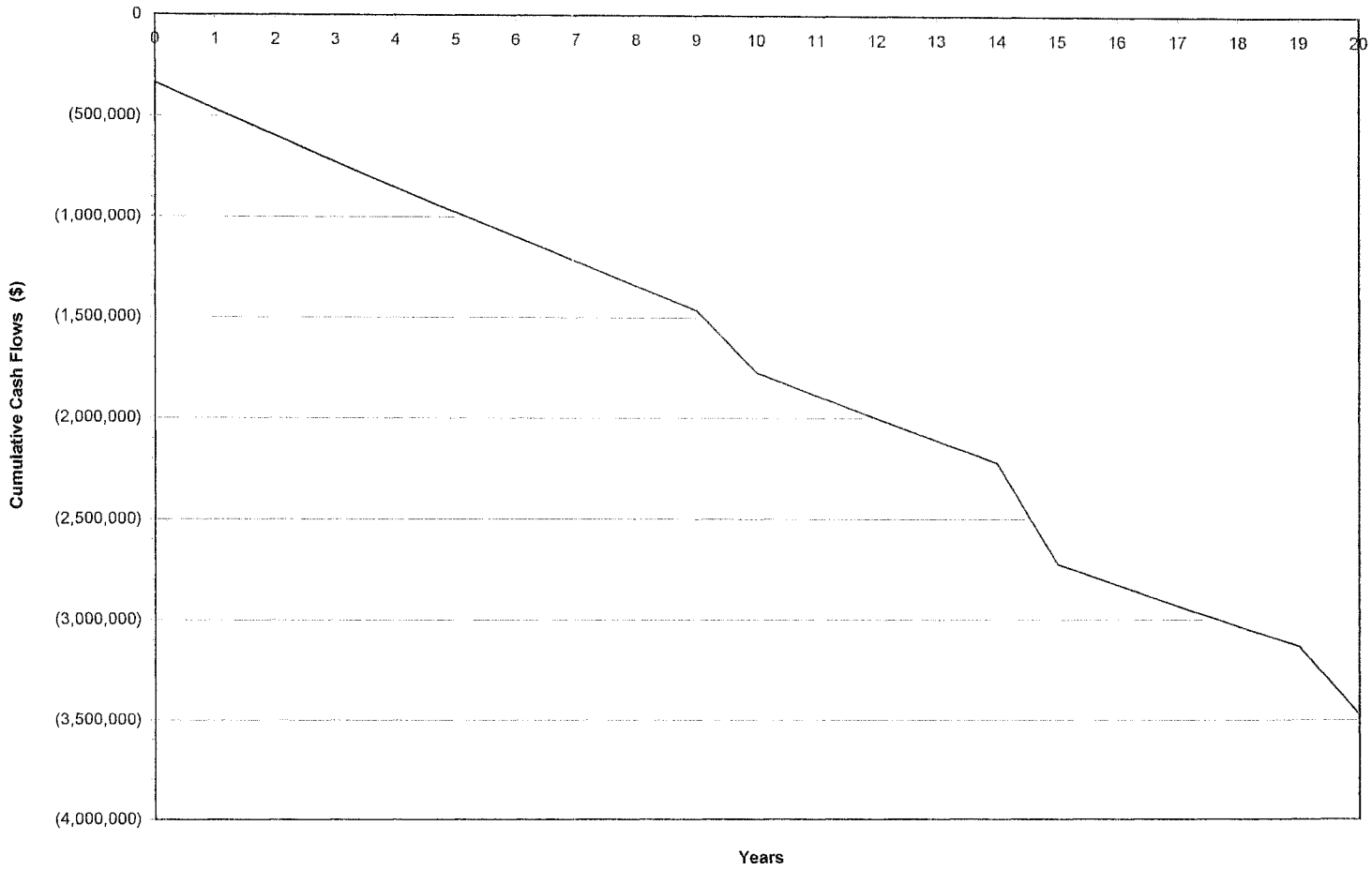
Year #	Pre-tax $	After-tax $	Cumulative $
0	(334,589)	(334,589)	(334,589)
1	(131,517)	(131,517)	(466,106)
2	(130,137)	(130,137)	(596,243)
3	(128,706)	(128,706)	(724,949)
4	(127,223)	(127,223)	(852,173)
5	(125,686)	(125,686)	(977,859)
6	(124,094)	(124,094)	(1,101,952)
7	(122,443)	(122,443)	(1,224,395)
8	(120,732)	(120,732)	(1,345,127)
9	(118,959)	(118,959)	(1,464,086)
10	(309,135)	(309,135)	(1,773,221)
11	(115,219)	(115,219)	(1,888,441)
12	(113,248)	(113,248)	(2,001,689)
13	(111,205)	(111,205)	(2,112,894)
14	(109,090)	(109,090)	(2,221,984)
15	(505,180)	(505,180)	(2,727,164)
16	(104,628)	(104,628)	(2,831,792)
17	(102,277)	(102,277)	(2,934,070)
18	(99,843)	(99,843)	(3,033,912)
19	(97,321)	(97,321)	(3,131,234)
20	(340,503)	(340,503)	(3,471,736)

RETScreen® Financial Summary - Wind Energy Project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
MNSCU Wind Feasibility Study, East Grand Forks, MN

Renewable energy delivered (MWh/yr): 3,016 | Total Initial Costs: $ 2,230,594 | Net average GHG reduction (t_{CO2}/yr): 1,482



IRR and ROI: negative | Year-to-positive cash flow: more than 20 yr | Net Present Value: $ -1,971,877

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		MnSCU Wind Feasibility Study	See Online Manual
Project location		Mankato, MN	
Wind data source		Wind speed	
Nearest location for weather data		Mankato, MN	See Weather Database
Annual average wind speed	m/s	8.1	
Height of wind measurement	m	80.0	3.0 to 100.0 m
Wind shear exponent	-	0.16	0.10 to 0.40
Wind speed at 10 m	m/s	5.8	
Average atmospheric pressure	kPa	100.0	60.0 to 103.0 kPa
Annual average temperature	°C	7	-20 to 30 °C

System Characteristics		Estimate		Notes/Range
Grid type	-	Central-grid		
Wind turbine rated power	kW	1250	➡	Complete Equipment Data sheet
Number of turbines	-	1		
Wind plant capacity	kW	1,250		
Hub height	m	65.0		6.0 to 100.0 m
Wind speed at hub height	m/s	7.8		
Array losses	%	0%		0% to 20%
Airfoil soiling and/or icing losses	%	1%		1% to 10%
Other downtime losses	%	2%		2% to 7%
Miscellaneous losses	%	2%		2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	1,250	1,250	
	MW	1.250	1.250	
Unadjusted energy production	MWh	3,675	3,675	
Pressure adjustment coefficient	-	0.99	0.99	0.59 to 1.02
Temperature adjustment coefficient	-	1.03	1.03	0.98 to 1.15
Gross energy production	MWh	3,747	3,747	
Losses coefficient	-	0.95	0.95	0.75 to 1.00
Specific yield	kWh/m²	1,041	1,041	150 to 1,500 kWh/m²
Wind plant capacity factor	%	33%	33%	20% to 40%
Renewable energy delivered	MWh	3,563	**3,563**	
	million Btu	12,157	12,157	
				Complete Cost Analysis sheet

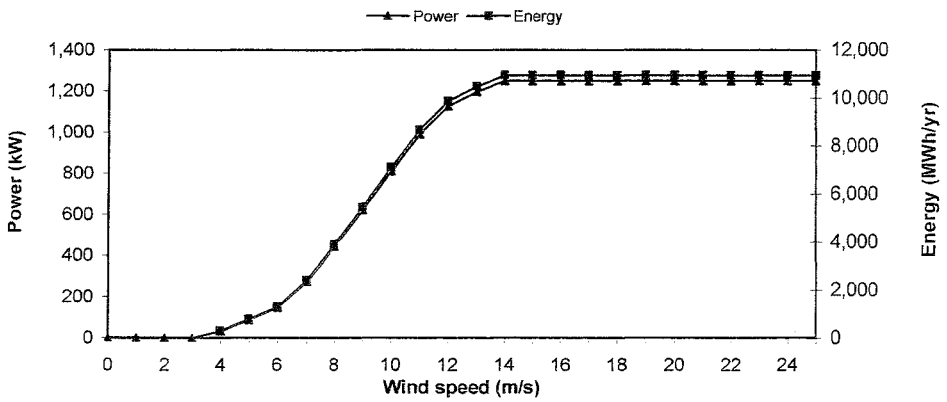
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	1250	See Product Database
Hub height	m	65.0	6.0 to 100.0 m
Rotor diameter	m	88	7 to 80 m
Swept area	m²	3,421	35 to 5,027 m²
Wind turbine manufacturer		Suzlon	
Wind turbine model		Suzlon S66-1.25 MW	
Energy curve data source	-	User-defined	Site specific

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	0.0	-
1	0.0	-
2	0.0	-
3	0.0	-
4	35.0	306.60
5	89.0	779.64
6	148.0	1,296.48
7	275.0	2,409.00
8	446.0	3,906.96
9	621.0	5,439.96
10	811.0	7,104.36
11	990.0	8,672.40
12	1,127.0	9,872.52
13	1,198.0	10,494.48
14	1,250.0	10,950.00
15	1,250.0	10,950.00
16	1,250.0	10,950.00
17	1,250.0	10,950.00
18	1,250.0	10,950.00
19	1,250.0	10,950.00
20	1,250.0	10,950.00
21	1,250.0	10,950.00
22	1,250.0	10,950.00
23	1,250.0	10,950.00
24	1,250.0	10,950.00
25	1,250.0	10,950.00

Power and Energy Curves



Return to Energy Model sheet

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Pre-feasibility | Currency: $ | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study							
Feasibility study	Cost	1	$ 75,000	$ 75,000		-	-
Sub-total:				**$ 75,000**	3.4%		
Development							
Development	Cost	1	$ 65,000	$ 65,000		-	-
Sub-total:				**$ 65,000**	2.9%		
Engineering							
Engineering	Cost	1	$ 70,000	$ 70,000		-	-
Sub-total:				**$ 70,000**	3.1%		
Energy Equipment							
Wind turbine(s)	kW	1,250	$ 1,000	$ 1,250,000		-	-
Spare parts	%	3.0%	$ 1,250,000	$ 37,500		-	-
Transportation	turbine	1	$ -	$ -		-	-
Other - Energy equipment	Cost	1	$ 150,000	$ 150,000		-	-
Sub-total:				**$ 1,437,500**	64.4%		
Balance of Plant							
Balance of plant	Cost	1	$ 415,000	$ 415,000		-	-
Sub-total:				**$ 415,000**	18.6%		
Miscellaneous							
Contingencies	%	5%	$ 2,062,500	$ 103,125		-	-
Interest during construction	6.0%	12 month(s)	$ 2,165,625	$ 64,969		-	-
Sub-total:				**$ 168,094**	7.5%		
Initial Costs - Total				**$ 2,230,594**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
O&M	Cost	1	$ 65,000	$ 65,000		-	-
Contingencies	%	10%	$ 65,000	$ 6,500		-	-
Annual Costs - Total				**$ 71,500**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost	Amount	Interval Range	Unit Cost Range
Drive train	Cost	10 yr	$ 150,000	**$ 150,000**	-	-
Blades	Cost	15 yr	$ 275,000	**$ 275,000**	-	-
				$ -	-	-
End of project life	Credit	-	$ -	$ -		*Go to GHG Analysis sheet*

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name		MnSCU Wind Feasibility Study
Project location		Mankato, MN
Renewable energy delivered	MWh	3,563
Excess RE available	MWh	-
Firm RE capacity	kW	-
Grid type		Central-grid

Financial Parameters

Avoided cost of energy	$/kWh	0.0560	Debt ratio	%	85.0%
RE production credit	$/kWh	-	Debt interest rate	%	6.0%
			Debt term	yr	20
			Income tax analysis?	yes/no	No
Energy cost escalation rate	%	3.0%			
Inflation	%	2.5%			
Discount rate	%	6.5%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				Annual Costs and Debt		
Feasibility study	3.4%	$	75,000	O&M	$	71,500
Development	2.9%	$	65,000			
Engineering	3.1%	$	70,000	Debt payments - 20 yrs	$	165,302
Energy equipment	64.4%	$	1,437,500	**Annual Costs and Debt - Total**	**$**	**236,802**
Balance of plant	18.6%	$	415,000			
Miscellaneous	7.5%	$	168,094	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**$**	**2,230,594**	Energy savings/income	$	199,516
				Capacity savings/income	$	-
Incentives/Grants		$	-			
				Annual Savings - Total	**$**	**199,516**
Periodic Costs (Credits)						
Drive train		$	150,000	Schedule yr # 10,20		
Blades		$	275,000	Schedule yr # 15		
		$	-			
End of project life - Credit		$	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	negative			
After-tax IRR and ROI	%	negative			
Simple Payback	yr	17.4			
Year-to-positive cash flow	yr	more than 20	Project equity	$	334,589
Net Present Value - NPV	$	(601,103)	Project debt	$	1,896,005
Annual Life Cycle Savings	$	(54,554)	Debt payments	$/yr	165,302
Benefit-Cost (B-C) ratio	-	(0.80)	Debt service coverage	-	(1.16)

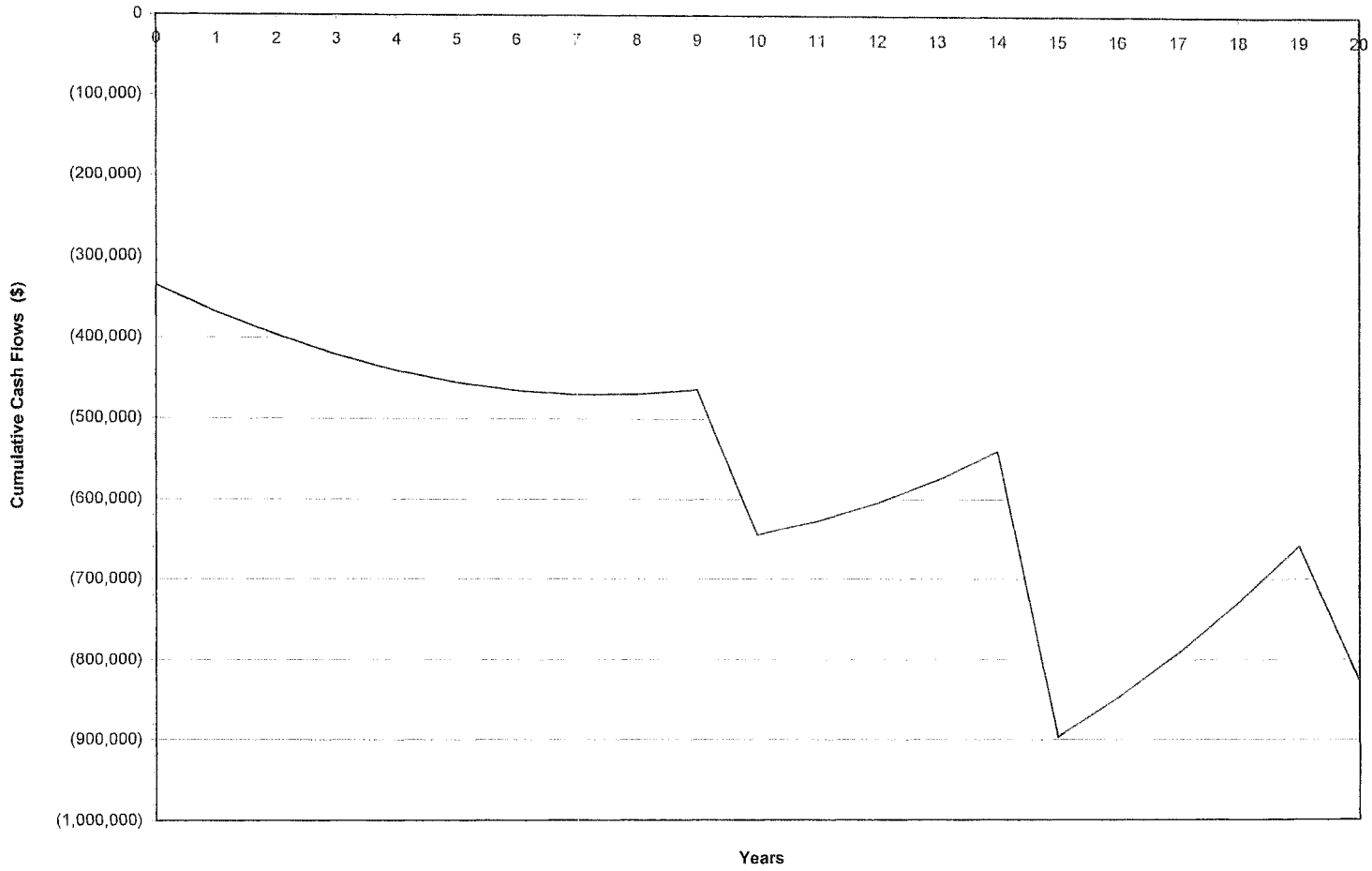
Yearly Cash Flows

Year #	Pre-tax $	After-tax $	Cumulative $
0	(334,589)	(334,589)	(334,589)
1	(33,088)	(33,088)	(367,677)
2	(28,756)	(28,756)	(396,433)
3	(24,284)	(24,284)	(420,717)
4	(19,668)	(19,668)	(440,385)
5	(14,904)	(14,904)	(455,289)
6	(9,988)	(9,988)	(465,277)
7	(4,914)	(4,914)	(470,191)
8	323	323	(469,868)
9	5,727	5,727	(464,141)
10	(180,708)	(180,708)	(644,850)
11	17,060	17,060	(627,789)
12	23,000	23,000	(604,789)
13	29,130	29,130	(575,659)
14	35,456	35,456	(540,204)
15	(356,298)	(356,298)	(896,502)
16	48,720	48,720	(847,782)
17	55,671	55,671	(792,111)
18	62,845	62,845	(729,266)
19	70,247	70,247	(659,019)
20	(167,908)	(167,908)	(826,927)

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
MnSCU Wind Feasibility Study, Mankato, MN

Renewable energy delivered (MWh/yr): 3,563 **Total Initial Costs: $ 2,230,594**



IRR and ROI: negative **Year-to-positive cash flow: more than 20 yr** **Net Present Value: $ -601,103**

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		MNSCU Wind Feasibility Study	See Online Manual
Project location		Willmar, MN	
Wind data source		Wind speed	
Nearest location for weather data		Willmar, MN	See Weather Database
Annual average wind speed	m/s	5.7	
Height of wind measurement	m	40.0	3.0 to 100.0 m
Wind shear exponent	-	0.16	0.10 to 0.40
Wind speed at 10 m	m/s	4.6	
Average atmospheric pressure	kPa	100.0	60.0 to 103.0 kPa
Annual average temperature	°C	6	-20 to 30 °C

System Characteristics		Estimate		Notes/Range
Grid type	-	Central-grid		
Wind turbine rated power	kW	1250	➡	Complete Equipment Data sheet
Number of turbines	-	1		
Wind plant capacity	kW	1,250		
Hub height	m	65.0		6.0 to 100.0 m
Wind speed at hub height	m/s	6.2		
Array losses	%	0%		0% to 20%
Airfoil soiling and/or icing losses	%	1%		1% to 10%
Other downtime losses	%	2%		2% to 7%
Miscellaneous losses	%	2%		2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	1,250	1,250	
	MW	1.250	1.250	
Unadjusted energy production	MWh	1,511	1,511	
Pressure adjustment coefficient	-	0.99	0.99	0.59 to 1.02
Temperature adjustment coefficient	-	1.03	1.03	0.98 to 1.15
Gross energy production	MWh	1,541	1,541	
Losses coefficient	-	0.95	0.95	0.75 to 1.00
Specific yield	kWh/m²	428	428	150 to 1,500 kWh/m²
Wind plant capacity factor	%	13%	13%	20% to 40%
Renewable energy delivered	MWh	1,465	**1,465**	
	million Btu	4,999	4,999	

Complete Cost Analysis sheet

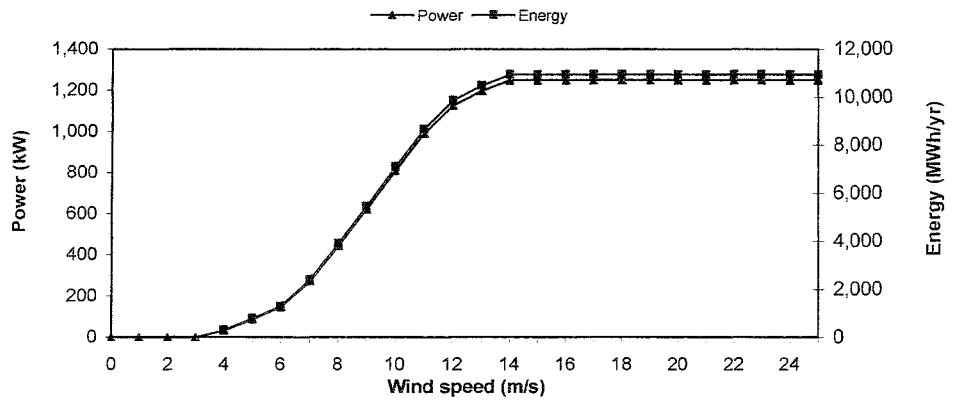
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	1250	*See Product Database*
Hub height	m	65.0	6.0 to 100.0 m
Rotor diameter	m	64	7 to 80 m
Swept area	m²	3,421	35 to 5,027 m²
Wind turbine manufacturer		Suzlon	
Wind turbine model		Suzlon S64-1.25 MW	
Energy curve data source	-	User-defined	Site specific

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	0.0	-
1	0.0	-
2	0.0	-
3	0.0	-
4	35.0	306.60
5	89.0	779.64
6	148.0	1,296.48
7	275.0	2,409.00
8	446.0	3,906.96
9	621.0	5,439.96
10	811.0	7,104.36
11	990.0	8,672.40
12	1,127.0	9,872.52
13	1,198.0	10,494.48
14	1,250.0	10,950.00
15	1,250.0	10,950.00
16	1,250.0	10,950.00
17	1,250.0	10,950.00
18	1,250.0	10,950.00
19	1,250.0	10,950.00
20	1,250.0	10,950.00
21	1,250.0	10,950.00
22	1,250.0	10,950.00
23	1,250.0	10,950.00
24	1,250.0	10,950.00
25	1,250.0	10,950.00

Power and Energy Curves



Return to Energy Model sheet

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Pre-feasibility | Currency: $ | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study							
Feasibility study	Cost	1	$ 75,000	$ 75,000		-	-
Sub-total:				**$ 75,000**	3.4%		
Development							
Development	Cost	1	$ 65,000	$ 65,000		-	-
Sub-total:				**$ 65,000**	2.9%		
Engineering							
Engineering	Cost	1	$ 70,000	$ 70,000		-	-
Sub-total:				**$ 70,000**	3.1%		
Energy Equipment							
Wind turbine(s)	kW	1,250	$ 1,000	$ 1,250,000		-	-
Spare parts	%	3.0%	$ 1,250,000	$ 37,500		-	-
Transportation	turbine	1	$ -	$ -		-	-
Other - Energy equipment	Cost	1	$ 150,000	$ 150,000		-	-
Sub-total:				**$ 1,437,500**	64.4%		
Balance of Plant							
Balance of plant	Cost	1	$ 415,000	$ 415,000		-	-
Sub-total:				**$ 415,000**	18.6%		
Miscellaneous							
Contingencies	%	5%	$ 2,062,500	$ 103,125		-	-
Interest during construction	6.0%	12 month(s)	$ 2,165,625	$ 64,969		-	-
Sub-total:				**$ 168,094**	7.5%		
Initial Costs - Total				**$ 2,230,594**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
O&M	Cost	1	$ 65,000	$ 65,000		-	-
Contingencies	%	10%	$ 65,000	$ 6,500		-	-
Annual Costs - Total				**$ 71,500**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost	Amount	Interval Range	Unit Cost Range
Drive train	Cost	10 yr	$ 150,000	**$ 150,000**	-	-
Blades	Cost	15 yr	$ 275,000	**$ 275,000**	-	-
				$ -	-	-
End of project life	Credit	-	$ -	$ -		*Go to GHG Analysis sheet*

RETScreen® Greenhouse Gas (GHG) Emission Reduction Analysis - Wind Energy Project

Use GHG analysis sheet? Yes
Potential CDM project? No

Type of analysis: Standard

Background Information

Project Information

Project name	MNSCU Wind Feasibility Study	Project capacity	1.25 MW		
Project location	Willmar, MN	Grid type	Central-grid		

Global Warming Potential of GHG

21	tonnes CO_2 = 1 tonne CH_4	(IPCC 1996)
310	tonnes CO_2 = 1 tonne N_2O	(IPCC 1996)

Base Case Electricity System (Baseline)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	T & D losses (%)	GHG emission factor (t_{CO2}/MWh)
Coal	50.0%	94.6	0.0020	0.0030	35.0%	12.0%	1.117
Large hydro	50.0%	0.0	0.0000	0.0000	100.0%	12.0%	0.000
Electricity mix	100%	153.6	0.0032	0.0049		12.0%	0.559

Does baseline change during project life? No

Proposed Case Electricity System (Wind Energy Project)

Fuel type	Fuel mix (%)	CO_2 emission factor (kg/GJ)	CH_4 emission factor (kg/GJ)	N_2O emission factor (kg/GJ)	Fuel conversion efficiency (%)	T & D losses (%)	GHG emission factor (t_{CO2}/MWh)
Electricity system							
Wind	100.0%	0.0	0.0000	0.0000	100.0%	12.0%	0.000

GHG Emission Reduction Summary

	Base case GHG emission factor (tCO2/MWh)	Proposed case GHG emission factor (tCO2/MWh)	End-use annual energy delivered (MWh)	Gross annual GHG emission reduction (t_{CO2})	GHG credits transaction fee (%)	Net annual GHG emission reduction (t_{CO2})
Electricity system	0.559	0.000	1,289	720	0.0%	**720**

Complete Financial Summary sheet

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name		MNSCU Wind Feasibility Study			
Project location		Willmar, MN			
Renewable energy delivered	MWh	1,465	Net GHG reduction	t_{CO2}/yr	720
Excess RE available	MWh	-			
Firm RE capacity	kW	-			
Grid type		Central-grid	Net GHG emission reduction - 20 yrs	t_{CO2}	14,401

Financial Parameters

Avoided cost of energy	$/kWh	0.0345	Debt ratio	%	85.0%
RE production credit	$/kWh	-	Debt interest rate	%	6.0%
			Debt term	yr	20
GHG emission reduction credit	$/$t_{CO2}$	-	Income tax analysis?	yes/no	No
Energy cost escalation rate	%	3.0%			
Inflation	%	2.5%			
Discount rate	%	6.5%			
Project life	yr	20			

Project Costs and Savings

Initial Costs			
Feasibility study	3.4%	$	75,000
Development	2.9%	$	65,000
Engineering	3.1%	$	70,000
Energy equipment	64.4%	$	1,437,500
Balance of plant	18.6%	$	415,000
Miscellaneous	7.5%	$	168,094
Initial Costs - Total	100.0%	**$**	**2,230,594**
Incentives/Grants		$	-

Periodic Costs (Credits)		
Drive train	$	150,000
Blades	$	275,000
	$	-
End of project life - Credit	$	-

Annual Costs and Debt		
O&M	$	71,500
Debt payments - 20 yrs	$	165,302
Annual Costs and Debt - Total	**$**	**236,802**

Annual Savings or Income		
Energy savings/income	$	50,498
Capacity savings/income	$	-
Annual Savings - Total	**$**	**50,498**

Schedule yr # 10,20
Schedule yr # 15

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	negative			
After-tax IRR and ROI	%	negative	Calculate GHG reduction cost?	yes/no	No
Simple Payback	yr	(106.2)			
Year-to-positive cash flow	yr	more than 20	Project equity	$	334,589
Net Present Value - NPV	$	(2,738,671)	Project debt	$	1,896,005
Annual Life Cycle Savings	$	(248,552)	Debt payments	$/yr	165,302
Benefit-Cost (B-C) ratio	-	(7.19)	Debt service coverage	-	(2.56)

Yearly Cash Flows

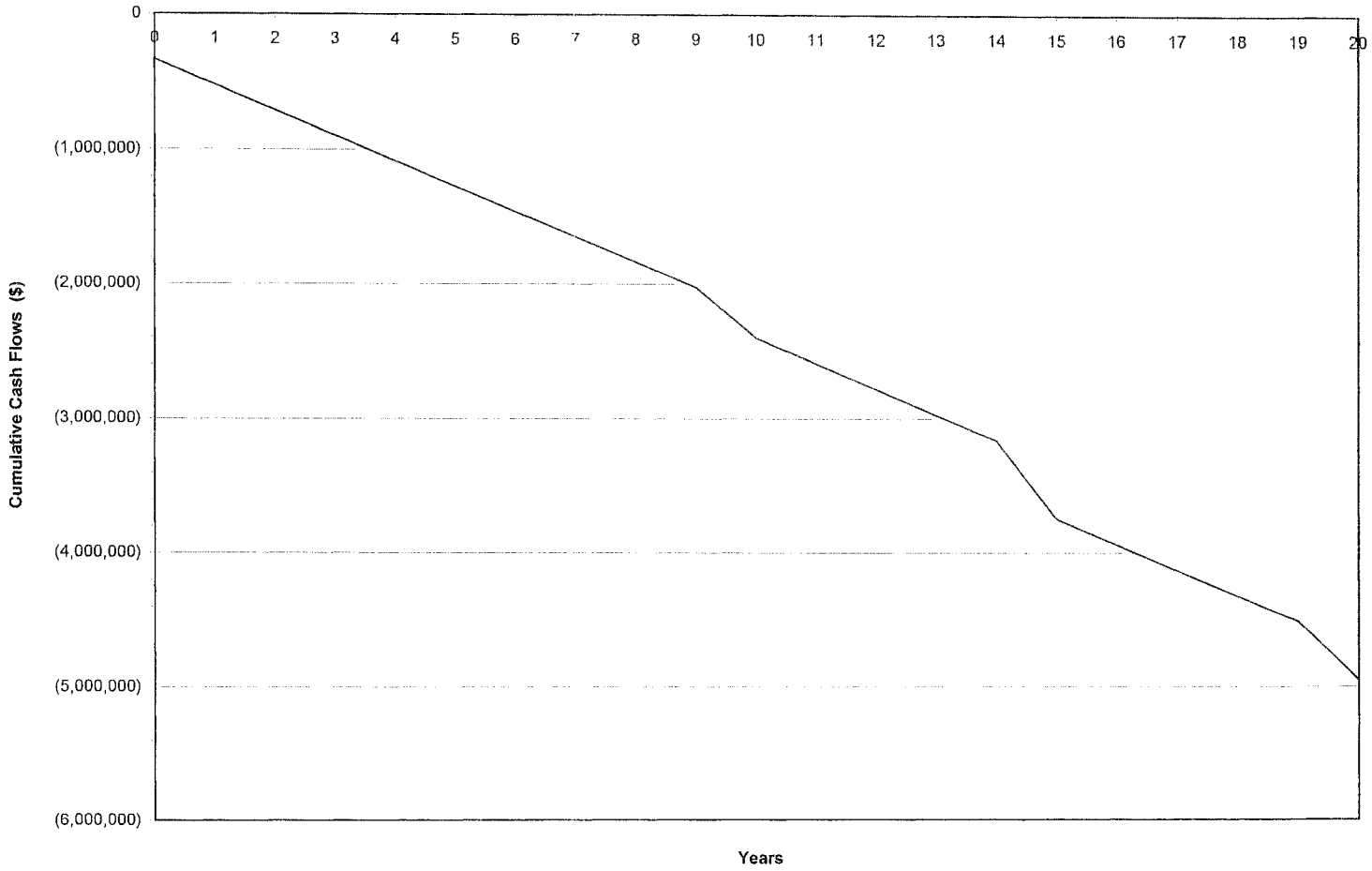
Year #	Pre-tax $	After-tax $	Cumulative $
0	(334,589)	(334,589)	(334,589)
1	(186,577)	(186,577)	(521,166)
2	(186,848)	(186,848)	(708,014)
3	(187,119)	(187,119)	(895,133)
4	(187,389)	(187,389)	(1,082,522)
5	(187,657)	(187,657)	(1,270,179)
6	(187,923)	(187,923)	(1,458,101)
7	(188,187)	(188,187)	(1,646,288)
8	(188,448)	(188,448)	(1,834,737)
9	(188,707)	(188,707)	(2,023,444)
10	(380,976)	(380,976)	(2,404,419)
11	(189,215)	(189,215)	(2,593,634)
12	(189,463)	(189,463)	(2,783,098)
13	(189,707)	(189,707)	(2,972,805)
14	(189,947)	(189,947)	(3,162,752)
15	(588,463)	(588,463)	(3,751,215)
16	(190,410)	(190,410)	(3,941,624)
17	(190,632)	(190,632)	(4,132,256)
18	(190,848)	(190,848)	(4,323,104)
19	(191,057)	(191,057)	(4,514,161)
20	(437,050)	(437,050)	(4,951,212)

RETScreen® Financial Summary - Wind Energy Project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
MNSCU Wind Feasibility Study, Willmar, MN

Renewable energy delivered (MWh/yr): 1,465 | Total Initial Costs: $ 2,230,594 | Net average GHG reduction (t_{CO2}/yr): 720



IRR and ROI: negative | Year-to-positive cash flow: more than 20 yr | Net Present Value: $ -2,738,671

APPENDIX B

RETScreen Energy Model Suzlon S88 2.1 MW

- East Grand Forks
- Mankato
- Willmar

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		MnSCU Wind Feasibility Study	See Online Manual
Project location		Mankato, MN	
Wind data source		Wind speed	
Nearest location for weather data		Mankato, MN	See Weather Database
Annual average wind speed	m/s	8.1	
Height of wind measurement	m	80.0	3.0 to 100.0 m
Wind shear exponent	-	0.16	0.10 to 0.40
Wind speed at 10 m	m/s	5.8	
Average atmospheric pressure	kPa	100.0	60.0 to 103.0 kPa
Annual average temperature	°C	7	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2100	➡ Complete Equipment Data sheet
Number of turbines	-	1	
Wind plant capacity	kW	2,100	
Hub height	m	80.0	6.0 to 100.0 m
Wind speed at hub height	m/s	8.1	
Array losses	%	0%	0% to 20%
Airfoil soiling and/or icing losses	%	1%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	2%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,100	2,100	
	MW	2.100	2.100	
Unadjusted energy production	MWh	7,686	7,686	
Pressure adjustment coefficient	-	0.99	0.99	0.59 to 1.02
Temperature adjustment coefficient	-	1.03	1.03	0.98 to 1.15
Gross energy production	MWh	7,837	7,837	
Losses coefficient	-	0.95	0.95	0.75 to 1.00
Specific yield	kWh/m²	1,225	1,225	150 to 1,500 kWh/m²
Wind plant capacity factor	%	41%	41%	20% to 40%
Renewable energy delivered	MWh	7,452	**7,452**	
	million Btu	25,427	25,427	

Complete Cost Analysis sheet

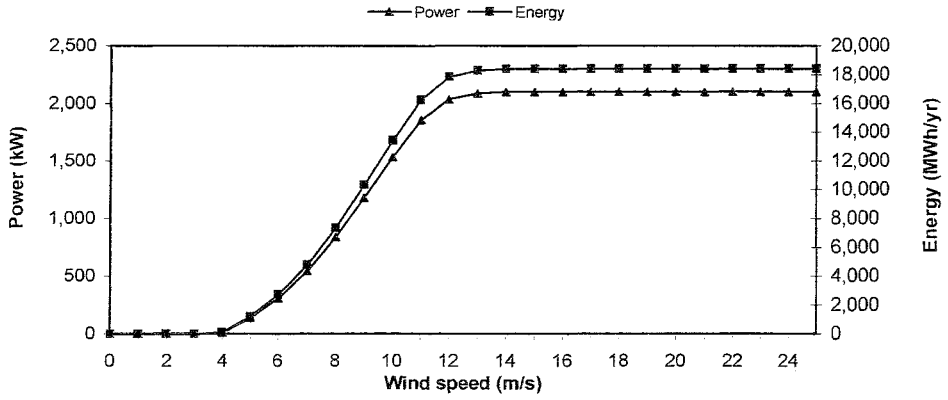
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2100	See Product Database
Hub height	m	80.0	6.0 to 100.0 m
Rotor diameter	m	88	7 to 80 m
Swept area	m²	6,082	35 to 5,027 m²
Wind turbine manufacturer		Suzlon	
Wind turbine model		Suzlon S88-2.1 MW	
Energy curve data source	-	User-defined	Site specific

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	0.0	0.0
1	0.0	0.0
2	0.0	0.0
3	0.0	0.0
4	14.0	122.6
5	138.0	1,208.9
6	312.0	2,733.1
7	546.0	4,783.0
8	840.0	7,358.4
9	1,180.0	10,336.8
10	1,535.0	13,446.6
11	1,856.0	16,258.6
12	2,037.0	17,844.1
13	2,088.0	18,290.9
14	2,100.0	18,396.0
15	2,100.0	18,396.0
16	2,100.0	18,396.0
17	2,100.0	18,396.0
18	2,100.0	18,396.0
19	2,100.0	18,396.0
20	2,100.0	18,396.0
21	2,100.0	18,396.0
22	2,100.0	18,396.0
23	2,100.0	18,396.0
24	2,100.0	18,396.0
25	2,100.0	18,396.0

Power and Energy Curves



Return to Energy Model sheet

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Pre-feasibility | Currency: $ | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study							
Feasibility study	Cost	1	$ 75,000	$ 75,000		-	-
Sub-total:				**$ 75,000**	2.0%		
Development							
Development	Cost	1	$ 125,000	$ 125,000		-	-
Sub-total:				**$ 125,000**	3.4%		
Engineering							
Engineering	Cost	1	$ 85,000	$ 85,000		-	-
Sub-total:				**$ 85,000**	2.3%		
Energy Equipment							
Wind turbine(s)	kW	2,100	$ 1,119	$ 2,349,900		-	-
Spare parts	%	3.0%	$ 2,349,900	$ 70,497		-	-
Transportation	turbine	1	$ -	$ -		-	-
Other - Energy equipment	Cost	1	$ 175,000	$ 175,000		-	-
Sub-total:				**$ 2,595,397**	70.5%		
Balance of Plant							
Balance of plant	Cost	1	$ 525,000	$ 525,000		-	-
Sub-total:				**$ 525,000**	14.3%		
Miscellaneous							
Contingencies	%	5%	$ 3,405,397	$ 170,270		-	-
Interest during construction	6.0%	12 month(s)	$ 3,575,667	$ 107,270		-	-
Sub-total:				**$ 277,540**	7.5%		
Initial Costs - Total				**$ 3,682,937**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
O&M	Cost	1	$ 75,000	$ 75,000		-	-
Contingencies	%	10%	$ 75,000	$ 7,500		-	-
Annual Costs - Total				**$ 82,500**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost	Amount	Interval Range	Unit Cost Range
Drive train	Cost	10 yr	$ 250,000	**$ 250,000**	-	-
Blades	Cost	15 yr	$ 400,000	**$ 400,000**	-	-
				$ -	-	-
End of project life	Credit	-	$ -	$ -		Go to GHG Analysis sheet

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name		MnSCU Wind Feasibility Study
Project location		Mankato, MN
Renewable energy delivered	MWh	7,452
Excess RE available	MWh	-
Firm RE capacity	kW	-
Grid type		Central-grid

Financial Parameters

Avoided cost of energy	$/kWh	0.0345	Debt ratio	%	85.0%
RE production credit	$/kWh	-	Debt interest rate	%	6.0%
			Debt term	yr	20
			Income tax analysis?	yes/no	No
Energy cost escalation rate	%	3.0%			
Inflation	%	2.5%			
Discount rate	%	6.5%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	2.0%	$	75,000	O&M	$	82,500
Development	3.4%	$	125,000			
Engineering	2.3%	$	85,000	Debt payments - 20 yrs	$	272,931
Energy equipment	70.5%	$	2,595,397	**Annual Costs and Debt - Total**	**$**	**355,431**
Balance of plant	14.3%	$	525,000			
Miscellaneous	7.5%	$	277,540	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**$**	**3,682,937**	Energy savings/income	$	256,864
				Capacity savings/income	$	-
Incentives/Grants		$	-			
				Annual Savings - Total	**$**	**256,864**
Periodic Costs (Credits)						
Drive train		$	250,000	Schedule yr # 10,20		
Blades		$	400,000	Schedule yr # 15		
		$	-			
End of project life - Credit		$	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	negative			
After-tax IRR and ROI	%	negative			
Simple Payback	yr	21.1			
Year-to-positive cash flow	yr	more than 20	Project equity	$	552,441
Net Present Value - NPV	$	(1,518,124)	Project debt	$	3,130,496
Annual Life Cycle Savings	$	(137,779)	Debt payments	$/yr	272,931
Benefit-Cost (B-C) ratio	-	(1.75)	Debt service coverage	-	(1.09)

Yearly Cash Flows

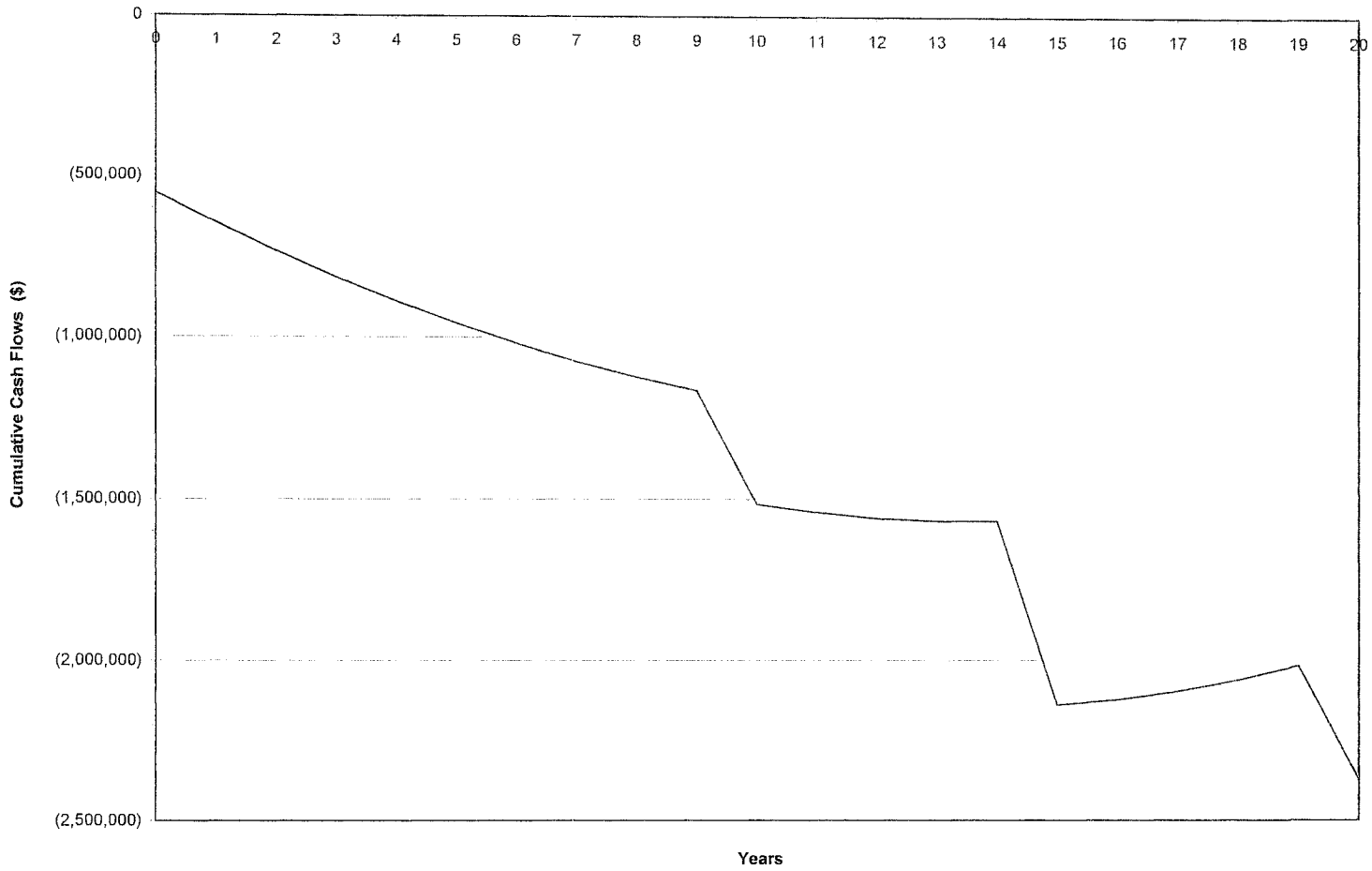
Year	Pre-tax	After-tax	Cumulative
#	$	$	$
0	(552,441)	(552,441)	(552,441)
1	(92,924)	(92,924)	(645,364)
2	(87,101)	(87,101)	(732,465)
3	(81,092)	(81,092)	(813,558)
4	(74,893)	(74,893)	(888,451)
5	(68,497)	(68,497)	(956,947)
6	(61,897)	(61,897)	(1,018,844)
7	(55,088)	(55,088)	(1,073,932)
8	(48,062)	(48,062)	(1,121,994)
9	(40,813)	(40,813)	(1,162,807)
10	(353,356)	(353,356)	(1,516,163)
11	(25,619)	(25,619)	(1,541,781)
12	(17,658)	(17,658)	(1,559,439)
13	(9,445)	(9,445)	(1,568,884)
14	(972)	(972)	(1,569,856)
15	(571,549)	(571,549)	(2,141,406)
16	16,788	16,788	(2,124,617)
17	26,092	26,092	(2,098,525)
18	35,691	35,691	(2,062,835)
19	45,593	45,593	(2,017,242)
20	(353,846)	(353,846)	(2,371,088)

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
MnSCU Wind Feasibility Study, Mankato, MN

Renewable energy delivered (MWh/yr): 7,452

Total Initial Costs: $ 3,682,937



IRR and ROI: negative

Year-to-positive cash flow: more than 20 yr

Net Present Value: $ -1,518,124

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		MnSCU Wind Feasibility Study	See Online Manual
Project location		East Grand Forks, MN	
Wind data source		Wind speed	
Nearest location for weather data		East Grand Forks, MN	See Weather Database
Annual average wind speed	m/s	7.7	
Height of wind measurement	m	80.0	3.0 to 100.0 m
Wind shear exponent	-	0.16	0.10 to 0.40
Wind speed at 10 m	m/s	5.5	
Average atmospheric pressure	kPa	100.0	60.0 to 103.0 kPa
Annual average temperature	°C	5	-20 to 30 °C

System Characteristics		Estimate		Notes/Range
Grid type	-	Central-grid		
Wind turbine rated power	kW	2100	➡	Complete Equipment Data sheet
Number of turbines	-	1		
Wind plant capacity	kW	2,100		
Hub height	m	80.0		6.0 to 100.0 m
Wind speed at hub height	m/s	7.7		
Array losses	%	0%		0% to 20%
Airfoil soiling and/or icing losses	%	1%		1% to 10%
Other downtime losses	%	2%		2% to 7%
Miscellaneous losses	%	2%		2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,100	2,100	
	MW	2.100	2.100	
Unadjusted energy production	MWh	6,586	6,586	
Pressure adjustment coefficient	-	0.99	0.99	0.59 to 1.02
Temperature adjustment coefficient	-	1.04	1.04	0.98 to 1.15
Gross energy production	MWh	6,781	6,781	
Losses coefficient	-	0.95	0.95	0.75 to 1.00
Specific yield	kWh/m²	1,060	1,060	150 to 1,500 kWh/m²
Wind plant capacity factor	%	35%	35%	20% to 40%
Renewable energy delivered	MWh	6,447	**6,447**	
	million Btu	21,998	21,998	
				Complete Cost Analysis sheet

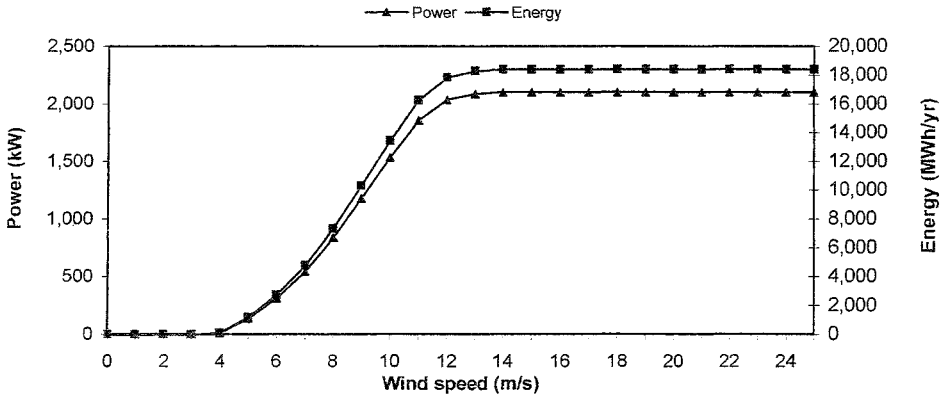
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2100	See Product Database
Hub height	m	80.0	6.0 to 100.0 m
Rotor diameter	m	88	7 to 80 m
Swept area	m²	6,082	35 to 5,027 m²
Wind turbine manufacturer		Suzlon	
Wind turbine model		Suzlon S88-2.1 MW	
Energy curve data source	-	User-defined	Site specific

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	0.0	0.0
1	0.0	0.0
2	0.0	0.0
3	0.0	0.0
4	14.0	122.6
5	138.0	1,208.9
6	312.0	2,733.1
7	546.0	4,783.0
8	840.0	7,358.4
9	1,180.0	10,336.8
10	1,535.0	13,446.6
11	1,856.0	16,258.6
12	2,037.0	17,844.1
13	2,088.0	18,290.9
14	2,100.0	18,396.0
15	2,100.0	18,396.0
16	2,100.0	18,396.0
17	2,100.0	18,396.0
18	2,100.0	18,396.0
19	2,100.0	18,396.0
20	2,100.0	18,396.0
21	2,100.0	18,396.0
22	2,100.0	18,396.0
23	2,100.0	18,396.0
24	2,100.0	18,396.0
25	2,100.0	18,396.0

Power and Energy Curves



Return to Energy Model sheet

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Pre-feasibility | Currency: $ | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study							
Feasibility study	Cost	1	$ 75,000	$ 75,000		-	-
Sub-total:				**$ 75,000**	2.0%		
Development							
Development	Cost	1	$ 125,000	$ 125,000		-	-
Sub-total:				**$ 125,000**	3.4%		
Engineering							
Engineering	Cost	1	$ 85,000	$ 85,000		-	-
Sub-total:				**$ 85,000**	2.3%		
Energy Equipment							
Wind turbine(s)	kW	2,100	$ 1,119	$ 2,349,900		-	-
Spare parts	%	3.0%	$ 2,349,900	$ 70,497		-	-
Transportation	turbine	1	$ -	$ -		-	-
Other - Energy equipment	Cost	1	$ 175,000	$ 175,000		-	-
Sub-total:				**$ 2,595,397**	70.5%		
Balance of Plant							
Balance of plant	Cost	1	$ 525,000	$ 525,000		-	-
Sub-total:				**$ 525,000**	14.3%		
Miscellaneous							
Contingencies	%	5%	$ 3,405,397	$ 170,270		-	-
Interest during construction	6.0%	12 month(s)	$ 3,575,667	$ 107,270		-	-
Sub-total:				**$ 277,540**	7.5%		
Initial Costs - Total				**$ 3,682,937**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
O&M	Cost	1	$ 75,000	$ 75,000		-	-
Contingencies	%	10%	$ 75,000	$ 7,500		-	-
Annual Costs - Total				**$ 82,500**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost	Amount	Interval Range	Unit Cost Range
Drive train	Cost	10 yr	$ 250,000	**$ 250,000**	-	-
Blades	Cost	15 yr	$ 400,000	**$ 400,000**	-	-
				$ -	-	-
End of project life	Credit	-	$ -	$ -		*Go to GHG Analysis sheet*

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name		MnSCU Wind Feasibility Study
Project location		East Grand Forks, MN
Renewable energy delivered	MWh	6,447
Excess RE available	MWh	-
Firm RE capacity	kW	-
Grid type		Central-grid

Financial Parameters

Avoided cost of energy	$/kWh	0.0345	Debt ratio	%	85.0%
RE production credit	$/kWh	-	Debt interest rate	%	6.0%
			Debt term	yr	20
			Income tax analysis?	yes/no	No
Energy cost escalation rate	%	3.0%			
Inflation	%	2.5%			
Discount rate	%	6.5%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				Annual Costs and Debt		
Feasibility study	2.0%	$	75,000	O&M	$	82,500
Development	3.4%	$	125,000			
Engineering	2.3%	$	85,000	Debt payments - 20 yrs	$	272,931
Energy equipment	70.5%	$	2,595,397	**Annual Costs and Debt - Total**	**$**	**355,431**
Balance of plant	14.3%	$	525,000			
Miscellaneous	7.5%	$	277,540	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**$**	**3,682,937**	Energy savings/income	$	222,230
				Capacity savings/income	$	-
Incentives/Grants		$	-			
				Annual Savings - Total	**$**	**222,230**
Periodic Costs (Credits)						
Drive train		$	250,000	Schedule yr # 10,20		
Blades		$	400,000	Schedule yr # 15		
		$	-			
End of project life - Credit		$	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	negative			
After-tax IRR and ROI	%	negative			
Simple Payback	yr	26.4			
Year-to-positive cash flow	yr	more than 20	Project equity	$	552,441
Net Present Value - NPV	$	(2,014,917)	Project debt	$	3,130,496
Annual Life Cycle Savings	$	(182,867)	Debt payments	$/yr	272,931
Benefit-Cost (B-C) ratio	-	(2.65)	Debt service coverage	-	(1.29)

Yearly Cash Flows

Year #	Pre-tax $	After-tax $	Cumulative $
0	(552,441)	(552,441)	(552,441)
1	(128,596)	(128,596)	(681,037)
2	(123,843)	(123,843)	(804,880)
3	(118,937)	(118,937)	(923,817)
4	(113,873)	(113,873)	(1,037,690)
5	(108,646)	(108,646)	(1,146,336)
6	(103,251)	(103,251)	(1,249,587)
7	(97,682)	(97,682)	(1,347,269)
8	(91,934)	(91,934)	(1,439,203)
9	(86,002)	(86,002)	(1,525,205)
10	(399,900)	(399,900)	(1,925,105)
11	(73,559)	(73,559)	(1,998,664)
12	(67,037)	(67,037)	(2,065,701)
13	(60,305)	(60,305)	(2,126,006)
14	(53,358)	(53,358)	(2,179,364)
15	(625,507)	(625,507)	(2,804,871)
16	(38,788)	(38,788)	(2,843,659)
17	(31,151)	(31,151)	(2,874,810)
18	(23,270)	(23,270)	(2,898,081)
19	(15,137)	(15,137)	(2,913,218)
20	(416,398)	(416,398)	(3,329,616)

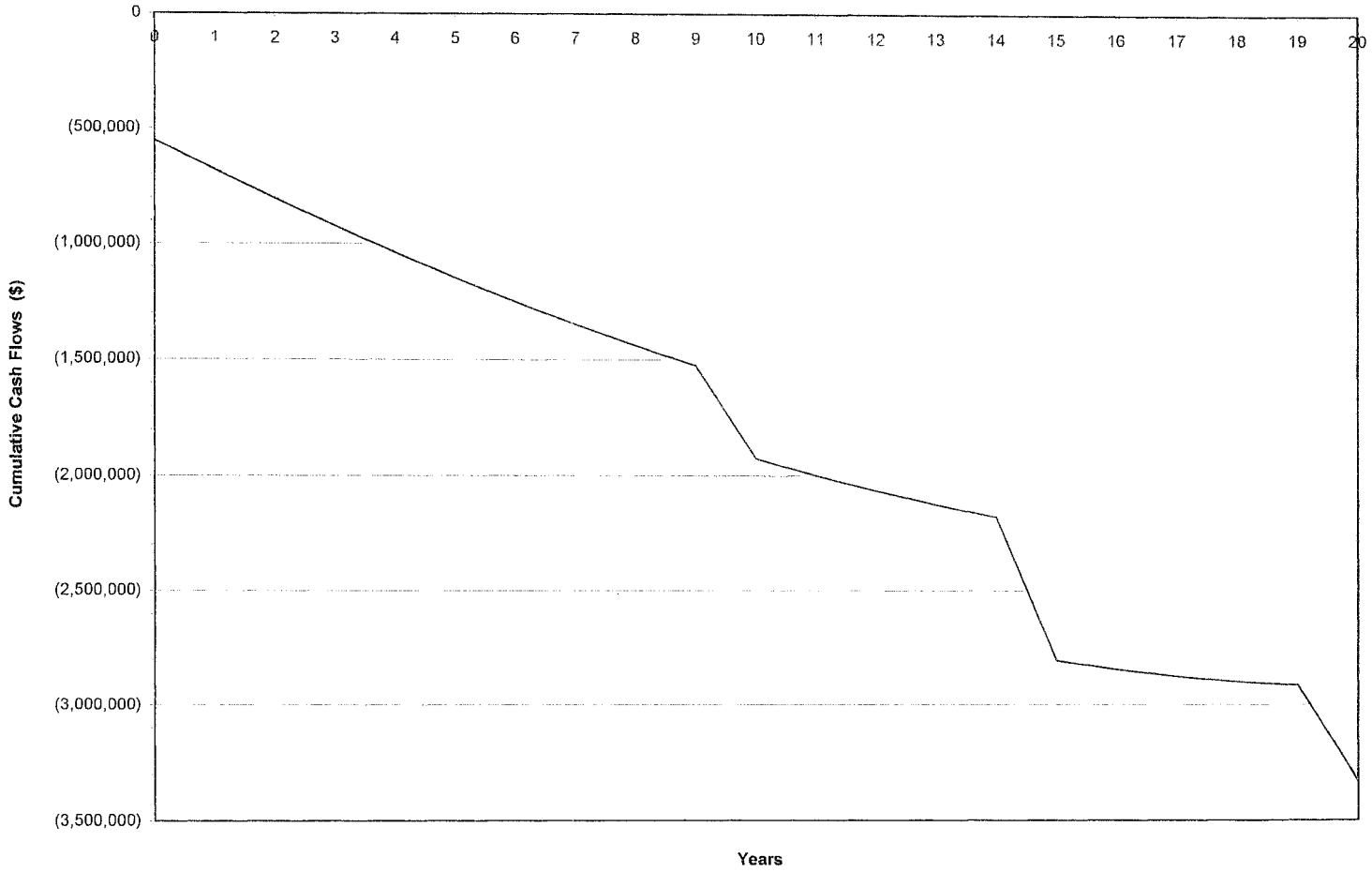
RETScreen® Financial Summary - Wind Energy Project

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
MnSCU Wind Feasibility Study, East Grand Forks, MN

Renewable energy delivered (MWh/yr): 6,447

Total Initial Costs: $ 3,682,937



IRR and ROI: negative

Year-to-positive cash flow: more than 20 yr

Net Present Value: $ -2,014,917

RETScreen® Energy Model - Wind Energy Project

Training & Support

Units: Metric

Site Conditions		Estimate	Notes/Range
Project name		MnSCU Wind Feasibility Study	See Online Manual
Project location		Willmar, MN	
Wind data source		Wind speed	
Nearest location for weather data		Willmar, MN	See Weather Database
Annual average wind speed	m/s	5.7	
Height of wind measurement	m	40.0	3.0 to 100.0 m
Wind shear exponent	-	0.16	0.10 to 0.40
Wind speed at 10 m	m/s	4.6	
Average atmospheric pressure	kPa	100.0	60.0 to 103.0 kPa
Annual average temperature	°C	6	-20 to 30 °C

System Characteristics		Estimate	Notes/Range
Grid type	-	Central-grid	
Wind turbine rated power	kW	2100	Complete Equipment Data sheet
Number of turbines	-	1	
Wind plant capacity	kW	2,100	
Hub height	m	80.0	6.0 to 100.0 m
Wind speed at hub height	m/s	6.4	
Array losses	%	0%	0% to 20%
Airfoil soiling and/or icing losses	%	1%	1% to 10%
Other downtime losses	%	2%	2% to 7%
Miscellaneous losses	%	2%	2% to 6%

Annual Energy Production		Estimate Per Turbine	Estimate Total	Notes/Range
Wind plant capacity	kW	2,100	2,100	
	MW	2.100	2.100	
Unadjusted energy production	MWh	3,489	3,489	
Pressure adjustment coefficient	-	0.99	0.99	0.59 to 1.02
Temperature adjustment coefficient	-	1.03	1.03	0.98 to 1.15
Gross energy production	MWh	3,557	3,557	
Losses coefficient	-	0.95	0.95	0.75 to 1.00
Specific yield	kWh/m²	556	556	150 to 1,500 kWh/m²
Wind plant capacity factor	%	18%	18%	20% to 40%
Renewable energy delivered	MWh	3,382	**3,382**	
	million Btu	11,541	11,541	

Complete Cost Analysis sheet

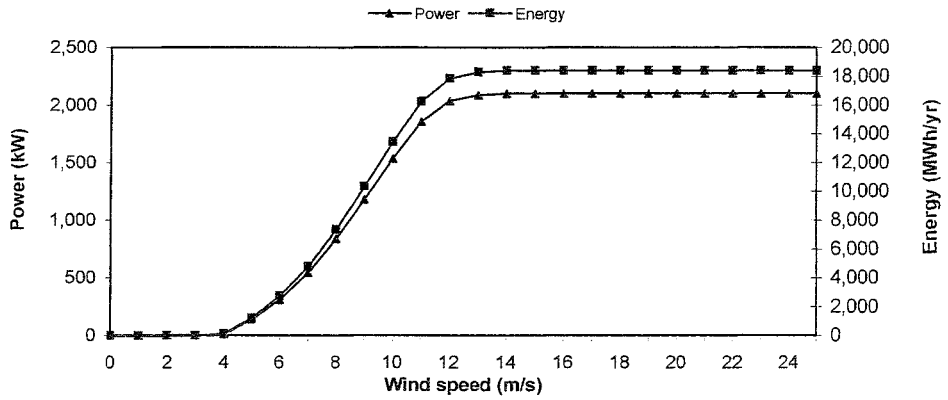
RETScreen® Equipment Data - Wind Energy Project

Wind Turbine Characteristics		Estimate	Notes/Range
Wind turbine rated power	kW	2100	*See Product Database*
Hub height	m	80.0	6.0 to 100.0 m
Rotor diameter	m	88	7 to 80 m
Swept area	m²	6,082	35 to 5,027 m²
Wind turbine manufacturer		Suzlon	
Wind turbine model		Suzlon S88-2.1 MW	
Energy curve data source	-	User-defined	Site specific

Wind Turbine Production Data

Wind speed (m/s)	Power curve data (kW)	Energy curve data (MWh/yr)
0	0.0	0.0
1	0.0	0.0
2	0.0	0.0
3	0.0	0.0
4	14.0	122.6
5	138.0	1,208.9
6	312.0	2,733.1
7	546.0	4,783.0
8	840.0	7,358.4
9	1,180.0	10,336.8
10	1,535.0	13,446.6
11	1,856.0	16,258.6
12	2,037.0	17,844.1
13	2,088.0	18,290.9
14	2,100.0	18,396.0
15	2,100.0	18,396.0
16	2,100.0	18,396.0
17	2,100.0	18,396.0
18	2,100.0	18,396.0
19	2,100.0	18,396.0
20	2,100.0	18,396.0
21	2,100.0	18,396.0
22	2,100.0	18,396.0
23	2,100.0	18,396.0
24	2,100.0	18,396.0
25	2,100.0	18,396.0

Power and Energy Curves



Return to Energy Model sheet

RETScreen® Cost Analysis - Wind Energy Project

Type of analysis: Pre-feasibility | Currency: $ | Cost references: None

Initial Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
Feasibility Study							
Feasibility study	Cost	1	$ 75,000	$ 75,000		-	-
Sub-total:				**$ 75,000**	2.0%		
Development							
Development	Cost	1	$ 125,000	$ 125,000		-	-
Sub-total:				**$ 125,000**	3.4%		
Engineering							
Engineering	Cost	1	$ 85,000	$ 85,000		-	-
Sub-total:				**$ 85,000**	2.3%		
Energy Equipment							
Wind turbine(s)	kW	2,100	$ 1,119	$ 2,349,900		-	-
Spare parts	%	3.0%	$ 2,349,900	$ 70,497		-	-
Transportation	turbine	1	$ -	$ -		-	-
Other - Energy equipment	Cost	1	$ 175,000	$ 175,000		-	-
Sub-total:				**$ 2,595,397**	70.5%		
Balance of Plant							
Balance of plant	Cost	1	$ 525,000	$ 525,000		-	-
Sub-total:				**$ 525,000**	14.3%		
Miscellaneous							
Contingencies	%	5%	$ 3,405,397	$ 170,270		-	-
Interest during construction	6.0%	12 month(s)	$ 3,575,667	$ 107,270		-	-
Sub-total:				**$ 277,540**	7.5%		
Initial Costs - Total				**$ 3,682,937**	100.0%		

Annual Costs (Credits)	Unit	Quantity	Unit Cost	Amount	Relative Costs	Quantity Range	Unit Cost Range
O&M							
O&M	Cost	1	$ 75,000	$ 75,000		-	-
Contingencies	%	10%	$ 75,000	$ 7,500		-	-
Annual Costs - Total				**$ 82,500**	100.0%		

Periodic Costs (Credits)		Period	Unit Cost	Amount	Interval Range	Unit Cost Range
Drive train	Cost	10 yr	$ 250,000	**$ 250,000**	-	-
Blades	Cost	15 yr	$ 400,000	**$ 400,000**	-	-
				$ -	-	-
End of project life	Credit	-	$ -	$ -		Go to GHG Analysis sheet

RETScreen® Financial Summary - Wind Energy Project

Annual Energy Balance

Project name		MnSCU Wind Feasibility Study
Project location		Willmar, MN
Renewable energy delivered	MWh	3,382
Excess RE available	MWh	-
Firm RE capacity	kW	-
Grid type		Central-grid

Financial Parameters

Avoided cost of energy	$/kWh	0.0345	Debt ratio	%	85.0%
RE production credit	$/kWh	-	Debt interest rate	%	6.0%
			Debt term	yr	20
			Income tax analysis?	yes/no	No
Energy cost escalation rate	%	3.0%			
Inflation	%	2.5%			
Discount rate	%	6.5%			
Project life	yr	20			

Project Costs and Savings

Initial Costs				**Annual Costs and Debt**		
Feasibility study	2.0%	$	75,000	O&M	$	82,500
Development	3.4%	$	125,000			
Engineering	2.3%	$	85,000	Debt payments - 20 yrs	$	272,931
Energy equipment	70.5%	$	2,595,397	**Annual Costs and Debt - Total**	**$**	**355,431**
Balance of plant	14.3%	$	525,000			
Miscellaneous	7.5%	$	277,540	**Annual Savings or Income**		
Initial Costs - Total	100.0%	**$**	**3,682,937**	Energy savings/income	$	116,586
				Capacity savings/income	$	-
Incentives/Grants		$	-			
				Annual Savings - Total	**$**	**116,586**
Periodic Costs (Credits)						
Drive train		$	250,000	Schedule yr # 10,20		
Blades		$	400,000	Schedule yr # 15		
		$	-			
End of project life - Credit		$	-			

Financial Feasibility

			Calculate energy production cost?	yes/no	No
Pre-tax IRR and ROI	%	negative			
After-tax IRR and ROI	%	negative			
Simple Payback	yr	108.0			
Year-to-positive cash flow	yr	more than 20	Project equity	$	552,441
Net Present Value - NPV	$	(3,530,320)	Project debt	$	3,130,496
Annual Life Cycle Savings	$	(320,399)	Debt payments	$/yr	272,931
Benefit-Cost (B-C) ratio	-	(5.39)	Debt service coverage	-	(1.89)

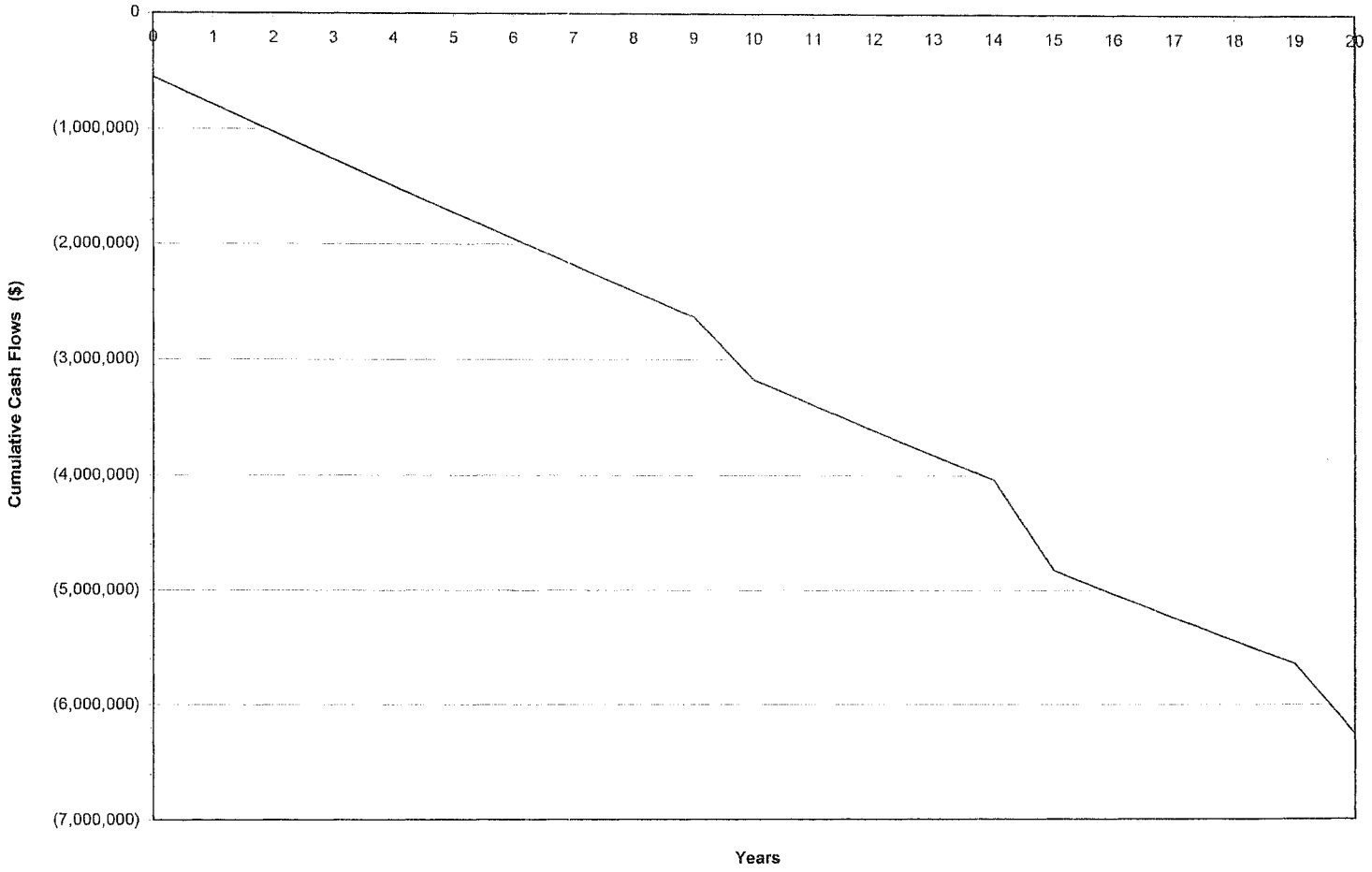
Yearly Cash Flows

Year #	Pre-tax $	After-tax $	Cumulative $
0	(552,441)	(552,441)	(552,441)
1	(237,410)	(237,410)	(789,850)
2	(235,921)	(235,921)	(1,025,771)
3	(234,377)	(234,377)	(1,260,149)
4	(232,777)	(232,777)	(1,492,925)
5	(231,117)	(231,117)	(1,724,042)
6	(229,396)	(229,396)	(1,953,438)
7	(227,611)	(227,611)	(2,181,049)
8	(225,761)	(225,761)	(2,406,810)
9	(223,843)	(223,843)	(2,630,653)
10	(541,877)	(541,877)	(3,172,530)
11	(219,795)	(219,795)	(3,392,326)
12	(217,660)	(217,660)	(3,609,986)
13	(215,447)	(215,447)	(3,825,433)
14	(213,154)	(213,154)	(4,038,587)
15	(790,097)	(790,097)	(4,828,684)
16	(208,316)	(208,316)	(5,037,000)
17	(205,765)	(205,765)	(5,242,765)
18	(203,122)	(203,122)	(5,445,888)
19	(200,385)	(200,385)	(5,646,273)
20	(607,203)	(607,203)	(6,253,476)

Cumulative Cash Flows Graph

Wind Energy Project Cumulative Cash Flows
MnSCU Wind Feasibility Study, Willmar, MN

Renewable energy delivered (MWh/yr): 3,382 **Total Initial Costs: $ 3,682,937**



IRR and ROI: negative **Year-to-positive cash flow: more than 20 yr** **Net Present Value: $ -3,530,320**