EAPC ARCHITECTS ENGINEERS

FINAL REPORT

Lake Region State College
Wind Energy with Boiler Conversion
Feasibility Study

Lake Region State College

September 6, 2006

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EXECUTIVE SUMMARY

Lake Region State College hired EAPC Architects Engineers to study the feasibility of replacing existing natural gas-fired boilers with electric boilers and integrating a wind turbine on or near the campus to provide electricity to the College Campus.

The College owns a parcel of land just north of the campus. The site is well suited for a wind turbine. It's in close proximity to the College's main electrical interconnection and the parcel is open farmland on a slight hill.

A number of different turbines were considered to determine which had the best cost/benefit ratio for this application. The turbine that best matched the campus load was the Vestas V82, which is a 1.65 megawatt (MW) wind turbine. The estimated total cost for the project to replace two boilers and install and interconnect the V82 is approximately $2,937,600 and would take approximately 10 ½ years to pay back based on projected annual savings of $287,500 per year.

INTRODUCTION

Lake Region State College is interested in the possibility of connecting a wind turbine into the campus electrical grid for a number of reasons, including saving money on utilities, public relations, helping to stimulate the growth of North Dakota's wind industry, and the environmental benefits associated with clean, renewable wind energy.

Single wind turbine applications require a favorable combination of three main factors; customer load, utility rates, and wind resource. If the customer load is substantial and the utility rates are high, then it may be financially feasible to supply electricity from a wind turbine owned and operated by the College.

In this type of application, the electricity supplied by the wind turbine displaces power that would otherwise be provided by the local utility. The value of the wind energy is then equivalent to the retail rate of the displaced power. Any excess electricity produced by the wind turbine is fed back onto the local utility's system. The local utility credits the College for the excess electricity at a lower rate based on the utility's avoided cost. The avoided cost rate is usually in the range of 2.3 cents per kilowatt-hour (kWh) in North Dakota.

Because the value of the excess electricity is low, it doesn't make financial sense to produce more energy than will be consumed directly by the College. This makes it important to size the wind turbine according to the load that it serves.

In this application, the College has four natural gas-fired boilers. By replacing two of the boilers with new, more efficient electric boilers, the College will be increasing the total electric load that can be served by the wind turbine, while at the same time qualifying for lower dual-fuel electric rates for the boilers.

METHODOLOGY

There are no standard methods for integrating a wind turbine on a campus. Each application is unique. Each campus has a different set of variables to work with including available land, utility provider, utility rates and rate structure, wind resource, and campus location relative to the surrounding city, roads, and airports.

The process of determining how best to integrate a wind turbine is a matter of gathering all the appropriate puzzle pieces and determining how they best fit together to achieve the College's goals and objectives.

Information gathered for this study included the following:

- Industry-quality wind data
- Local air density
- Utility bills for each of the utilities that serve the campus
- Background information on existing loads and future load growth or decrease.
- Digital height information describing the topography within a 5-kilometer (km) radius of the wind monitoring station and the selected wind turbine site
- Aerial photographs (1 m per pixel resolution)
- Aerial photographs (8 m per pixel resolution)
- Topographic maps (1:24,000)
- Topographic maps (1:100,000)
- Power curves and other technical specifications for the candidate wind turbines
- Photographs from various locations where the wind turbine would be visible
- FAA Airport Runway Classifications for nearest airports

WIND RESOURCE ASSESSMENT

Methodology

Wind measurements at the location and hub height of the wind turbine generator (WTG) are required to predict the annual energy production (AEP). Typically, wind measurements are not available at the WTG site; however, data is available from a local meteorological (met) mast in the region. Computer programs (WindPRO and WAsP) were used to estimate the AEP of a WTG utilizing various modules to analyze the wind data and make corrections for the local site effects (topography, surface roughness and obstacles) incorporating vertical and horizontal extrapolation flow models. The procedure used to estimate the AEP is as follows:

- Locate and acquire wind data from a local met mast. If less than three years of data is available, then locate and acquire longer-term coincidental data for long-term correlation.
- Screen, clean, and analyze the wind data collected from the met mast.
- Evaluate and describe the site effects surrounding the met masts including topography, surface roughness, and obstacles.
- Correct the analyzed wind data for the met mast site effects to produce a site-independent characterization of the local wind climate known as a wind statistic.
- Describe the site effects surrounding the proposed WTG site including topography, surface roughness, and obstacles.
- Specify the location, air density and WTG parameters.
- Use the wind statistic and engineering data for the WTG to estimate the AEP.
- If less than three years of wind data is available, correct the AEP estimate based on a wind index developed from longer-term wind data.

Wind Data

Wind data from ALP0102 met mast was available from the Plains Organization for Wind Energy Resources (POWER) web site. ALP0102 is Site 2 of the 2001 North Dakota Anemometer Loan Program performed in cooperation with the North Dakota Division of Community Services. The monitoring system was installed for the City of Devils Lake in Devils Lake, North Dakota, and is located in Ruger Park, which is shown relative to the wind turbine location in Figure 1. The wind speed and direction were measured at a 20 m level starting 11/23/01 and stopping 7/8/03.

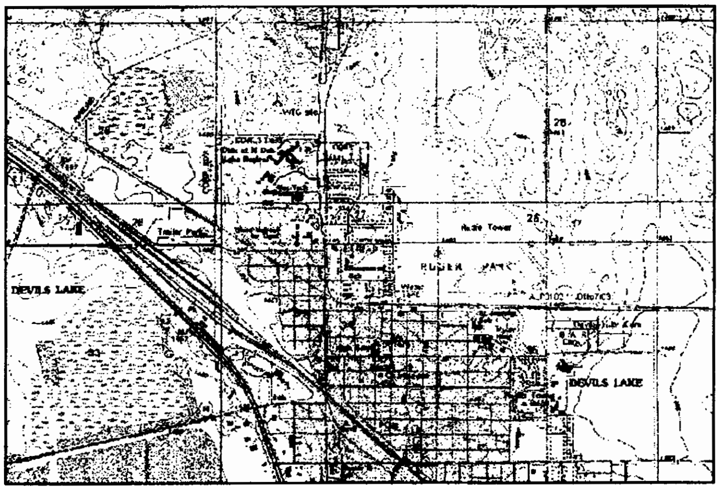

Figure 1 – Location of wind turbine and ALP0102 met mast

The results of the analysis of the 20 m wind data is shown in Figure 2 and the Weibull data is shown in Table 1. The mean wind speed is 5.2 meters per second (m/s) and the wind energy is predominantly from the W to NNW.

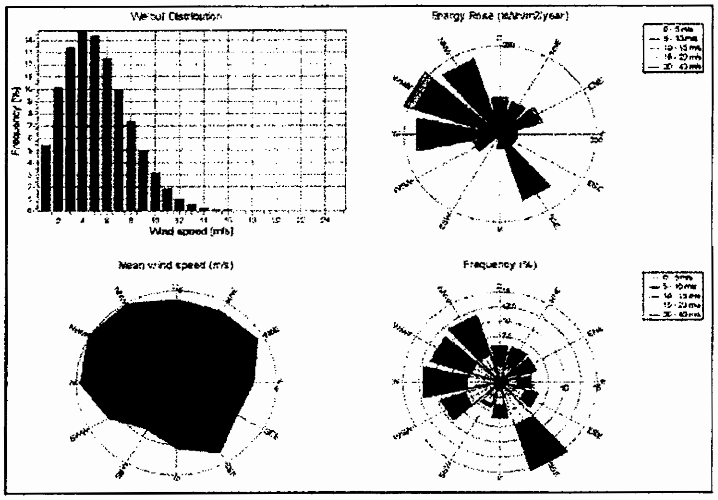

Figure 2 – 20 m ALP0102 wind data analysis

Weibull Data				
Sector	A- parameter	Wind speed	k- parameter	Frequency
	[m/s]	[m/s]		[%]
0 N	6.14	5.45	1.892	6.0
1 NNE	6.00	5.32	1.940	6.2
2 ENE	6.28	5.58	1.839	6.0
3 E	5.17	4.58	2.013	4.7
4 ESE	4.73	4.19	2.216	6.3
5 SSE	5.90	5.23	2.392	15.5
6 S	4.80	4.25	2.456	6.1
7 SSW	3.90	3.48	2.854	4.5
8 WSW	5.16	4.60	2.817	9.6
9 W	6.49	5.75	2.137	12.0
10 WNW	6.80	6.03	1.942	11.3
11 NNW	6.65	5.89	2.215	11.8
All	5.88	5.21	2.039	100.0

Table 1 – 20 m ALP0102 Weibull data

Wind Resource Calculation

Site conditions that can effect the spatial variation of the wind are input into the flow models as follows:

1. Surface Roughness (shown in Figure 3). The digital map is generated by digitizing discrete surface roughness areas within a 20 km radius of the site.
2. Topography (shown in Figure 4). The digital map is generated from digital elevation models (DEM's) containing height contour descriptions at 10-foot intervals within a 5 km radius of the site.
3. Obstacles (shown in Figure 5). Obstacles are identified by specifying the shape and porosity of obstacles within a 500 m radius of the site.

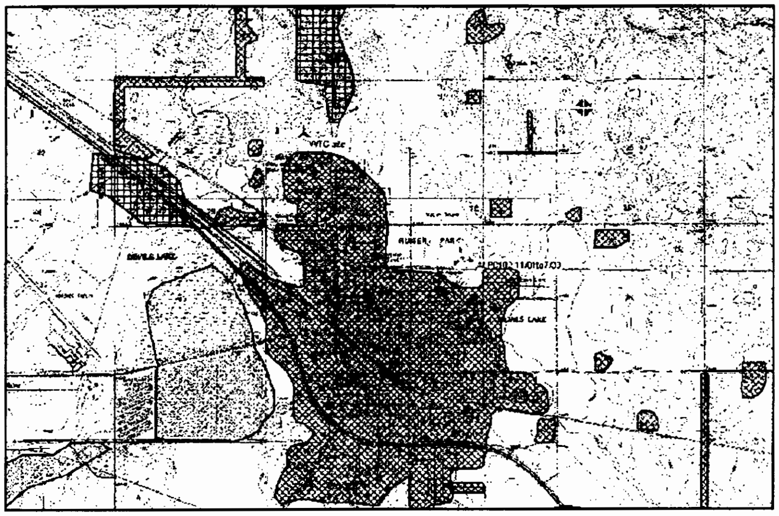

Figure 3 – Surface roughness classifications

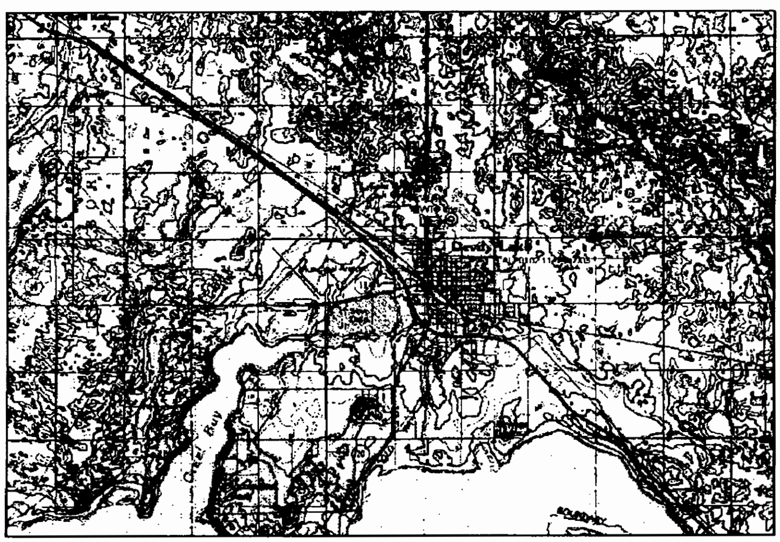

Figure 4 – Digital height contours

Figure 5 – Obstacles at the WTG site

Annual Energy Production Calculation

Once a specific location is chosen for the wind turbine, a detailed energy production calculation is made using the WindPRO software for each candidate wind turbine. The location chosen for the wind turbine is shown in Figure 6. Production estimates are based on the following parameters:

1. Wind turbine power curves corrected to site air density.
2. 20 m ALP0103 wind statistics.
3. Topography - digital map generated from digital elevation models (DEM's) containing height contour descriptions at 10-foot intervals within a 5 km radius of the site.
4. Surface Roughness - digital map generated by digitizing discrete surface roughness areas within 20 km of the site.
5. Obstacles – specify the shape and porosity of obstacles within 500 m radius of the site.

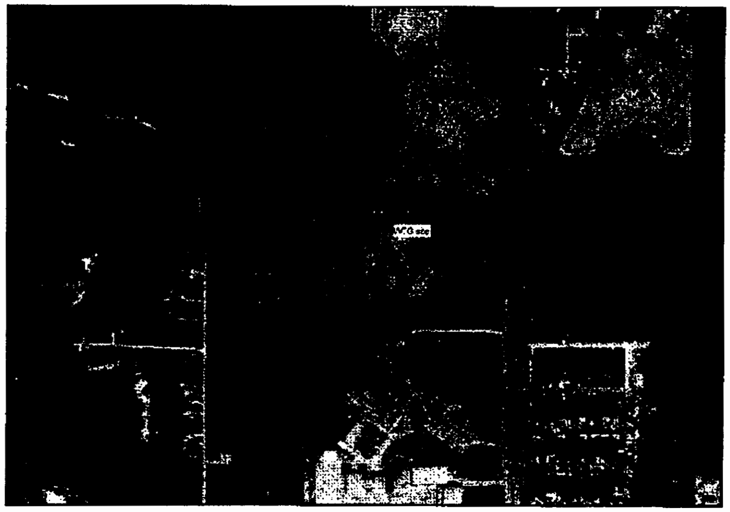

Figure 6 – Wind Turbine Generator location

To compare the wind energy level of the APL0102 data collection period to a longer term average, 8.3 years of wind data was obtain from the North Dakota Agricultural Weather Network (NDAWN) McHenry site. The location of the McHenry met mast is approximately 31 miles SSW of the APL0102 met mast shown in Figure 7.

Figure 7 – Location of the McHenry and APL0102 met mast

The average monthly wind speed and direction were compared for the two sites using 21 months of concurrent data. There is a good correlation between the two sites. The wind speed comparison shown in Figure 8, has a correlation coefficient of 0.91 and the wind direction comparison shown in Figure 9, has a correlation coefficient of 0.96.

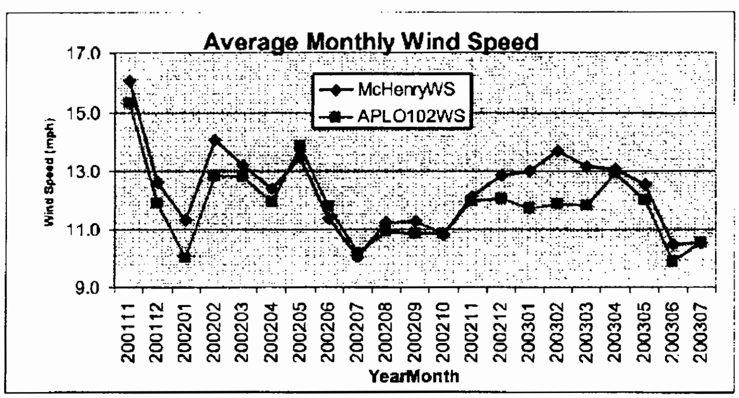

Figure 8 – Chart of average monthly wind speed for McHenry and APL0102

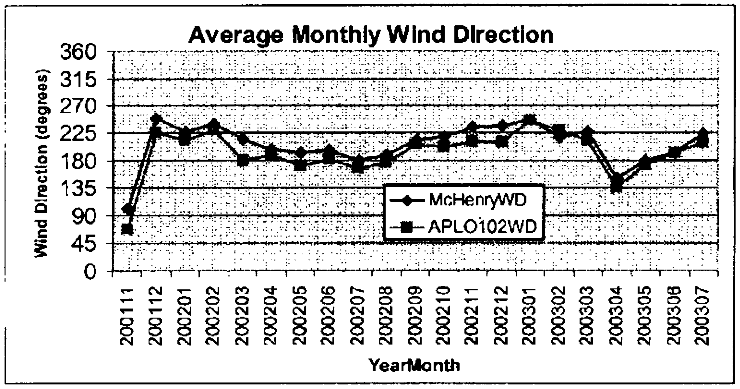

Figure 9 – Chart of average monthly wind direction for McHenry and APL0102

A monthly wind energy index shown in Figure 10 as developed using the McHenry data normalized over the 8.3 years. The chart shows how the monthly wind energy varies from the average of 100. The wind energy index was used to determine what the energy level was during the APL0102 data collection period and apply a correction factor to the energy calculations if required. The wind energy index was 101for this period indicating an average energy level therefore, the energy calculations were not corrected.

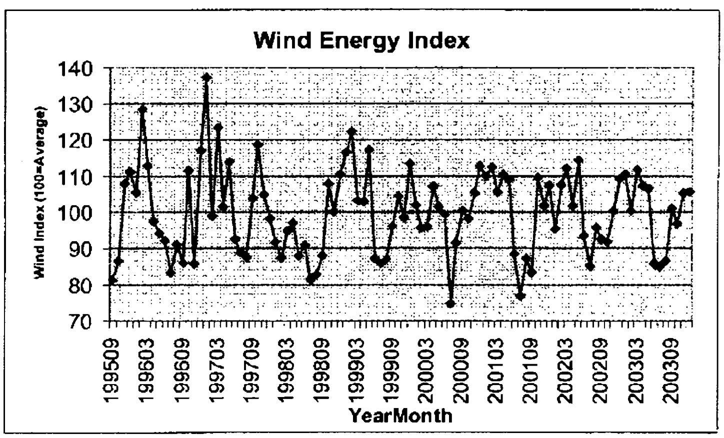

Figure 10 – Chart of the McHenry monthly wind energy index

RESULTS

Wind Resource Map

As can be seen from the wind resource map (Figure 11) the lowest level wind resource areas are those within the City of Devils Lake. The trees and buildings provide surface roughness, which tends to decrease wind speeds. As you move away from the city in any direction, you can see that the surface roughness effects diminish and the wind speeds increase.

Moving the wind turbine further from the city to a higher-level wind resource zone would increase energy production, but would also increase the power cable costs. Also, in order to directly supply energy to the campus, it is necessary to interconnect directly at the campus. Interconnecting to a power line somewhere off-campus and delivering the energy to the campus would involve transmission and wheeling charges, which complicates the project contractually, and increases the costs due to the transmission fees.

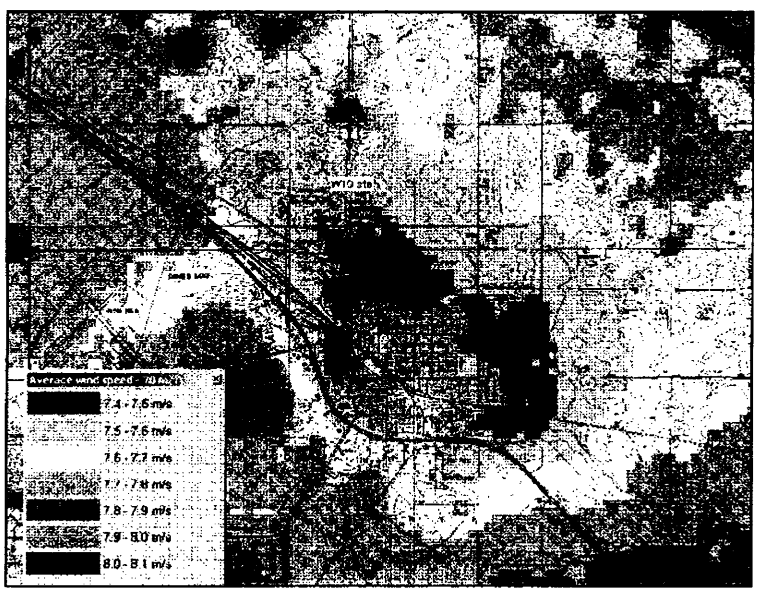

Figure 11 – 70 m wind resource map

Estimated Annual Energy Production

The annual energy production was calculated for a number of different wind turbines. The wind turbines considered ranged in size from a 660 kW machine up to a 1.65 megawatt (MW) sized machine. With the exception of the GE 1.5, which is made by General Electric in the United States, the rest of the wind turbines considered are of Danish manufacture. Each machine considered is a current production model available for sale in the U.S. with production models installed and operating in the Midwest. Each is capable of operating in extreme cold weather.

The estimated annual energy production is listed in Table 2 for each of the candidate wind turbines. The predicted energy production for each turbine, less 10% to account for losses and uncertainties, was input into the utility analysis to determine the amount of electricity the College would need to purchase, and how much would be provided by the wind turbine.

Calculated Annual Energy

WTG type						Power curve		Annual Energy			
Valid	Manufact.	Type	Power	Diam.	Height	Creator	Name	Result	Result-10.0%	Mean wind speed	Capacity Factor
			[kW]	[m]	[m]			[MWh]	[MWh]	[m/s]	[%]
Yes	GE WIND ENERGY	GEWE 1.5sl	1,500	77.0	65.0	USER	Manufacturer 09/03 1.225 20.00 0.00	5,044.3	4,540	7.3	38.4
Yes	NEG MICON	NM 48/750	750/200	48.2	58.0	EMD	Windtest/Man. 17-09-99 1.225 25.00 0.00	1,883.5	1,695	7.0	28.6
Yes	NEG MICON	NM54 Power Trim	950/200	54.5	72.3	EMD	Man. 09-2003	2,763.1	2,487	7.6	33.2
Yes	VESTAS	82/1650	1,650	82.0	80.0	USER	Man. 09-2003	6,303.3	5,673	7.8	43.6
Yes	VESTAS	V47-US	660	47.0	65.0	USER	US version	1,988.4	1,790	7.3	34.4

Table 2 – Estimated annual energy production

SITING ISSUES

Land Availability

It was preferable to locate the wind turbine on state property in order to minimize costs and potential permitting issues. The best available site for consideration was the parcel just north of the campus. This site had adequate setbacks and was close to the main point of interconnection for the campus, which helps to minimize power cable costs.

Setbacks

Typical setback requirements usually pertain to the fall distance of the structure. Local zoning ordinances were not checked in this case. Because of the actual location selected, the turbine would be well beyond typical minimum setback requirements dealing with fall distance. If the project were to go forward, it would be necessary to confirm compliance with any local zoning ordinances.

Icing

Under certain atmospheric conditions, the rotor blades can develop a buildup of ice. If the rotor is turning while the blades are ice-laden, the ice can be thrown some distance from the turbine as it breaks free. In most cases, the turbine will automatically shut down during an icing event due to the rotor imbalance caused by the ice buildup. The ice will then fall directly at the base of the turbine, as it breaks free. Even when the rotor is turning, most ice will fall relatively close to the turbine base. It should be noted that there are no recorded incidents of ice thrown from a wind turbine striking a human being.

While there are no uniform standards regarding the safe setback distance for ice throws, the most conservative recommendations found in the public domain come from a European study suggesting a setback distance equal to 1.5 times the sum of the hub height plus the rotor diameter. For the V82 wind turbine selected for this project, which has an 80 m hub height and a 82 m rotor diameter, this equates to a setback of 800 feet. The 800-foot setback is shown in Figure 12. There are a number of single wind turbine applications with a setback that is less than this recommendation. For example, there is a wind turbine installed at a grade school in Spirit Lake, Iowa with a 300-foot setback from the school playground.

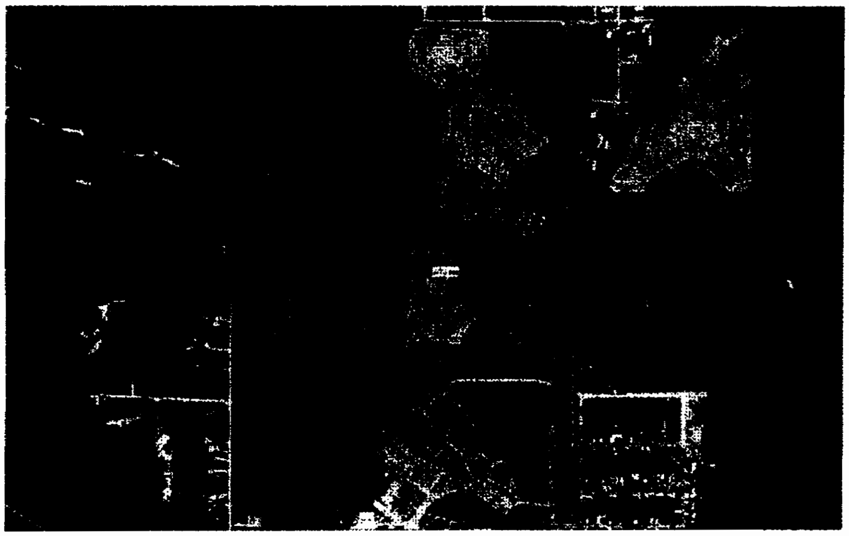

Figure 12 – 800 foot setback for ice throws

Shadow Flicker

As the blades rotate, they cast a moving shadow on the ground and on nearby buildings. This moving shadow creates a flickering phenomenon that can be annoying to some people. The zone where shadow flicker will occur has been calculated and the actual amount of time and time of occurrence has been calculated as well for four key locations near the wind turbine (shown in Figure 13). The different colored isolines indicate the number of hours per year that shadow flicker occur in the respective areas.

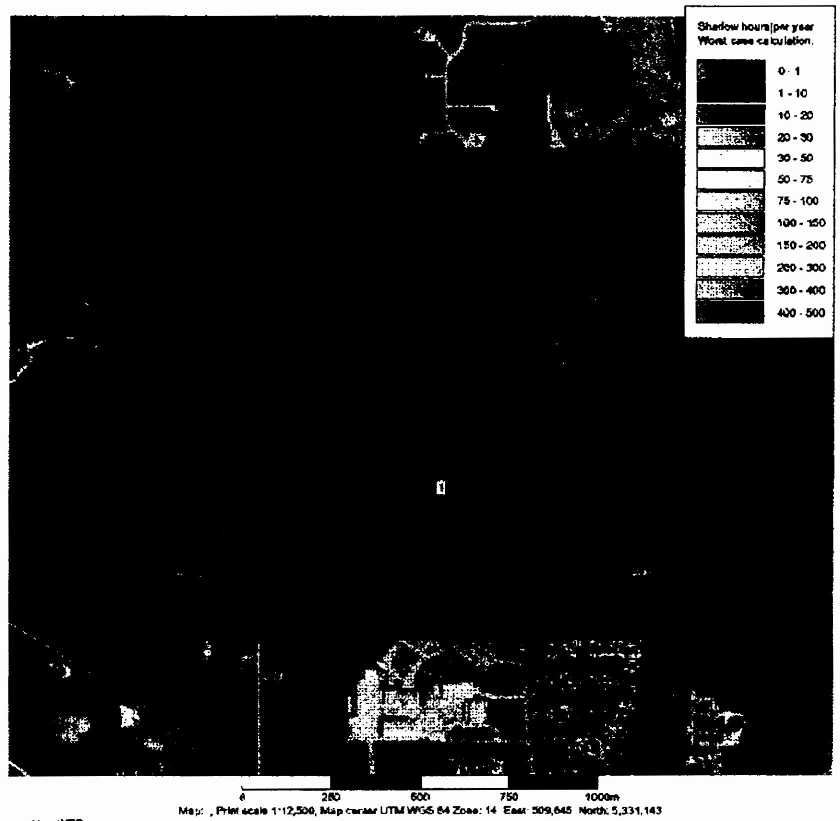

Figure 13 – Shadow flicker zones

Noise

Today's modern wind turbines are relatively quite. In most cases, the wind rushing past a person's ears will prevent them from actually hearing the wind turbine. Noise standards vary across the country, but a maximum level of 45 decibels in a residential area at night is a typical limit enforced by ordinance. Figure 14 shows what the expected noise level will be at various distances from the wind turbine.

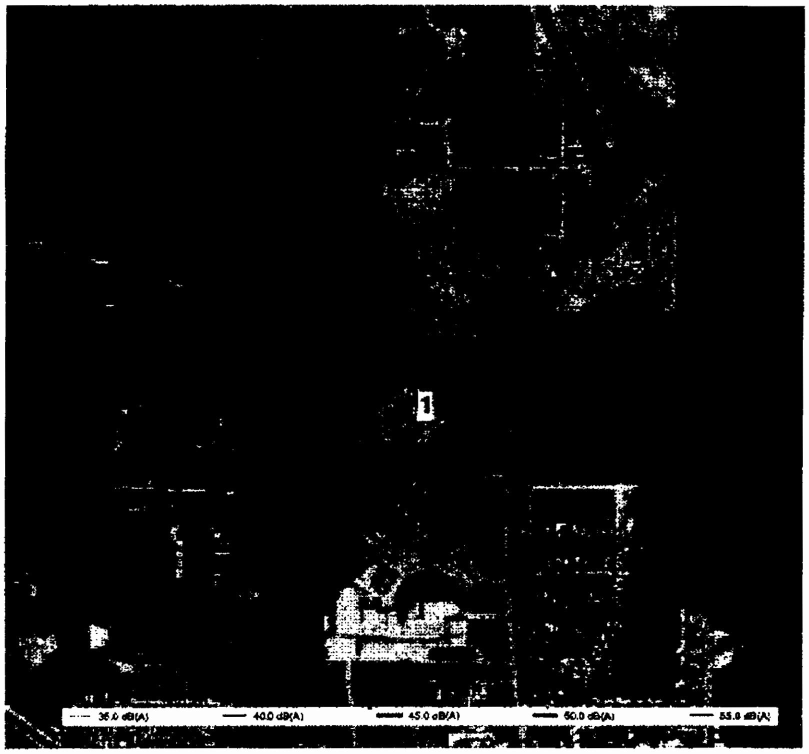

Figure 14 – Noise level isolines

FAA Considerations

The Federal Aviation Administration maintains restricted airspace in the vicinity of public airports. The allowable structure height depends on the type of runway and the distance from the runway. The zone of restricted airspace and the wind turbine location can be seen in Figure 15. In order to find out if the wind turbine is considered a hazard to air traffic, it would be necessary to submit an application to the FAA for a determination. Because the overall height of the wind turbine is greater than 200 feet, the FAA requires that the structure be lighted. Although the FAA has not adopted nationwide uniform lighting standards for wind turbines yet, red flashing beacons are usually considered to be acceptable.

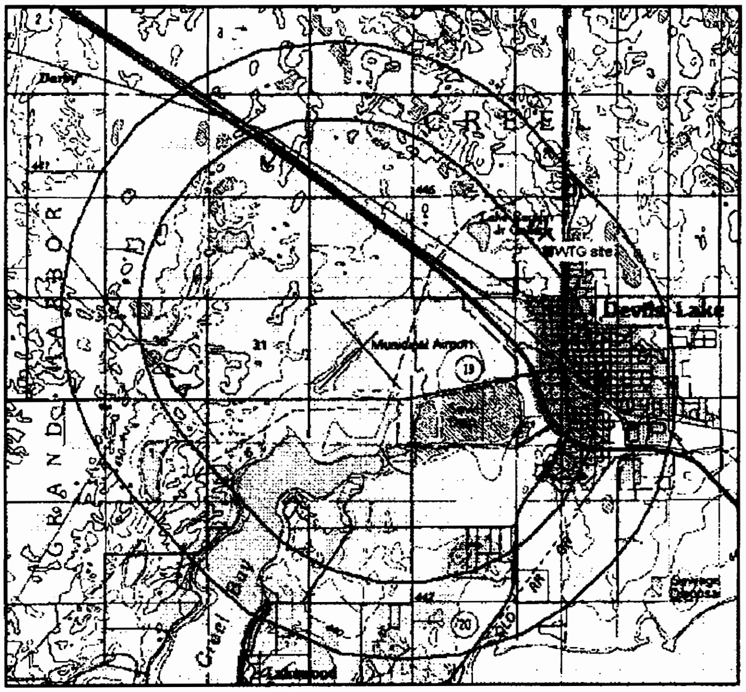

Figure 15 – Airport approach zone

Aesthetics

Photomontage

Digital photographs were taken at a number of locations from which the wind turbine would be visible. The exact coordinates where each photograph was taken are recorded. Using a sophisticated computer program, the wind turbine is artificially rendered into the photographs to provide a realistic representation of what the wind turbine will look like from the various vantage points. The computer model uses manufacturer's information about the wind turbine to ensure that the wind turbine is properly represented in terms of size, shape, color, logo, etc.

In order to ensure that the turbine is accurately rendered into the photographs in terms of size and location, a number of known points such as radio towers, water towers, corners of buildings, and trees in the photographs are marked and the coordinates are entered into the computer model. By using these control points, we are able to calibrate each photograph by adjusting the focal length, camera position and tilt angles, so that the wind turbine is accurately positioned and sized in each photograph.

In addition, the exact time and date of each photograph is recorded and entered into the computer model as well. Using this information in combination with the sky conditions at the time of the photograph, the lighting on the wind turbine is also rendered accurately.

Figure 16 – Photomontage view from Strong's Hill

Permitting

Determining actual compliance with local zoning and ordinances was not within the scope of this study. In the event that this project should move forward, it will be necessary to investigate municipal, township, county, state and federal regulatory requirements during the permitting phase of the project.

UTILITY ANALYSIS

Overview

Otter Tail Power Company supplies Lake Region State College's electricity. Most of the campus load is supplied through the same meter.

In order to determine the financial feasibility of this project, it is necessary to compare a "business-as-usual" case where nothing is changed, to the case where the wind turbine supplies some portion of the campus's electricity. The campus's usage of electricity, as well as the amount of electricity generated by the wind turbine, will vary from month to month.

In order to make an accurate comparison, the two cases must be compared on a monthly basis. Based on monthly utility bills, an average usage is projected for each month of the year. Based on detailed wind data and the specific power curve for the candidate wind turbine, the wind energy production is estimated for each month of the year.

Since the monthly wind turbine output is always greater than the campus load for appliances and lights, an assumption is made that the wind turbine serves 80% of the campus load for appliances and lights. The remaining campus load is assumed to be served by the local utility. The remaining wind energy is assumed to be consumed by the electric boilers.

If there is excess wind energy after the total campus load has been served, then the excess energy is sold back to the local utility at a rate of $0.02361/kWh.

Business-as-Usual Case

Electricity

In the "business-as-usual" case, a simplifying assumption is made to combine service charges, demand charges, and energy charges into a single "blended rate". This is done by taking the total utility charges for the year and dividing by the total energy usage to arrive at an average annual price per kWh. The blended rate for this project is $0.071 per kWh.

The estimated monthly electric load is based on 4 years of historical data with a 20% increase.

Natural Gas

The blended rate for natural gas for this study is estimated to be $9 per decatherm (Dkt). This estimate is based on historical utility billing data as well as attempting to guess at what may happen to the price in the near future.

The estimated monthly load is based on 4 years of historical data with a 20% increase.

Wind Energy Case with New Electric Boilers

Electricity

In the case where some of the electricity is supplied by the wind turbine, actual utility service charges, demand charges, and energy charges are calculated on a monthly basis. Wind energy consumed by the campus is valued at the utilities retail rate. Excess wind energy that is fed back onto the local distribution grid is valued at the utilities avoided cost. Campus energy usage and wind generation are summed up on a monthly basis.

The amount of electricity consumed by the new electric boilers is based on 4 years of historical data with a 20% increase. The gas boilers were assumed to be 65% efficient in converting energy to heat. The resulting actual heat energy used was then converted to equivalent kWh of electricity at 100% efficiency. The electricity consumed by the electric boilers that is purchased from the local utility is at the dual-fuel rate of $0.0253/kWh.

Natural Gas

Two existing gas boilers will be kept in service as backup to the new electric boilers. This allows the College to qualify for the dual-fuel rate of $0.0253/kWh as compared to the standard blended rate of $0.071/kWh. This rate only applies to electricity consumed by the electric boilers (not appliances, lights, etc.). Under the dual-fuel rate, the utility can ask the College to go off-line and use the backup gas boilers for a total of 400 hours per year during the winter months from November through April. During this time, the fuel cost for operating the boilers is assumed to be at the rate of $9/Dkt.

Estimated Annual Savings

The estimated annual savings is derived by comparing the estimated monthly utility bill from the "business-as-usual" case, to the wind energy case. The monthly savings are summed up to determine the annual savings. The detailed utility analysis can be found in Appendix C.

CASH FLOW ANALYSIS

Once the annual saving have been estimated, a cash flow analysis is performed, which incorporates the annual savings along with associated annual expenses to arrive at a net annual cash flow.

Project costs have been estimated based on current prices. Actual project costs will vary based on current exchange rates, interest rates, the price of steel, and permitting costs. Cost assumptions can be found in Appendix A.

The annual expenses taken into account are property and liability insurance, extended warranty costs, landowner lease payments, debt service, and operating and maintenance costs. For this particular application, landowner lease payments and debt service were assumed to be $0.

The cost assumptions used for annual operations and maintenance (O&M) costs, insurance and extended warranties are shown in Appendix B. The first two years of O&M and warranty are included in the initial cost. An extended warranty is assumed for years three through five. Beyond year five, the factory warranty is dropped.

The detailed cash flow analysis can be found in Appendix D.

CONCLUSIONS AND RECOMMENDATIONS

This project appears to be feasible with a reasonable payback period that is considerably shorter than the expected operating life of the equipment.

If the College decides to go forward with this project, it would be advisable to initiate discussions with the local utility in the earliest stages.

It would also be advisable to start the permitting process as soon as possible. Particular attention should be given to the FAA permit, due to the close proximity to the airport. The FAA permit should be considered as a potential fatal flaw, and it would be wise to get clearance before purchasing equipment.

Because of the short world supply of wind turbines, it is also important to secure the purchase of the turbine as soon as possible due to long delivery dates.

APPENDIX A

PROJECT COST ESTIMATE

Lake Region State College
Wind Energy Study
Costs

Description		Qty	Unit	Total	Comments
Wind Turbines		1.65	MW		Using 1.65 MW size turbine
Turbines/Towers		1	$2,200,000	$2,200,000	Vestas V82 - 80 m tower, includes 2-yr warranty
FAA Lighting		1	$5,000	$5,000	
	Subtotal			$2,205,000	
Balance of Plant					
Foundation		1	$120,000	$120,000	Assuming spread footing, includes labor
Transformer		1	$20,000	$20,000	
Turbine Erection Cranes		1	$100,000	$100,000	
Turbine Erection Labor		1	$35,000	$35,000	
Turbine Electrical Labor		1	$30,000	$30,000	
Access Roads	(feet)	1,000	$11	$11,000	Geotech cloth & 12" gravel, includes labor
Collection System (buried)	(feet)	2,500	$12	$30,000	Includes labor
Collection System (overhead)	(miles)	0.00	$30,000	$0	Includes labor
	Subtotal			$346,000	
Interconnection					
Facilities Study		1	$30,000	$30,000	
Transformer		1	$10,000	$10,000	
Interconnection		1	$30,000	$30,000	Switch gear, protection, etc.
Substation		0	$0	$0	
Transmission Upgrades		0	$0	$0	
	Subtotal			$70,000	
Other					
Maintenance Building		0	$0	$0	
Land Acquisition Costs		1	$1,000	$1,000	
Construction Insurance		1	$10,000	$10,000	
Professional Fees		1	$40,000	$40,000	Legal, Engineering, Permitting
	Subtotal			$51,000	
	Subtotal			$2,672,000	
	Contingency	5%		$133,600	
	Total Installed Wind Turbine Cost			**$2,805,600**	
	Total Cost per Turbine			**$2,805,600**	
	Cost per MW			**$1,700,364**	
	1500 kW Electric Boilers	2	$66,000	**$132,000**	
	Total Installed Project Cost			**$2,937,600**	

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APPENDIX B

PRIMARY INPUTS

Lake Region State College
Wind Energy Study
Primary Inputs

DESCRIPTION	INPUT	UNITS	COMMENTS
Financial			
Total Cost (from Costs Worksheet)	$2,937,600	$$	Vestas V82 - 80 m tower & 2 - Electric Boilers
% Down Payment	100.0%	%	
Down Payment	$2,937,600	$$	
Amount Financed	$0	$$	
Loan Rate	5.0%	%	
Loan Term	10	years	
Project Life	25	years	
Revenue			
Annual Energy Output (AEO)	5,673,000	kWh/yr	See WindPRO reports
Capacity Factor	39.2%	%	
Interest on Replacement Reserve	3.0%	%	
Expenses			
Landowner Payment	0.0%	%	Percent of gross revenue from sale of energy
Standard Warranty Period	2	years	First two years typically included in purchase price
Additional Warranty Years	3	years	Maximum of 5 years typically
Additional Warranty Cost per Year	$15,000	$/turbine/year	
Annual Service & Maintenance	$15,000	$/turbine/year	
Business Interruption Insurance	$2,000	$/turbine/year	
Property Insurance	$15,000	$/turbine/year	Based on turbine cost
Liability Insurance	$3,000	$/year	$2 Million Coverage
Replacement Reserve	$3,000	$/year	No rule of thumb. What can you afford? Shouldn't need before year 10.
Escalation			
Energy Sales Rate Escalation	3.0%	%/year	
General Inflation Rate	3.0%	%/year	

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APPENDIX C

UTILITY ANALYSIS

Lake Region State College
Wind Energy Study
Utility Analysis

Vestas V82 1.65 MW Wind Turbine
80 meter hub height

Business As Usual	Average Year												Totals
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	
Blended Rate ($/kWh)	$0.0710	$0.0710	$0.0710	$0.0710	$0.0710	$0.0710	$0.0710	$0.0710	$0.0710	$0.0710	$0.0710	$0.0710	
Average Energy Used (kWh)	185,813	195,563	178,125	172,313	148,875	158,813	171,188	184,031	191,063	184,125	198,563	165,188	2,133,656
Total Electric Bill	$13,193	$13,885	$12,647	$12,234	$10,570	$11,276	$12,154	$13,066	$13,565	$13,073	$14,098	$11,728	$151,490
Nat. Gas Bill @ $9/Dkt	$31,726	$28,104	$24,935	$14,568	$8,801	$1,636	$1,341	$1,660	$4,898	$14,792	$24,743	$29,723	$186,927
Total Utility Bill without Turbine	**$44,919**	**$41,989**	**$37,581**	**$26,802**	**$19,371**	**$12,912**	**$13,496**	**$14,726**	**$18,464**	**$27,865**	**$38,841**	**$41,451**	**$338,416**

With Wind Turbine	Average Year												Totals
	Jan	Feb	Mar	Apr	[redacted]						Nov	Dec	
Average Usage (kWh)	185,813	195,503	178,125	172,313	148,875	158,813	171,188	184,031	191,063	184,125	198,503	165,186	2,133,656
Electric Boilers (kWh)	620,663	544,001	476,930	257,576	93,118	0	0	0	51,826	313,016	472,686	578,256	3,408,283
Gas Boilers (Dkt)	266	266	266	266	0	0	0	0	0	0	266	266	1,596
Total Energy Used (kWh)	808,476	739,563	655,064	429,889	241,993	158,813	171,188	184,031	242,889	497,141	671,446	743,446	5,541,939
Total Wind Energy Generated (kWh)	513,502	504,075	508,236	487,895	499,024	431,388	390,980	419,351	437,451	485,967	477,854	517,575	5,573,000
Percent of Wind Energy Used for Appliances (%)	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	80%	
Total Wind Energy Used for Appliances (kWh)	148,650	156,450	142,500	137,850	119,100	127,050	136,950	147,225	152,850	147,300	158,850	132,150	1,706,925
Total Wind Energy Used for Boilers (kWh)	364,852	347,625	365,736	257,575	93,118	0	0	0	51,826	313,015	319,004	385,425	2,498,179
Total Wind Energy Used (kWh)	513,502	504,075	508,236	395,425	212,218	127,050	136,950	147,225	204,676	460,315	477,854	517,575	4,205,104
Total Energy Purchased for Appliances (kWh)	37,163	39,113	35,625	34,463	29,775	31,763	34,238	36,806	38,213	36,825	39,713	33,038	426,731
Total Electric Energy Purchased for Boilers (kWh)	255,811	196,376	111,203	0	0	0	0	0	0	0	153,882	192,833	910,105
Total Wind Energy Sold (kWh)	0	0	0	92,470	286,806	304,338	254,030	272,126	232,775	25,651	0	0	1,467,896
Demand Charge													
Average Demand (kW)	351	388	374	374	330	368	375	459	429	403	395	371	
Demand Charge @ $8.04/kW	$804	$804	$804	$804	$804	$804	$804	$804	$804	$804	$804	$804	$9,648
Demand Charge @ $6.51/kW	$1,827	$1,876	$1,780	$1,785	$1,499	$1,669	$1,788	$2,339	$2,144	$1,974	$1,919	$1,763	$22,366
Total Demand Charge	$2,631	$2,680	$2,584	$2,590	$2,303	$2,473	$2,592	$3,143	$2,948	$2,778	$2,723	$2,567	$32,014
Energy Charges for Appliances													
First 700,000 @ $0.03784/kWh	$1,406	$1,480	$1,348	$1,304	$1,127	$1,202	$1,296	$1,393	$1,446	$1,393	$1,503	$1,250	$16,148
Dual Rate Charges for Boilers @ $0.0253/kWh	$6,472	$4,968	$2,813	$0	$0	$0	$0	$0	$0	$0	$3,893	$4,879	$23,026
Natural Gas @ $9/Dkt	$2,394	$2,394	$2,394	$2,394	$0	$0	$0	$0	$0	$0	$2,394	$2,394	$14,364
Total Utility Charges	$12,904	$11,523	$9,140	$6,288	$3,430	$3,675	$3,888	$4,536	$4,394	$4,172	$10,513	$11,090	$85,552
Utility Credits for Energy Sales @ $0.02351/kWh	$0	$0	$0	$2,183	$6,771	$7,178	$5,998	$6,425	$5,496	$606	$0	$0	$34,657
Total Utility Bill with Turbine	**$12,904**	**$11,523**	**$9,140**	**$4,105**	**-$3,342**	**-$3,503**	**-$2,110**	**-$1,889**	**-$1,102**	**$3,566**	**$10,513**	**$11,090**	**$50,895**

[redacted]													
Total Utility Bill without Turbine	$44,919.09	$41,988.56	$37,581.38	$26,802.38	$19,371.00	$12,911.72	$13,495.59	$14,726.16	$18,463.69	$27,864.94	$38,840.91	$41,450.81	$338,416
Total Utility Bill with Turbine	$12,903.60	$11,522.50	$9,139.98	$4,105.20	-$3,341.54	-$3,503.25	-$2,109.81	-$1,889.11	-$1,102.12	$3,565.32	$10,513.07	$11,089.73	$50,895
Total Savings with Turbine	**$32,016**	**$30,466**	**$28,441**	**$22,697**	**$22,713**	**$16,415**	**$15,605**	**$16,615**	**$19,566**	**$24,299**	**$28,328**	**$30,361**	**$287,522**

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APPENDIX D

CASH FLOW ANALYSIS

Lake Region State College
Wind Energy Study
Cash Flow Model

Year		0	1	2	3	4	5	6	7	8	9	10
Savings												
Savings From V82 - 80 m Hub Height			$287,522	$296,147	$305,032	$314,183	$323,608	$333,316	$343,316	$353,615	$364,224	$375,151
Interest Earned on RR			$0	$90	$183	$278	$377	$476	$582	$690	$803	$914
	Subtotal		$287,522	$296,237	$305,214	$314,461	$323,985	$333,794	$343,898	$354,305	$365,024	$376,065
Operating Expenses												
Landowner Payments			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Warranty			$0	$0	($15,000)	($15,000)	($15,000)	$0	$0	$0	$0	$0
Service & Maintenance			($15,000)	($15,450)	($15,914)	($16,391)	($16,883)	($17,389)	($17,911)	($18,448)	($19,002)	($19,572)
Liability Insurance			($3,000)	($3,090)	($3,183)	($3,278)	($3,377)	($3,478)	($3,582)	($3,690)	($3,800)	($3,914)
Property Insurance			($15,000)	($15,450)	($15,914)	($16,391)	($16,883)	($17,389)	($17,911)	($18,448)	($19,002)	($19,572)
Business Interuption Insurance			($2,000)	($2,060)	($2,122)	($2,185)	($2,251)	($2,319)	($2,388)	($2,460)	($2,534)	($2,610)
	Subtotal		($35,000)	($36,050)	($52,132)	($53,245)	($54,393)	($40,575)	($41,792)	($43,046)	($44,337)	($45,667)
Replacement Reserve (RR)			($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($3,000)
Net Savings			$249,522	$257,187	$250,083	$258,215	$266,592	$290,220	$299,106	$308,259	$317,687	$327,398
Accumulated Savings			$249,522	$506,709	$756,792	$1,015,007	$1,281,599	$1,571,819	$1,670,925	$2,179,185	$2,496,872	$2,824,270

Accumulated Replacement Reserve			$3,000	$6,090	$9,273	$12,551	$15,927	$19,405	$22,987	$26,677	$30,477	$34,392
Debt Service Amortization (Annual)												
Total Project Cost			$2,937,600									
Downpayment			$2,937,600									
Amount Financed			$0									
Term (yrs)			10									
			5%									
Interest on Debt			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Less Principal Payments on Debt			$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Subtotal		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Savings Less Debt Service			$249,522	$257,187	$250,083	$258,215	$266,592	$290,220	$299,106	$308,259	$317,687	$327,398
Accumulated Savings Less Debt Service			$249,522	$506,709	$756,792	$1,015,007	$1,281,599	$1,571,819	$1,870,925	$2,179,185	$2,496,872	$2,824,270
		($2,937,600)	$249,522	$257,187	$250,083	$258,215	$266,592	$290,220	$299,106	$308,259	$317,687	$327,398

IRR 10%

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Lake Region State College
Wind Energy Study
Cash Flow Model

	Year	11	12	13	14	15	16	17	18	19	20
Savings											
Savings From V82 - 80 m Hub Height		$388,405	$397,997	$409,937	$422,235	$434,902	$447,949	$461,388	$475,230	$489,486	$504,171
Interest Earned on RR		$1,032	$1,153	$1,277	$1,406	$1,538	$1,674	$1,814	$1,959	$2,107	$2,261
	Subtotal	$387,437	$399,150	$411,214	$423,641	$436,440	$449,623	$463,202	$477,188	$491,594	$506,432
Operating Expenses											
Landowner Payments		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Additional Warranty		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Service & Maintenance		($20,159)	($20,764)	($21,386)	($22,028)	($22,689)	($23,370)	($24,071)	($24,793)	($25,536)	($26,303)
Liability Insurance		($4,032)	($4,153)	($4,277)	($4,406)	($4,538)	($4,674)	($4,814)	($4,959)	($5,107)	($5,261)
Property Insurance		($20,159)	($20,764)	($21,386)	($22,028)	($22,689)	($23,370)	($24,071)	($24,793)	($25,536)	($26,303)
Business Interuption Insurance		($2,688)	($2,768)	($2,852)	($2,937)	($3,025)	($3,116)	($3,209)	($3,306)	($3,405)	($3,507)
	Subtotal	($47,037)	($48,448)	($49,902)	($51,399)	($52,941)	($54,529)	($56,165)	($57,850)	($59,585)	($61,373)
Replacement Reserve (RR)		($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($3,000)
Net Savings		$337,400	$347,702	$358,313	$369,242	$380,499	$392,094	$404,037	$416,338	$429,009	$442,059
Accumulated Savings		$3,161,670	$3,509,371	$3,867,684	$4,236,926	$4,617,426	$5,009,520	$5,413,558	$5,829,896	$6,258,905	$6,700,964

Accumulated Replacement Reserve		$38,423	$42,576	$46,853	$51,259	$55,797	$60,471	$65,285	$70,243	$75,351	$80,611
Debt Service Amortization (Annual)											
Total Project Cost											
Downpayment											
Amount Financed											
Term (yrs)											
Interest on Debt		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Less Principal Payments on Debt		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
	Subtotal	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Net Savings Less Debt Service		$337,400	$347,702	$358,313	$369,242	$380,499	$392,094	$404,037	$416,338	$429,009	$442,059
Accumulated Savings Less Debt Service		$3,161,670	$3,509,371	$3,867,684	$4,236,926	$4,617,426	$5,009,520	$5,413,558	$5,829,896	$6,258,905	$6,700,964
		$337,400	$347,702	$358,313	$369,242	$380,499	$392,094	$404,037	$416,338	$429,009	$442,059
	IRR										

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Lake Region State College
Wind Energy Study
Cash Flow Model

	Year	21	22	23	24	25	TOTALS
Savings							
Savings From V82 - 80 m Hub Height		$519,296	$534,875	$550,921	$567,449	$584,472	$10,482,829
Interest Earned on RR		$2,418	$2,581	$2,748	$2,921	$3,098	$34,378
	Subtotal	$521,714	$537,456	$553,670	$570,370	$587,571	$10,517,207
Operating Expenses							
Landowner Payments		$0	$0	$0	$0	$0	$0
Additional Warranty		$0	$0	$0	$0	$0	($45,000)
Service & Maintenance		($27,092)	($27,904)	($28,742)	($29,604)	($30,492)	($546,889)
Liability Insurance		($5,418)	($5,581)	($5,748)	($5,921)	($6,098)	($109,378)
Property Insurance		($27,092)	($27,904)	($28,742)	($29,604)	($30,492)	($546,889)
Business Interruption Insurance		($3,612)	($3,721)	($3,832)	($3,947)	($4,066)	($72,919)
	Subtotal	($63,214)	($65,110)	($67,064)	($69,076)	($71,148)	($1,321,074)
Replacement Reserve (RR)		($3,000)	($3,000)	($3,000)	($3,000)	($3,000)	($75,000)
Net Savings		$455,501	$469,346	$483,606	$498,294	$513,423	$9,121,133
Accumulated Savings		$7,156,464	$7,625,810	$8,109,416	$8,607,710	$9,121,133	$9,121,133

Accumulated Replacement Reserve		$86,029	$91,610	$97,359	$103,279	$109,378	$109,378
Debt Service Amortization (Annual)							
Total Project Cost							
Downpayment							
Amount Financed							
Term (yrs)							
Interest on Debt		$0	$0	$0	$0	$0	$0
Less Principal Payments on Debt		$0	$0	$0	$0	$0	$0
	Subtotal	$0	$0	$0	$0	$0	$0
Net Savings Less Debt Service		$455,501	$469,346	$483,605	$498,294	$513,423	$9,121,133
Accumulated Savings Less Debt Service		$7,156,464	$7,625,810	$8,109,415	$8,607,710	$9,121,133	$9,121,133
		$455,501	$469,346	$483,603	$498,294	$513,423	
	IRR						

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Wind Energy Technician Program Final Report and Project Summary

The Lake Region State College Wind Energy Project had two major objectives: (1) To site and erect an operating 1.65 MW wind turbine with step up and down transformers, interconnection facilities, standby capacity, retrofit boilers, and education/training use capacity. (2) To design and implement a wind turbine technician training program. Lake Region State College successfully completed both of these objectives.

Objective 1

As the Wind Turbine project was developed through the NDUS budgeting process and submitted to the Legislative Assembly in 2009, the total cost of the Turbine portion of the project was increased to 6.3 million dollars. The increased in total cost was due to several factors: 1) increased costs of turbine components and construction costs (2) the need to enter into an energy performance management contract to pay the costs of the purchase and installation of the turbine that exceeded the appropriation (3) costs to convert LRSC's boiler system to high efficiency operation to increase energy savings in order to make the energy performance contract cash flow (4)inclusion of an existing energy performance contract. Turbine construction began in October 2012 and was completed in February 2013. The LRSC turbine began commercial operation on February 15th 2013. Native Energy provided $200,000 cash match in exchange for the Renewable Energy Credits. Received 12/16/13, documentation attached.

Objective 2

Lake Region State College completed development of the Wind Energy Technician Program certificate in July 2009. In July 2009, 18 students were accepted into the 1st class of the Wind Energy Technician Program. The first students completed the certificate program in May 2010. Students then have the option of continuing in the program to receive and Associate in Arts degree or seeking employment. During fall semester of 2010, the program will began to serve the first cohort of AAS degree seeking students. Placement for graduates the first two years was outstanding, but has slowed due to the slow-down in the Wind Industry related to the stability of the PTC (Production Tax Credit). Placement reports attached.

Private Matching Funds Summary

Forward DL	50000	Received
Nordic Fiberglass	29500	Received
Cavalier County JDA	20000	Received
Curriculum Develop	3300	Received
Native Energy	200000	Received
Nextera (Florida Power and Light)	187200	Received
eCollege	10000	Received
	500000	

Lake Region received $500,000 of private matching funds. Native Energy only provided $200,000 based on current market for RECs, but an additional contribution of $50,000 was received from Forward Devils Lake. Lake Region State College has only received $104,000 in grant payments ($25,000 on 1-6-09 and $79,000 on 11-30-10) and requests that the balance of $346,000 paid upon receipt of this report.