RENEWABLE ENERGY OPPORTUNITES
SAGINAW CHIPPEWA INDIAN TRIBE

Final Report

DOE Grant: GO14252 Saginaw Chippewa Indian Tribe

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Submitted by:

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1.0: The Vision (and its challenges):

The Saginaw Chippewa Indian Tribe has a vision to become self-sufficient in its energy needs and, in respect and concern for the next seven generations, to maintain its culture and protect Mother Earth.

To achieve this vision, sustainable green energy sources such as solar, wind and biomass energy are the best energy paths to travel. This study provides analysis and details on these and other green technologies illustrating the environmental, economic and energy sovereignty benefits of traveling this path. The results of this study show how this vision can be achieved in less than five years, all while providing significant economic development benefits to the Tribe.

Most of these green technologies can be immediately justified and implemented at the appropriate scale and with appropriate policies. However, for small individual home applications small windmills, solar electric and some biomass systems can be quite expensive for the renewable energy they produce. Therefore, it is critical to examine and consider the size and scale of each system to optimize the costs and benefits, economically, socially and environmentally. It is also important to consider how each location and each application fits into the total social-economic picture. For example, when considering the capital investment of renewable energy systems one can ask, "how does the Tribe justify delivering potable water to the residence at the far end of the system?" Should the analysis be different for energy? Should clean energy be as important as clean potable water? The Tribe has a top quality, well managed and operated plant and system for water and sewer, there is no reason why it can't do the same for renewable energy systems.

Under narrow economic thinking, where only short-term financial payback is considered comparing new systems to sunk costs (and fossil fuel subsidies, supply chain and other social and environmental costs are ignored), it can be seen that it is difficult to implement renewable energy systems.

We are aware of the challenges of this green path. Converting the conventional fossil fuel infrastructure that reliably provides heat and electricity to the homes, public facilities and commercial facilities to renewable energy is a major change in thinking for operations and maintenance staff. Therefore, the vision and its goals must also include assurances of reliability and economic sustainability. Converting the large Soaring Eagle Casino Resort (SECR) to renewable energy systems may seem especially risky because that facility is the economic engine of the Tribe. The engineering, maintenance and facility operations staff does an excellent job, reliably providing comfort for the visitors that come to this world class resort. Therefore, there must be good justification for retrofitting and/or replacing the energy plants and systems in these facilities. We believe that the information provided below will make the case, and provide the justification that the renewable energy systems analyzed below should be implemented by the Tribe as soon as possible.

The Saginaw Chippewa Indian Tribe has a vision to become self-sufficient in its energy needs and to maintain its culture and protect Mother Earth with respect and honor for the next seven generations. To achieve this vision, green energy sources such as solar, wind and biomass energy are the best energy paths to travel.

1.1: Executive Summary: Renewable Energy and the "New Vision"

With a total Tribal energy bill for electricity and natural gas of $5.4 million in 2007, over $75 million of capital cost investments in renewable can be justified. Put another way, in simple investment terms, if the Tribe could purchase a bond that would return $5.4 million a year on the investment, how big of a bond would the Tribe be willing to buy? Renewable energy systems are like purchasing a secure, long-term bond.

With increasing and volatile electric and natural gas energy costs, wind and solar power with zero fuel costs, and biomass (wood chips, wood waste, etc.) with low fuel costs, provide the opportunity to minimize and basically fix energy fuel costs for the Tribe. What is required, however, is the investment in the capital costs for these renewable energy technologies in order to capture and harvest the clean energy that all comes from the sun.

In this feasibility study we have analyzed and provided data on the nature of the renewable resources available to the Tribe and the costs of implementing these technologies. This analysis provides many options. In total these options can provide the needed clean energy not just for the existing facilities, (including public, commercial and residential), but also that for the "new vision" preliminary plans. Table 1 illustrates that these combine energy measures will provide three times the electric needs and three times the thermal (heat and cooling) needs of the existing Tribal facilities. With 2007 annual electric consumption at 51 million kilowatt-hrs/yr and natural gas at 1.9 million CCF (150,000 million BTU's per year (MMBTU) adjusted for efficiency), at a capital cost of $124 million, this total will roughly meet the energy requirements of the "new vision" plan, including the existing facilities. Table 1 summarizes these costs and energy:

While solar photovoltaic (electric) systems are not listed as a capital expenditure in Table 1 due to its high cost, this technology may have some applications in remote installations, new building structure integration and in emergency stand-by systems. Such solar electric systems have high reliability, low maintenance and long term guaranteed electricity. The Tribe could initiate a solar electric incentive program for its residences to create a large market for a Tribal solar business. Good policies in Europe have caused a boom in solar electric installations, and the Tribe could model these successful programs. In the future solar electric systems will play a very large role as costs come down. There are unlimited solar resources for the Tribe to capture, especially during the spring, summer and fall. If cost was not a factor, the Tribe could easily generate its net annual electric consumption of 51 million kW-hrs/year on less than 80 acres of land with existing solar photovoltaic technology.

Table 1: Total Capital Costs, Expenses and Energy

Saginaw Chippewa Summary Costs June-08
Integrated Renewable Energy & Stand-by CHP

	Capital Cost	Energy $ Value / Year	Fuel & O&M Expenses Per Year	Electric KWh/yr	Heat MMBTU/Yr
Wind – Saganing	$ 34,996,000	$ 4,095,355	$ 523,218	43,109,001	-
Wind – Isabella	$ 49,780,000	$ 5,126,260	$ 898,938	53,960,633	-
Biomass CHP Stage 1	$ 11,770,000	$ 2,952,120	$ 924,283	21,900,000	157,000
Biomass CHP Stage 2	$ 20,320,000	$ 2,952,120	$ 940,314	21,900,000	157,000
Solar Thermal Commercial	$ 4,800,000	$ 420,000	$ 24,000	-	43,200
CHP NG Stand-by SECR	$ 2,900,000	$ 1,848,179	$ 1,396,900	10,055,430	68,638
Solar PV	$ -	$ -	$ -	-	
Total	$ 124,566,000	$ 17,394,034	$ 4,707,653	150,925,064	425,838

2.0: The Problem

One of the biggest problems and challenges for the Tribe is protecting Mother Earth and assuring an economic, cultural and environmental future for the seventh generation. Fossil fuels such as oil and gas and uranium will be gone in one or two generations and the carbon we are pouring into the sky to electrify the Tribe, mostly coming from coal, threaten to dramatically change life on earth in a couple of generations. For these simple reasons, we are in a race against time.

If these fossil resources are not diminished quickly it will be because they will have become too expensive for any to afford, or too prohibitive to burn. Just in the last two years of this study period, fossil fuel costs have become a much greater economic burden. While there is a lot of price volatility, we predict natural gas prices for the Soaring Eagle Casino Resort and residences will be 20% higher during this coming 2008-09 heating season compared to that of the year before. Delaying one year to install low energy cost renewables such as solar, wind and biomass will have cost an additional $200,000 at the SECR and $300,000 or more for the Tribe overall with added natural gas energy costs for the 2008-09 heating season. Higher cost expectations exist for electricity as well, with 30% electric price increases predicted over the next few years. Of course, solar, wind and biomass renewable energy systems have capital costs just as with the fossil fuel systems, but the capital costs paid for renewable energy systems provide energy self-sufficiency. Paying the $300,000 per year lost on natural gas for the 2008-09 heating season would finance a lot of renewable energy plant and system capital--$6 million at minimum. With a total Tribal energy bill of $5.4 million in 2007, over $75 million of capital costs in renewable energy investments can be justified. Put another way, the Tribe has a simple choice; does it want to own its energy, or continue to rent its energy?

There are seven major problems[1] locally, nationally and internationally, associated with the Tribes' use of fossil fuel energy to support its activities:

1. The global climate crisis
2. The exhaustion & dependence crisis
3. The poverty crisis
4. The nuclear crisis
5. The water crisis
6. The farming crisis
7. The health crisis

[1]See "Energy Autonomy" 2007, Dr. Herman Scheer, pages 36-45.

Global warming is already impacting the indigenous people of the arctic, changing their culture, environment and future. Recent high gasoline costs are increasing poverty levels for those dependent on the automobile, nationally and locally at the Tribe (driving to Saganing, etc.). Over 60 underdeveloped countries have higher fossil fuel import costs than the value of their exports, and therefore they are doomed to spiral further into poverty. Coal and atomic powered electric plants consume more water than any other energy technology. The primary source of pollution in the Great Lakes water comes from the air--when the coal fired power plants deposit mercury, sulfur and other pollutants into air and then from the air to the lakes and land. The negative health effects come both from breathing the polluted air and eating fish with mercury. As a consumer of fossil and atomic fuels the Tribe has responsibility to do its part to address these important problems.

3.0: The Tribe Demographic Profile

The Saginaw Chippewa Indian Tribe had the following demographic and geographic characteristics as of 2007:

- Tribe member population ~3,300
- Isabella ~ 138,240 acres total area (1788 acres in trust)
- Saganing ~ 500 acres (184 ac in trust)
- Residential: ~ 500 homes and apartments (trust and non-trust lands) ~ 600,000 sq.ft.
- Public Facilities: ~ 24 ~ 320,000 sq. ft.
- Commercial: 5 + ~ 550,000 sq. ft.

4.0: The Energy Profile

$5,412,646: This $5.4 million is the 2007 annual total energy cost for the Saginaw Chippewa Indian Tribe. This includes commercial, public and residential energy use. Importantly, it does not include vehicle transport, money spent on wood heating systems, higher cost LP gas at residences, and any solar or wind systems Tribal members may be utilizing. Residential energy costs are included, but this cost is based on regional residential energy use averages for natural gas and electricity. Therefore, this cost is a conservative estimate of the Tribes' energy use. With 2008 energy prices increasing significantly it will be safe to assume the total Tribe energy cost, without transport, will exceed $6 million per year. While Tribal transportation costs are beyond the scope of this study, we recommend this be included in the next energy studies so there can be a full picture in the Tribal energy use profile. A comprehensive energy use profile, including transportation, should be accomplished as soon as possible.

As shown below in Figure 1, $3.6 million or 67% of the Tribes' energy cost was for electricity and $1.8 million or 33% was for natural gas.

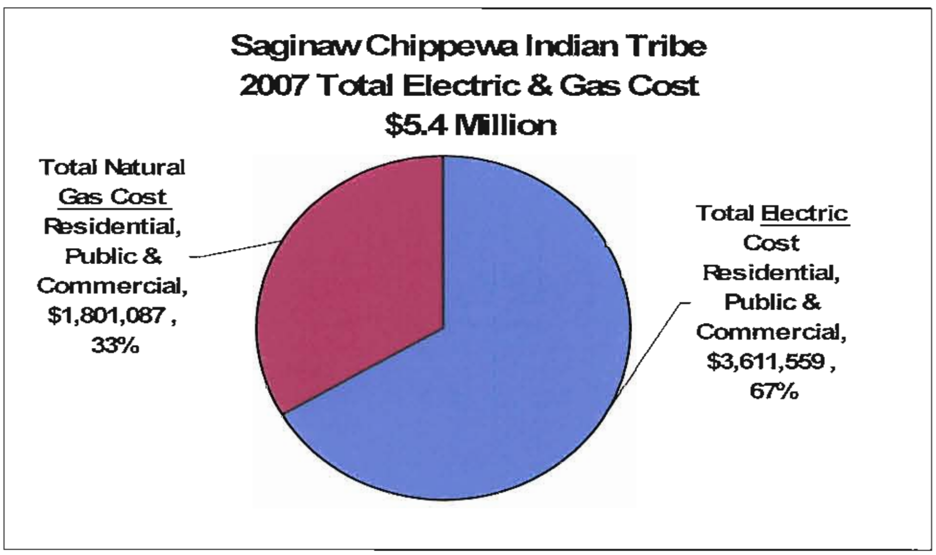

Figure 1

Of the $3.6 million dollars per year 2007 spent on electricity purchases, $2.77 million, or 77% went to commercial facilities (see Figure 2), with the large majority for the SECR. $535,000 per year, or 15% of electric costs were for public facilities and approximately $300,000, or 8% was for residential electric consumption by Tribal members during the year 2007.

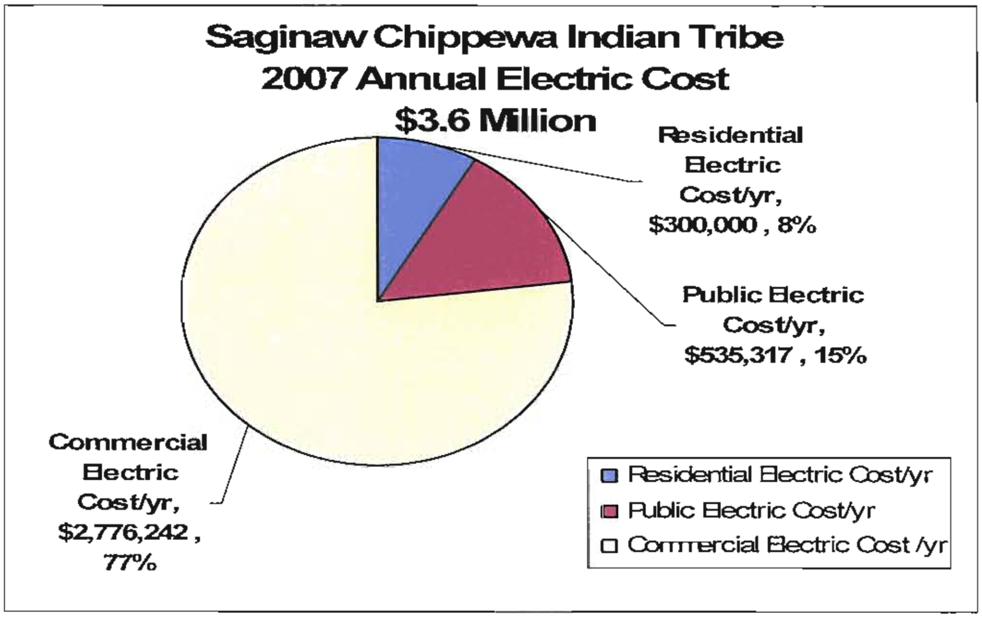

Figure 2

$1.8 million dollars per year 2007 was spent on natural gas purchases (see Figure 3). Of this amount, $1.04 million, or 58% went to commercial facilities, with the large majority to the SECR. $350,000 per year, or 19% of natural gas purchases were for public facilities and approximately $407,000, or 23% was for residential natural gas consumption by Tribal members during the year 2007.

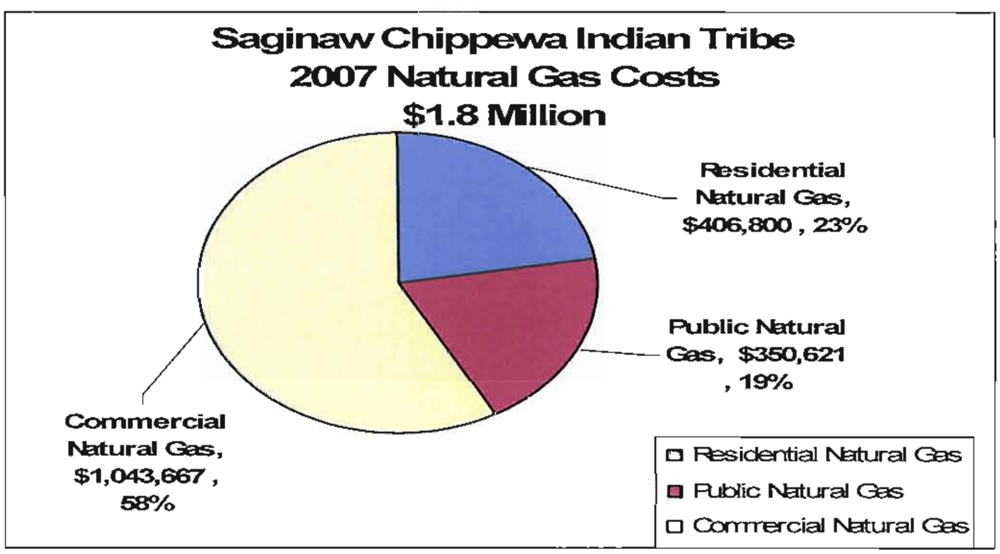

Figure 3

Total electrical energy consumed by the Tribe in 2007 was 51 million kilowatt-hours (kW-hrs/yr). Most notably, 42 million or 82% was consumed by commercial facilities, largely from the SECR (see Figure 4).

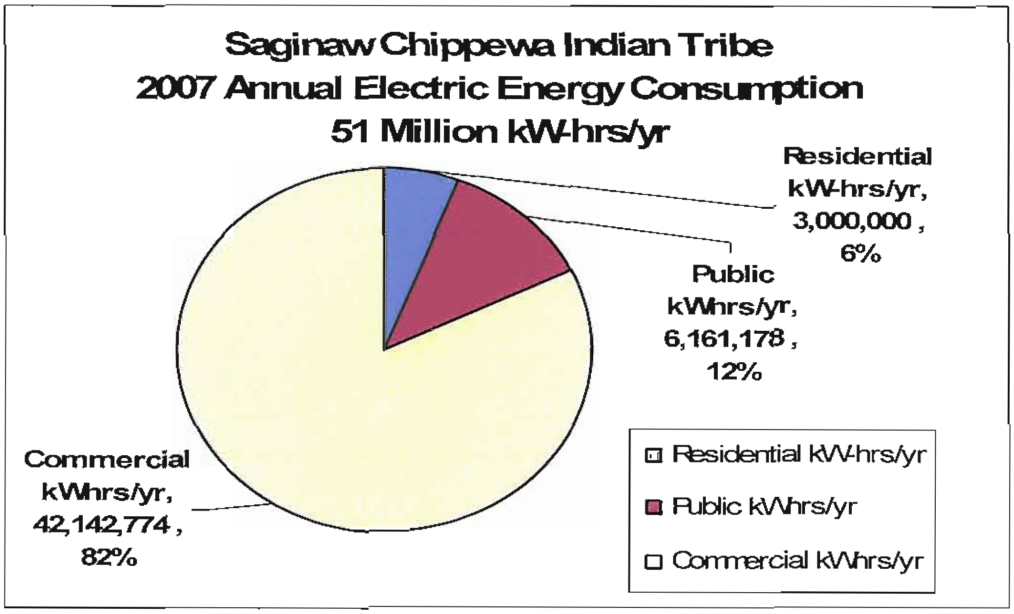

Figure 4

Peak electric demand for the Tribe in year 2007 is approximately 8,833 kilowatts (kW). Peak electric demand is a measure of the highest metered electric consumption during a short period of highest use (usually a 15 or 30 minute average depending on metering)--when the most electrical equipment is operating. Of this peak demand, the SECR accounts for 6,741 kW. The average demand for the SECR is 4,800 kW. This maximum kW demand of 8,833 can only be approximated due to the lack of meters that record peak demand (see Figure 5). Also, there are "non-simultaneous" peak events, which mean some facilities may not be peaking at the same hour of other facilities, and therefore the overall peak for the entire Tribe is measured to be less than the sum of these estimated peaks. However, statistical electrical "rules of thumb" can be used to make fairly accurate estimates of peak electric demand.

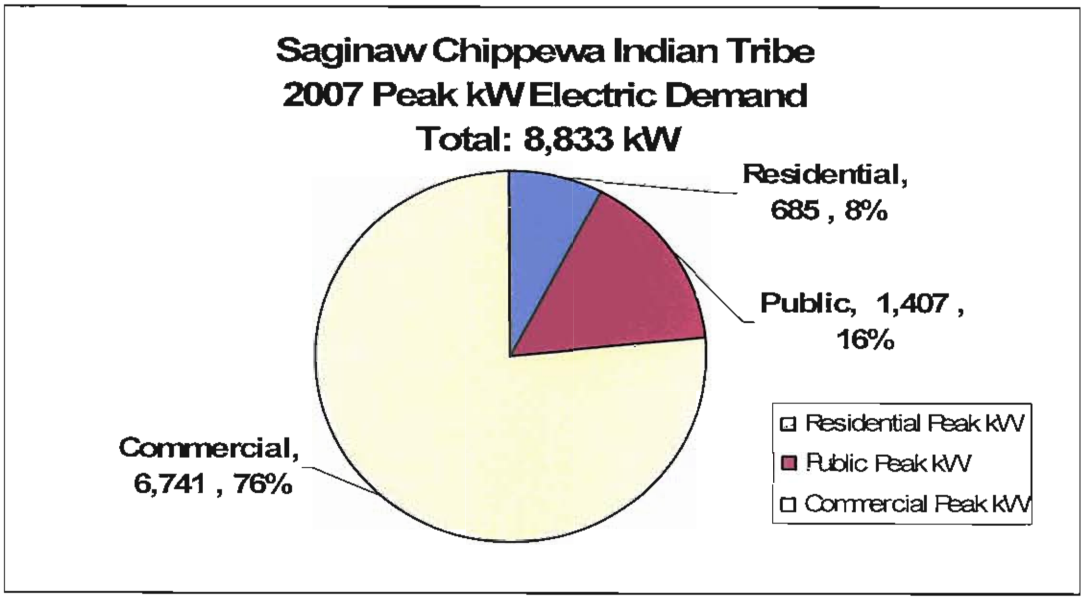

Figure 5

For natural gas, sixty percent (60%) or 1.14 million hundred cubic feet (CCF) per year of the total 1.9 million CCF's were consumed by the SECR and related commercial facilities (see Figure 6). While 406,800 CCF's per year, or 21% of natural gas was used in Tribal member residences in 2007, it is important to note this is the largest part of a residents energy bill, and of most concern to the residences. Also, it should be noted that while LP gas has not been accounted for (due to the difficulty of gathering exact data), its cost is roughly twice that of natural gas for the same heating requirement.

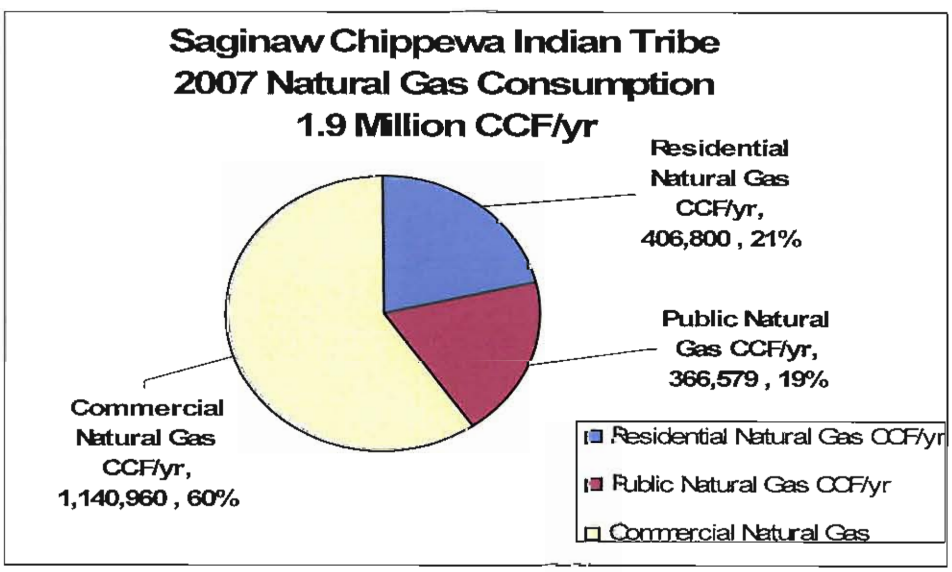

Figure 6

Establishing this energy profile provides valuable planning information to start on the path to energy self-sufficiency. Important conclusions can be made by looking at the total Tribal energy profile.

To begin, it is shown that electricity use and costs, versus natural gas, are a much greater concern in commercial facilities, especially at the Soaring Eagle Casino Resort, while natural gas and LP gas heating costs are a higher priority for single home residents. Tribal members will individually see home heating "rate shock" this 2008-09 heating season with an estimated 20% cost increase, while there will not be as much concern by individual Tribal members about energy costs at the commercial facilities since they are not individually impacted. Other conclusions can be surmised from the energy profile, including:

- Individual residential natural and LP gas heating costs are, and will continue to be an important priority for members
- Commercial electric consumption is the biggest part of the budget for the SECR and needs special attention.
- Commercially, natural gas costs, mostly for heating at the SECR, will be the biggest part of the overall energy cost increases in the coming years
- With high peak electric demand at SECR during the hot summer days, added electric capacity from the local grid and substation may soon be required, especially if any expansion plans are initiated. Adding either new generation (electric and thermal heat) and/or significantly expanding energy infrastructure will be required with the "new vision" plans.
- For energy self-sufficiency, new heat and electric generation, based on local renewable energy sources of wind, biomass and solar, should be a priority, in contrast to increasing gas pipe lines, electric lines and sub-station capacity.
- While it can be shown that providing self-sufficiency for individual residential members is more costly per home due to the distance for district heat piping, higher cost per output small scale wind and solar systems, the benefits are spread over the entire Tribal membership, much like water and sewer. The entire membership is happy when all have access to affordable clean water.

5.0: Renewable Energy and Combined Heat and Power Technologies

A comprehensive survey of all practical and proven renewable energy technologies has been undertaken for this study. These include small and large scale wind power, small and large scale solar thermal systems, solar photovoltaics, biomass, district heating with renewables, energy storage and integration of these technologies and resources.

This study originated from a desire by Tribal staff and Councilors to find Seventh Generation solutions, especially with an emphasis on wind power. At the beginning of the study focus was put on a wind resource assessment with the installation of two, 50 meter (164 ft.) meteorological wind test towers and a kick-off event consisting of an all day wind conference for Tribal members and regional community members with interest in wind power (see appendix). The wind conference, attended by over 200 people, was held at the Soaring Eagle Casino Resort and presenters included Winona LaDuke and, Steven B. Smiley.

In addition to the emphasis on wind energy, the objectives of the grant included that; "The Tribe is seeking to become self-sufficient in their energy needs…." And "These efforts are to help the Tribe become sufficient in providing their own energy for the various buildings, cultural centers, schools and residences on Tribe land," and also, "The Tribes' objectives are to provide power for its facilities and potentially create economic development and employment opportunities in its depressed areas…" (See appendix).

Technologies analyzed

- Wind power (big and small)
- Biomass combined heat and power (CHP) and district heat: Stage 1 & 2.
- Stand-by natural gas engine electric and heat generation with combined heat and power (CHP),
- Solar Thermal, large scale at the SECR and small scale on each home Solar Electric (photovoltaic)
- Energy Storage and integration: thermal, electric, heat and chilled water

5.1: Seventh Generation Renewable Energy Recommendations

Since the initial focus of this study was to examine solutions for energizing the Seventh Generation facilities we begin by review of our results for this facility.

From our studies of Seventh Generation we concluded two basic options should be recommended for consideration. Option one, make the facility partially supplied on-site with renewable energy systems while receiving most of its renewable energy from the larger Tribal renewable energy system, or option two the Tribe can make the Seventh Generation complex completely independent (but not disconnected from the electric grid) in its energy supply with wind, sun and bioenergy.

<u>Option one</u>, involves installing a smaller windmill, a 10 kW, 6.7 meter (22 ft.) wind turbine, 2000 watts of solar electric, a solar thermal system, and interconnection to the Tribal (utility) electric grid and interconnect to a future district hot water heating system. A small biogas digester may or may not be considered as part of this option, however, there may be an interesting opportunity to utilize food waste from the various food services at the Tribe.

Option two, involves installing a larger windmill, a 100 kilowatt (kW), 21 meter (69 feet) rotor diameter wind turbine, 2000 watts of solar electric, a solar thermal (hot water system), an efficient wood boiler, and a small biogas digester.

For option one, in our analysis, after considering the energy use at the Seventh Generation facilities and the nature of the buildings, and examining many windmill and solar options, we concluded that for electricity, a 10 kilowatt, Ventera VT10 windmill and a 2000 watt solar photovoltaic array (see appendix) will provide an excellent demonstration of wind and solar electric systems, providing roughly 10% of the annual needs of the electricity for the facilities. We conducted site analysis and wind resource analysis, based on the measured data from the meteorological tower across the road to the north-east and we recommend the proposed the windmill be sited to the north-east of the maintenance garage, east utility pole, 300 feet. This location provides a reasonable distance from the offices and the homes on Remus Road and Shepard Road, with roughly 500 feet to the nearest home and the RTC. It is very unlikely noise will be issue at the RTC however, under very rare circumstances the Seventh Generation staff should be prepared to stop the windmill for short periods of time if it causes disturbances. A photo of the site area is shown in Figure 7.

The cost of the Ventera windmill, with electronics prepared for interfacing the 2000 watts of solar PV, is $47,000, installed. This is subject to vary depending on foundation soil conditions. It assumes a 100 foot tower with a 12 foot wind turbine adapter, for a total hub height of 112 feet. The blade rotor diameter is 24 feet.

For option two we propose the wind turbine model NorthWind 100, a 100 kW peak rated wind turbine with a 21 meter (69 feet) rotor diameter on a 37 meter (121 feet) steel tube tower (see appendix). This is wind turbine, built in Vermont, is a heavy duty machine, built for higher wind conditions in severe climates and therefore is very reliable, but more expensive. We estimate the installed cost at $350,000. Presently, there are not other new wind turbines in this size range that we would recommend. One possibility that we considered, is using used, reconditioned windmills, roughly 20+ years old, that are available at a lower cost. One example of this is the three 65 kW windmills installed at the Elkton-Pigeon-Bayport schools in the "thumb" and web link: http://www.energy-now.com/lakerschools/. These three windmills, totaling 195 kW peak rated capacity (65 kW x 3), were built with a $265,000 grant. Energy production numbers are available from those wind turbine's, however there is a lot of unknown information regarding operating time and real costs, so without more details it is difficult to make a detailed

economic comparison. Reconditioned wind turbines like this, however, will be a cheaper installation option at this scale.
There is a web site video on NorthWind 100 in Alaska at
http://www.greenenergytv.com/Browse/Wind.aspx?428948141#428948141

Figure 7

5.2: Wind Resource Assessment

A wind resource assessment was completed. In order to conduct this study two fifty meter meteorological towers were installed, one at a site on the Isabella Reservation east of Shepard Road (see photo Figure 8) and one at the Saganing Reservation west of the Eagles Landing Casino on Worth Road (see photo Figure 9).

Figure 8

Figure 9

The wind resource study included measurements of wind speed, direction and temperature, with wind speeds at booth towers similarly measured at 30, 40 and 50 meters, and direction measured at 40 and 50 meters. From this data wind speed, wind shear factors and wind rose results have been determined and analyzed. While all of the wind sensors on both "met" towers have worked (one, temperature sensor failure), and are continuing to work and gather data, there were some early occurrences of battery failure and lost data. However, since December 2006, wind data has been successfully collected at a 100% recovery rate. The following Figure 10 documents sensor operation at the Isabella site.

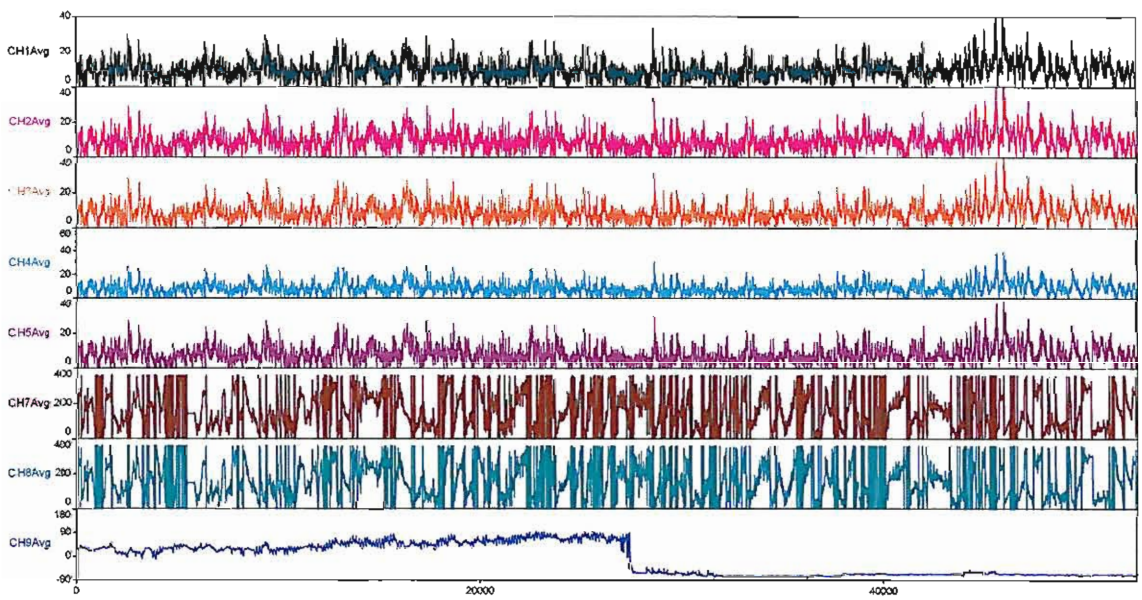

Figure 10

The general conclusions from the wind resource study are as follows:

- The Saganing site has better wind resources than the Isabella site. (see Figure 11) While both sites have relatively flat terrain within 3 to 5 kilometers (2 – 3 miles), small forested tree stands within the farm lands have the most impact on wind resources and site selection. See the Saganing monthly wind speed graph, Figure 12.
- There is a good correlation of wind speeds between the sites, where Isabella has a coefficient of fit of 0.863 compared to Saganing at the 50 meter level.
- The average annual wind speed at Saganing over the four year period was 10.42 mph (4.65 m/s) at the 50 meter (164 ft) height.
- The average annual wind speed at Isabella over the four year period was 9.6 mph (4.3 m/s) at the 50 meter (164 ft) height (see Figure 13).
- For the years 2005 – 2008 there have been historically low winds, and therefore the data collected should provide a conservative long-term projection.
- Wind shear for both sites, from various sensors ranged from an exponent of .17 to .35 with an average of .26. At a hub height of 80 meters (262 ft.) we see a 13% increase in wind speed and at 100 meters (328 ft.) we see a 20% increase in wind speed averages. For Saganing this represents an annual wind speed average increase to 11.8 mph (5.26 m/s) at 80 meters to 12.5 mph (5.6 m/s) at 100 meters wind turbine hub height.
- In summary, at a nominal hub height of 80 meters (262 ft.) we can assume an annual average of 5.5 m/s (12.32 mph) for Isabella and 6.0 m/s (13.44 mph) for Saganing. This will provide a good reference number for comparing wind turbine models.

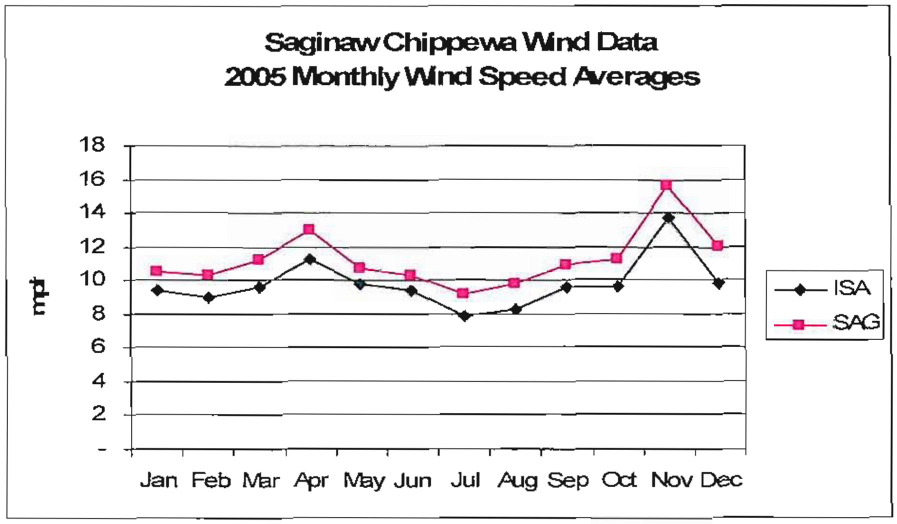

Figure 11

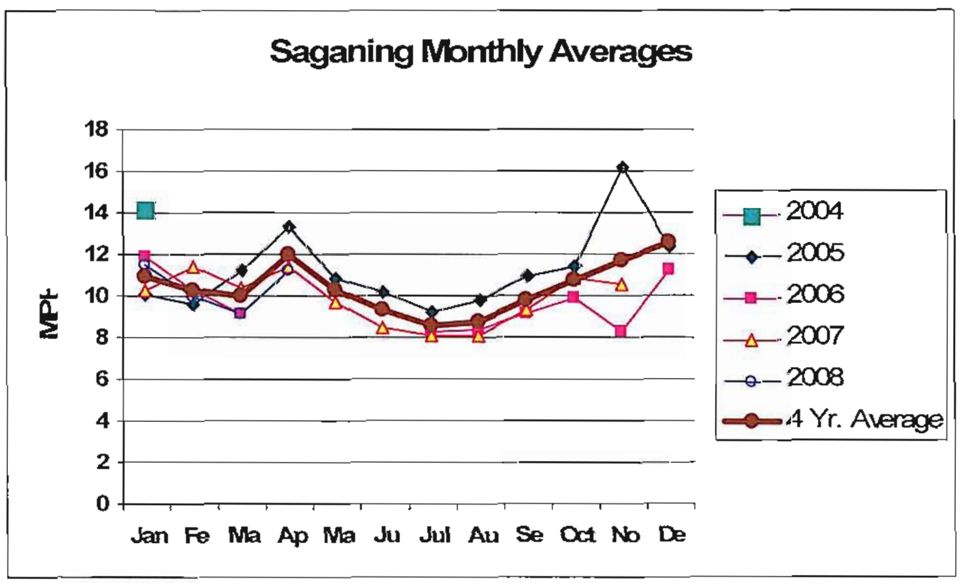

Figure 12

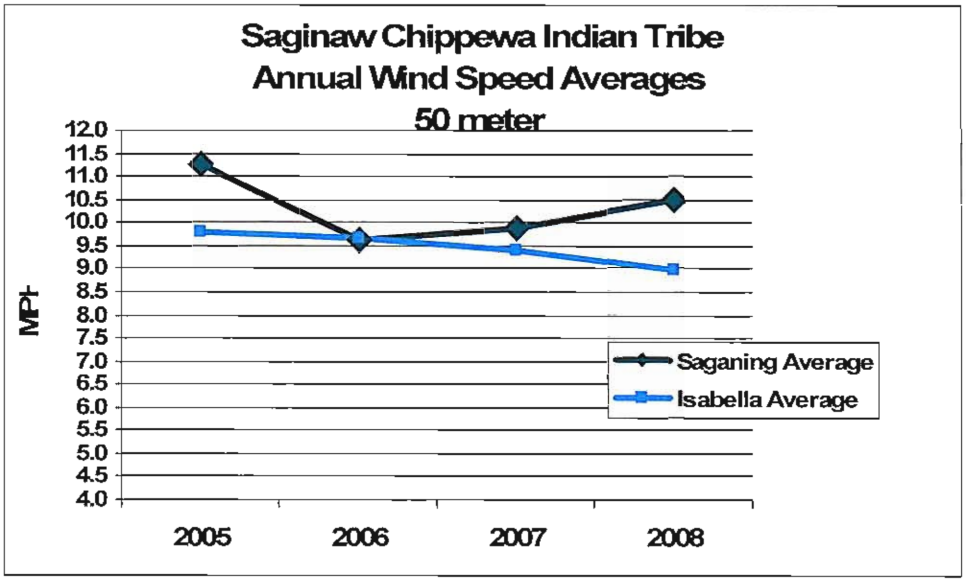

Figure 13

Cost comparisons for small versus large commercial wind energy at the Tribes wind sites illustrate the significant advantages large scale wind energy has over small (less than 100 kW peak capacity). The following cost curves show per kilowatt-hour (Figure 14) and peak kilowatt installed costs (Figure 15) for both sites.

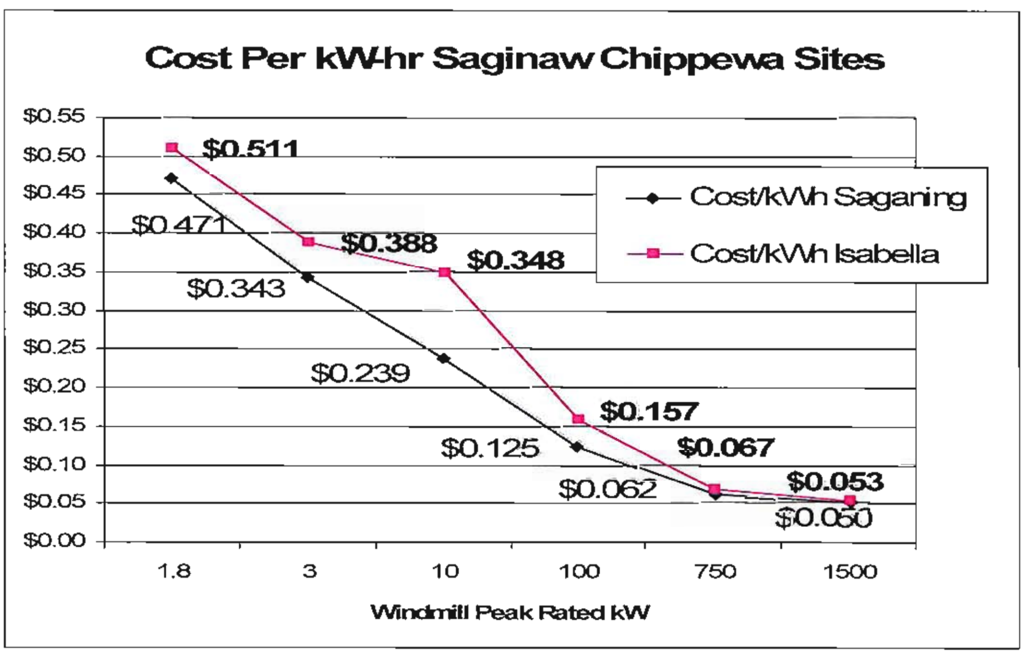

Figure 14

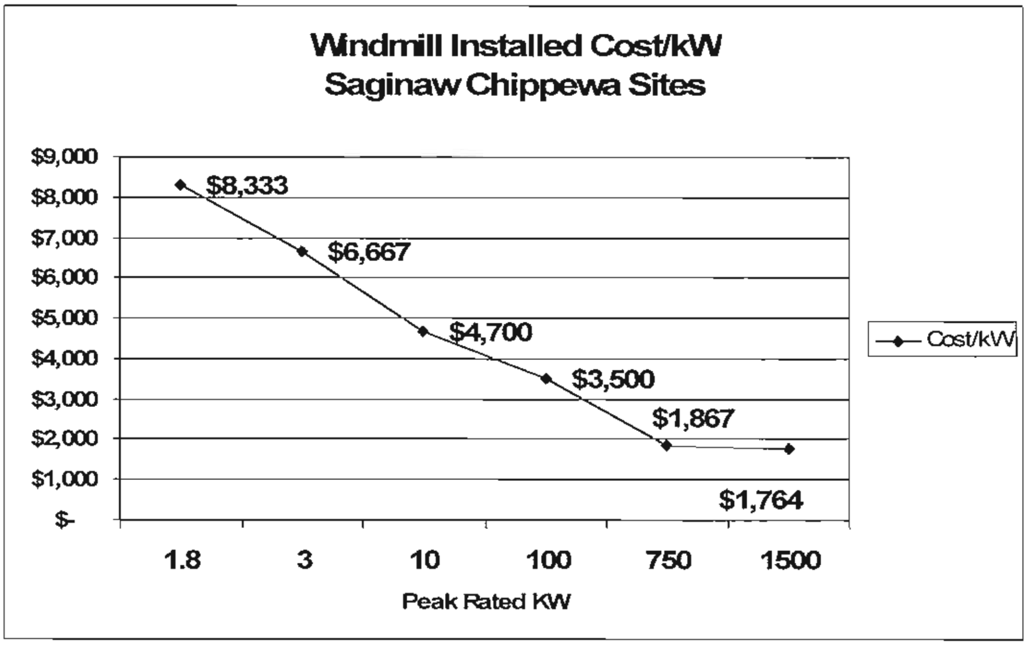

Figure 15

Under present conventional commercial wind industry thinking and project development approaches in the USA these wind resources would not be considered viable. This conventional approach assumes that wind sites are not location constrained, that the electricity payment will come from the lower priced energy only wholesale market. With pollution credits, private tax credits and accelerated depreciation and good wind resources, a large scale project can just be made viable. All of these conventional conditions may be different for the Saginaw Chippewa Indian Tribe.

First, the Tribe can form its own electric utility and make new power generation self-serving, thus increasing the value of the electricity from wind power at its own reservation sites. Next, the renewable energy production incentive payment, presently at 2 cents per kilowatt-hr for ten years, will be available to the Tribe. In addition, new wind turbine models are available that are designed to produce more cost effectively in these lower wind regimes (Euro Class III). Finally, with the expectation of much higher electric prices in the next few years, the Tribe can be offsetting higher retail electric prices, therefore achieving higher savings on the wind power investment. The project economics are very sensitive to future electric price increases, and with a fixed wind energy price, wind power can be cost effective in these lower wind regime areas. Various wind project economic scenarios are provided in the appendix to illustrate the project possibilities at Saganing and Isabella.

5.2.1: Small Wind Power Options

Small electric wind power options available for the Tribe were analyzed, and our general conclusions are that the best opportunities exist where the there are residential or remote applications that are disconnected from the grid, or that the installation will otherwise avoid high grid interconnection costs. Small windmills in the 1 to 10 kW peak capacity range will provide electricity at costs from 24 cents to 50 cents per kilowatt-hour, depending on the size, site, tower height and other factors. The 100 kW size range can produce electricity in the 12 to 16 cents per kilowatt-hour range, however the electric generation from this size wind turbine will far exceed a single residential application. This size would be more applicable for a remote commercial or housing district (10 – 15 homes).

The models examined included the direct interconnect Skystream 3.4, Whisper 500, Bergey Excel, Ventera and NorthWind 100 (see appendix).

5.2.2: Large Commercial Wind Power Options

As shown from the wind power cost curves above large wind turbines in the size range of 750 to 2000 kW peak capacity can provide the most cost effective electricity. In particular windmill models must be selected that are designed and rated for Euro Class III conditions and optimized for lower wind regime areas. The wind studies indicate that tall towers in the 70 meter (230 ft.) to 100 meter (328 ft) windmill hub height should be considered. The optimal hub height will be dependent on the local terrain and vegetation. All of the Tribe reservation sites are relatively flat ground. Where there are wood lots or small forested areas within a quarter or half mile, a taller tower is recommended. High crane costs and logistics can be an important limiting factor with the larger wind turbines and taller towers. These issues need to be carefully considered when a project is planned for implementation. Recent 2008 installations in eastern lower and mid-Michigan with towers in the 80 and 100 meter range can be examined for comparisons.

With an installed windmill cost of roughly $1,900 per peak rated kW, and depending upon financing assumptions, the specific wind site selection, wind turbine selection and hub height, the wholesale cost per kilowatt-hour generated will range from 4.5 cents to 8 cents per kW-hr, accounting for the 2 cent per kW-hr ten year renewable energy production incentive payment available to Tribes. The net present value levelized cost can be below 5 cents per kW-hr, and the benefit/cost ratio will typically fall between 1.5 and 2.0. The return on the investment (IRR

"Yield") will range from 8% to 25%, particularly dependent on future conventional electric cost increase projections. In Michigan, high electric cost increases are projected in the next few years, ranging from 10% to 30% over the next five years, depending on specific policy and electric utility plans.

Should the Tribe proceed with large commercial wind power it can focus on installing wind power close to the electric consumption at Saganing and Isabella, or consider a remotely based economic development project in better wind resource areas distant from the Tribal lands.

Most commercial wind project developments consist of wind turbines installed in the better wind areas, generating electricity into the transmission system with the electric energy sold at a low price on the wholesale energy market. With additional green credits (REC's or renewable energy credits), power purchase agreements and private tax advantages, projects can be economically viable. Improved payments for electricity sold into the market are guaranteed by a long-term power purchase agreement from a credit worthy buyer, typically an electric utility.

Connecting wind power generation directly into the consumption points and "net metering" is most desirable, avoiding transmission losses and complicated contracts for the delivery of power however, without Tribal ownership and control of the local electric grid, existing utility policy in Michigan limits this opportunity to small wind systems, 30 kW or less. In addition, commercial wind power must work in conjunction with the electric grid to balance out consumption and generation. When the wind is not blowing, assuming the Tribe has no firm spinning generation such as with a biomass steam turbine, the utility grid power must be available. Either policy changes are needed or the Tribe must directly arrange a special contract with Consumers Energy (the utility service provider) for a significant self-generation system. Consumers Energy is interested in seeing more green power and more electric power in its system. Since the Tribe is major customer of Consumers Energy and the sub-station at Broadway is limited in its capacity, Consumers Energy may be willing to work cooperatively with the Tribe.

Our analysis is focused on the options of making 100% of the net annual electric consumption of the Tribe at Saganing and Isabella. Presently, Saganing has relatively low electric consumption at residences, the community center and the Eagles Landing Casino, compared to Isabella with the Soaring Eagle Casino Resort (SECR). A single large commercial wind turbine could make all of the electricity consumed at Saganing, while it will take up to 19 large commercial wind turbines at Isabella to make 100% net annual electric consumption for the Tribe.

5.2.3: Saganing Wind Project Options

Of the two measured wind sites, as shown above, Saganing has the best wind resources. If the Tribe wishes to develop the most economical commercial wind project development on its own lands, Saganing is the best location. Some of the advantages of a Saganing wind project include:

- More available land area owned by the Tribe that is not limited by zoning, buildings, airports or other land-use conflicts or restrictions.
- Access to grid transmission lines that will not limit the size of a project (however a new substation will be needed if the project is larger in scope).
- If a project is developed off Tribal owned lands in the Saganing area under leases from neighboring farms there will be more sites available with an easier zoning and permitting process.
- Better wind resources

A single large commercial wind turbine can make enough net electricity for the Saganing Eagles Landing Casino, other uses, and a potential new small hotel. Generating over 3 million kW-hrs per year, such a wind turbine would be roughly 1,500 kW or more in peak rated capacity with an 80 meter plus (262 ft.) rotor diameter. At an installed cost of $2.9 for such a wind turbine (without need of a sub-station), the simple payback on such a project would be less than 10 years, a return on investment over 10%, a benefit/cost ratio of 1.4 and a net present value of $1.7 million dollars over 25 years. This analysis assumes the inflation rate of conventional electricity is 2% per year, a conservative estimate. If electric utility purchase rates rise faster than 2% per year the benefits will be significantly larger. If, for example, an electric inflation rate of 5% per year is assumed, as predicted by some, the net present value of this project would more than double to $3.8 million dollars, for an investment that generates all the clean energy, on a net annual basis, needed by the facilities. The alternative is to continue to pay roughly $200,000 per year for electricity, infinitely. This estimated $200,000 annual electric bill can be considered the annual budget for the wind turbine. The Tribe may chose: pay for a wind turbine or just pay the electric bill.

"Pro-forma" spreadsheets, with various assumptions, illustrating a range of wind power costs for a single wind turbine at Saganing are provided in the appendix.

Analysis and preliminary design has been completed for a wind project at Saganing that will maximize the use of existing Tribal owned lands in the area. To approximate the total annual electric consumption of the Tribe of 51 million kW-hrs per year, 15 wind turbines is required, however a plan with 13 turbines appears to be appropriate for the present available sites, assuming there are no future plans that would be in conflict with these wind sites. The following bullet points summarize the project:

- Total installed capital cost: $35 million
- Number of wind turbines: 13 @ 80 meter + (262 ft) rotor diameter
- Peak rated wind farm capacity: 20 MW +
- Cost of electricity: < 5 cents/kW-hr (with REPI)
- Net present value (25 years): $41 million
- IRR Yield: 21%

The above financial results assume that the value of electricity off-set or paid is 7 cents per kW-hr (increasing at 2% per year) and renewable energy credits of 0.5 cents are available. A sensitivity analysis illustrating various financial assumptions is included in the appendix.

5.2.4: Isabella Wind Project Options

Of the two measured wind sites, as shown above, Isabella has the lower wind resources. In order to generate the required 51 million kW-hrs per year to provide 100% of the net annual electric consumption at the Tribe, approximately 19 wind turbines will be required. Some of the advantages however, of an Isabella wind project include:

- Access to two sub-stations that have lower cost retrofit requirements for interconnection to the Tribe and to grid transmission lines that will not limit the size of a project.
- Close to the large electric loads of the Tribe including the Soaring Eagle Casino Resort, public facilities and residences at the Broadway 10 MVA sub-station, especially if the Tribe establishes its own electric utility.
- The possibility of "net metering" or otherwise having a high value electricity.
- The opportunity to integrate and control the wind power with other electric generation sources, including biomass steam turbines and natural gas CHP.

Siting wind turbines on Tribal owned land is a problem at Isabella due to the height restrictions presented by the Mt. Pleasant airport just north of the Tribal facilities. For this reason the large commercial wind turbines will need to be sited mostly off Tribal owned lands, requiring leases or easements on the larger farms to the south. Twenty-five large commercial wind turbine sites have been identified. Five of these wind turbines can be sited on Tribal lands. The balance would require either Tribal purchase of the lands or long-term wind turbine easements with the land owners.

"Pro-forma" spreadsheets, with various assumptions, illustrating a range of wind power costs for large project at Isabella are included in the appendix.

Analysis and preliminary design has been completed for a wind project at Isabella that will maximize the use of existing Tribal owned lands in the area. To approximate the total annual electric consumption of the Tribe of 51 million kW-hrs per year, 19 wind turbines are required. A plan with up to 24 sites for wind turbines appears feasible. The following bullet points summarize the project:

- Total installed capital cost: $49 million
- Number of wind turbines: 19 @ 80 meter + (262 ft) rotor diameter
- Peak rated wind farm capacity: 28 MW +
- Cost of electricity: 6 cents/kW-hr (with REPI)
- Net present value (25 years): $39 million
- IRR Yield: 15%

The above financial results assume that the value of electricity off-set is 7 cents per kW-hr (increasing at 4% per year) and renewable energy credits of 0.5 cents are available. A sensitivity analysis illustrating various financial assumptions is included in the appendix.

5.3: Biomass Combined Heat and Power and District Heat

A biomass combined heat and power (CHP) and district heat project for the Isabella Reservation area has been analyzed and a preliminary plan developed. The scope of this analysis focused on providing all of the thermal (heat) requirements for the Tribe at Isabella including the Soaring Eagle Casino Resort, and the other commercial, public and residential facilities.

The sustainable use of biomass, in this case wood chips, provides a cost effective and environmentally preferable energy source. In mid-Michigan there is a well established market for the harvesting and delivery of wood chips in 30 to 40 ton capacity semi-trailers. The cost ranges from $20 to $26 dollars per ton, delivered. In addition there are plentiful suppliers of biomass in the form of county and city cuttings from streets, parks and landscaping. Also, the emerald ash bore infestation is requiring the harvest of many ash trees to deal with this serious problem. The neighboring Central Michigan University (CMU) in Mt. Pleasant, Michigan has a 50,000 lb steam wood chip boiler that substantially heats the campus of 15,000 students while also making roughly 900 kW of electric in a CHP system. The CMU facility contracts for the delivery of green wood chips at a price ranging from $21 to $26 dollars per ton, depending on delivery terms. The County of Isabella handles 35,000 cubic yards of biomass annually, most of which is composted, and handled at a substantial cost to the county. This county biomass supply would provide roughly one-half the heat requirements of the Soaring Eagle Casino Resort at a very low cost of fuel.

At a cost of $25 per ton of wood chips, this translates to a price of $2.79 per million BTU (MMBTU) compared to a natural gas fuel cost of roughly $10 per MMBTU. Natural gas prices have been volatile, and recent "transportation" gas costs to the SECR have ranged from $9 to $13 per MMBTU including distribution fees. Small residential and commercial Tribal natural gas costs have been around $10 per MMBTU, or four times the cost of wood chip biomass fuel. A twenty percent natural gas price increase is expected during the 2008-09 winter heating season. With this low cost sustainable, CO_2 neutral fuel supply, a biomass CHP district heat system is cost effective.

The biomass plant has been sized to meet all of the thermal heating needs of the district and the SECR and large percentage of the electric needs, varying with seasonal operating conditions. A total 60 MMBTU thermal and nominal 5 MW electric steam turbine is recommended.

The biomass CHP district project is planned in two stages. Stage one involves the installation of the biomass CHP power plant at the SECR, close to the largest heat loads. The selected site is to the south of the SECR on the north side of Broadway Avenue, near the employee entrance drive. See the map Figure 16 below.

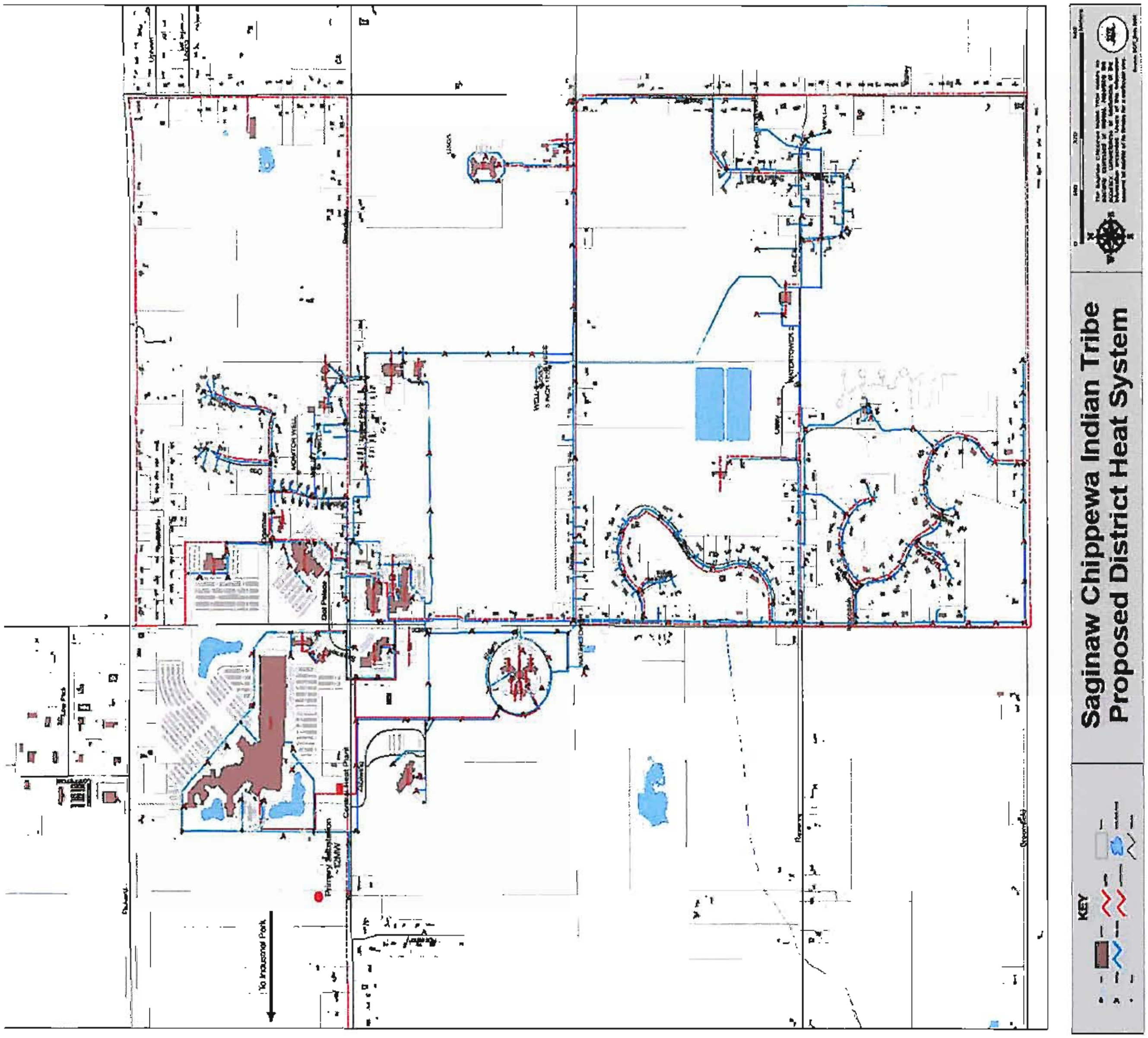

Figure 16

This location for the biomass CHP plant has many advantages. The location is on the mechanical and electrical infrastructure side of the SECR and provides easy access for biomass truck delivery via Broadway Road. Next, the largest heat load, at the SECR is very close to the plant, reducing heat loss and providing short distance heat pipe and electric interconnection, inside the SECR big meter on Broadway. Next, the existing natural gas boiler capacity at the SECR consists of three, 20 MMBTU/hr capacity boilers for a total of 60 MMBTU/hr. (See photo Figure 17) During the summer season much less than 20 MMBTU/hr heat capacity is required, and rarely in the winter are more than two boilers, or 40 MMBTU/hr heat, required. These existing and relatively new boilers can provide auxiliary or stand-by heat capacity, and the biomass heating system can be directly interconnected to the heating loop of the SECR boilers and the existing controls can be utilized to manage the entire heat distribution system. Finally, there is a concentration of other large commercial and public facilities nearby on and around the intersection of Broadway and Leaton Roads. The interconnection to this concentration of heat and electric loads is the basis for stage one. At an estimated capital cost of $11.8 million dollars, it is estimated that heat can be delivered at a cost of $6.65 per MMBTU, roughly thirty percent lower than present natural gas costs. The price includes capital, O&M and fuel costs. Typically there will be required retrofit of the heating systems inside the buildings to accommodate the district heat. This cost will vary from $1000 to $3000 depending upon the system, and the energy cost savings will justify this investment. Heat delivery will be metered just as with electricity. A breakdown of costs and financial details are included in the appendix.

Figure 17

Stage two involves the installation and interconnection of the district heat pipes to all homes, school facilities, and public facilities bordered by Pickard Road (M-20) to the north, Shepherd Road to the east, Broomfield Road to the south and buildings on both sides of Leaton Road. Installing a two pipe heat system to the dispersed Tribal facilities and homes is costly however, this system is fundamentally the same as the existing Tribal district potable water and sewer system operated by the Tribe. In effect, the large economic benefits from stage one off set the higher distribution system cost for stage two. At an additional capital cost for stage two of roughly $9 million, and a total system cost of $20.3 million the combined cost of delivered heat is estimated to be $8.99 per MMBTU, competitive with existing natural gas heating costs.

The cost of electric generation from the CHP biomass plant, utilizing a steam turbine with a nominal 5,000 kWe capacity is roughly 4 cents per kW-hr, with out any federal renewable energy production incentive (REPI) payments. These incentive payments may be available for ten years, however, the US congress must fund the program adequately to guarantee the money, and there are no assurances the money will be available.

If the 5,000 kWe steam turbine operated at a 50% capacity factor the electric generation would provide roughly 22 million kW-hrs per year, or 40% of the total Tribal electric consumption. The steam turbine could run at a much higher capacity level, nearly doubling the output however, the optimal electric generation must be determined by an evaluation of the heat requirements for the total district, balanced with the electric requirements. While the peak electric demand is roughly 8,800 kWe and the SECR around 6,700 kWe, the <u>average</u> kWe demand at the SECR is roughly 4,800 kW. Careful consideration must be made of the operating characteristics of the biomass plant to optimize energy production, off set peak power consumption, integrate it with other generation such as wind power, and not waste fuel, both natural gas and wood chips.

Sustainable use of biomass, with good emission controls to reduce particulate matter, has many environmental advantages including net zero CO2, no SOx, and no mercury (Hg) emissions. Ash residue can be recycled to farms and mixed with compost.

This biomass CHP district heat plan can be a primary source of heat and electric power for the Tribes Isabella Reservation. Integrating this system with wind power, solar hot water and other energy systems can provide the basis for cost effective 100% renewable energy to the Tribe.

5.4: Natural Gas Engine Stand-by and Combined Heat and Power

While a natural gas stand-by CHP system is not renewable energy, the electric O&M staff indicated that the Tribes existing stand-by diesel electric generation cannot fully operate both the casino and the hotel in the event of a power outage. For this reason analysis of additional stand-by generation was undertaken. Our recommendation is that if additional stand-by generation is considered it should be a combined heat and power (CHP) natural gas engine set (preferably two engines) that can both generate electricity and heat during operation. These units can be started in a short period of time (30 minutes maximum for heat) and then replace the existing natural gas boiler heating capacity, without adding additional natural gas pipe line capacity to the SECR. These engine sets can also operate during peak electric demand periods, supplying domestic hot water to the SECR during any season, utilizing natural gas as efficiently (85% – 90%) with electricity and heat than the existing natural gas boilers. For example, one natural gas CHP engine can provide all of the domestic hot water for the SECR while generating electricity of roughly 1,400 kW electric capacity. While such system may be considered over-kill, if stand-by electric capacity is a critical concern, at a capital cost of approximately $2.9 million for two engine sets, this plant has the following advantages:

- Provides stand-by and peak electric capacity of 3,500 to 4,000 kW depending on the number and size of engines selected.
- Using the same amount of present natural gas consumption, it will generate up to 25% of the SECR electricity and 2/3rds of heat, saving $500,000 per year while having 100% SECR stand-by electric capacity.
- Provide a quick infrastructure basis for initiating the biomass CHP installation and district heat system, especially with the addition of a large heat storage system.

This option should be considered in conjunction with the other renewable energy options being examined. If, for example, the biomass CHP system is considered a priority, the natural gas CHP option may be downsized or eliminated all together. It should be noted however, that the timeline for this option is shorter than the biomass steam turbine, roughly one year versus two years. Cost and design details are provided in the appendix.

5.5: Solar Thermal – Big and Small

Solar hot water heating (solar thermal) is cost effective and should be considered. The system recommended is a flat plate collector (see appendix), typically consisting of 4 foot by 8 foot glass covered panels mounted in series and parallel to approximate the hot water heating loads. In mid-Michigan such systems can provide up to 50% of the annual domestic hot water heating requirement, while providing 90 to 100% of requirements during the spring, summer and early fall months.

Our analysis, utilizing solar data available from the US National Renewable Energy Laboratory for the MBS airport 30 miles east of the Tribe, determined the optimal size of a commercial system and small residential system. For the Soaring Eagle Casino Resort (SECR) we calculate that an optimal system should consist of solar hot water panels up to 200,000 sq. ft., mounted either on the upper level of the SECR parking deck, or in the adjacent parking or grass areas to the south. Our preference is on the parking deck with either an open or covered parking area under the panels. The following summarizes our analysis:

- Estimated cost: $4.8 million
- Annual natural gas savings: $400,000
- Large array to be installed, up to 200,000 sq. ft. on the parking deck or adjacent field near the SECR heating mechanical system to reduce heat distribution loss.
- Installation of a large hot water storage tank in with the system.

The following two photos (Figure 18) show the upper parking deck area where a large commercial solar hot water system can be installed at the SECR.

Figure 18

Solar hot water systems are recommended to be installed on all Tribal homes that have adequate solar access. While the size of the systems will vary slightly depending upon the individual family requirements, a family of three or four will typically require a 64 sq. ft. solar panel system, mounted south facing, tilted approximately 45 degrees on the roof or on the ground. Photos of a typical ground mounted system and heat exchanger and storage tank is shown here in Figure 19. A hot water storage system consisting of either the existing hot water heater, or preferably a secondary tank feeding directly to the existing hot water heater with a recommended capacity of 80 to 100 gallons. The efficiency of a solar hot water heat exchanger is directly related to the temperature difference (delta T) of the solar hot water storage system and the solar heat exchange fluid heated by the sun. Therefore, additional hot water storage in conjunction with the existing home hot water heater can provide a more efficient system and additional hot water supply.

Figure 19

Depending upon the installation requirements of each individual home, the cost will range from $5,000 to $7,000, less personal income tax credits available from the federal government, up to $2,000. The cost of the solar hot water will be competitive with the typical heat source in Tribal rural homes, either electricity or LP gas. Solar hot water heating systems such as those shown in the appendix are low maintenance and provide fixed price energy for the lifetime of the solar panels, 20 years or more.

We recommend the Tribe public works department establish a solar hot water installation service or encourage Tribal members skilled in mechanical systems and service to establish a new major solar hot water commercial business in the region. In addition a financing program, with low interest loans, perhaps based at the Tribal Credit Union could be utilized to help spread the higher capital cost of the systems over time, such as with auto and home renovation loan.

5.6: Solar Electric

Solar electric (photovoltaic) systems, while extremely durable, reliable and low maintenance, especially when directly interconnected without battery storage systems, are not recommended for any significant electric power generation at the Tribe. We do recommend the Seventh Generation solar electric system discussed above. It also would be advisable for the Tribe to install a small, say 10 kW peak capacity system for experience and preparation for expanded solar PV systems as costs go down and incentive policies improve. The cost of a 10 kW system would be less than $100,000.

The primary reason for this recommendation is due to the present high cost of these systems. Depending on the application the electric energy cost of a solar system in mid-Michigan solar conditions will range in the 50 to 60 cents per kW-hr price. When the long-term, low maintenance, fixed cost electric energy from solar electricity is considered in contrast to increasing conventional electric costs, if reasonable financing is available, new policies and incentives can make this a serious option to consider.

One situation where we would recommend consideration of a solar electric system is for remote homes and facilities where high grid interconnection costs make the solar electric system cost effective. It can also be cost effective if a new facility is planned (such as a new hotel) where a solar electric system may be integrated into the new structure and budgeted in the new construction costs and long-term mortgage.

5.7: Energy Storage, Controls, and Integration of Resources.

Integration of the renewable energy resources and the installation of energy storage systems, particularly thermal (heat) storage and chilled water storage can optimize the systems and balance energy loads to achieve the goal of 100% renewable energy for the Tribe.

As shown in the introduction of this report, the renewable energy systems analyzed, if all implemented in their full extent, can provide three to four times the present energy needs of the Tribe. Therefore, unless the Tribe is prepared to implement the "new vision" development plans in the near future (which require at least triple the present energy infrastructure and consumption), each system proposed should be downsized, integrated and optimized to provide the most economical, efficient and environmentally beneficial system possible. A computer controlled energy management system, with operations oversight, can adjust the renewable energy systems and plants according to the daily solar and wind resources available to the Tribe in accordance with the energy loads. The following graph, Figure 20, is a representation of two weeks (winter and summer) of how a mix of renewable energy systems, CHP systems and storage can cover the daily swings of energy consumption.

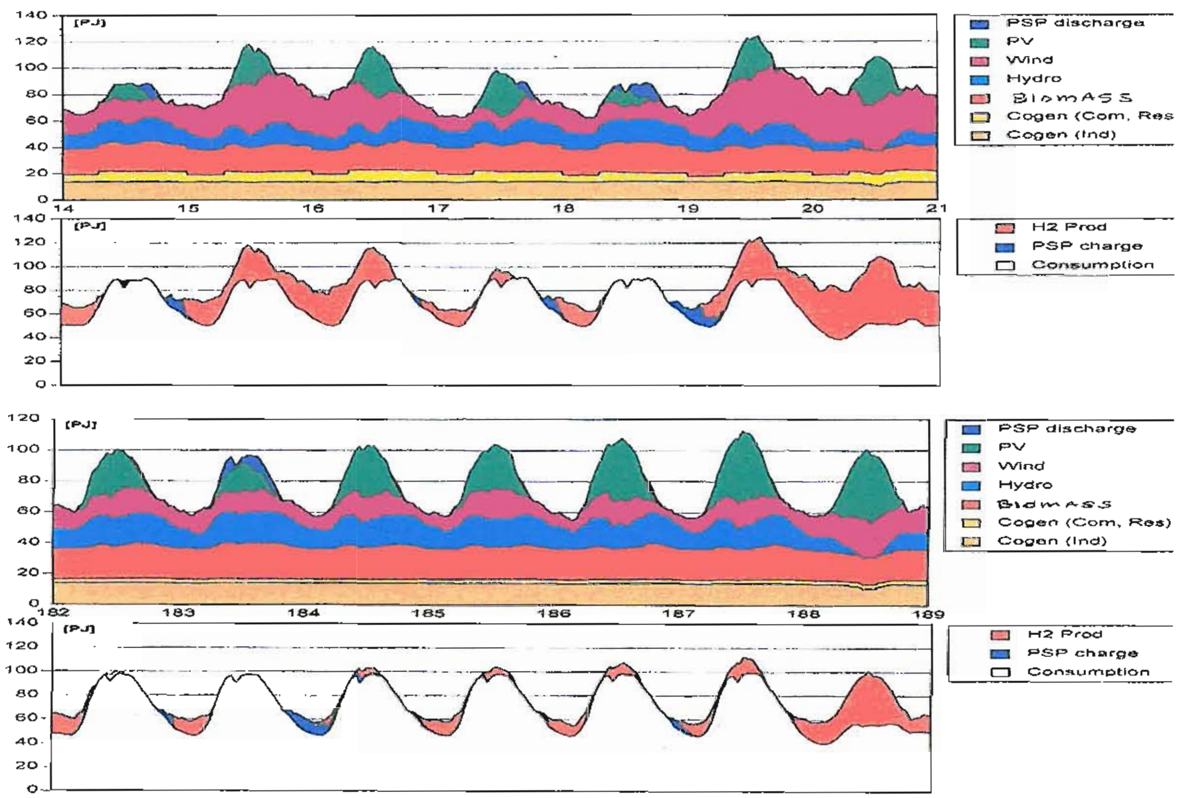

Figure 20

Once the Tribal Council moves forward with a decision to implement the new technologies, integrating the renewable energy systems, including energy storage, is the next frontier for the Tribe to analyze and consider.

5.8: Energy Efficiency

Energy efficiency is almost always one of the most cost effective options for the Tribe to consider, particularly in older commercial and public facilities and homes. The Soaring Eagle Casino Resort, however, has unique operating conditions and entertainment qualities that make it difficult to change the efficiency of the operations. The hotel has a four-pipe heat and cooling system that provides efficient and high quality comfort, unmatched in most hotels. It is an excellently operated and managed facility as a world class resort.

While an energy efficiency study was beyond the scope of this project, an energy efficiency study was recently completed in 2007 by engineers from the Council of Energy Resource Tribes (CERT) and is available for review and consideration by the Tribe facility managers.

6.0: Conclusions

With a total Tribal energy bill for electricity and natural gas of $5.4 million in 2007, over $75 million of capital cost investments in renewable can be justified. Put another way, in simple investment terms, if the Tribe could purchase a bond that would return $5.4 million a year on the investment, how big of a bond would the Tribe be willing to buy? Renewable energy systems are like purchasing a secure, long-term bond.

With increasing electric and natural gas energy costs, wind and solar power with zero fuel costs, and biomass (wood chips, wood waste, etc.) with low fuel costs, provide the opportunity to minimize and basically fix energy fuel costs for the Tribe. What is required, however, is the investment in the capital costs for these renewable energy technologies in order to harvest the clean energy that all come from the sun.

The Tribal Council and administrative and operations staff must make a decision, if, how and when to proceed, based upon this menu of options. The next step will be detailed engineering and architectural plans to provide the basis for specific cost estimates and financing plans for the implementation of the selected options.

7.0: Appendix

Appendix A. Wind Conference Brochure

Appendix B. Statement of Objectives

Statement of Objectives
Saginaw Chippewa Indian Tribe
Wind/Alternative Energy Feasibility Study

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July 28, 2004

DOE Grant Number
DE-FG36-04GO14252

Statement of Objectives

Saginaw Chippewa Indian Tribe

Wind/Alternative Energy Feasibility Study

Background:

The Saginaw Chippewa Indian Tribe is seeking to become self sufficient in their energy needs. Further, they wish to maintain their culture by protecting Mother Earth and looking ahead seven generations to preserve natural resources for the future. "Green" energy sources are the best way to accomplish both these objectives.

The Tribe's objectives are to provide power for its facilities and potentially create economic development and employment opportunities in its depressed areas, specifically Arenac County. Also utilizing renewable energy is consistent with the cultural heritage of the Tribe. Specifically, the use of renewable energy to provide power for the Seventh Generation greenhouses, residential treatment center and proposed school is desired.

Project Summary:

The Saginaw Chippewa Indian Tribe is seeking funding from the D.O.E. to perform a feasibility study on Tribal lands in Isabella County and Arenac County. The Tribe wishes to study the feasibility of wind energy, solar energy, geo-thermal energy, as well as other options that may be available. These efforts are to help the Tribe become sufficient in providing their own energy for the various buildings, cultural centers, schools and residences on Tribal land.

The study would include the initial program outline, through site selection, land agreements, wind assessment, environmental review, economic modeling, interconnection studies, permitting, sales agreements, financing, turbine procurement, construction contracting and operations and maintenance. If other alternative energy sources are more feasible parts of the scope of work will change to reflect investigation into the alternative sources and less on procuring a wind turbine.

Tasks:

a. Develop a detailed work plan for Tribe and DOE approval.
b. Order and install 2 meteorological towers and begin data collection.
c. Identify, select, and schedule work for subcontractors for cultural and avian issues.
d. Issue required progress and technical reports.
e. Conduct Wind & Renewable Energy Conference.

f. Engage local utilities and power marketers for interconnectivity power purchase agreements.
g. Prepare project economic performas with options.
h. Determine Tribal plans for development.

Constraints to be considered

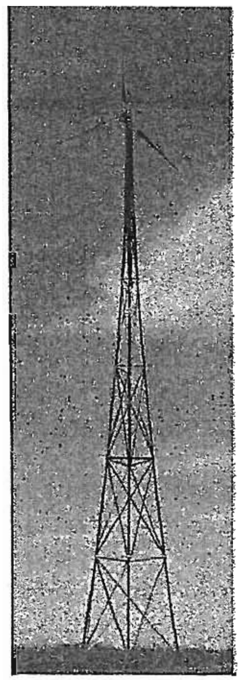
a. Wind resource- if the wind resource is not sufficient to provide enough quantity to utilize wind turbines.
b. Market-the supply of energy may not be sufficient to market on the electric grid. There may be enough energy to supply the internal needs of the Tribe.
c. Transmission Constraints-if the Tribe exports energy the existing power lines may not have the thermal/physical load to support the extra electricity. Also contractual transmission constraints may exist.
d. Community acceptance-if members of the community feel the visual impact is too severe, or a historical/cultural area is affected they may not wish to have the turbine located in that area.
e. Environmental-if an environmental constraint is insurmountable. e.g endangered species; avian flyways; negative visual impact.

Appendix C. Small Wind Turbine Spec Sheets

Introducing the new

VENTERA

12kW Wind & Solar
Hybrid Electric System



Run Your Electric Meter Backwards!

It doesn't get any simpler than this. This new concept in generating your own renewable energy performs much like any large electrical appliance such as a clothes dryer or air conditioner, but instead of taking electrical power FROM an outlet, you put electricity INTO the outlet! If at any time your wind and solar system is producing more energy than you are using, your electric meter will run backwards reducing your electric bill. If your electrical loads are larger than the wind generator and solar production, your meter will slow down reflecting your reduced need to buy electricity at retail from the utility. No batteries are used or required! You get up to 12 kilowatts of hybrid renewable electricity, 10 kilowatts from the new Ventera VT10 wind turbine and 2 kilowatts from solar photovoltaics 100% of which goes directly to reduce your electric bill by means of our exclusive dual input VI12 synchronous inverter.

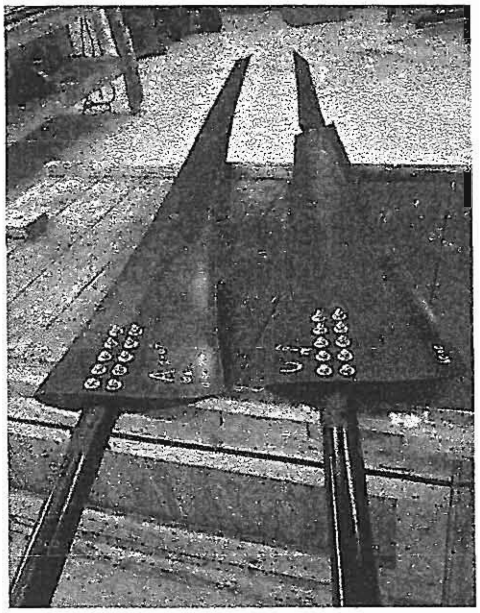
Designed to Pay for Itself Quickly

Few things in this life are free, but you might agree our new era Ventera V12 wind and solar system comes pretty close. Designed for at least a 30 year life and minimum maintenance, the Ventera wind turbine on an 80 foot tower can produce $2000 or more worth of electricity per year, electricity you would otherwise have to buy, if your wind regime is 12.5mph-5.5m/s (class III) or better and you pay 8 cents or more for electricity. In not much more than 10 years you'll have earned back your original investment and in 30 years you could pocket 3 times or more the original investment! If you assume electric rates will go up in the coming years, and many predict they'll go up faster than the rate of inflation, you'll earn back your investment even faster. If you can depreciate the wind turbine cost as a farm or business expense, your payback will be even sooner. If your average wind speed is greater than 12.5 mph-5.5m/s, which is true for many sites in the US Midwest, your payback can be sooner yet. And, some states offer tax credits for small wind systems reducing the payback time even further. Careful design of every component and advanced tooling and manufacturing processes bring the initial cost of the Ventera turbine, synchronous inverter and self-supporting tower to historic lows. The frame is an aluminum casting (made from environmentally friendly recycled aluminum), not an expensive weldment. The downwind orientation eliminates the need for a costly and cumbersome tail. The blades are injection molded for low cost and absolute uniformity. The brushless, one-moving-part, large diameter alternator minimizes the use of copper, steel and rare earth magnet material. Our unique synchronous inverter utilizes a common power handling stage with separate wind and solar peak power tracking input stages to bring you hybrid grid connection at an unheard of low price.

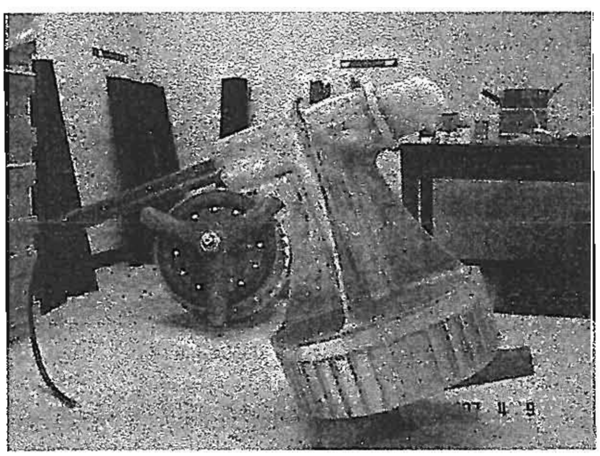
How the Ventera VT10 Wind Generator Works

The new Ventera 10 kilowatt turbine is specifically designed to be the most efficient wind turbine available to convert wind energy into electricity. Three advanced, proprietary airfoil-shaped blades "fly" in the wind, much like a modern airplane wing, to convert the kinetic energy of moving air mass into rotating mechanical force. The blades of this propeller have a specific shape which has been developed from over 30 years experience in wind turbine design to provide the highest output at the lowest noise level at all wind speeds for a propeller of this diameter.

Our patented (Number 7,186,083), exclusive governor automatically pitches the outer portion of each blade in response to a combination of wind force and propeller rpm. This governor effectively limits propeller rpm to avoid damage to the propeller, generator, tower and electronics. This centrifugal-force activated blade pitching governor results in maximum power output in winds above governing speed as opposed to more primitive methods such as furling or stalling that result in steep reductions in power output in high winds. Our advanced governor will limit propeller rpm at much lower wind speed in the event of electrical load loss insuring always quiet operation.



The rotating mechanical force of the propeller directly drives an ultra high efficiency permanent magnet generator mounted to an aluminum mainframe with no transmission to rob power, require lubrication or need maintenance. On the tower end of the mainframe is the vertical yaw shaft housing which also includes a redundant connection brush and slip ring assembly allowing the turbine to follow the changing wind direction without twisting the power output cable. Another function of the aerodynamic mainframe casting is to orient the wind turbine blades to the wind direction. In this modern, tailless, downwind design the wind first passes the tower and then flows over the propeller blades.



Electricity is generated by the Ventera generator in a high voltage, three phase form that minimizes the wire size and cost necessary to carry the electricity from the turbine to the inverter and your electric meter. This permits you to economically place the turbine and tower at a location on your property up to several thousand feet or 1000 meters from your electric meter which allows you to choose the tower site on your property with maximum exposure to the wind.

The advanced generator features oversize rare earth super strength magnets rotated by the propeller inside an extra large, stationary copper winding assembly. By over sizing these components and choosing the highest grade steel for the winding laminations, Ventera achieves a superior generator efficiency averaging over 90% resulting in more kilowatt hours of electrical energy per month for this size propeller. There are no electronic components on top of the tower to require inspection or repair or to be prone to damage from lightning or static electricity.

Ventera VI12 Synchronous Inverter

From the wind generator and tower and the solar panels the electricity flows to the Ventera VI12 Synchronous Inverter normally located near your circuit breaker box and electric meter. The inverter has two separate inputs, one for wind and one for solar. Each input has its own "peak power tracking" algorithm controlled by the inverter microprocessor. The wind input is programmed to control the propeller rpm to its optimum value for every wind speed, thus maximizing the turbine efficiency of converting wind energy to electricity. This Ventera exclusive feature alone increases monthly kilowatt hour production by up to 15% over other wind turbine-synchronous inverter combinations.

The solar input has a separate peak power tracker that maximizes the available solar electricity even early in the morning or late in the evening or on cloudy days. The Ventera inverter has been designed to have the highest efficiency in the industry assuring you of maximum energy available to reduce your electric bill. This efficiency at full 12kw output is

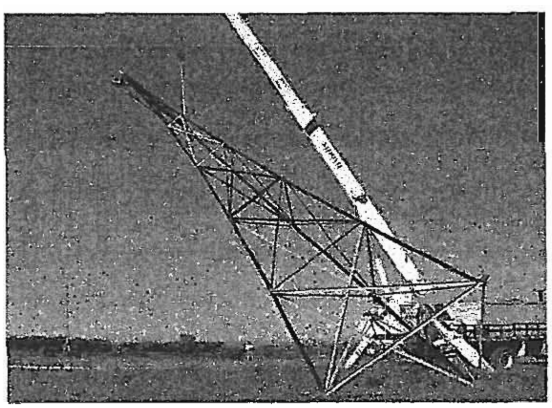
94% or better. Another unique feature of our inverter is that electrical consumption has been minimized when the inverter is idle or when no solar or wind input is available, for example at night when the wind is calm.

A key function of the inverter is to automatically disconnect from the utility in the event of utility failure to prevent possible back feeding of the utility line and any hazard to workers on the utility line. The inverter will detect an out-of-frequency or out-of-voltage line condition and disconnect immediately meeting requirements of the national electric code. The UL/CSA approval sticker on the inverter assures your electrician and utility of compliance with this important requirement.

You will appreciate the full monitoring features we've included with our new inverter. The front panel readout provide continuous readout of power in kilowatts, wind and solar energy in kwh since last reset and total kwh since installation plus convenient diagnostic information. For solar PV only systems we also offer a 12kw solar PV version of the new synchronous inverter.

Ventera VSST Self Supporting, Fold Over Tower

No one wants unsightly guy wires in the yard to interrupt mowing, grazing, volleyball or gardening, and Ventera Energy has designed a rugged, good looking three-legged, self-supporting tower to complement the Ventera V12 wind turbine with a beauty and grace you'll be proud to have on your homestead. A specially designed die-formed leg gives the tower a graceful curved taper reminiscent of the Eiffel Tower in Paris. It will remind you of the common windmill tower seen pumping water around the world, but you and your neighbors will also immediately recognize the exclusive, Ventera style. Towers come painted in weather-resisting black enamel to enhance the beauty of the silver and black colors of the Ventera turbine.



The tower is offered in heights of 35, 50, 60, 70 and 80 feet and comes complete with assembly hardware, tower top to bottom wiring harness, junction box and mounting hardware for the Ventera VT10 wind turbine. The tower is shipped in bundles by truck to your door and is designed for easy owner assembly following the included instructions. Each leg, vertical brace and horizontal brace is clearly labeled according to its position in the assembled tower.

The tower is hinged at the base and the hinged base plates that go over your anchor bolts are included. Each base plate is provided with a leveling arrangement to assure the tower is perfectly plumb. Users with a farm tractor can design a gin pole system for raising and lowering the tower and turbine for ground level service. Others will use a crane service to raise and lower the tower.

About Ventera Energy Corporation

Three principals, each with over 30 years experience designing and manufacturing small wind turbines, solar hot water systems, solar PV systems and high performance glazing systems, teamed together to form Ventera (the new era of wind) Energy Corporation January 1st, 2004 with the goal of designing, proving and manufacturing an all-new wind and solar hybrid renewable energy system that would be the first ever cost effective small wind system for the moderate wind regimes where most people live. Our experience includes design and manufacture of the WhirlWind line of 1000 to 4000 watt wind generators and the Whisper line of 500 to 4500 watt turbines sold to and now manufactured by Southwest Windpower. After 3 years of design, prototyping and field testing, Ventera is proud to present to the world our all-new 10 kilowatt VT10 Wind Turbine, our exclusive taper leg self-supporting tower and the first ever dual wind and solar input, dual peak power tracking 12 kilowatt VI12 Synchronous Inverter. In wind regimes having 12.5 mph-5.5m/s or better average wind speeds at 30 feet (10 meters elevation), we have achieved our goal of a 10-year payback for many if not most potential users.

NorthWind® 100 Wind Turbine

Distributed
ENERGY SYSTEMS

Extending today's resources...
creating tomorrow's choices

Distributed Energy Systems' NorthWind 100 wind turbine provides cost-effective, highly reliable renewable energy in demanding environments worldwide.

Designed specifically for isolated grid and distributed generation applications, the NorthWind 100 wind turbine is a state-of-the-art, village-scale wind turbine. Distributed Energy Systems has drawn on 30 years of experience to engineer a wind turbine that provides cost-effective, highly reliable renewable energy in a wide variety of applications. The patented design of the NorthWind 100 wind turbine meets the needs of small utilities and independent power producers.

Key Features

Simplicity

High reliability and low maintenance were the focus in developing the NorthWind 100 wind turbine. The design integrates industry proven robust components with innovative design features to maximize wind energy capture in rural, remote and harsh environment locations. The NorthWind 100 wind turbine features a minimum of moving parts and vital subsystems to deliver high system availability. The uncomplicated rotor design allows safe, efficient turbine operation.

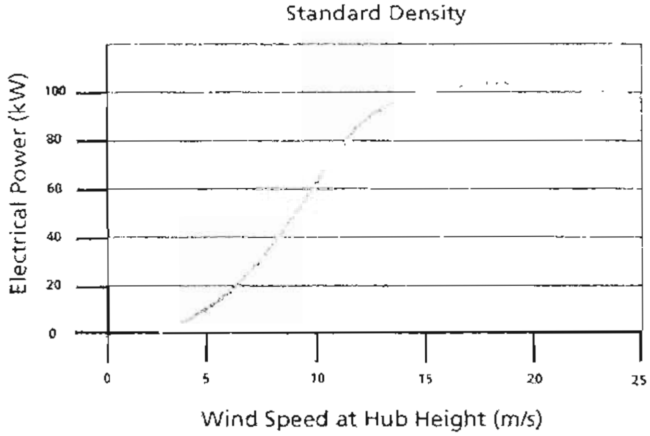
Serviceability

Our sophisticated remote monitoring and control software allows real-time accessibility of the turbine thus minimizing unnecessary service calls. When a site visit is required, all service activities can occur within the tubular tower or heated nacelle housing, providing complete protection from harsh or unpredictable weather conditions. Designated work areas provide ample room to perform service activities.

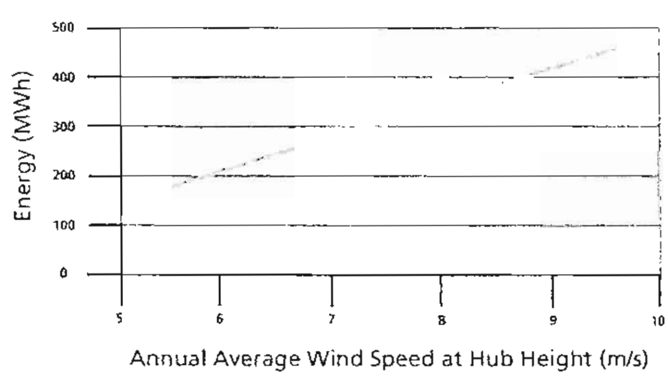
Power Quality

The NorthWind 100 wind turbine provides reliable power in distributed generation and village systems where the power grid is typically "soft and unbalanced." Our synchronous, variable speed, permanent magnet, direct drive generator and integrated power converter increase energy capture while eliminating current inrush during control transitions. This turbine can be connected to large power grids and remote wind-diesel configurations without inducing surges, effectively providing grid support rather than compromising it.

NorthWind 100/21 Wind Turbine Power Curve
Standard Density



NorthWind 100/21 Wind Turbine Annual Energy Production
Standard Density, Rayleigh Distribution



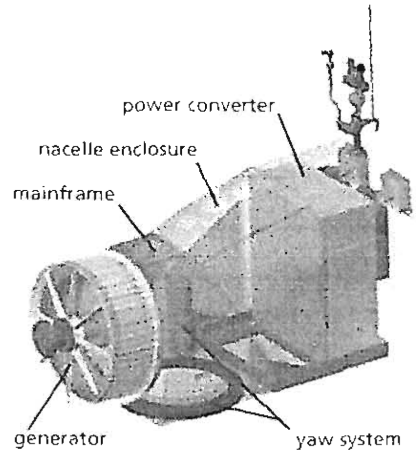
- Three fiberglass reinforced plastic blades bolted to a rigid hub that mounts directly to the generator shaft eliminates the need for rotating blade tips, blade pitch systems and speed increasing gearboxes.

- Variable speed, permanent magnet, direct drive generator/converter system is tuned to operate the rotor at the peak performance coefficient, and also allows stall point rotor control to contend with wide variation in air density found in the target applications.

- Safety system provides both normal shutdown and emergency braking backup functions.

- Advanced power converter features setpoint control of power factor and/or VARs.

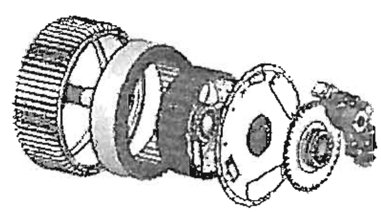
- Web-based SmartView® remote monitoring system also available.



Nacelle assembly

NorthWind 100 Wind Turbine Technical Specifications

Turbine Design Class	IEC WTGS Class S
Design Standard	Compliant with IEC 61400-1
Rated Power	100kW
Power Regulation	Variable speed stall
Rotor Diameters	19m, 20m, 21m
Hub Heights	25m, 30m
Yaw System	Active upwind
Turbine Electrical Output	480VAC, 3 phase, 50/60Hz
Grid Tolerance	+10/-15% voltage; +/- 2Hz
Grid Interface	115kVA transformer (spec available)
Operating Temperature	-40 °C to 50 °C
Lightning Protection	Compliant with IEC 61024-1
Icing	to 30mm

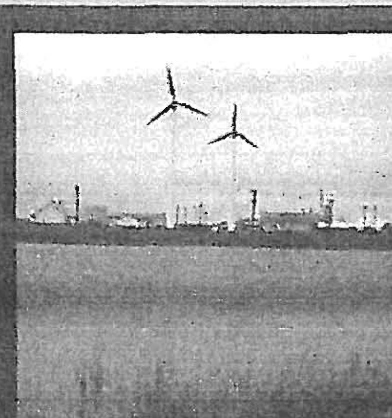


Passively-cooled, permanent magnet, direct drive generator eliminates the drivetrain gearbox and maximizes energy capture.

Case Study

Wind-Diesel Systems in Remote Alaska

Distributed Energy Systems successfully installed and commissioned three new NorthWind 100 turbines in the community of Kasigluk, Alaska. As part of a larger wind-diesel energy initiative by Alaska Village Electric Cooperative (AVEC), these turbines will produce approximately 675,000 kWh annually. By displacing 32% of the energy normally generated by diesel fuel, the new systems are expected to generate a potential savings of over $95,000 per year.



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Power Generation
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Tel +01 802.461 2955

Visit us online at
www distributed-energy com

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creating tomorrow's choices

NorthWind® 100 Wind Turbine

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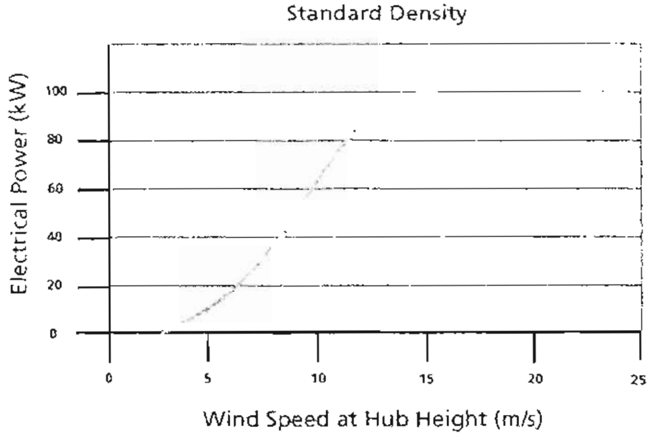

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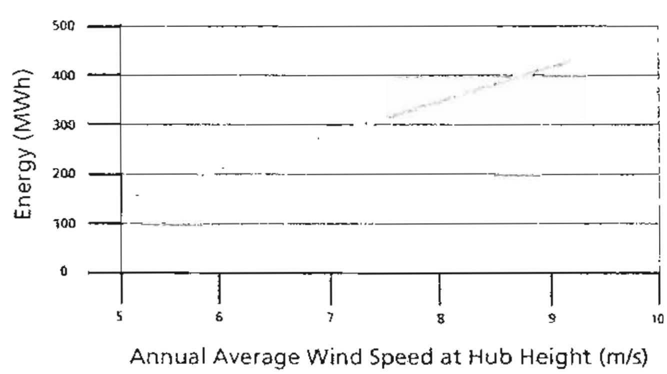

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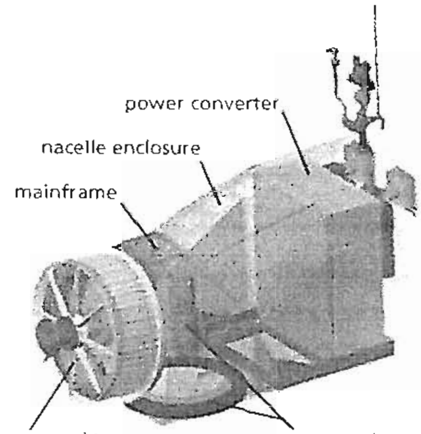

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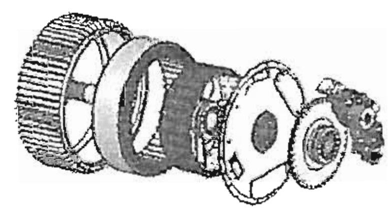
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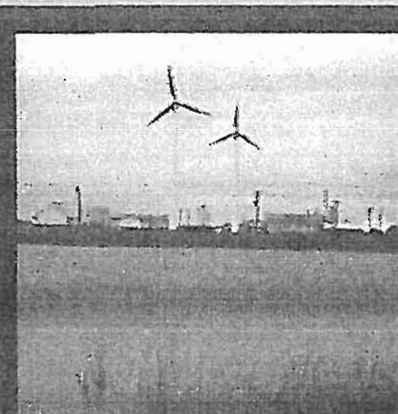

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Distributed ENERGY SYSTEMS

Extending today's resources...
creating tomorrow's choices

Saginaw Chippewa Casino Resort 7/17/08

Domestic Hot Water	Input Useage:	100	Mbtu/day	160064	gallons/day
		29300	kWh/day		

Thermo Dynamics model G32-P	Gross Panel Area =	2.982 sq m		Price/panel	$865
		32.1 sq ft		Balance/Shipping	30%
Note: panel output from SRCC certification				Installation/panel	$300

Month	Solar Radiation kWh/sq m/day	Panel Output kWh/Panel/day	Number Panels	sq ft	sq m	Panel Cost	Balance of Equipment & Shipping	Installation Cost	Total Cost
Jan	2.69	0.33	87548	2810278	261067				
Feb	3.79	1.14	25749	826552	8635				
Mar	4.3	1.82	16093	516595	5397				
Apr	4.99	5.99	4887	156886	1639				
May	5.43	6.74	4348	139581	1458				
Jun	5.57	6.97	4201	134848	1409	$4,236,968	$1,271,090	$1,260,265	$6,768,323
Jul	5.43	6.74	4348	139581	1458				
Aug	5.34	6.59	4449	142803	1492				
Sep	4.77	5.62	5210	167254	1747				
Oct	3.83	4.04	7261	233064	2435				
Nov	2.41	0.71	41296	1325603	13848				
Dec	1.79	1.54	19032	610930	6382				
Annual Avg.	4.195	4.02	7290	233994	2445				

Average Output Warm Climate	6.10	kWh/panel/day
Average Output Cool Climate	1.11	kWh/panel/day

Output April thru October	4201	panels -	5,482,661	kWh
Output November thru March	4201	panels -	703,116	kWh
Annual Output	4201	panels -	6,163,066	kWh

Saginaw Chippewa - Residential 7/17/08

Domestic Hot Water — Input Useage: 80 gallons/day — 49980 Btu/day, 14.6 kWh/day

Panel - Thermo Dynamics model G32 Gross Panel Area = 2.982 sq m, 32.1 sq ft

SB64-9 PV	$4,660	2 - 32 sq. ft. panels
Balance/Ship.	30%	
Installation	$1,000	

Note: panel output from SRCC certification

Month	Solar Radiation kWh/sq m/day	Panel Output kWh/panel/day	Number Panels	sq ft	sq m	System Cost	Balance of Equipment & Shipping	Installation Cost	Total Cost
Jan	2.69	0.33	43.8	1404.6	130.5				
Feb	3.79	1.14	12.9	413.1	38.4				
Mar	4.3	1.82	8.0	258.2	24.0				
Apr	4.99	5.99	2.4	78.4	7.3				
May	5.43	6.74	2.2	69.8	6.5				
Jun	5.57	6.97	2.1	67.4	6.3	$5,434	$1,630	$1,000	$8,064
Jul	5.43	6.74	2.2	69.8	6.5				
Aug	5.34	6.59	2.2	71.4	6.6				
Sep	4.77	5.62	2.6	83.6	7.8				
Oct	3.83	4.04	3.6	116.5	10.8				
Nov	2.41	0.71	20.6	662.5	61.5				
Dec	1.79	1.54	9.5	305.3	28.4				

Annual Average Output per day 4.02 kWh/panel/day

Annual Output 2 panels 3,080 kWh/year

2008

JANUARY 2008

THERMO DYNAMICS LTD.

101 Frazee Avenue • Dartmouth
Nova Scotia • Canada • B3B-1Z4

Tel: (902) 468-1001 • Fax: (902) 468-1002
solarinfo@thermo-dynamics.com
www.thermo-dynamics.com

RETAIL Price List

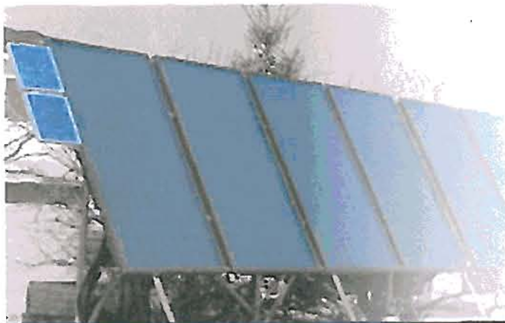
Product #	Description	Retail $
Solar Boiler™ Systems c/w module, collector(s), K1055, K1060, K2030-50, & PV Module		
SB32-9 PV	SBM-9, S32B semi-selective painted collector	3764
SB64-9 PV	SBM-9, S32A, S32B semi-selective painted collectors	4659
SB32-9PV-SP *	SBM-9, S32B selective surface collector	3862
SB64-9PV-SP *	SBM-9, S32A, S32B selective surface collectors	4855
Solar Collectors		
G32 - P	4' x 8' grid, 3/4" headers, semi-selective painted surface	864
G32 - SP *	4' x 8' grid, 3/4" headers, selective surface	976
GXX	1" header - additional charge	83
GU34	3/4" unions installed on grid collector - additional charge	32
S32A - P	4' x 8' serpentine, semi-selective painted surface	863
S32B - P	4' x 8' serpentine, semi-selective painted surface	852
S32A - SP *	4' x 8' serpentine, selective surface	962
S32B - SP *	4' x 8' serpentine, selective surface	950
ST or GT	4' x 8' - 4" thick collector additional charge	88
Collector Rack Kits		
K1000	Galvanized strut, 1-5/8", per foot (Unistrut)	4.39
K1002	Galvanized strut - single tier upright - for pitched roof	219
K1004	Galvanized strut - single tier upright - 45° - ground or flat roof	224
K1006	Galvanized strut - single tier upright - 60° - ground or flat roof	231
K1050	Flush mount kit (for 1 G or S collector)	31
K1052S	Single collector pinch clip, c/w spring nut and ss bolt	5.49
K1052D	Double collector pinch clip, c/w spring nut and ss bolt	7.94
K1055	Flush mount kit (for 2 S collectors)	63
K1056	Flat roof kit (for 2 S collectors)	323
K1057	Flat roof kit (for 1 S collector)	153
K1058	Inclined roof kit (for 2 S collectors)	277
K1059	Inclined roof kit (for 1 S collector)	130
K1060	PV module mounting kit (mounts PV20 to collector)	29
Solar Boiler™ Module		
SBM-9DC *	Solar Boiler™ module (12 VDC)	1777
SBM-13DC	Solar Boiler™ module MAG DRIVE (12 VDC)	1921
PV modules and LCB		
PV20	20 watt PV module	528
PV30	30 watt PV module	754
DTB	Delta-T Booster (Sensors not included)	132
Solar Boiler™ Installation Kits		
K2030-50	Copper tube kit, 50' (3/8" & 3/8")	403
K3015	Copper tube interface kit (3/8" CT to 1/4" BHU)	14
K3035	Copper tube splicing kit (for one 3/8" and one 1/4" CT)	16
K3036	Copper tube splicing kit (for one 3/8" and one 3/8" CT)	16
K4000	Solar Boiler PRV upgrade kit	38
CT6-100	Copper tube (100' x 3/8")	209
LVT18/4	PV and Sesnor Wire, 18 gauge, 4 conductor, per foot	1.66
CTI	Pipe insulation 3/8", per 6 ft length	7.98

Prices do not include GST, HST, & PST. Prices are FOB Dartmouth, Nova Scotia, Canada.
Prices are subject to change without notice. Prices are in Canadian dollars.
** Limited quantities available. For repairs only.*
*** Built-in strainer not available for this pump model*

Visit us on the web at: **www.thermo-dynamics.com**
Email us at: **solarinfo@thermo-dynamics.com**

PRICE LIST (Retail)

Product #	Description	Retail $
Storage Tanks		
TG180	Tank - glass lined (180 liter glass lined)	579
TG270	Tank - glass lined (270 liter glass lined)	752
Miscellaneous Hardware		
GLYUSP	Propylene glycol, USP pure ($/litre)	10.78
GLYUSM	Propylene glycol, USP mixed 40/60 with Distilled water ($/litre)	6.38
GL-30	Solar controller (110 VAC)	224
SAS-10	Thermistor temperature sensor (10,000 ohm)	20
MGE	120 VAC motor (1/12 hp, 125 watts)	102
P1542F	Grundfos circulator (15 ft-21 USGPM)	175
PS1542F	Grundfos circulator (3 Speed)	174
P1518SU	Grundfos circulator SS (7 ft-11 USGPM) c/w unions	294
P2699BF	Grundfos circulator Bronze (30 ft-35 USGPM)	467
PFL	Flanges, pair (P008 or P009 or P1542 or P2699F)	29
Solar Pumps™ & accessories		
P24070	Solar Pump™, (Pump/motor/LCB) 2.4 L/min - 70 GPH	619
P50140	Solar Pump™, (Pump/motor/LCB) 5.0 L/min - 140 GPH	642
P118330**	Solar Pump™, (Pump/motor/LCB) 11.8 L/min - 330 GPH	731
P24070M**	Solar Pump™, P24070 - Magnetic Drive - built-in strainer n/a	684
P50140M**	Solar Pump™, P50140 - Magnetic Drive - built-in strainer n/a	692
BP015	Pump (brass, rotary vane) c/w built-in strainer (replaces 1521)	215
BP070	Pump (brass, rotary vane) c/w built-in strainer (replaces 1505)	215
BP140	Pump (brass, rotary vane) c/w built-in strainer 140 GPH	240
BP330**	Pump (brass, rotary vane) 330 GPH - built-in strainer n/a	332
BP070M**	Pump (brass, rotary vane) 70 GPH - Magnetic Drive	306
BP140M**	Pump (brass, rotary vane) 140 GPH - Magnetic Drive	322
MPS-DCM**	Pump/motor set (includes MDCF and BP070M)	552
MPS-DC	Pump/motor set (includes MDCV and BP070)	469
MDCV	DC motor, (1/15 hp, 20 watts), V-band mount	255
MDCF	DC motor, (1/15 hp, 20 watts), flange mount	223
RH-1	Rubber Hoses c/w 1/2" female swivel fitting, pair	29
PST100	Replacement strainer for P10586 & P1321 (100 mesh)	4
Solar Glass		
GL24 *	Solar glass (34" x 96") tempered	152
GL25 *	Solar glass (46" x 76") tempered	163
GL28 *	Solar glass (46" x 84") tempered	180
GL32	Solar glass (46" x 96") tempered	165
GL40	Solar glass (46" x120") tempered	304
GLC	Solar glass crate (per 1-3 sheets)	58
Solar Collector Absorbers and Headers, (packaging not included)		
AG25 *	4' x 6.5' grid, 3/4" headers	316
AG32 - P	4' x 8' grid, 3/4" headers, semi-selective painted surface	330
AG32 - SP	4' x 8' grid, 3/4" headers, selective surface	432
AG40 - P	4' x 10' grid, 3/4" headers	406
AS25 *	4' x 6.5' serpentine	254
AS32 - P	4' x 8' serpentine, semi-selective painted surface	296
AS32 - SP	4' x 8' serpentine, selective surface	400
AS40 - P	4' x 10' serpentine	393
RN12	Round-rhombic nipple, 12 mm	1.20
H075	Header, 3/4", c/w brazed nipples	44
H100	Header, 1", c/w brazed nipples	61
Sunstrip™ Solar Fin		
SS146/12	146 mm fin/12 mm tube ($/sq.m)	48
SS146/12 - P	146 mm fin/12 mm tube, semi-selective surface ($/sq.m)	57
SS146/12 - SP	146 mm fin/12 mm tube, selective surface ($/sq.m)	92
SScutting	Cutting charge for fin	0.71
DTL Shell-and-tube Heat Exchangers		
D2T7L3	2" by 3' all copper shell-and-tube	458
	each extra foot add	86
D3T14L3	3" by 3' all copper tube shell-and-tube	727
	each extra foot add	131
D4T28L4	4" by 4' all copper shell-and-tube	1472
	each extra foot add	226



Thermo Dynamics Ltd.

Solar Heating

THERMO

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- Solar Pool Heat
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Solar Domestic Water Heating System

Environmentally-Friendly Technology That Can Save You Money.

The Solar Boiler collects energy from the sun and converts it into hot water.

Domestic hot water is the second-highest energy cost in the typical household. In fact, for some homes it can be the highest energy expenditure. Solar water heating can now reduce your domestic water heating costs by **as much as 65%**.

The Thermo Dynamics' Solar Boiler is today's state-of-the-art solar water-heating appliance. Designed to pre-heat the domestic water that is supplied to your conventional water heater, it can result in remarkable savings. It's easy to install and maintenance free. The installation package contains all the necessary hardware and complete instructions. As a homeowner, you can install it yourself or have your local Thermo Dynamics dealer do it for you.

All parts of the system are built to demanding specifications, employing the latest solar technology for maximum performance. The Solar Boiler is manufactured from readily-available components, ensuring lower costs and reliability. The solar collectors are constructed of aluminum, copper, and tempered glass. The assembly incorporates the MICRO-FLO® absorber, a continuous tube with only two connections for effortless installation.

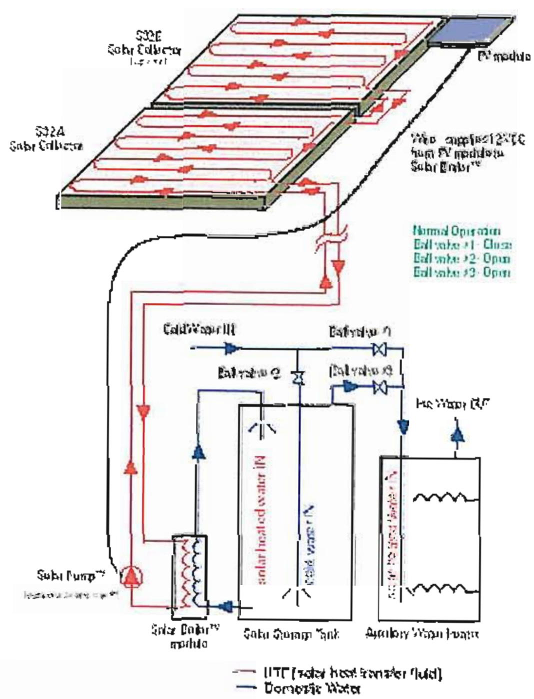
Your investment in clean and natural.

The Solar Boiler is environmentally-friendly. It does not pollute or use valuable non-renewable resources. Even the pump to transport heat from the collectors to the storage tank is powered by the sun. Solar energy is a sound **investment in everyone's future, today.**

The Solar Boiler is designed for automatic daily and year round operation. A non-toxic glycol solution in the solar collectors eliminates winter freezing problems. A photovoltaic module regulates the proper daily operation of the Solar Boiler and the solar loop circulator turns on only when the panels are hot enough to heat the solar tank.

As one of Thermo Dynamics' new generation of solar products, the Solar Boiler makes solar energy economically available to your family's needs. It's an investment in reliable performance.
You have our name on it!

How it works:



How the Solar Boiler™ works

- Solar collectors absorb sunlight and convert it to heat.
- When there is sufficient sunlight, the photovoltaic module produces electricity and turns the pump.
- The pump circulates heat transfer fluid (HTF), through the solar collectors.
- Heat is transferred to the HTF in the solar collector.
- The HTF is returned to the heat exchanger in the Solar Boiler™ module.
- The heat is transferred to the water which circulates naturally to the top of the solar storage tank.
- Solar heated water is stored in the solar storage tank until water is drawn from the auxiliary tank.
- As hot water is drawn from the electric water heater it is replaced with solar heated water.
- The electric heaters increase the temperature of the solar heated water, if necessary.
- The electrical energy required to heat water is significantly less when water is preheated by solar.
- In this manner, the solar water heater saves electrical energy.

Light from the sun strikes the solar collector and heats the black metal Sunstrip absorber underneath the glass cover. This heat is transferred to a non-toxic anti-freeze solution (propylene glycol and water) that is pumped through the collector and returns to the Solar Boiler.

The hot glycol then transfers heat to the water in the storage tank via the Solar Boiler 's heat exchanger. The water is heated repeatedly in this fashion, until the solar tank is hot.

The Solar Boiler is used as a domestic water pre-heater in conjunction with your conventional heating system. Cold water enters the Solar Boiler for initial heating, and is then delivered to the backup or conventional heating system for final heating as required. The conventional system is typically fueled by oil, electricity, propane, natural gas, etc....

Conventional energy requirements can be reduced substantially by using the Solar Boiler, and on many days the Solar Boiler will provide ample hot water without the backup (conventional) heater turning on. In most families, the Solar Boiler will displace up to 65% of the water heating requirements. A typical system for a family of four would include two solar panels (6 square meters), 270 litres of solar water storage (not included with the system), and a photovoltaic module to drive the glycol pump.

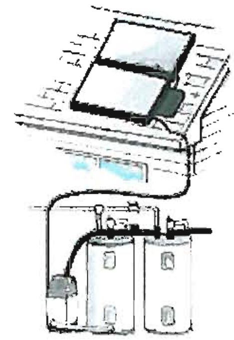
Sizing Your Solar Domestic Hot Water System

Family Size	System Model	Solar Collectors	Collector Area	Solar Boiler Module	DHW Load	Recommended Solar Storage Capacity*
1 - 3 people	SB32-9PV	1 - S32B	2.97 m2 (32 ft2)	SBM-9DC	<250 liters/day (<55 IG/day) (<66 USG/day)	273 liters (60 IG) (80 USG)
4 - 7 people	SB64-9PV	1 - S32A 1 - S32B	5.82 m2 (64 ft2)	SBM-9DC	>250 liters/day (>55 IG/day) (>66 USG/day)	454 liters (100 IG) (120 USG)

* Solar storage tanks are available from Thermo Dynamics Ltd. The solar storage tanks are not included with the system. Thermo Dynamics Ltd. recommends the use of an electric water heater with the elements disconnected for a solar storage tank. These can be obtained

locally to save on shipping costs.

System Components



SB32-9PV Solar Boiler System - $3,764.oo CAD

Quantity	Model	Description
1	S32B-P	4ft x 8ft Serpentine solar collector, "B", 2 connection ports + sensor well
1	SBM-9DC	Solar Boiler Module - Solar Pump - Expansion tank - Glycol Resevoir [complete with 4 liters of glycol] - Glycol inlet/outlet ports - Water inlet/outlet ports
1	PV20	20 Wp photovoltaic module
1	K1050	Serpentine collector mounting kit [mounts flush to roof]
1	K1060	PV mounting kit
1	K2030-50	50 Copper tube kit [connects collector to Solar Boiler module, 50 ft distance between] - 50 ft supply copper tube, 3/8" dia - 50 ft return copper tube, 3/8" dia - 50 ft 18/4 LVT wire - 100 ft pipe insulation
1	GLYUSM	4 liter of Glycol for topping up the system

SB64-9PV Solar Boiler System - $4,659.oo CAD

Quantity	Model	Description
1	S32A-P	4ft x 8ft Serpentine solar collector, "A", 4 connection ports
1	S32B-P	4ft x 8ft Serpentine solar collector, "B", 2 connection ports + sensor well
1	SBM-9DC	Solar Boiler Module - Solar Pump - Expansion tank - Glycol Resevoir [complete with 4 liters of glycol] - Glycol inlet/outlet ports - Water inlet/outlet ports
1	PV20	20 Wp photovoltaic module
1	K1055	Serpentine collector mounting kit [mounts flush to roof]
1	K1060	PV mounting kit

SOLAR COLLECTOR CERTIFICATION AND RATING	**CERTIFIED SOLAR COLLECTOR**
SRCC (SOLAR CERTIFICATION)	SUPPLIER: **Thermo Dynamics, Ltd.** 101 Frazee Avenue, Dartmouth, Nova Scotia B3B 1Z4 Canada
SRCC OG-100	MODEL: Thermo Dynamics G Series G32-P COLLECTOR TYPE: Glazed Flat-Plate CERTIFICATION #: 100-2006-005A

COLLECTOR THERMAL PERFORMANCE RATING

Megajoules Per Panel Per Day				Thousands of Btu Per Panel Per Day			
CATEGORY (Ti-Ta)	CLEAR DAY 23 $MJ/m^2 \cdot d$ 6.39	MILDLY CLOUDY 17 $MJ/m^2 \cdot d$ 4.73	CLOUDY DAY 11 $MJ/m^2 \cdot d$	CATEGORY (Ti-Ta)	CLEAR DAY 2000 $Btu/ft^2 \cdot d$	MILDLY CLOUDY 1500 $Btu/ft^2 \cdot d$	CLOUDY DAY 1000 $Btu/ft^2 \cdot d$
A (-5°C)	42	32	21	A (-9°F)	40	30	20
B (5°C)	37	27	17	B (9°F)	35	26	16
C (20°C)	30	20	10	C (36°F)	29	19	10
D (50°C)	17	8	1	D (90°F)	16	8	1
E (80°C)	6			E (144°F)	5		

A-Pool Heating (Warm Climate) **B**-Pool Heating (Cool Climate) **C**-Water Heating (Warm Climate) **D**-Water Heating (Cool Climate) **E**-Air Conditioning

Original Certification Date: March 12, 2007

COLLECTOR SPECIFICATIONS

Gross Area:	2.982	m^2	32.10	ft^2	**Net Aperture Area:**	2.783	m^2	29.96	ft^2
Dry Weight:	43.5	kg	96	lb	**Fluid Capacity:**	2.3	l	0.6	gal
Test Pressure:	1103	kPa	160	psig					

COLLECTOR MATERIALS

Frame:	Aluminum
Cover (Outer):	Low Iron Tempered Glass
Cover (Inner):	None
Absorber Material:	Tube - Copper / Plate - Aluminum
Absorber Coating:	Moderately Selective Black Paint
Insulation (Side):	Fiberglass
Insulation (Back):	Fiberglass

PRESSURE DROP

Flow		ΔP	
ml/s	gpm	Pa	in H_2O
20	0.32	73	0.29
50	0.79	228	0.91
80	1.27	437	1.75

TECHNICAL INFORMATION

Efficiency Equation [NOTE: Based on gross area and (P) = Ti-Ta]

				Y Intercept	Slope	
S I Units:	η = 0.689	-3.8475 (P)/I	-0.0174 $(P)^2/I$	0.7	-4.934	$W/m^2 \cdot °C$
I P Units:	η = 0.689	-0.6780 (P)/I	-0.0017 $(P)^2/I$	0.7	-0.870	$Btu/hr \cdot ft^2 \cdot °F$

Incident Angle Modifier [(S) = 1/cos θ - 1, 0°≤ θ ≤60°]

$K_{\alpha\tau}$ = 1.0 -0.4920 (S) -0.1291 $(S)^2$

$K_{\alpha\tau}$ = 1.0 -0.36 (S) (Linear Fit)

Model Tested: G32-P
Test Fluid: Water
Test Flow Rate: 60 ml/s 0.94 gpm

REMARKS:

Ti – temp H_2O entering collector
Ta – temp air around panel

Evergreen Solar UT 2500 EG

PV Watts *** AC Energy & Cost Savings

Cautions for Interpreting the Results

Station Identification	
City:	Flint
State:	MI
Latitude:	42.97° N
Longitude:	83.73° W
Elevation:	233 m
PV System Specifications	
DC Rating:	3.0 kW
DC to AC Derate Factor:	0.770
AC Rating:	2.3 kW
Array Type:	Fixed Tilt
Array Tilt:	43.0°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	8.3 ¢/kWh

Results

Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	2.69	201	16.68
2	3.79	255	21.16
3	4.30	309	25.65
4	4.99	335	27.80
5	5.43	365	30.30
6	5.57	353	29.30
7	5.43	345	28.64
8	5.34	347	28.80
9	4.77	307	25.48
10	3.83	259	21.50
11	2.41	162	13.45
12	1.79	127	10.54
Year	4.19	3365	279.30

Output Hourly Performance Data * Output Results as Text

About the Hourly Performance Data Saving Text from a Browser

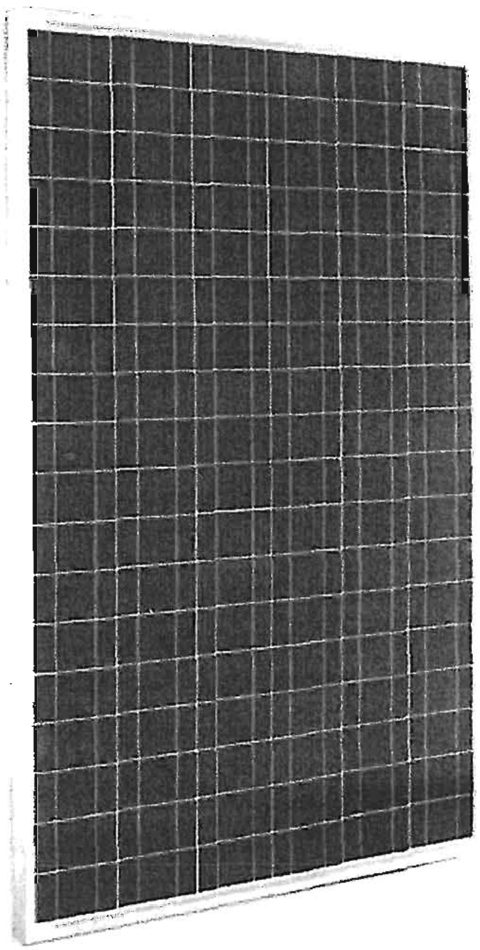
Run PVWATTS v.1 for another US location or an International location
Run PVWATTS v.2 (US only)

Please send questions and comments regarding PVWATTS to Webmaster

RReDC Return to RReDC home page (*http://rredc.nrel.gov*)

evergreensolar
Think Beyond.

SPRUCE LINE™
photovoltaic modules



190W module

Born in the USA

A high quality polycrystalline solar panel for on-grid markets offering exceptional performance, extraordinary versatility and industry-leading environmental credentials based on our cutting-edge String Ribbon™ wafer technology.

- Superior performance under real field conditions
- Get up to 102.5% of rated power, with a guaranteed minimum of 98%
- 5 year workmanship and 25 year power warranty for ultimate peace of mind*
- More installation versatility with our extensive range of mounting options
- Higher strength with wind speeds guaranteed up to 130 mph and snow loads up to 80 lbs/ft^2
- Qualified to all major industry certifications and regulatory standards
- Smallest carbon foot-print leading the fight against global warming
- Quickest energy payback time for the maximum energy conservation
- Cardboard-free packaging for minimal on-site waste and disposal cost
- Industry-first paid return and re-use program for product packaging

*For full details see the **Evergreen Solar Limited Warranty** available on request or online.
This product is qualified to UL 1703, UL Fire Safety Class C, IEC 61215 Ed.2, TÜV Safety Class 2 and CE

evergreensolar

Electrical Characteristics

Standard Test Conditions (STC)[1]

		ES-190 RL, SL, TL or VL*
P_{mp}[2]	(W)	190
$P_{tolerance}$	(%)	-2%/+2.7%
$P_{mp, max}$	(W)	194.9
$P_{mp, min}$	(W)	186.2
P_{ptc}[3]	(W)	168.8
V_{mp}	(V)	26.7
I_{mp}	(A)	7.12
V_{oc}	(V)	32.8
I_{sc}	(A)	8.05

Nominal Operating Cell Temperature Conditions (NOCT)[4]

P_{mp}	(W)	136.7
V_{mp}	(V)	23.8
I_{mp}	(A)	5.75
V_{oc}	(V)	30.3
I_{sc}	(A)	6.46
T_{NOCT}	(°C)	45.9

[1] 1000 W/m², 25°C cell temperature, AM 1.5 spectrum;
[2] Maximum power point or rated power
[3] At PV-USA Test Conditions: 1000 W/m², 20°C ambient temperature, 1 m/s wind speed
[4] 800 W/m², 20°C ambient temperature, 1m/s wind speed, AM 1.5 spectrum
* RL model made in Germany without cell texturing; SL model made in USA without cell texturing; TL model made in Germany with cell texturing; VL model made in USA with cell texturing

Low Irradiance

The typical relative reduction of module efficiency at an irradiance of 200W/m² in relation to 1000W/m² both at 25°C cell temperature and spectrum AM 1.5 is 0%.

Temperature Coefficients

$\alpha\ P_{mp}$	(%/ °C)	-0.49
$\alpha\ V_{mp}$	(%/ °C)	-0.47
$\alpha\ I_{mp}$	(%/ °C)	-0.02
$\alpha\ V_{oc}$	(%/ °C)	-0.34
$\alpha\ I_{sc}$	(%/ °C)	0.06

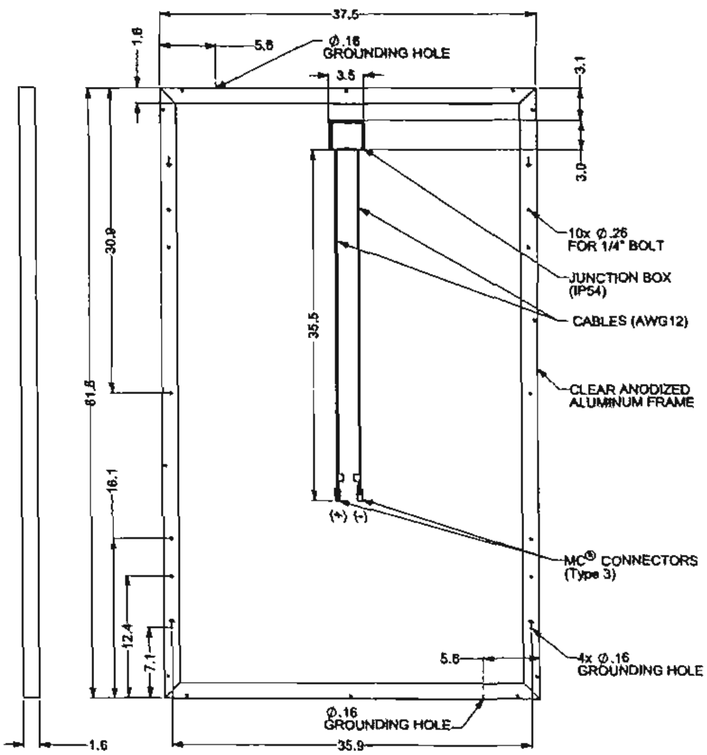
System Design

Series Fuse Rating[5]	15 A
UL Rated System Voltage	600 V

[5] Also known as Maximum Reverse Current

ELECTRICAL EQUIPMENT
CHECK WITH YOUR INSTALLER

Mechanical Specifications



All dimensions in inches; module weight 40.1 lbs

Product constructed with 108 polycrystalline silicon solar cells, anti-reflective tempered solar glass, EVA encapsulant, Tedlar® back-skin and a double-walled anodized aluminum frame. Product packaging tested to International Safe Transit Association (ISTA) Standard 2B. All specifications in this product information sheet conform to EN50380. See the **Evergreen Solar Safety, Installation and Operation Manual** and **Mounting Design Guide** for further information on approved installation and use of this product.

Due to continuous innovation, research and product improvement, the specifications in this product information sheet are subject to change without notice. No rights can be derived from this product information sheet and Evergreen Solar assumes no liability whatsoever connected to or resulting from the use of any information contained herein.

Partner:

S190i_US_010707; effective July 1st 2007

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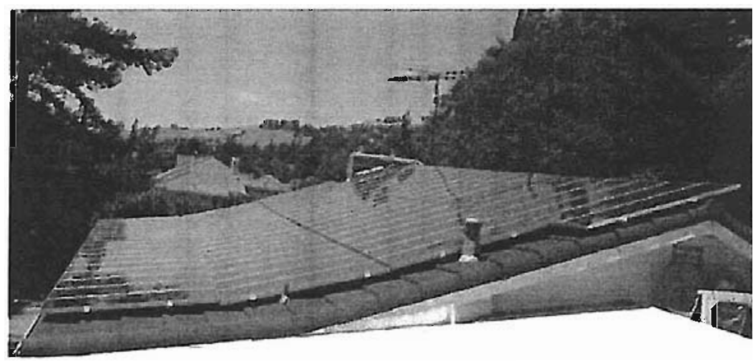
SOL-GEN™ UT Solar Electric Generators w vergreen Modules and Various Inverters

These Systems put a reverse spin on your electric meter, and they qualify for a rebate from the California Public Utilities Commission and a 30% Federal Tax Credit ($2000 max for residential)

SOL-GEN™ UT systems automatically convert sunshine directly into electricity.

These systems produce clean, cost-effective power, silently, with no moving parts. When the power you generate is greater than what your house is using, your electric meter will run backwards and reduce your utility bill. Current laws require the utility companies to credit you for the power at the same rate you pay up to break even. These systems include a choice of several high quality inverters and all the major components needed for a complete installation.

The modules are Evergreen Spruce Line String Ribbon 190 watt. These modules come with a 98% guaranteed power output (2% power tolerance) and a 25 year power output warranty. The flush mounting hardware included is fabricated with stainless steel hardware and anodized aluminum, engineered and designed for rapid, durable installation. All switchgear and ground fault protection for the array are included and UL listed. An approved system performance meter is included. It shows the instantaneous power output, as well as daily and cumulative KWH production. In the event of a utility power failure these systems will not operate. If you would like a system that would protect you from blackouts, select one of our SOL-GEN™ UB systems. Feeding power back to the utility grid requires approval from your utility company. Similar systems available for 3-phase 208VAC output. Installation cost will vary depending on the size of the system, type of roof and location. System ratings below are not adjusted for geographic or design factors. These factors may reduce the system rating based on site specific factors.



Sol-Gen UT Systems w/ Evergreen 190 watt Modules and Various Inverters

Model Number	UT2500EG	UT3200EF	UT3800EF	UT4500EP	UT4800ES	UT4800EG	UT5500ES	UT6800ES
Order Number	101032	105872	105881	105882	104384	102322	105883	101038
PV Peak Power (Watts AC) CEC*	2539	3173	3808	4537	4836	4836	5510	6806
No. of Strings, No. per String	1 x 16	2 x 10	2 x 12	2 x 14	2 x 15	2 x 15	2 x 17	3 x 14
PV Array Area Sq. Ft. (Approx)	262	332	400	462	495	495	560	680
Average KWH/Day (CEC)*	12.7	15.9	19.0	22.7	24.2	24.2	27.6	34.0
Inverter Model	GT 2800	IG4000	IG4000	PVP 4800	SMA 5000US	GT 5000	SMA 6000US	SMA 7000US
List Price	$22,161	$28,573	$33,529	$38,381	$41,119	$40,743	$46,464	$56,558
PG&E / CCSE Rebate (@$2.20/Watt)*	$5,586	$6,981	$8,378	$9,981	$10,639	$10,639	$12,122	$14,973
SCE Rebate (@$2.50/Watt)*	$6,348	$7,933	$9,520	$11,343	$12,090	$12,090	$13,775	$17,015

L = good for minimum Temp of 30 deg F or higher L

Suggested retail prices do not include tax, installation or permitting costs. Contractor discounts available.

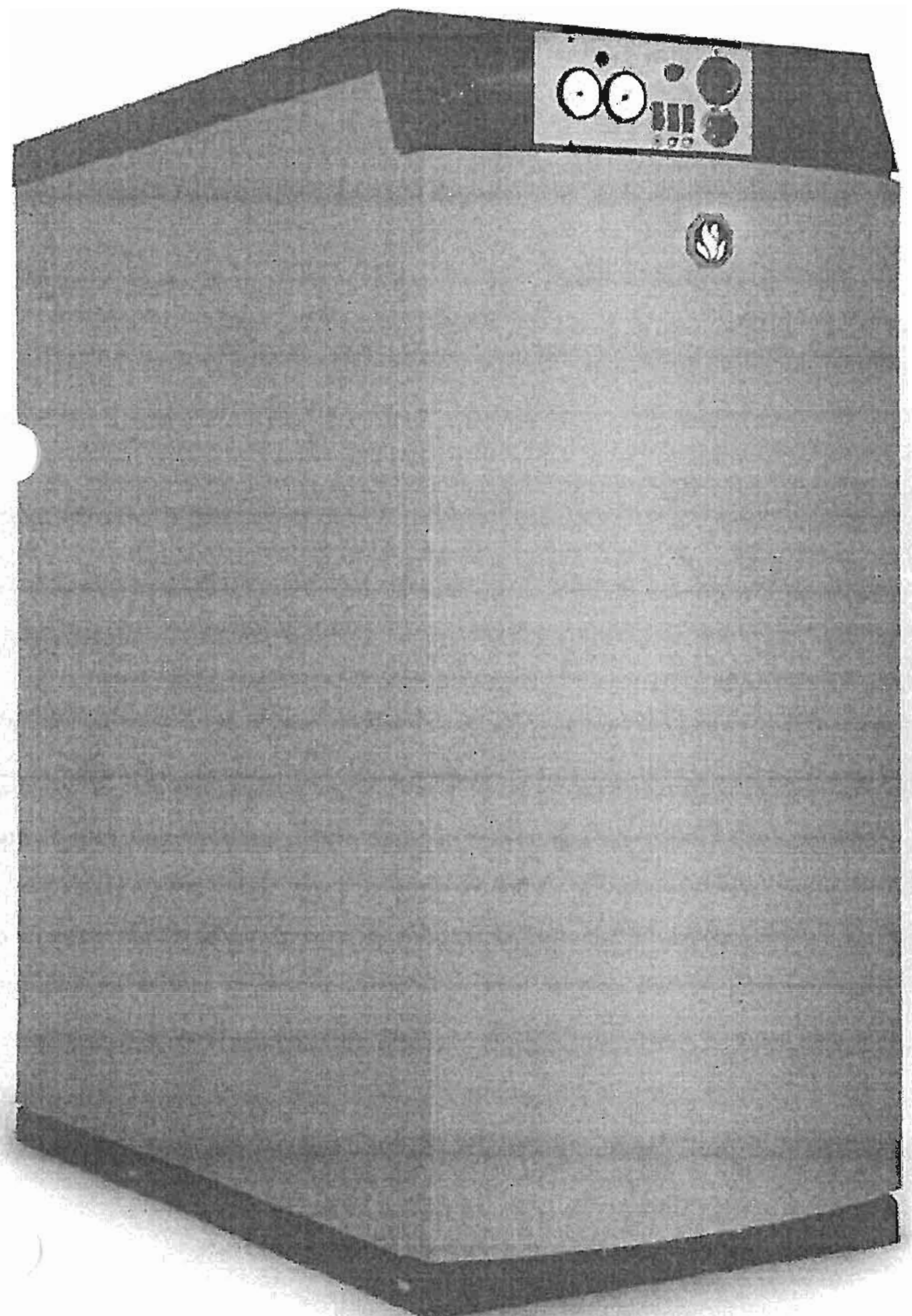
*Estimate based on 5 ESH Equivalent Sun Hours, south facing array. Design & Geographic Factor of 1.0. May be lower based on site specific factors. Rev 1-08

3040 W Peak DC

Appendix D. Small Wood Boiler Spec Sheet

BIOHEAT USA™

IN THE FINEST TRADITION OF TARM USA



Solo Plus

Wood-fired Gasification Add-on Boiler

- Easy to Operate
- High Efficiency
- Carbon Neutral
- DS/EN ISO 9001 Certified

Solo Plus

Solo Plus Applications

- [illegible]
- hot water baseboard
- radiant floors
- [illegible]

Wood-fired Gasification Add-on Boiler

Independence and Self-Reliance

Solo Plus boilers provide a convenient, safe, and environmentally responsible way to heat your home and hot water with wood. Solo Plus owners are ensured of unusually high heating efficiency, low heating costs, and use of an abundant, locally available, renewable fuel. The Solo Plus wood gasification combustion technology is the most efficient way to burn cordwood. As a result, the Solo Plus boiler uses substantially less wood than conventional wood boilers and outdoor water stoves. Additionally, this high-efficiency burn technology produces little or no creosote, virtually eliminating the risk of chimney fires and greatly reducing greenhouse gas emissions.

Sizing Your Boiler

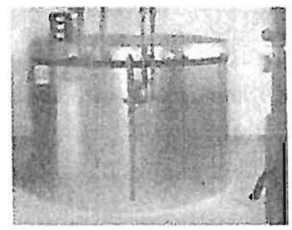
As with any heating system, choosing an appropriately sized heat source is necessary to optimize efficiency, ease of operation and home comfort. Be wary of using simple techniques based only on square footage. The heat load of a home can vary widely depending on age and type of construction, type of heating system and location of the home. If you have questions about which boiler is most appropriate for your needs, please contact your local BioHeatUSA dealer or contact us directly at our toll free number and we would be happy to discuss your application with you.

Reliability

The internal boiler is made of fully welded 7mm thick plate steel. BioHeat USA boilers are constructed to European boiler design standard EN 303-5 and are designed for pressurized systems. Solo Plus boilers are UL and ULC approved.

Efficiency

The Solo Plus boiler uses down draft gasification technology to achieve very high efficiency. The key to this process is the high temperature (1800° or more) reached in a second refractory-lined combustion chamber. This secondary combustion consumes the creosote and smoke that normally goes up the chimney, thereby wringing every bit of energy out of the wood fuel and resulting in a very clean burn. The three-inch vertical heat exchange tubes are sized for maximum extraction of the energy in the high-temperature exhaust stream. Despite the very high secondary burn temperatures, stack temperatures remain relatively low. Periodic brushing of the heat exchange tubes will help maintain boiler efficiency, and is easily accomplished via the hatch on the top of the boiler.



A heat storage unit is an excellent addition to any home heating solution

Optimization and Heat Storage

Firewood burns most efficiently and cleanly when it is burned hot and fast. Down draft gasification facilitates just this kind of burn. Your home, however, does not use heat in this same way, it calls for heat only as needed. In order to match both of these demands, we recommend combining a wood boiler with a water storage tank of 500-1000 gallons. Instead of smoking and smoldering in idle mode when your home is up to temperature, a storage tank will allow the Solo Plus to continue to burn at maximum efficiency. The excess heat generated will simply be stored in the water tank for later use. A certain amount of idling is acceptable, and if you are only intending to burn wood during the coldest part of the year, no storage tank is necessary. However, once the warm days of early spring arrive, it will be time to shut down your wood boiler for the summer. By incorporating thermal storage you maximize the efficiency of your wood boiler and are able to use it througnout the spring and fall—and even right through summer—to produce your domestic hot water, if you choose. Thermal storage can easily be added to a system at a later date.

About BioHeatUSA

BioHeatUSA™, formerly Tarm USA, is a third-generation, family-owned business that has pioneered the sales and service of European residential central heating equipment in North America for over 30 years. BioHeatUSA's primary objective is to offer innovative home heating solutions, along with a significant commitment to consumer education and environmental awareness. Exclusive partnerships with ISO 9001 certified manufacturers allows BioHeatUSA to offer products with operational reliability, unique firing efficiency, and to promote the clean burning of carbon-cycle biomass that is critical to the lowering of net greenhouse gas emissions.

About Scandtec

Scandtec, located in Skjern, Denmark, is a producer of central heating biomass boilers. Hans Sorenson, the former Managing Director of Baxi, (and grandson of the founder of HS Tarm), now owns and manages the company which employs an experienced team of R&D and production/distribution professionals.

Features

- [illegible] overall efficiency
- clean burn with virtually no smoke or creosote [illegible] large, easily accessible firebox
- easy to clean with very little ash

Combustion is regulated by a thermostatically controlled draft blower that forces combustion air into the boiler's ceramic combustion tunnel, where exceptionally efficient combustion takes place at high temperatures allowing the Solo Plus to use very little fuel in comparison to conventional boilers.

How It Works

Solo Plus is a patented, wood-fired gasification boiler available in three sizes with outputs from 100,000 to 198,000 BTU/hr. The wood gasification combustion process within the Solo Plus begins when the small, quiet draft fan turns on in response to your home's thermostat.

The draft fan forces fresh air into the top of the firebox and down through the wood and live charcoal bed. This hot air and smoke mixture is forced through a slot in the top of the ceramic combustion chamber. Super-heated secondary air is injected into these gases. The correct combination of wood, gas, smoke and high-temperature oxygen results in an 1800° flame in the ceramic combustion tunnel. Gases stay in this hot, turbulent environment long enough to achieve extremely high combustion efficiency. The resultant high-temperature gases pass into the vertical heat exchange tubes, giving off heat to the boiler water for house heating and hot water demands.

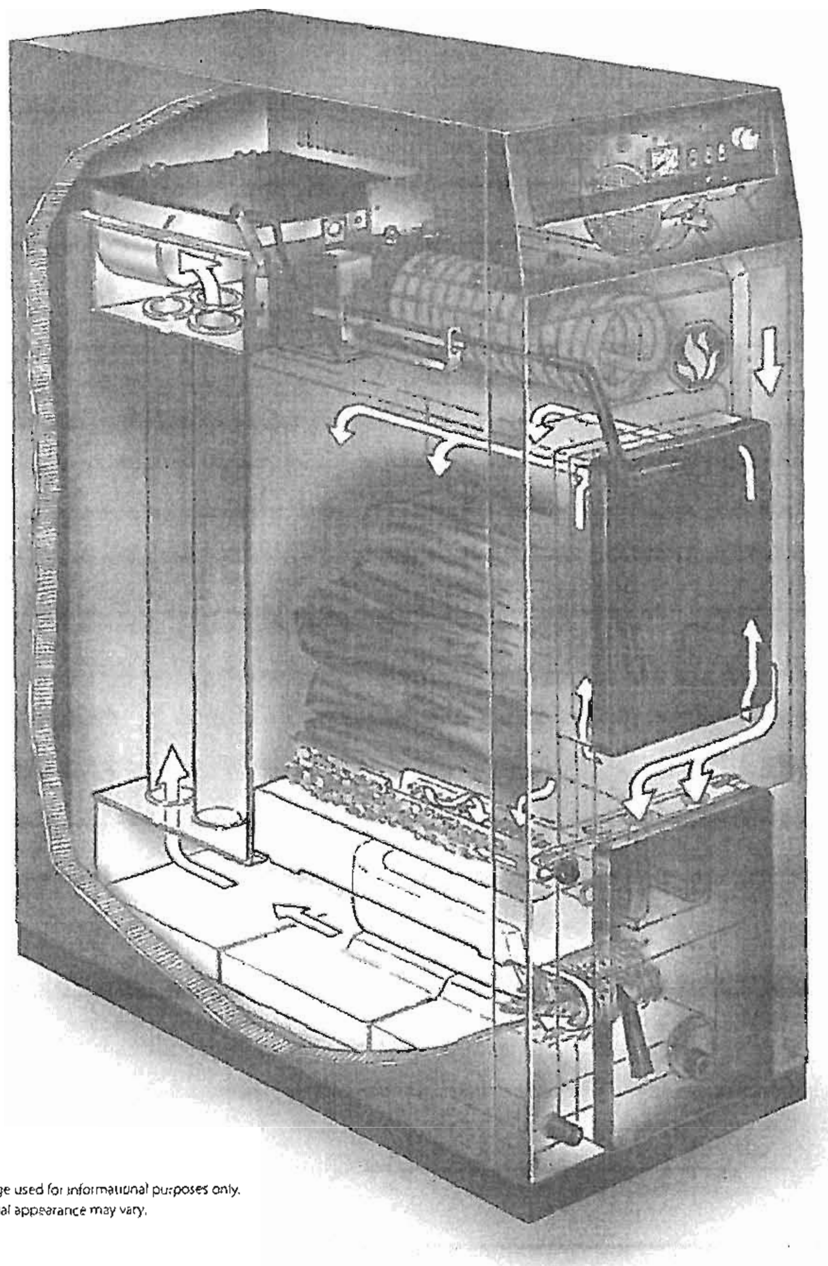


Image used for informational purposes only.
Actual appearance may vary.

Standard Equipment

- jacket with insulation
- steel doors with gasketing
- draft fan
- relief valve
- boiler control
- cleaning implements
- manual

Optional Equipment

- heat storage system
- domestic hot water coil
- Termovar boiler protection valve
- contact BioHeat USA for a full list of accessories

Warranty

Each Solo Plus boiler is covered by a 20-year limited warranty. A copy is available for your inspection, and is provided with each boiler.

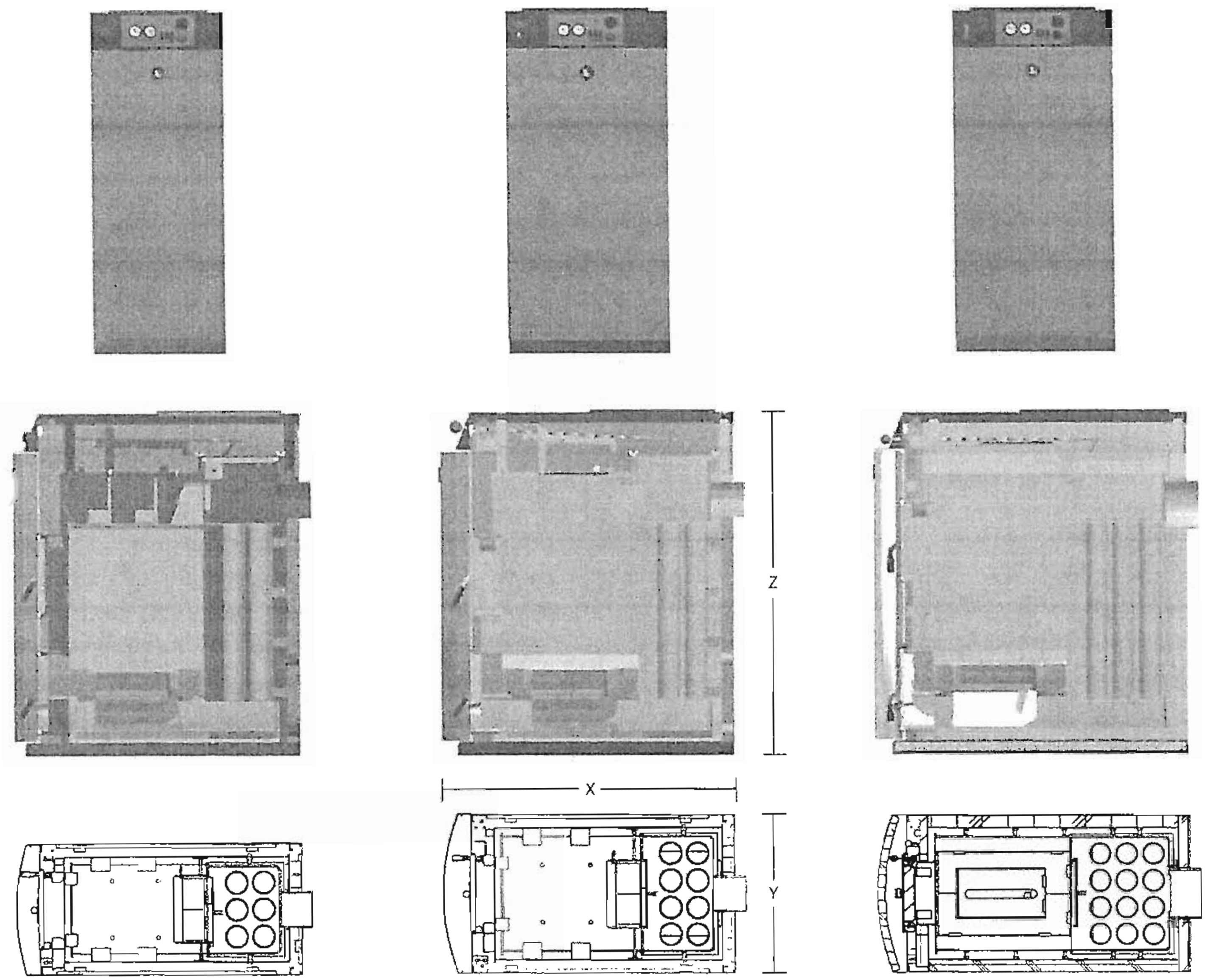
Disclaimer

BioHeat USA is not responsible for factory alterations to measurements. For final specifications, please see the Scandtec Solo Plus Owner's Manual.

BIOHEATUSA™
Innovative Leaders in Alternative Heating Solutions

Listed Appliance

4 Britton Lane | P.O. Box 285 | Lyme, NH 03768 | 800.782.9927 | info@bioheatusa.com | www.bioheatusa.com



Solo Plus 30

Solo Plus 40

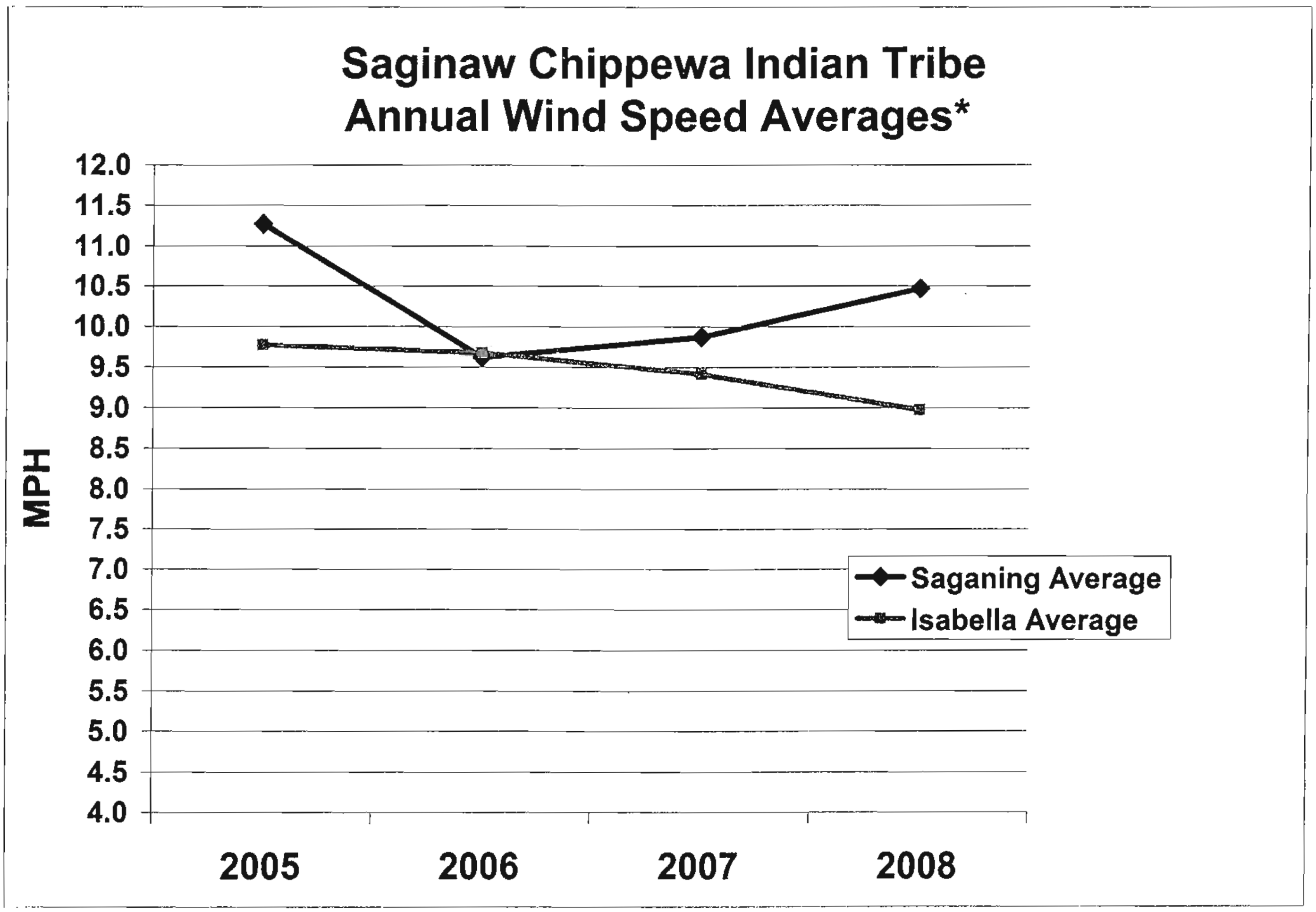
Solo Plus 60

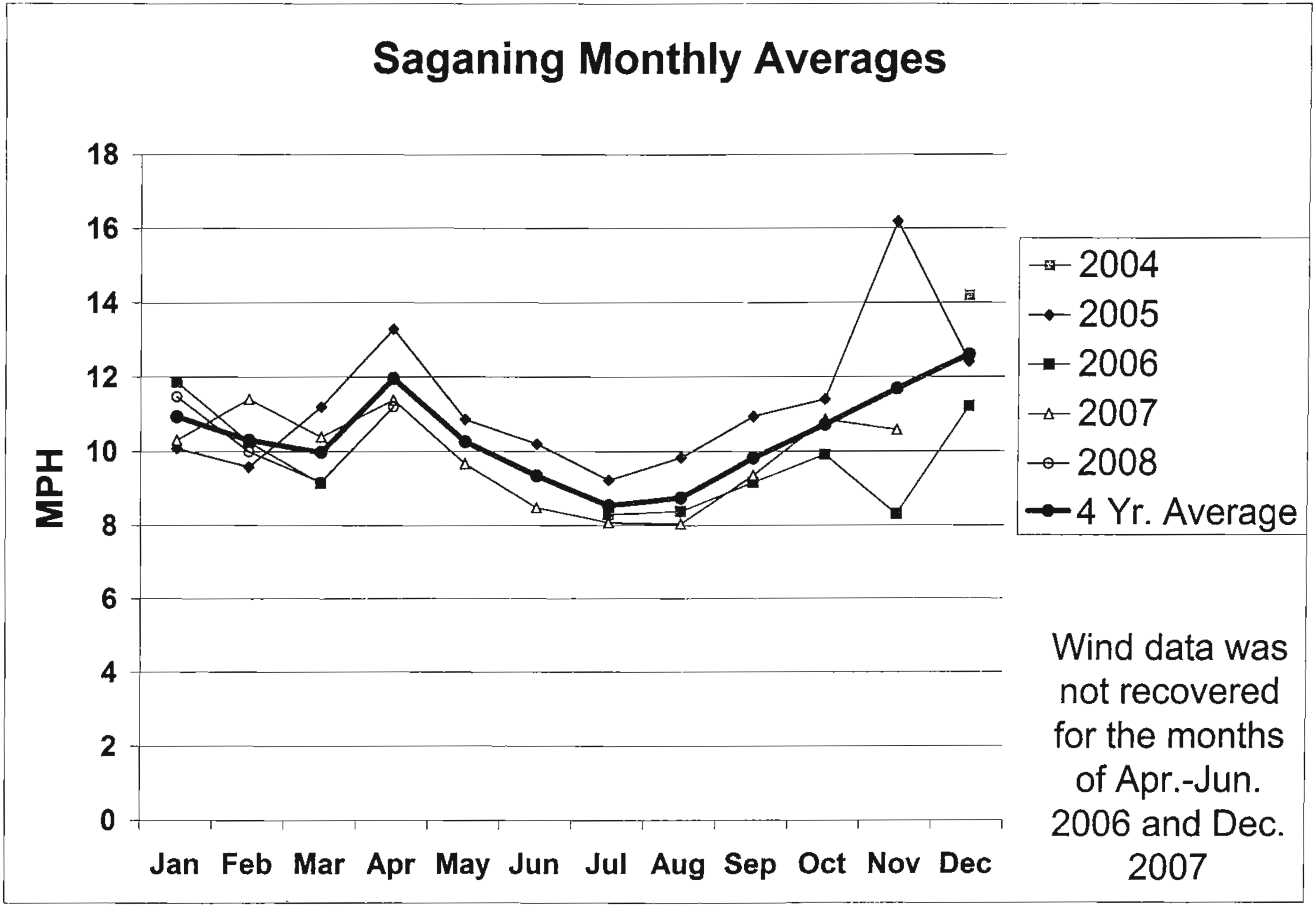
Technical Data		30	40	60
Maximum heat/output	BTU/hr	100,000	140,000	198,000
Firebox depth	inches	21	21	21
Load door	in. X in.	10 X 12	10 X 12	10 X 12
irebox volume	cubic feet	4.01	5.35	6.01
Maximum wood length	inches	20	20	20
Test pressure boiler	PSI	65	65	65

Dimensions are subject to technical alterations.

Technical Data			30	40	60
Unit length	X	inches	46½	46½	50½
Unit width	Y	inches	21	25	25
Unit height	Z	inches	55½	55½	55½
Unit weight		pounds	1,080	1,180	1,230
Flue collar size		inches	6	6	8
Height of flue collar		inches	41¾	41¾	41¾

Storage tank ideal volume is 100 gallons/14,000 BTUs


Saginaw Chippewa Indian Tribe
Annual Wind Speed Averages*
MPH
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
2005
2006
2007
2008
Saganing Average
Isabella Average

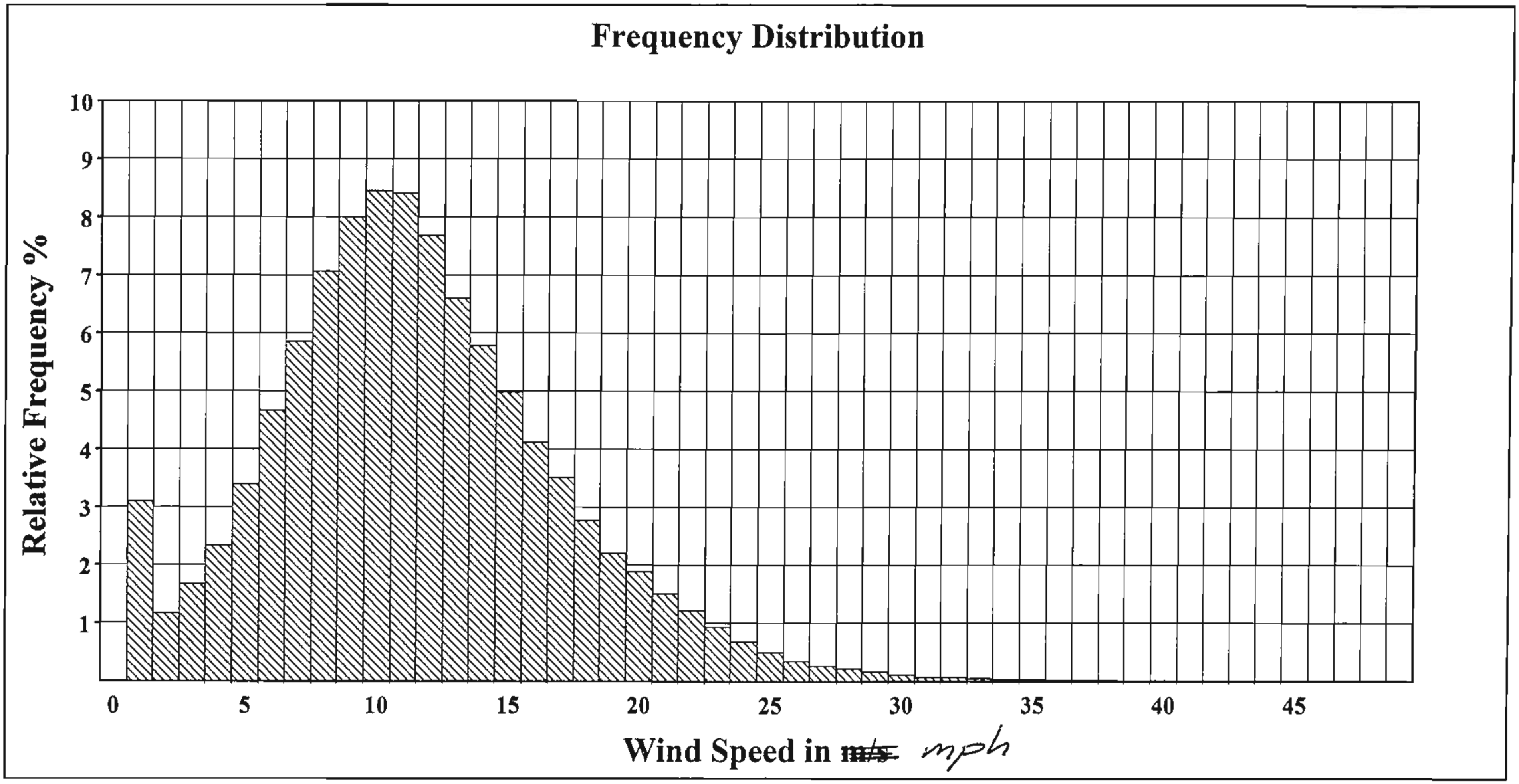

Saganing Monthly Averages
MPH
18
16
14
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2004
2005
2006
2007
2008
4 Yr. Average
Wind data was not recovered for the months of Apr.-Jun. 2006 and Dec. 2007

Site Information:
Project: New Project
Location:
Elevation:

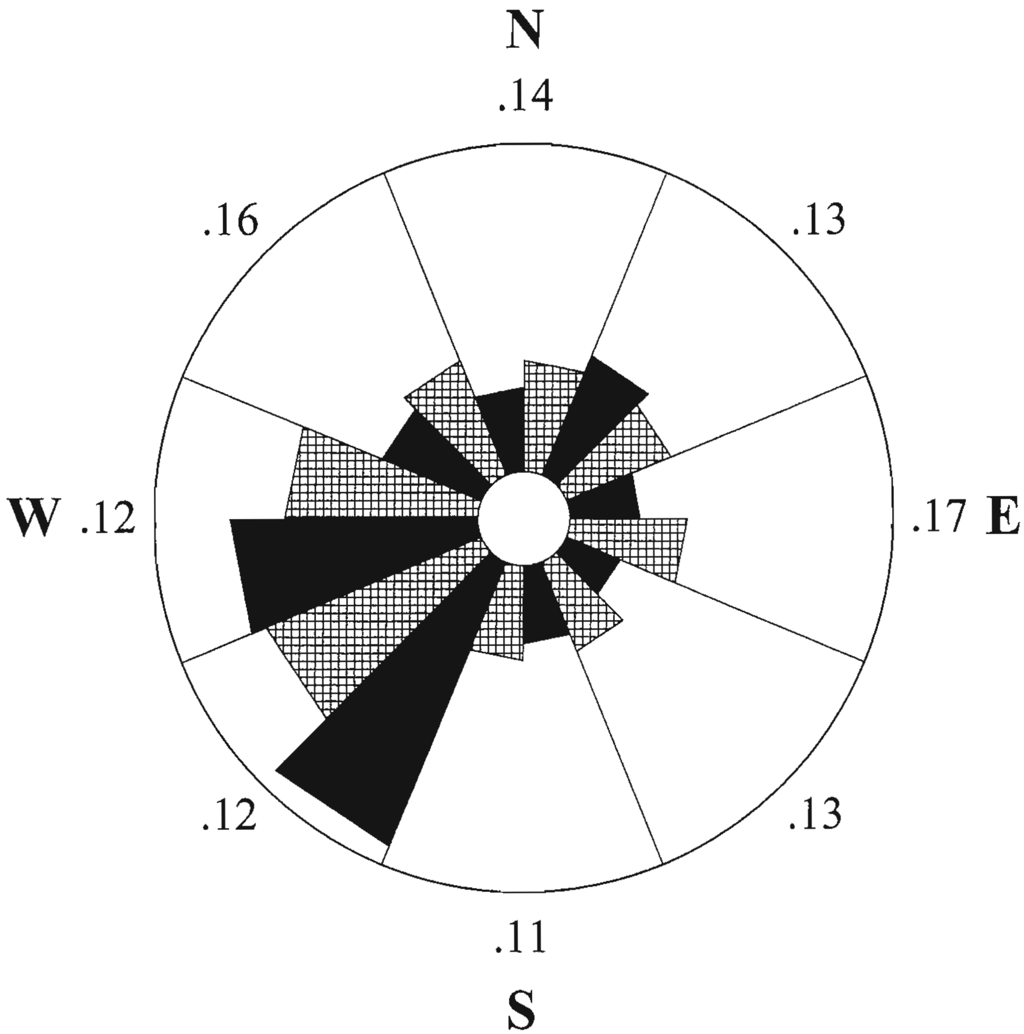
Sensor on channel 1:
NRG #40 Anem. mph
Height: 50 m
Serial #: SN:

12/15/2004 to 4/27/2008

Frequency Distribution Ch 1
SITE 5436
Saganing



Generated Wednesday, July 16, 2008 Total 10-minute intervals: 177120 Intervals used in calculations: 144064 Percent data used: 81.3 NRG Systems SDR Version 5.10



12/15/2004 to 4/27/2008

Wind Rose Ch 1, 7

SITE 5436

Saganing

Site Information:

Project: New Project

Location:

Elevation:

Anemometer on channel 1:

NRG #40 Anem. mph

Height: 50 m

Serial #: SN:

Vane on channel 7:

#200P Wind Vane

Height: 0

Serial #: SN:

Outer Numbers are Average TIs for speeds greater than 4.5 m/s

Inner Circle = 0%

Outer Circle = 30%

■ Percent of Total Wind Energy

▦ Percent of Total Time

Generated Wednesday, July 16, 2008 Total 10-minute intervals: 177120 Intervals used in calculations: 144064 Percent data used: 81.3 NRG Systems SDR Version 5.10

Site Information:

Project: Saginaw Chippewa Indian Tribe

Location:

Elevation:

Sensor Information:

1 NRG #40 Anem. 50 m
2 NRG #40 Anem. 50 m
3 NRG #40 Anem. 40 m
4 NRG #40 Anem. 40 m
5 NRG #40 Anem. 30 m
6 No SCM Installed
7 #200P Wind Vane
8 #200P Wind Vane
9 NRG #110S Temp F
10 No SCM Installed
11 No SCM Installed
12 No SCM Installed

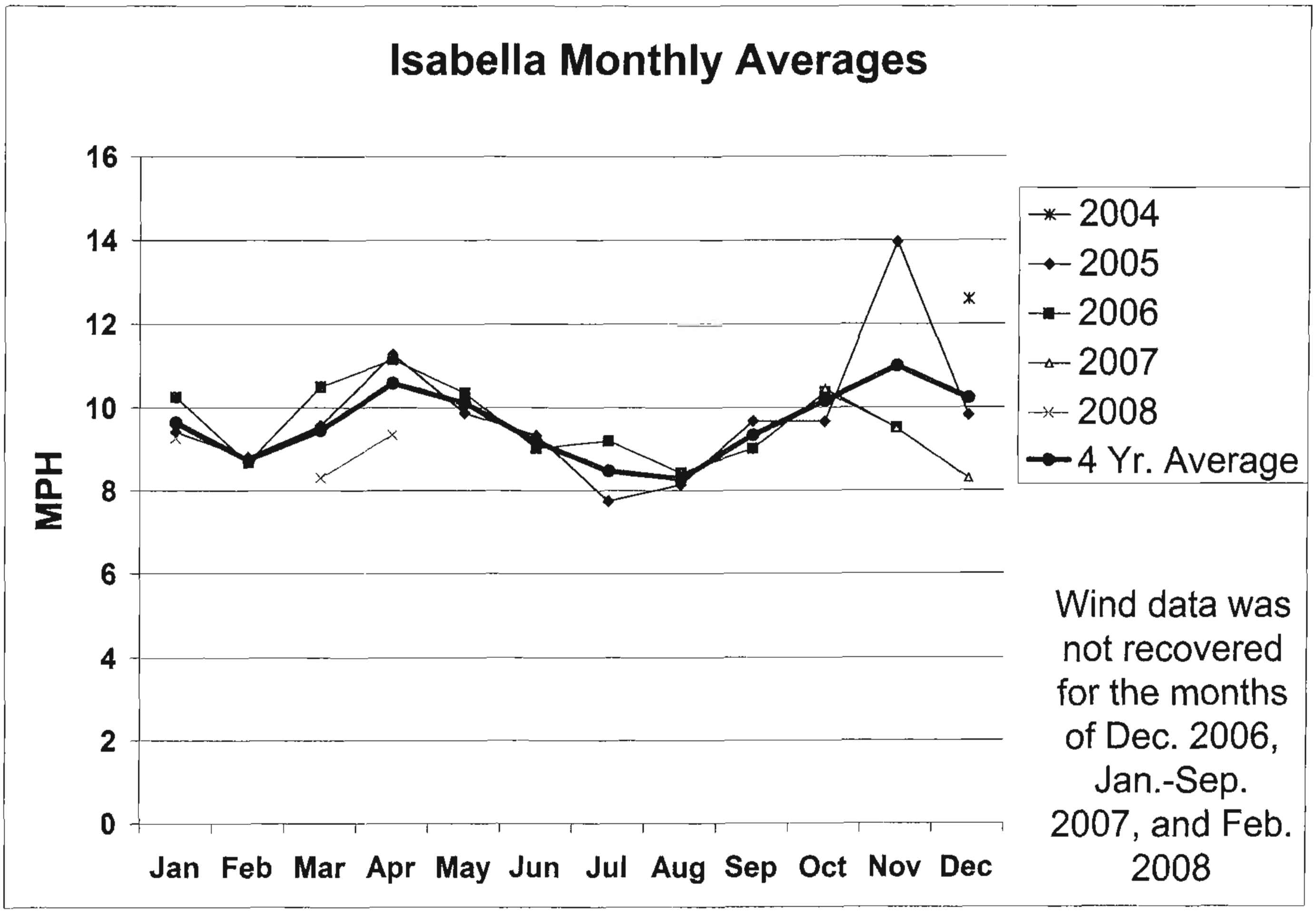
12/15/2004 to 4/27/2008

Summary Report

SITE 5436

Saganing

Channel	1	2	3	4	5		7	8	9			
Height	50 m	50 m	40 m	40 m	30 m	------	0	0	0	------	------	------
Units	mph	mph	mph	mph	mph	-----	deg	deg	F	-----	-----	-----
Intervals with Valid Data	144064	144064	144064	144064	144064		144064	144064	144064			
Average Filtered Data	11.47	11.41	10.54	10.49	9.85		255.6	251.1	46.61			
Average for All Data	11.47	11.41	10.54	10.49	9.85		255.6	251.1	46.61			
Min Interval Average	0.8	0.8	0.8	0.8	0.8				-12			
Date of Min Interval	12/26/2004	12/17/2004	12/26/2004	12/26/2004	12/26/2004				1/25/2007			
Time of Min Interval	2:10:00 AM	12:00:00 PM	2:10:00 AM	2:10:00 AM	1:50:00 AM				9:00:00 PM			
Max Interval Average	45.4	46	44.4	67.9	42.7				99.1			
Date of Max Interval	11/13/2005	11/13/2005	11/13/2005	3/3/2007	11/13/2005				8/1/2006			
Time of Max Interval	1:30:00 PM	1:30:00 PM	1:30:00 PM	11:30:00 AM	1:30:00 PM				2:10:00 PM			
Average Interval SD	1.51	1.54	1.52	1.6	1.58		9.76	8.92	0.11			
Min Sample	0.8	0.8	0.8	0.8	0.8				-58.8			
Date of Min Sample	12/17/2004	12/17/2004	12/17/2004	12/17/2004	12/17/2004				11/26/2007			
Time of Min Sample	10:00:00 AM	10:00:00 AM	9:40:00 AM	9:40:00 AM	7:30:00 AM				12:00:00 AM			
Max Sample	62.5	6358.2	61.5	20147.8	59.8				99.6			
Date of Max Sample	11/16/2005	3/1/2007	7/9/2007	3/3/2007	11/13/2005				8/1/2006			
Time of Max Sample	3:50:00 AM	7:50:00 PM	3:20:00 PM	11:30:00 AM	5:00:00 PM				2:10:00 PM			
Average Interval TI	0.14	0.15	0.15	0.16	0.17							
Wind Speed Direction							SW	SW				


Isabella Monthly Averages
MPH
16
14
12
10
8
6
4
2
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
2004
2005
2006
2007
2008
4 Yr. Average
Wind data was not recovered for the months of Dec. 2006, Jan.-Sep. 2007, and Feb. 2008

Site Information:

Project: New Project

Location:

Elevation:

Sensor on channel 1:

NRG #40 Anem. mph

Height: 50 m

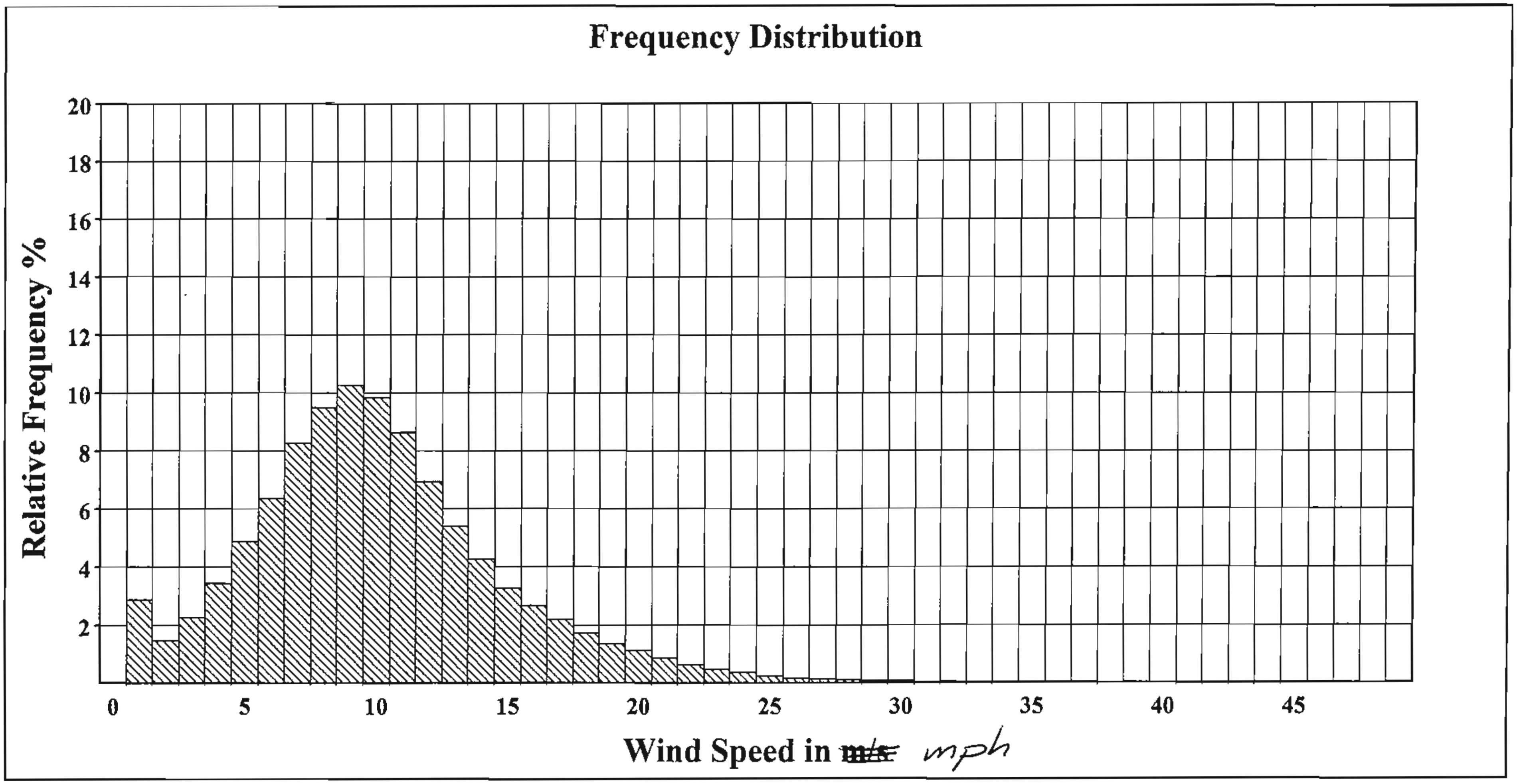
Serial #: SN:

12/15/2004 to 4/23/2008

Frequency Distribution Ch 1

SITE 5435

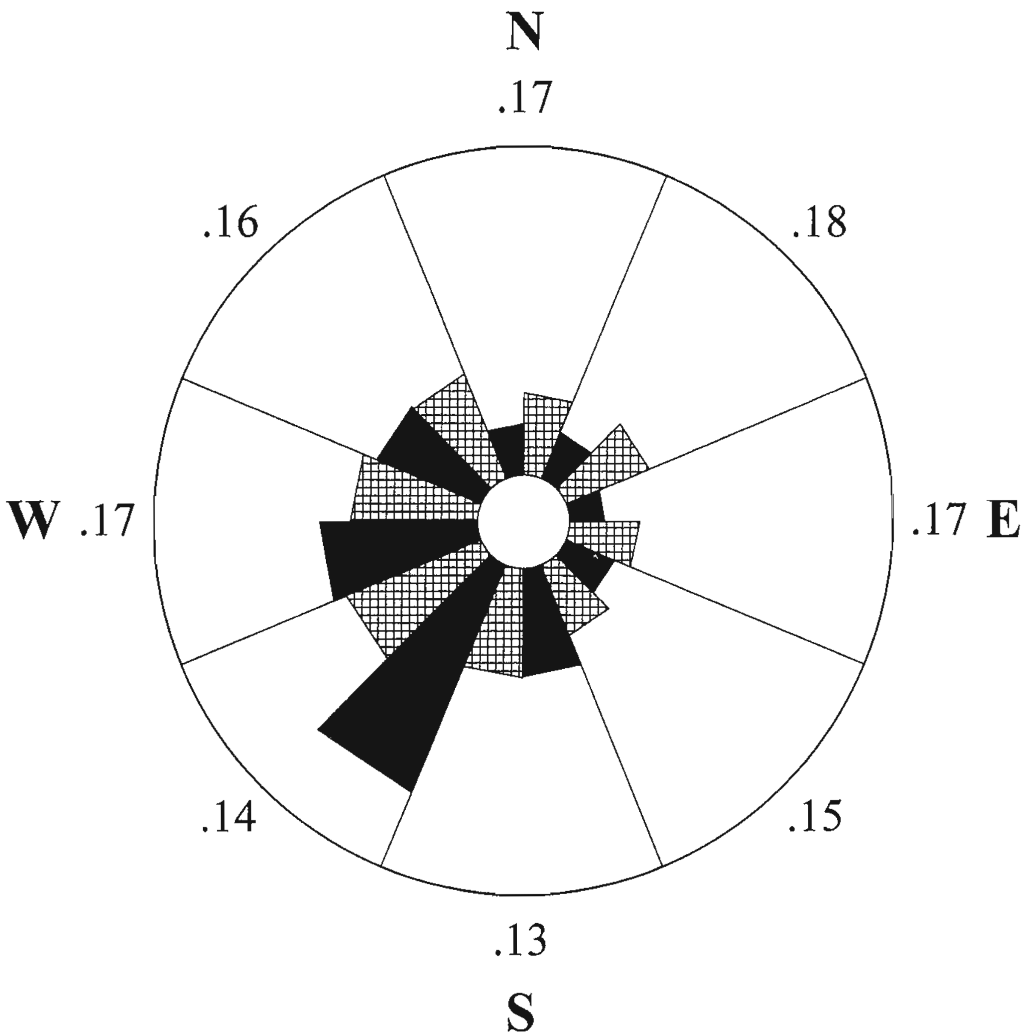
Isabella



Generated Wednesday, July 16, 2008

Total 10-minute intervals: 176544 Intervals used in calculations: 118504 Percent data used: 67.1

NRG Systems SDR Version 5.10



12/15/2004 to 4/23/2008

Wind Rose Ch 1, 7 new

SITE 5435

Isabella

Site Information:

Project: New Project

Location:

Elevation:

Anemometer on channel 1:

NRG #40 Anem. mph

Height: 50 m

Serial #: SN:

Vane on channel 7:

#200P Wind Vane

Height: 0

Serial #: SN:

Outer Numbers are Average TIs for speeds greater than 4.5 m/s

Inner Circle = 0%

Outer Circle = 40%

■ Percent of Total Wind Energy

▦ Percent of Total Time

Site Information:

Project: Saginaw Chippewa Indian Tribe

Location:

Elevation:

Sensor Information:

1 NRG #40 Anem. 50 m
2 NRG #40 Anem. 50 m
3 NRG #40 Anem. 40 m
4 NRG #40 Anem. 40 m
5 NRG #40 Anem. 30 m
6 No SCM Installed
7 #200P Wind Vane
8 #200P Wind Vane
9 NRG #110S Temp F
10 No SCM Installed
11 No SCM Installed
12 No SCM Installed

12/15/2004 to 4/23/2008

Summary Report

SITE 5435

Isabella

Channel	1	2	3	4	5		7	8	9			
Height	50 m	50 m	40 m	40 m	30 m	------	0	0	0	------	------	------
Units	mph	mph	mph	mph	mph	-----	deg	deg	F	-----	-----	-----
Intervals with Valid Data	118504	118504	118504	118504	118504		118504	118504	118504			
Average Filtered Data	10.03	9.67	9.14	9.08	8.3		250.8	253.43	-24.64			
Average for All Data	10.03	9.67	9.14	9.08	8.3		250.8	253.43	-24.64			
Min Interval Average	0.8	0.8	0.8	0.8	0.8				-121.8			
Date of Min Interval	12/27/2004	12/26/2004	12/27/2004	12/27/2004	12/27/2004				2/23/2007			
Time of Min Interval	8:10:00 AM	1:40:00 AM	10:10:00 AM	10:10:00 AM	9:50:00 AM				5:40:00 PM			
Max Interval Average	42.9	42.9	40.9	41.3	39.7				94.1			
Date of Max Interval	3/13/2006	3/13/2006	3/13/2006	3/13/2006	3/13/2006				6/27/2005			
Time of Max Interval	5:00:00 PM	5:00:00 PM	6:30:00 PM	6:30:00 PM	6:30:00 PM				2:20:00 PM			
Average Interval SD	1.63	1.7	1.64	1.64	1.63		11	11.73	0.23			
Min Sample	0.8	0.8	0.8	0.8	0.8				-122.5			
Date of Min Sample	12/17/2004	12/17/2004	12/17/2004	12/17/2004	12/17/2004				2/23/2007			
Time of Min Sample	9:10:00 AM	9:10:00 AM	9:10:00 AM	9:10:00 AM	9:00:00 AM				6:10:00 PM			
Max Sample	68.4	68.4	66.6	67.5	65				94.8			
Date of Max Sample	7/17/2006	7/17/2006	7/17/2006	7/17/2006	7/17/2006				6/27/2005			
Time of Max Sample	5:10:00 PM	5:10:00 PM	5:10:00 PM	5:10:00 PM	5:10:00 PM				2:10:00 PM			
Average Interval TI	0.17	0.19	0.19	0.19	0.21							
Wind Speed Direction							SW	W				

Appendix E. Saganing Single Commercial Wind Turbine Pro Forma's

SAGINAW CHIPPEWA PRO FORMA CASH FLOW PROJECTIONS Sep-08
WIND TURBINE GENERATORS 1 83 meter
S^GANING WIND PROJECT 1500 kW Net Wind Output 613 kWhrs/yr/m2
Rotor Dia 83 meter

ASSUMPTIONS

		Cost per WTG	$2,900,000	Cost/kW			
Total Cost:		Total Cost	**$2,900,000**	$1,933	**Finance Term:**	**20**	**years**
Debt:	75%		$2,175,000		Interest Rate:	6.00%	year
Equity:	25%		$725,000		Federal Tax:	0%	per annum
Wind Power Purchase Electric Rate or Offset:			$0.0700		Federal Incentive (10 yrs):	$0.0200	per kW-hr
Electric escalation rate:			4.00%		Federal Tax Credit:	$0.000	
Annual Output kwh/yr./WTG:			3,316,077		O&M & REPI Escalation rate:	2.00%	
Maintenance fee/yr./WTG:			28,000		Mgt. fee/yr./WTG:	$6,000	
All-Risk Insurance/$100:			$0.25		Utility/Sub. fee/yr./WTG:	$1,200	
Air Pollution Emission Credits/kW-hr			$0.005		Land Rent/yr./WTG:	$0	
					Local Property Tax:	0.00%	

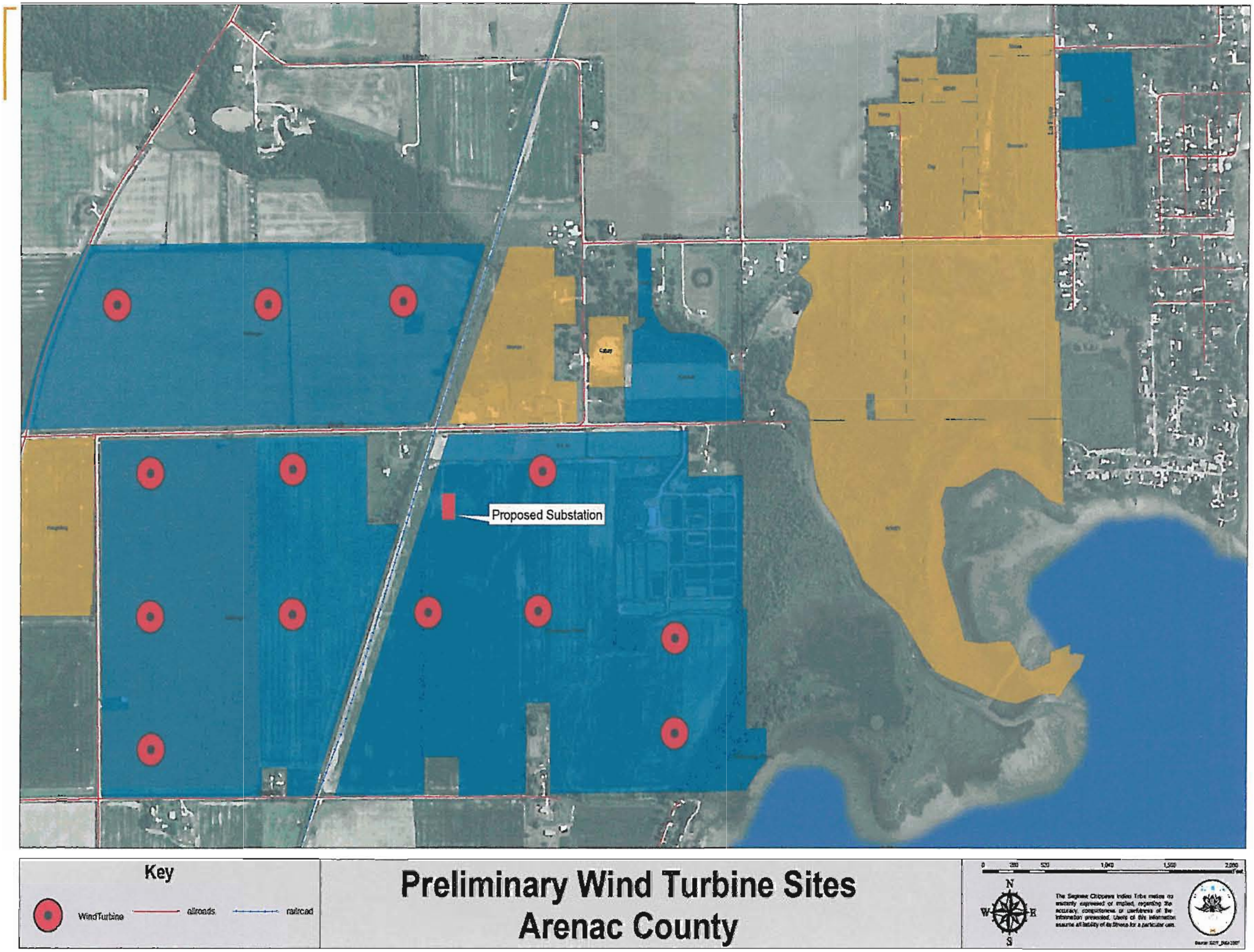
YEAR	2009	2010	2011	2012	2013	2014	2015	2016
	1	2	3	4	5	6	7	8
Price/kwh	0.0700	0.0728	0.0757	0.0787	0.0819	0.0852	0.0886	0.0921
Output/year	3316077	3316077	3316077	3316077	3316077	3316077	3316077	3316077
Electric Sales Revenues	232125	241410	251067	261109	271554	282416	293713	305461
Fed Re Incentive Pmt./credit	66322	67648	69001	70381	71789	73224	74689	76183
Air Emission Credits	16580	16912	17250	17595	17947	18306	18672	19046
GROSS INCOME	**315,027**	**325,970**	**337,318**	**349,086**	**361,290**	**373,946**	**387,074**	**400,689**
EXPENSES								
Rent	0	0	0	0	0	0	0	0
Management	6,000	6,120	6,242	6,367	6,495	6,624	6,757	6,892
Maintenance	28,000	28,560	29,131	29,714	30,308	30,914	31,533	32,163
Local Taxes	0	0	0	0	0	0	0	0
All-risk Insurance	5,438	5,546	5,657	5,770	5,886	6,003	6,124	6,246
Performance Insur.	0	0	0	0	0	0	0	0
Utility & Substation	1,200	1,224	1,248	1,273	1,299	1,325	1,351	1,378
TOTAL EXPENSES	**40,638**	**41,450**	**42,279**	**43,125**	**43,987**	**44,867**	**45,764**	**46,680**
NET REVENUE	**274,390**	**284,520**	**295,039**	**305,961**	**317,302**	**329,079**	**341,309**	**354,010**
Debt Service	189,626	189,626	189,626	189,626	189,626	189,626	189,626	189,626
Total Debt & O&M Expense	230,264	231,077	231,906	232,751	233,614	234,493	235,391	236,306
CASH FLOW	**84,763**	**94,894**	**105,412**	**116,334**	**127,676**	**139,453**	**151,683**	**164,383**
Debt Coverage Ratio	1.45	1.50	1.56	1.61	1.67	1.74	1.80	1.87
Cost/ kW-hr. (pre REPI)	**$0.069**	**$0.070**	**$0.070**	**$0.070**	**$0.070**	**$0.071**	**$0.071**	**$0.071**
Cost/kW-hr With REPI	$0.049	$0.049	$0.049	$0.049	$0.049	$0.049	$0.048	$0.048
Principal	59,126	62,674	66,434	70,421	74,646	79,124	83,872	88,904
Interest	130,500	126,952	123,192	119,206	114,981	110,502	105,754	100,722

FINANCIAL SUMMARY DATA

BENEFIT/COST RATIO	**1.65**
PV of Benefits w/REPI	**$7,317,435**
PV of Costs	**$4,425,710**
1st year "Cash on Cash"	**9.46%** (net revenue/total cost)
25 YR PRE TAX IRR "Yield"	**18.37%**
NPV Electric Cost/kwh	**$0.045**
Discount Rate	**3.00%**

$2,891,725 Net Present Value (25 yr)

Appendix F. Saganing Wind Farm Pro Forma's



Preliminary Wind Turbine Sites
Arenac County

Saganing Wind Project Economics:

13 Wind Turbines

- Total Cost: $35 Million
- Gross Income per year $4 million
- Cost of Electricity 4.5 cents per kWh
- Net Present Value: $41 million

SAGINAW CHIPPEWA | PRO FORMA CASH FLOW PROJECTIONS | Apr-08

WIND TURBINE GENERATORS | 13 83 meter

SAGANING WIND PROJECT | 1500 kW | Net Wind Output 613 kWhrs/yr/m2 | Rotor Dia 83 meter

ASSUMPTIONS		Cost per WTG	$2,692,000	Cost/kW			
Total Cost:		Total Cost	$34,996,000	$1,795	Finance Term:	20	years
Debt	75%		$26,247,000		Interest Rate:	6.00%	year
Equity:	25%		$8,749,000		Federal Tax:	0%	per annum
Wind Power Purchase Electric Rate or Offset:			$0.0700		Federal Incentive (10 yrs):	$0.0200	per kW-hr
Electric escalation rate:			4.00%		Federal Tax Credit:	$0.000	
Annual Output kwh/yr./WTG:			43,109,001		O&M & REPI Escalation rate:	2.00%	
Maintenance fee/yr./WTG:			28,000		Mgt. fee/yr./WTG:	$6,000	
At-Risk Insurance/$100:			$0.25		Utility/Sub. fee/yr./WTG:	$1,200	
Air Pollution Emission Credits/kW-hr			$0.005		Land Rent/yr./WTG:	$0	
					Local Property Tax:	0.00%	

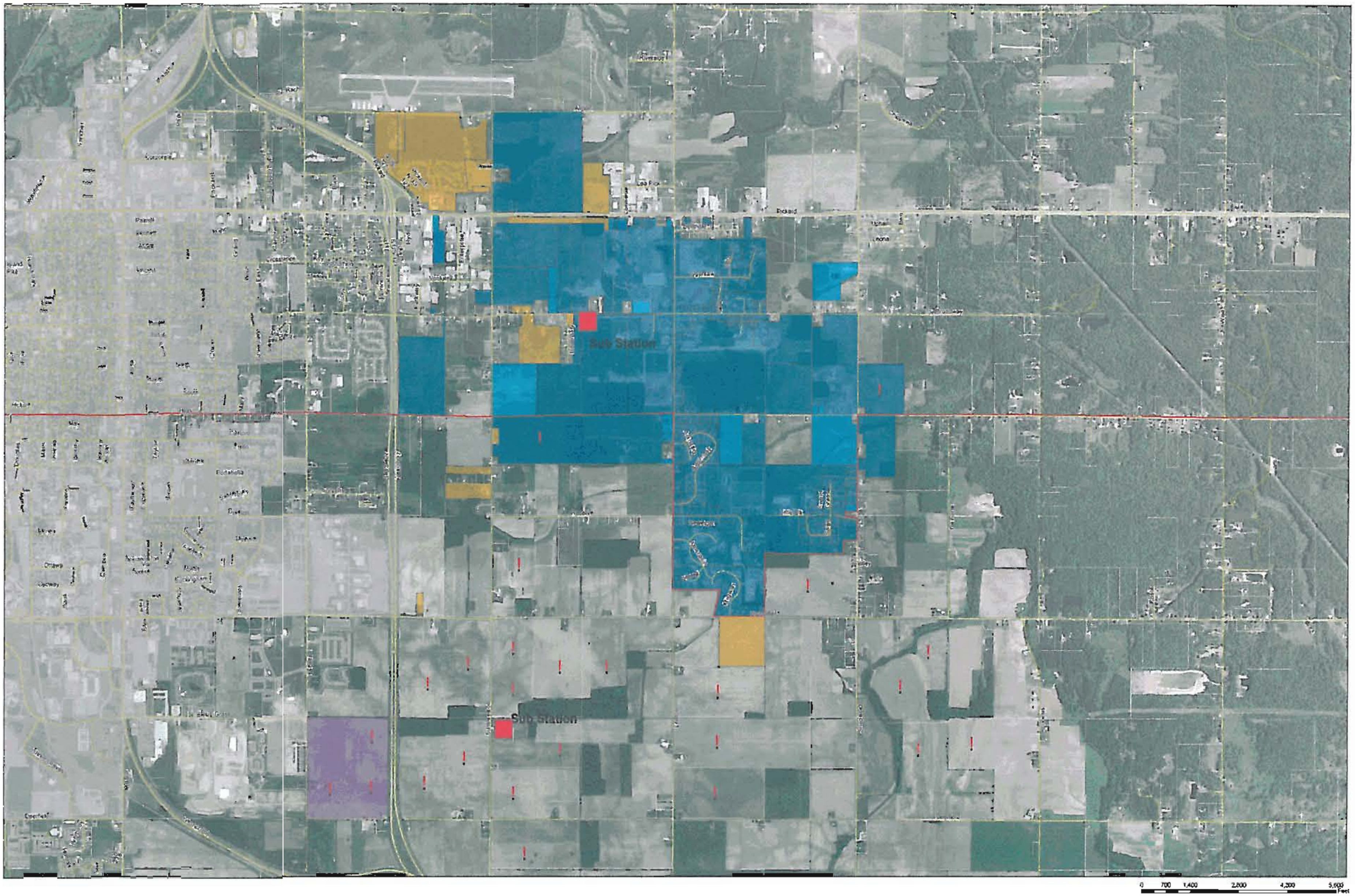
YEAR	2009	2010	2011	2012	2013	2014	2015	2016
	1	2	3	4	5	6	7	8
Price/kwh	0.0700	0.0728	0.0757	0.0787	0.0819	0.0852	0.0886	0.0921
Output/year	43109001	43109001	43109001	43109001	43109001	43109001	43109001	43109001
Electric Sales Revenues	3017630	3138335	3263869	3394423	3530200	3671408	3818265	3970995
Fed Re Incentive Pmt./credit	862180	879424	897012	914952	933251	951916	970955	990374
Air Emission Credits	215545	219856	224253	228738	233313	237979	242739	247593
GROSS INCOME	4,095,355	4,237,615	4,385,134	4,538,114	4,696,765	4,861,304	5,031,958	5,208,963
EXPENSES								
Land Rent	0	0	0	0	0	0	0	0
Management	78,000	79,560	81,151	82,774	84,430	86,118	87,841	89,597
Maintenance	364,000	371,280	378,706	386,280	394,006	401,886	409,923	418,122
Local Taxes	0	0	0	0	0	0	0	0
At-risk Insurance	65,618	66,930	68,268	69,634	71,026	72,447	73,896	75,374
Performance Insur.	0	0	0	0	0	0	0	0
Utility & Substation	15,600	15,912	16,230	16,555	16,886	17,224	17,568	17,919
TOTAL EXPENSES	523,218	533,682	544,355	555,243	566,347	577,674	589,228	601,012
NET REVENUE	3,572,136	3,703,933	3,840,778	3,982,871	4,130,417	4,283,629	4,442,730	4,607,950
Debt Service	2,288,333	2,288,333	2,288,333	2,288,333	2,288,333	2,288,333	2,288,333	2,288,333
Total Debt & O&M Expense	2,811,551	2,822,015	2,832,689	2,843,576	2,854,681	2,866,007	2,877,561	2,889,346
CASH FLOW	1,283,805	1,415,600	1,552,445	1,694,538	1,842,084	1,995,296	2,154,397	2,319,617
Debt Coverage Ratio	1.56	1.62	1.68	1.74	1.80	1.87	1.94	2.01
Cost/ kW-hr. (pre REPI)	$0.065	$0.065	$0.066	$0.066	$0.066	$0.066	$0.067	$0.067
Cost/kW-hr With REPI	$0.045	$0.045	$0.045	$0.045	$0.045	$0.044	$0.044	$0.044
Principal	713,513	756,324	801,703	849,805	900,794	954,841	1,012,132	1,072,860
Interest	1,574,820	1,532,009	1,486,630	1,438,528	1,387,539	1,333,492	1,276,201	1,215,473

FINANCIAL SUMMARY DATA

BENEFIT/COST RATIO	1.76	
PV of Benefits w/REPI	$95,126,649	
PV of Costs	$54,118,003	
First year "Cash on Cash"	10.21%	(net revenue/total cost)
25 YR PRE TAX IRR "Yield"	21.12%	
NPV Electric Cost/kwh	$0.042	
Discount Rate	3.00%	

$41,008,646 Net Present Value (25 yr)

Appendix G. Isabella Wind Project Pro Forma's



Preliminary Wind Turbine Sites
Isabella County

Key

Wind Turbine Isa
Reservation1_1
County Roads

The Saginaw Chippewa Indian Tribe makes no warranty expressed or implied, regarding the accuracy, completeness or usefulness of the information presented. Users of this information assume all liability of its fitness for a particular use.

Source: SCIT_Data 2009

Isabella Wind Project:

19 Wind Turbines

- Total Project Cost: $49 Million
- Gross Income per year: $5.1 million
- Cost per kWh: 5.7 cents / kWh
- Net Present Value: $39.3 million

SAGINAW CHIPPEWA PRO FORMA CASH FLOW PROJECTIONS Apr-08
WIND TURBINE GENERATORS 19 83 meter
ISABELLA WIND SITES 1500 kW

ASSUMPTIONS							
		Net Wind Output:	525	kWhrs/yr/m2			
		Rotor Dia	83	meter			
Cost per WTG	$2,620,000	Cost/kW					
Total Cost:	Total Cost	$49,780,000	$1,747	Finance Term:	20	years
Debt:	75%	$37,335,000		Interest Rate:	6.00%	year
Equity:	25%	$12,445,000		Federal Tax:	0%	per annum
Wind Power Purchase Electric Rate or Offset:		$0.0700		Federal Incentive (10 yrs):	$0.0200	per kW-hr
Electric escalation rate:		4.00%		Federal Tax Credit:	$0.000	
Annual Output kwh/yr./WTG:		53,960,633		O&M & REPI Escalation rate:	2.00%	
Maintenance fee/yr./WTG:		28,000		Mgt. fee/yr./WTG:	$6,000	
At-Risk Insurance/$100:		$0.25		Utility/Sub. fee/yr./WTG.	$1,200	
Air Pollution Emission Credits/kW-hr		$0.005		Land Rent/yr./WTG:	$7,200	
				Local Property Tax:	0.00%	

YEAR	2009	2010	2011	2012	2013	2014	2015	2016
	1	2	3	4	5	6	7	8
Price/kwh	0.0700	0.0728	0.0757	0.0787	0.0819	0.0852	0.0886	0.0921
Output/year	53960633	53960633	53960633	53960633	53960633	53960633	53960633	53960633
Electric Sales Revenues	3777244	3928334	4085467	4248886	4418842	4595595	4779419	4970596
Fed Re Incentive Pmt./credit	1079213	1100797	1122813	1145269	1168174	1191538	1215369	1239676
Air Emission Credits	269803	275199	280703	286317	292044	297884	303842	309919
GROSS INCOME	5,126,260	5,304,330	5,488,983	5,680,473	5,879,060	6,085,018	6,298,630	6,520,191
EXPENSES								
Land Rent	136,800	136,800	136,800	136,800	136,800	136,800	136,800	136,800
Management	114,000	116,280	118,606	120,978	123,397	125,865	128,383	130,950
Maintenance	532,000	542,640	553,493	564,563	575,854	587,371	599,118	611,101
Local Taxes	0	0	0	0	0	0	0	0
All-risk Insurance	93,338	95,204	97,108	99,051	101,032	103,052	105,113	107,215
Performance Insur	0	0	0	0	0	0	0	0
Utility & Substation	22,800	23,256	23,721	24,196	24,679	25,173	25,677	26,190
TOTAL EXPENSES	898,938	914,180	929,728	945,586	961,762	978,261	995,091	1,012,256
NET REVENUE	4,227,323	4,390,150	4,559,256	4,734,886	4,917,298	5,106,756	5,303,539	5,507,935
Debt Service	3,255,035	3,255,035	3,255,035	3,255,035	3,255,035	3,255,035	3,255,035	3,255,035
Total Debt & O&M Expense	4,153,973	4,169,216	4,184,763	4,200,622	4,216,798	4,233,297	4,250,126	4,267,292
CASH FLOW	972,287	1,135,115	1,304,220	1,479,851	1,662,262	1,851,721	2,048,504	2,252,899
Debt Coverage Ratio	1.30	1.35	1.40	1.45	1.51	1.57	1.63	1.69
Cost/ kW-hr. (pre REPI)	$0.077	$0.077	$0.078	$0.078	$0.078	$0.078	$0.079	$0.079
Cost/kW-hr With REPI	$0.057	$0.057	$0.057	$0.057	$0.056	$0.056	$0.056	$0.056
Principal	1,014,935	1,075,832	1,140,381	1,208,804	1,281,333	1,358,213	1,439,705	1,526,088
Interest	2,240,100	2,179,204	2,114,654	2,046,231	1,973,703	1,896,823	1,815,330	1,728,948

FINANCIAL SUMMARY DATA

BENEFIT/COST RATIO	1.49	
PV of Benefits w/REPI	$119,072,447	
PV of Costs	$79,749,335	
First year "Cash on Cash"	8.49%	(net revenue/total cost)
25 YR PRE TAX IRR "Yield"	15.05%	
NPV Electric Cost/kwh	$0.050	
Discount Rate	3.00%	

$39,323,111 Net Present Value (25 yr)

Wind Power Economic Sensitivity Analysis

Net Present Value (NPV) From Generating approximately 100% of Annual Electric Consumption of 51 million kWhr/yr. Assumes 7 cent per kW-hr cost avoidance, with avoided electric costs projected to increase either 2%, 4% or 6% over a 25 year period. (see attached preliminary pro forma spreadsheets)

Saganing: 13 Wind Turbines - Project Cost - $34,996,000

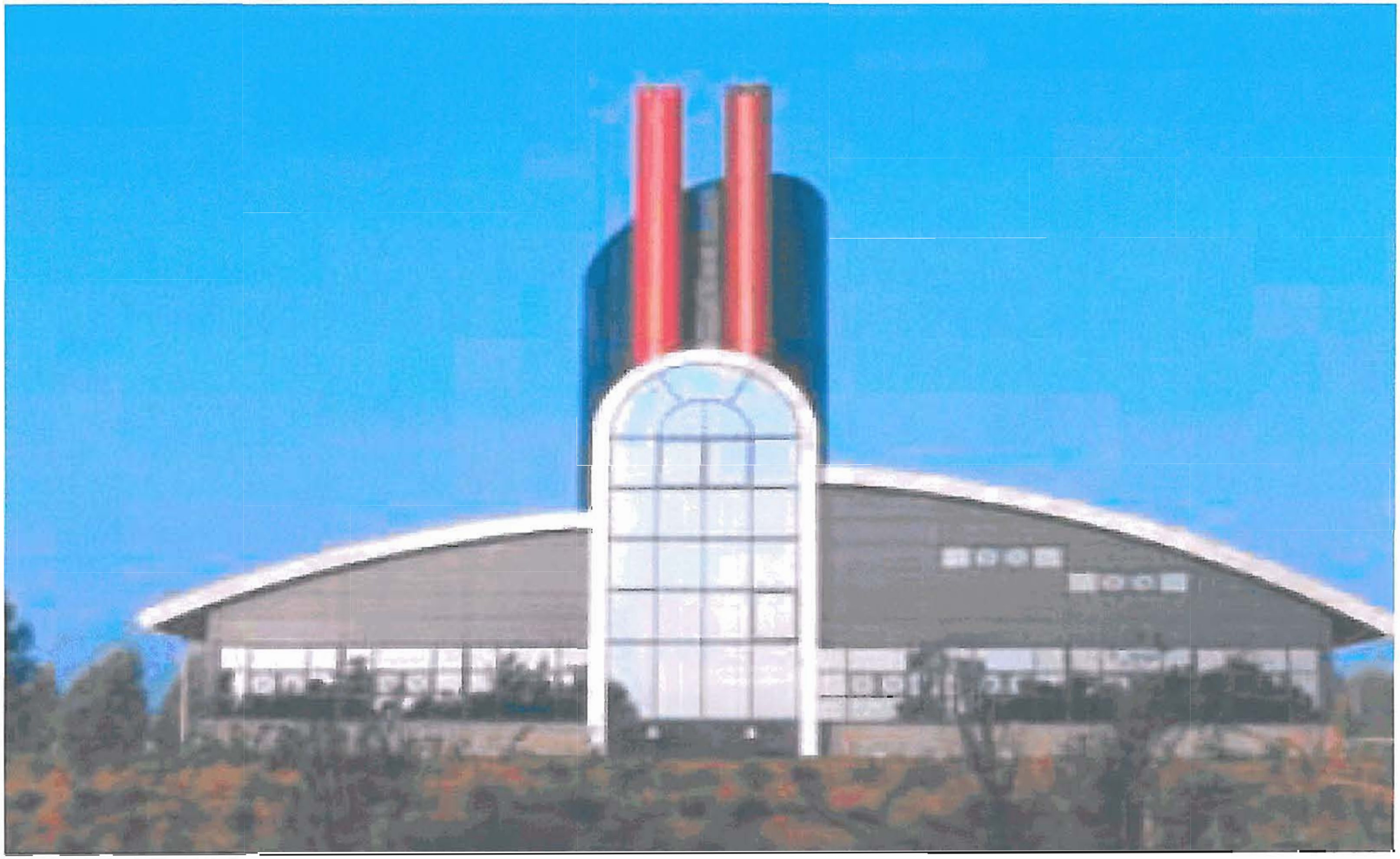
Avoided Cost Inflation	NPV(25 yr)
2%	$23,847,290
4%	$41,008,646
6%	$64,160,560

Isabella: 19 Wind Turbines - Project Cost - $49,780,000

	NPV (25 yr)
2%	$17,875,602
4%	$39,323,111
6%	$68,302,951

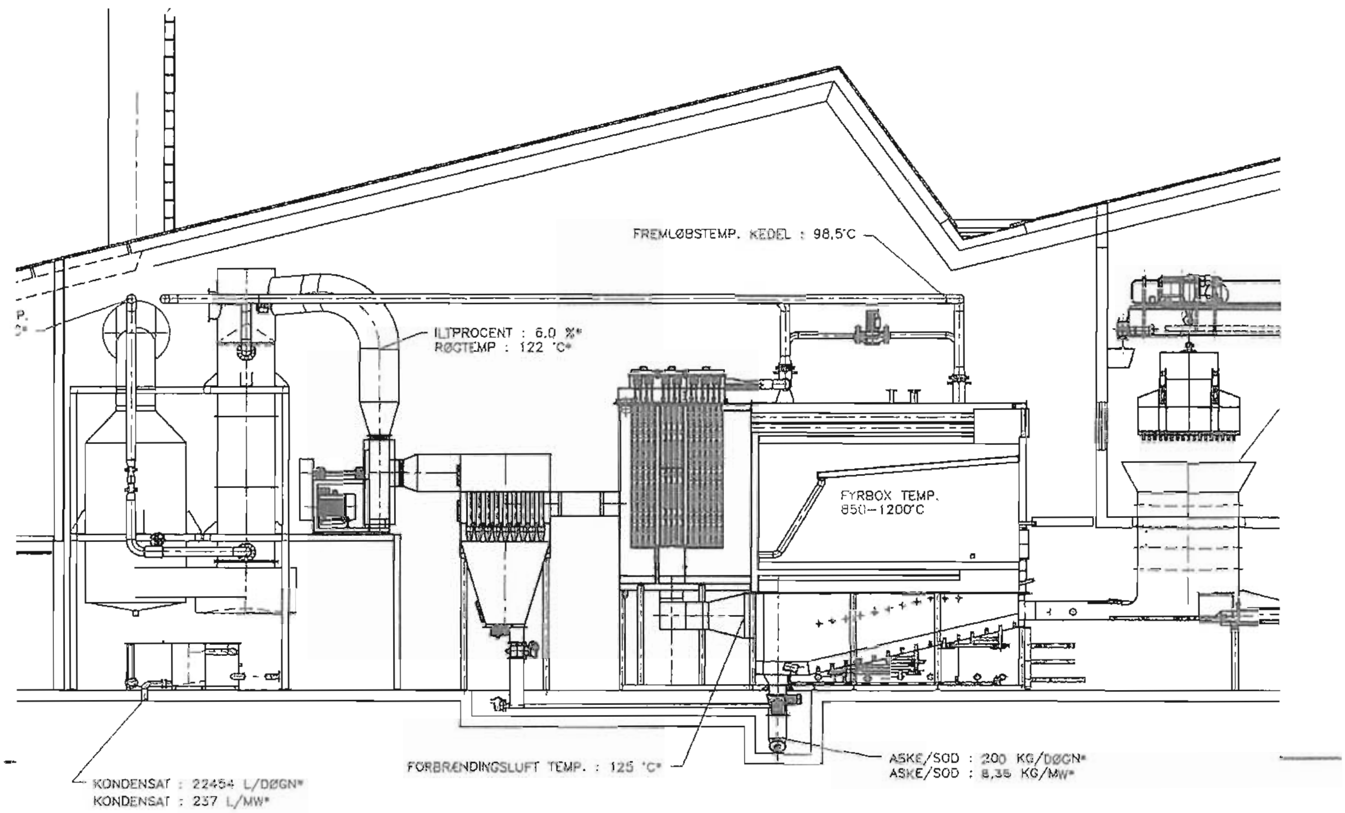
Appendix H. Biomass Stage I and II Financial Study

Power Plants Can Look Good!!



Wood Chip Biomass Heat Plant

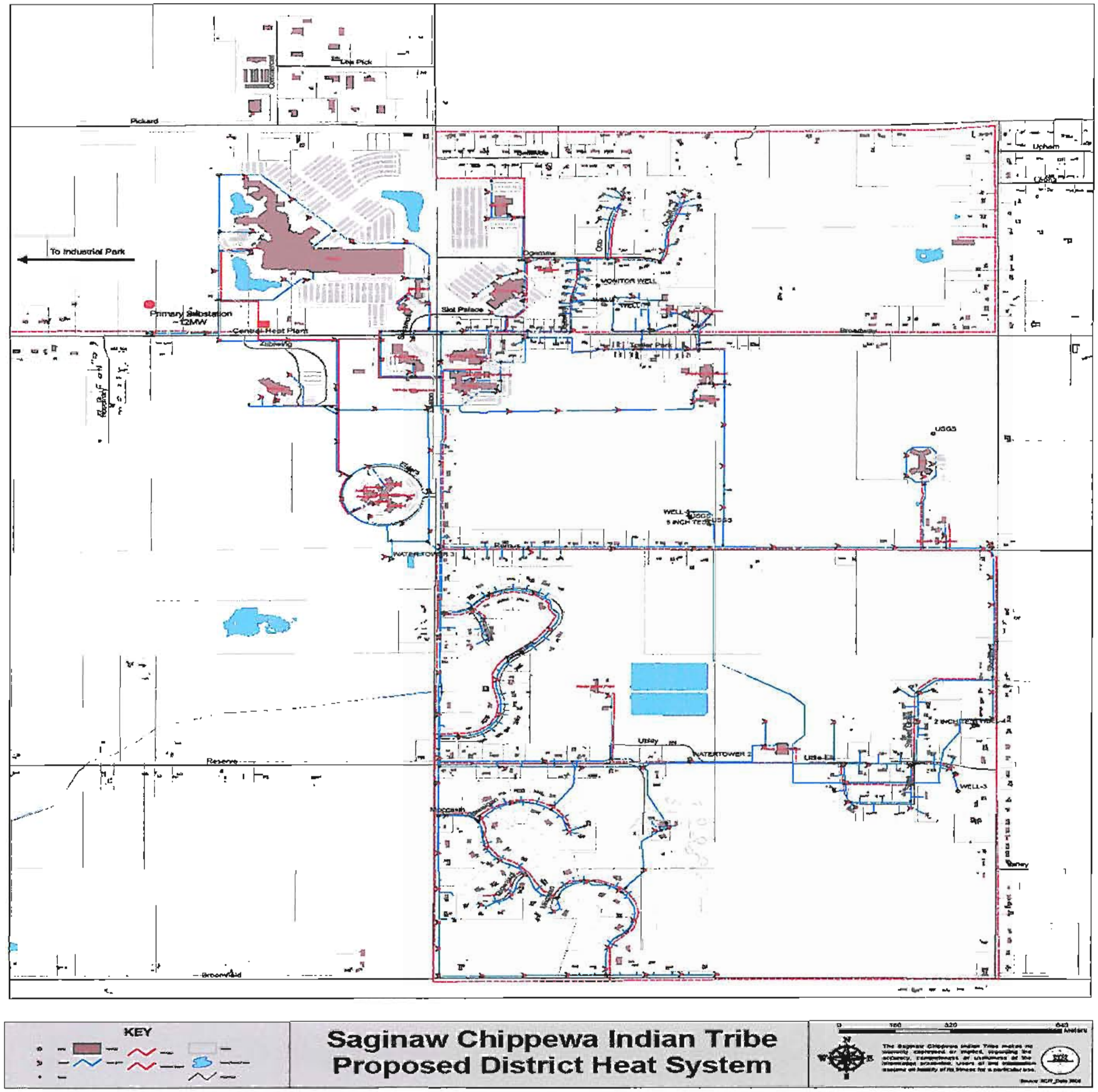
(courtesy of Force Technology A. Evald)



Biomass District Heat Preliminary Concept Plan

Stage I: Central Commercial and Public District

Stage II: Residential and remote facilities



Saginaw Chippewa Soaring Eagle Resort		Stage 1	
Wood Fired Steam CHP	60 MMBTU		
	17.58	mW	
Peak Wood Heat Output (million BTU)		60	mmbtu
Wood Fuel Cost per ton	$	25.00	/US ton
Peak Electric Capacity (kW)		5,000	kW
Electric CHP Operating Capacity Factor %		50%	CF
Utility Electric Sale Price $/kW-hr	$	0.065	/kW-hr
Local Electric Sale Price (to self) $/kWh	$	0.065	/kW-hr
Thermal Heating Capacity Factor %	NA		CF
Thermal Heating Sales Price $/mmBTU	$	9.00	mmbtu

CAPITAL COSTS

Wood Fired Unit at Site w/ Boiler & storage	$8,000,000
Mechanical Interconnection & Distribution	$1,270,000
Steam Turbine	$2,000,000
Building Retrofit & Prep	$200,000
Utility Interconnection w/transformer	$200,000
Engineering & Development	$80,000
Legal & Financial Expense	$20,000
TOTAL CAPITAL COST	$11,770,000

COST SUMMARY ANALYSIS

Installed Capital Cost		$11,770,000	
First Year Fuel, O&M & Admin Cost		$924,283	
First Year Capital Recovery Cost		$823,900	
First Year Expense (Debt & O&M)		$1,748,183	
Installed Cost per KWe	$	2,354	
Installed Cost per kW-hr/yr	$	0.537	/kW-hr
First Year Cost per kW-hr w/o REPI	$	0.015	/kW-hr
First Yr Cost per kWh w/REPI	$	(0.003)	/kW-hr

First Year Operating Cost Data

			Percent
Fuel	$	733,914	42.0%
Rent	$	-	0.0%
Admin	$	43,800	2.5%
O&M	$	124,500	7.1%
Taxes	$	-	0.0%
Insurance	$	22,069	1.3%
Capital Recovery	$	823,900	47.1%
TOTAL	$	1,748,183	100%

Note: Discount Rate for Present Value Calc. 3.0%

SECR		100000
Public Facilities		10000
		0
Annual Heat Load Requir. (mmbtu)		110,000
Heat Output mmbtu/year		157,680
Heat Cost per mmbtu	$	2.79
Total Heat Fuel Cost/yr	$	440,349
Heat Only $/mmbtu (w/capital & O&M)	$	6.65
Heat Energy $/mmbtu (fuel only)	$	2.79
N. Gas Cost $/mmbtu @75% eff.	$	12.00
Thermal Heat Sales @75%NG Cost	$	1,419,120
Total Electric Expense per/yr	$	329,063
Electric Output kW-hrs/year		21,900,000
First Year Electric Cost per kW-hr	$	0.015
Electricity kWh/yr Available for Sale		(20,100,000)
Value of Excess Elec/yr at $.06/kwh	$	(1,206,000)
Local Consumption Electric kWh		42,000,000
Percent Local Electric to Total Gen.		192%
Natural Gas Cost/CCF	$	1.20
Energy Cost to Electric kW-hr Price	$	329,063
(assumes thermal energy sold at 75% NG)		
Exess Heat and Electric Sales	$	213,120

Energy Efficiency	
Total Wood Fuel Energy in mmbtu/yr	262,800
Heat Output mmbtu/year	157,680
Electric Output kW-hrs/year	21,900,000
Electric Output mmbtu/yr	74,745
Thermal Efficiency	60%
Electric Efficiency	28%
Total Efficiency	

Total O&M & K Cost less Excess Sale	$	1,535,063
Present Total Natural Gas Cost/yr	$	1,400,000
Electric Cost Savings /yr	$	1,094,437
Net Annual Savings	$	959,374

Saginaw Chippewa Soaring Eagle Resort — **Stage 2**

Wood Fired Steam CHP — **60 MMBTU**

	17.58	mW
Peak Wood Heat Output (million BTU)	60	mmbtu
Wood Fuel Cost per ton	$ 25.00	/US ton
Peak Electric Capacity (kW)	5,000	kW
Electric CHP Operating Capacity Factor %	50%	CF
Utility Electric Sale Price $/kW-hr	$ 0.065	/kW-hr
Local Electric Sale Price (to self) $/kWh	$ 0.065	/kW-hr
Thermal Heating Capacity Factor %	NA	CF
Thermal Heating Sales Price $/mmBTU	$ 9.00	mmbtu

CAPITAL COSTS

Wood Fired Unit at Site w/ Boiler & storage	$8,000,000
Mechanical Interconnection & Distribution	$9,820,000
Steam Turbine	$2,000,000
Building Retrofit & Prep	$200,000
Utility Interconnection w/transformer	$200,000
Engineering & Development	$80,000
Legal & Financial Expense	$20,000
TOTAL CAPITAL COST	$20,320,000

COST SUMMARY ANALYSIS

Installed Capital Cost	$20,320,000	
First Year Fuel, O&M & Admin Cost	$940,314	
First Year Capital Recovery Cost	$1,422,400	
First Year Expense (Debt & O&M)	$2,362,714	
Installed Cost per KWe	$ 4,064	
Installed Cost per kW-hr/yr	$ 0.928	/kW-hr
First Year Cost per kW-hr w/o REPI	$ 0.043	/kW-hr
First Yr Cost per kWh w/REPI	$ 0.025	/kW-hr

First Year Operating Cost Data		Percent
Fuel	$ 733,914	31.1%
Rent	$ -	0.0%
Admin	$ 43,800	1.9%
O&M	$ 124,500	5.3%
Taxes	$ -	0.0%
Insurance	$ 38,100	1.6%
Capital Recovery	$ 1,422,400	60.2%
TOTAL	$ 2,362,714	100%

Note: Discount Rate for Present Value Calc. 3.0%

SECR		100000
Public Facilities		10000
Residential		40000
Annual Heat Load Requir. (mmbtu)		150,000
Heat Output mmbtu/year		157,680
Heat Cost per mmbtu	$	2.79
Total Heat Fuel Cost/yr	$	440,349
Heat Only $/mmbtu (w/capital & O&M)	$	8.99
Heat Energy $/mmbtu (fuel only)	$	2.79
N. Gas Cost $/mmbtu @75% eff.	$	12.00
Thermal Heat Sales @75%NG Cost	$	1,419,120
Total Electric Expense per/yr	$	943,594
Electric Output kW-hrs/year		21,900,000
First Year Electric Cost per kW-hr	$	0.043
Electricity kWh/yr Available for Sale		(29,100,000)
Value of Excess Elec/yr at $.06/kwh	$	(1,746,000)
Local Consumption Electric kWh		51,000,000
Percent Local Electric to Total Gen.		233%
Natural Gas Cost/CCF	$	1.20
Energy Cost to Electric kW-hr Price	$	943,594
(assumes thermal energy sold at 75% NG)		
Exess Heat and Electric Sales	$	(326,880)

Energy Efficiency	
Total Wood Fuel Energy in mmbtu/yr	262,800
Heat Output mmbtu/year	157,680
Electric Output kW-hrs/year	21,900,000
Electric Output mmbtu/yr	74,745
Thermal Efficiency	60%
Electric Efficiency	28%
Total Efficiency	

Total O&M & K Cost less Excess Sale	$	2,689,594
Present Total Natural Gas Cost/yr	$	1,400,000
Electric Cost Savings /yr	$	479,906
Net Annual Savings	$	(809,688)

Appendix I. Natural Gas Engine Cost and Details

SECTION 2: CHP TECHNOLOGIES

2.1 PRIME MOVERS

This chapter presents ***ONLY highlights*** of the applicable technologies.
For more detailed information, visit the following DOE Website:
www.**CHPB.net/prof-status.html**

Purpose of Prime Mover:

Convert fuel energy directly to ***mechanical shaft power***. The shaft power can then drive a generator to produce utility grade ***electricity***. There are ***many proven prime mover technologies*** used for ***generating electricity*** on-site or near site.

Most Commonly Used Prime Movers

- **Reciprocating Internal Combustion (IC) Engines**
- **Combustion Turbines**
- **Microturbines**
- **Fuel Cells**

Table 2-1 ***Prime Mover "Rules-of-Thumb"***

RECIPROCATING IC ENGINES	**Capacity Rage** *(kW)*	100 – 500	500 – 2,000
	Electric Generation Efficiency		
	% of LHV of Fuel	24 – 28	28 – 38+
	Heat Rate, *Btu/kWh*	14,000 – 12,000	12,000 – 9,000
	Recoverable Useful Heat		
	Hot Water (@ *160°F), Btu/h per kW*	4,000 – 5,000	4,000 – 5,000
	Steam *(@ 15 psig), lbs/h per kW*	4 – 5	4 – 5
	Installed Cost, *$/kW*		
	(with Heat Recovery)	1,800 – 1,400	1,400 – 1,000
	O & M Costs, *$/kWh*	0.015 – 0.012	0.012 – 0.010
	NO_x Emission Levels, *lbs/MWH*		
	Rich Burn w/3-way catalyst (w/o)	≈0.5 (30-40)	≈0.5 (30-40)
	Lean Burn w/SCR treatment (w/o)	≈0.5 (2-6)	≈0.5 (2-6)
GAS TURBINES	**Capacity Rage,** *kW*	1,000 – 10,000	10,000 – 50,000
	Electric Generation Efficiency		
	% of LHV of Fuel	24 – 28	31 – 36
	Heat Rate, *Btu/kWh*	14,000 – 12,000	11,000 – 9,500
	Recoverable Useful Heat		
	Hot Water *(@ 160°F), Btu/h per kW*	5,000 – 6,000	5,000 – 6,000
	Steam *(@15 psig, lbs/h per kW*	5 – 6	5 – 6
	Installed Cost, *$/kW*		
	(with Heat Recovery)	1,500 – 1,000	1,000 – 800
	O & M Costs, *$/kWh*	0.015 – 0.012	0.012 – 0.010
	NOx Emission Levels, *ppm*		
	With Dry Low NOx Burner	< 25	< 25
	With SCR	< 10	< 10
MICROTURBINES	**Capacity Rage,** ***kW***	100 – 400	
	Electric Generation Efficiency		
	% of LHV of Fuel	25 – 30	
	Heat Rate, *Btu/kWh)*	13,700 – 11,400	
	Recoverable Useful Heat		
	Hot Water *(@ 160°F), Btu/h per kW*	6,000– 7,000	
	Steam (@ *15psig), lbs/h per kW*	N/A	
	Installed Cost, *$/kW*		
	(with Heat Recovery)	2,000 – 1,000	
	O & M Costs, *$/kWh*	0.015 – 0.01	
	NO_x Emission Levels, *lbs/MWh*	< 0.49	

2.1.1 Reciprocating Internal Combustion Engines (IC Engines)

One of the ***most common*** technologies used for power generation. These engines are the ***fastest growing segment*** of the market for CHP systems < ***5 MW***.

Sizes:

Capacities range from about ***5 kW* to *10 MW***.

Characteristics:

- ***Better at load following and part load operation*** than most of the other prime mover technologies.
- Can be ***fueled*** by ***natural gas, diesel*** or ***gasoline***:
  - CHP systems ***most commonly*** use ***natural gas*** because it results in ***significantly lower emissions*** than those fueled by the other two fuels.

> Most **backup** and **emergency** generator sets using IC engines are fueled with ***diesel*** or ***gasoline*** and are similar to an ***automotive design***. They are generally ***NOT*** designed for **continuous** operation nor are they setup to ***recover thermal energy*** from the engine exhaust streams.

- CHP systems generally use ***industrial grade*** engines because these are designed for ***continuous*** (24/7) ***operation***.
- Two types of ignition systems: **spark** and **compression**. **Spark** ignited engines can use natural gas or gasoline as fuel and **compression** ignited engines can only use diesel fuel.
- Designed to operate in one of the two modes:
  1) **Rich-burn** operation uses ***higher*** fuel-to-air ratios than the stoichiometric ratio (defined as the fuel-to-air ratio theoretically required for complete combustion of the fuel).
     - More common for engine capacities ***<500 kW*** (670 hp).
     - Normally produce **NO_x** emissions in the range of ***30 to 50 lbs per MWh*** with ***no exhaust treatment***. Therefore, most installations using **rich burn** engines will ***REQUIRE*** a ***3-way catalyst*** to treat the engine exhaust. This can reduce NO_x emissions to as low as ***0.5 lb/MWh***, but adds approximately ***$50/kW*** to the engine's installed cost.
  2) **Lean-burn** operation uses ***lower*** fuel-to-air ratios than the stoichiometric ratio.
     - The **energy efficiency** is ***slightly higher*** than that for rich-burn engines.
     - Normally produce **NO_x** emissions in the range of ***2 to 6 lbs per MWh*** with ***no exhaust treatment***.
     - Most installations using **lean-burn** engines do **NOT** ***require exhaust treatment***. ***If*** exhaust treatment is needed to reduce **NOx** emissions, the ***most common*** treatment is the use of a ***Selective Catalytic Reduction (SCR)***. Use of an SCR is **very expensive**. It adds approximately ***$100/kW*** to the engine installed cost and **$1400/ton of NO_x removed** in operating cost.

> In order to put the emissions of engines in some perspective, it is important to note that the ***average*** for all ***central power plant*** in the U.S. produces approximately ***3 lbs of NOx per MWh***. *(Per e-Grid data for the year 2000)*

➢ The **fuel utilization efficiency** of IC engines for producing electricity ranges from approximately ***25% to 40%*** on the basis of lower heating value (LHV). Usable ***thermal energy*** from these prime movers is normally ***recovered*** from two streams: 1) ***engine exhaust gases***, and 2) ***engine-jacket coolant***. ***Distribution of energy*** for a typical engine is shown in Figure 2-1.

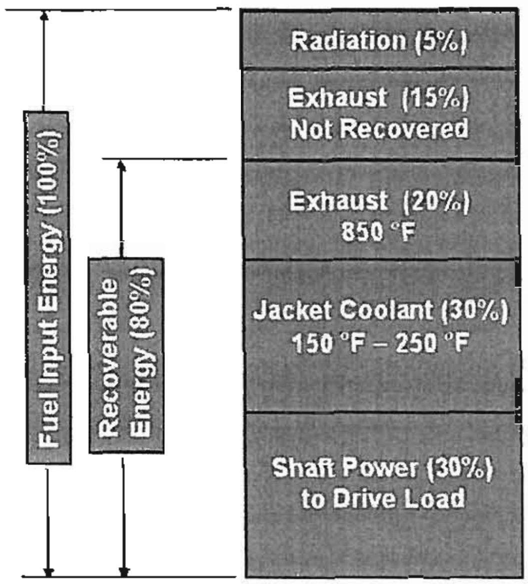


Figure 2-1 Energy Distributions for a Typical Reciprocating Engine

2.3 Thermally-Activated Technologies

The technologies that use ***thermal energy*** as the ***primary energy*** for their operation are collectively called **"Thermally Activated Technologies (TATs)."** The three most common TATs that are applicable to CHP systems are as follows:

1. **Absorption Chillers**
2. **Desiccant Dehumidifiers**
3. **Space and Process Heaters**

For a detailed discussion on the ***benefits*** of a CHP system, visit the U.S. Department of Energy (DOE) Website (www.**CHPB.net/prof-benefit.html**) for CHP for Buildings.

Table 2-4 ***Absorption Chillers "Rules-of-Thumb"***

ABSORPTION CHILLERS	Single-Effect	Double-Effect
Capacity Range *(kW)*		
COP	0.6-0.67	0.9-1.2
Heat Source		
Minimum Temperature, *°F*	180	350
Steam Flow Rate, *lbs/h per RT*	18	10-11
Steam Pressure, *psig*	15	115-125
Integration w/ Waste Heat from:		
Reciprocating engines, RT/kW	0.22 - 0.28	0.3-0.4
Combustion turbines, RT/kW	0.28 - 0.33	0.4-0.5
Microturbines, RT/kW	0.33 - 0.45	0.4-0.5
Average Electric Power Offset	0.6kW/RT	0.6kW/RT
Installed Cost *($/RT)*		
100 RT	1000	1200
500 RT	700	900
1,000 RT	650	850
2,000 RT	500	700
O&M Costs *($/RT/yr)*		
100 RT	30	30
500 RT- 2,000 RT	16-28	17-25

Table 2-5 ***Desiccant "Rules-of-Thumb"***

	Parameter	Units	Industrial		Commercial	
SOLID	Flow Rate	SCFM	600	40,000	2,000	12,000
SOLID	Installed Cost	$/SCFM	$20	$5	$8	$4.50
SOLID	O&M Costs	¢/SCFM/yr	0.26	0.06	0.09	0.06
SOLID	Regeneration (200°F)	BTU/hr per SCFM	55	55	45	45
SOLID	Latent Heat Removal	lbs/hr per 1000 SCFM	35	35	30	30
SOLID	Parasitic Electric Use	KWh per 1000 SCFM	1.1	1.1	0.8	0.8
LIQUID	Flow Rate	SCFM	3,000	84,000	10,000	84,000
LIQUID	Installed Cost	$/SCFM	$18	$5	$7	$5
LIQUID	O&M Costs	¢/SCFM/yr	0.38	0.11	0.15	0.11
LIQUID	Regeneration (200°F)	BTU/hr per SCFM	45	45	35	35
LIQUID	Latent Heat Removal	lbs/hr per 1000 SCFM	30	30	30	30
LIQUID	Parasitic Electric Use	KWh per 1000 SCFM	1.3	1.3	1.3	1.3

2.3.1 Absorption Chillers

Absorption chillers are ***similar*** to ***vapor compression chillers*** with a few ***key differences***.

- Basic ***difference*** is that a:
  - ***Vapor compression*** chiller uses a ***rotating device*** (electric motor, engine, combustion turbine or steam turbine) to ***operate the compressor*** to raise the pressure of refrigerant vapors, while an
  - **Absorption chiller** uses ***heat*** to ***compress*** the ***refrigerant*** vapors to a high-pressure, therefore this ***"thermal compressor" has no moving parts***.
- A process schematic of an absorption chiller is shown in Figure 2-5.

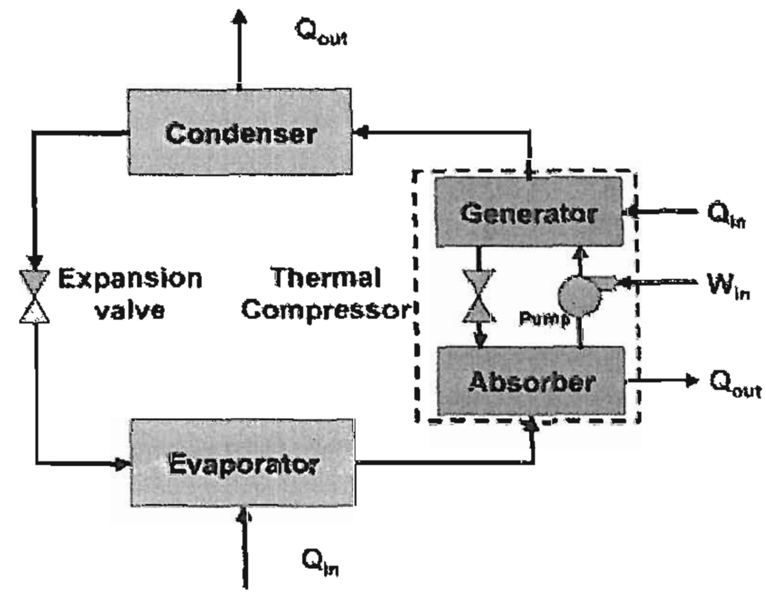


Figure 2-5 Process Schematic of an Absorption Chiller

- Commercially available **absorption chillers** that can be utilized within a CHP system can ***use***:
  1) ***Steam,***
  2) ***Hot Water,*** *or*
  3) ***Hot Exhaust Gases***
- Current ***absorber media / refrigerant*** for absorptions chillers are ***either***:
  - ***Lithium bromide / water***, or
  - ***Ammonia / water***
- Two types of steam absorption chillers are commercially available:

1. **Single Effect:**
   - ***Lower initial costs*** but ***less efficient*** and thus take more energy and are more expensive to operate.
   - Requires about ***18 lbs/h of steam at 15 psig for 1 ton of cooling.***
   - ***Most*** CHP systems ***utilize single effect absorption chillers*** to keep initial cost low.

2. **Double Effect:**
   - ***Higher initial*** costs but are ***more energy efficient*** and thus require less energy to operate.
   - Requires about 10 ***lbs/h of steam at about 120 psig for 1 ton of cooling***.

- Rated ***capacities*** of absorption chillers are based on producing ***chilled water*** at ***44°F***.
- Absorption chillers can also be used in chilled water storage systems to ***produce chilled water during off-peak electric load periods*** when ***the cost of electricity is low*** and the demand for cooling is low. The ***stored chilled water is then drawn upon during the peak cooling periods*** when ***electricity costs are high***, to supplement the chiller operation. The storage system helps to reduce the chiller capacity requirement and total installed cost of chillers.

SECTION 4: FEASIBILITY EVALUATION

Implementing a CHP system requires significant time, effort, and investment. Therefore, it's prudent to ***first estimate*** its ***financial*** *AND* ***technical*** feasibility using a systematic approach that incorporates the sequence of the process outlined below. The ***three levels*** of analyses have ***different scope***, ***depth of analysis*** and ***accuracy*** of total costs to complete, and require different levels of effort.

Collect Site Data

- **Minimum** Site Data Collection Recommended:
  - ✓ ***12 Months*** of ***Electric*** AND ***Fuel Bills***
  - ✓ ***Operating Hours*** of the Facility/ Building
  - ✓ ***Existing / Planned Heating*** AND ***Cooling*** (Space and Process)
  - ✓ ***Number*** of ***Electric Feeders*** and ***Meters*** to the Facility / Building
- **Appendix A** provides a ***detailed Site Data Collection Sheet*** that can be used when visiting and collecting data for a potential CHP site. Collecting the information requested in this data sheet will minimize the need for additional site visits and will allow more detailed analyses to be performed.

An ***electronic*** version of the ***Site Data Collection Sheet***, along with ***"Helpful Hints"*** is available at: *www.CHPCenterMW.org/html/10_library.html#tools*

It often ***expedites*** the ***site visit*** and the ***gathering of information*** if the ***sample table*** shown in **Appendix A** is ***faxed*** AND ***discussed*** with he facility manager ***prior*** to the visit.

Level I Analysis Screening Analysis

Purpose: Establish if a Site has the ***potential*** to be a "***Good: Candidate***" for CHP

- Uses **"Rules-of-Thumb"** to Perform Analysis
- Based on ***Annual Average Costs***
- Uses ***Average*** or ***"Estimated" Load Profiles***
- Best ± ***30%*** Accuracy
- ***Estimates Rough Savings***, ***Installation Cost***, and ***Payback***

A CHP **Screening Analysis Tool**, along with instructions for use, is ***available*** at: *www.CHPCenterMW.org/html/10_library.html#tools*

Results

Action: ***Discuss results*** and ***recommendations*** with ***end-user*** to determine if results ***merit further analysis***.

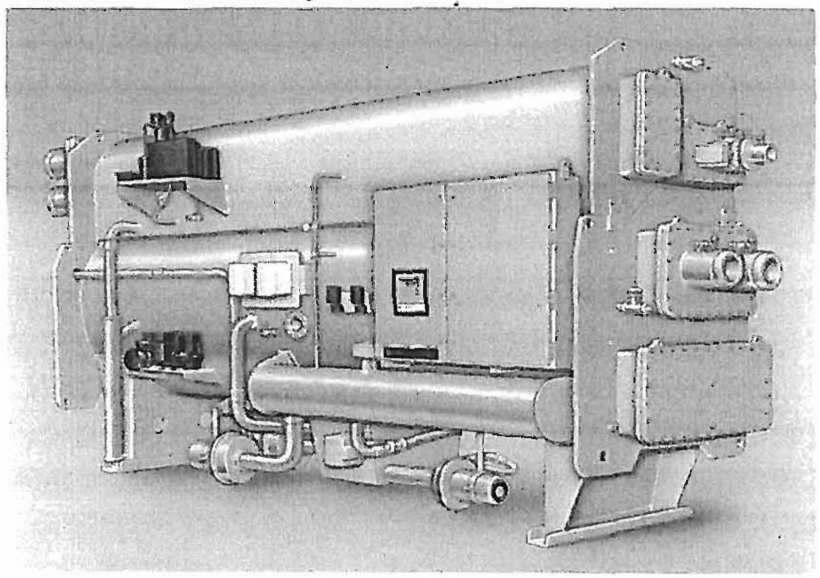
- ✓ ***Stress "limited accuracy"*** of results
- ✓ ***If*** potential savings and payback are ***acceptable*** to ***end-user*** a more ***detailed*** and ***accurate analysis*** should be ***recommended***.

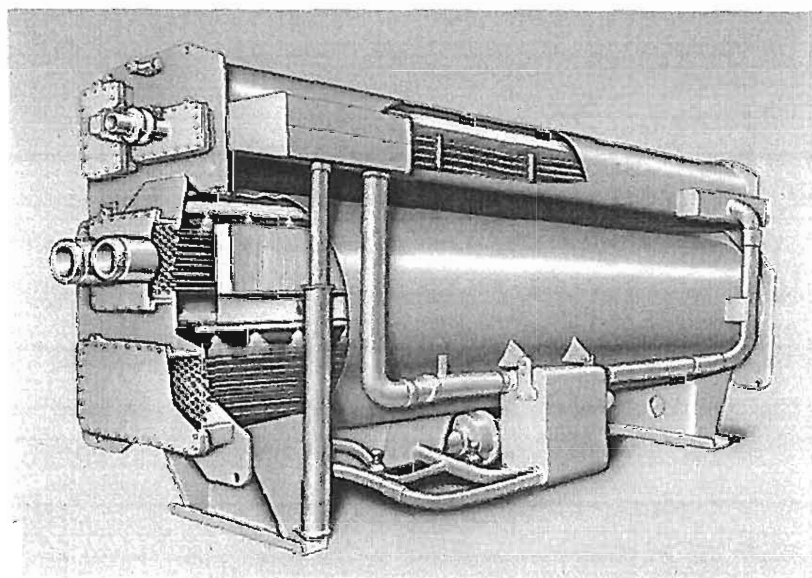
YES

Above addressed within the scope of this Guide!

Continued

Trane Horizon™ Absorption Series Single-Stage Hot Water or Steam-Fired Absorption Water Chillers, 500-1350 Tons





Technology You Can Trust
Absorption water chillers and Trane have been synonymous for forty years. In fact, Trane is the only North American chiller manufacturer to commercialize double-effect absorption over 25 years ago. With over 10,000 absorption chillers manufactured and shipped, Trane serves the commercial, industrial and process worldwide markets. Trane continues its worldwide leadership as the number one provider in absorption, centrifugal, scroll and helical rotary chillers.

Dynamic By Design
In the early 1990's, with the assistance of the Gas Research Institute, Trane began development of a series of advanced absorption chiller designs. The new design was to redefine industry standards for overall system performance, efficiency and reliability.

In 1996, Trane announced the Horizon™ line of two-stage steam/hot water absorption chillers. True to its name and true to the high standards for its design, the Trane Horizon chiller offers system advantages that go beyond those of other absorption chillers currently on the market.

Operates With Steam ≤ 13 psig or Hot Water ≤ 270 F
In 2000, the Horizon series expanded to include single stage hot water and steam fired absorption. This state-of-the-art chiller design can produce chilled water temperatures as cold as 40 F and start up with tower water temperatures as low as 55 F These lower operating temperatures can significantly reduce system energy consumption and cost.

This capability of making chilled water from these comparatively low temperature inputs is particularly important for energy conserving applications such as waste heat recovery, co-generation equipment and solar-energy powered cooling. Using water as the refrigerant helps eliminate concerns about refrigerant management and availability. Additionally, absorption technology reduces the requirement for electric energy.

Sophisticated Reliability
Whether your specification calls for standalone chiller control, hybrid chiller control, or a building automation system, the Trane UCP2 control panel as provided on all Horizon chillers, is critical to reliable operation and optimal performance. Controls from Trane are compatible with Integrated Comfort™ systems (ICS) and they can be easily integrated into the Tracer™ family of flexible chiller plant system controllers with a single twisted-wire pair communications cable.

Ideal for Process and Commercial Applications

With Horizon chillers, the application possibilities for the absorption machine are expanded. Capabilities such as lower tower flow, variable evaporator flow, lower chilled water temperatures and advanced control capabilities make the single-stage Horizon absorption chiller ideal for both process and comfort applications.

When Long-lived Reliability Is Important

Trane has been a long-time proponent of the use of high quality materials in absorption chiller designs. The lithium bromide temperatures and water refrigerant, typical of all absorbers, can more quickly corrode lower-grade metals in the presence of air. Trane recommends and uses industrial-grade materials to provide long-lived, reliable cooling.

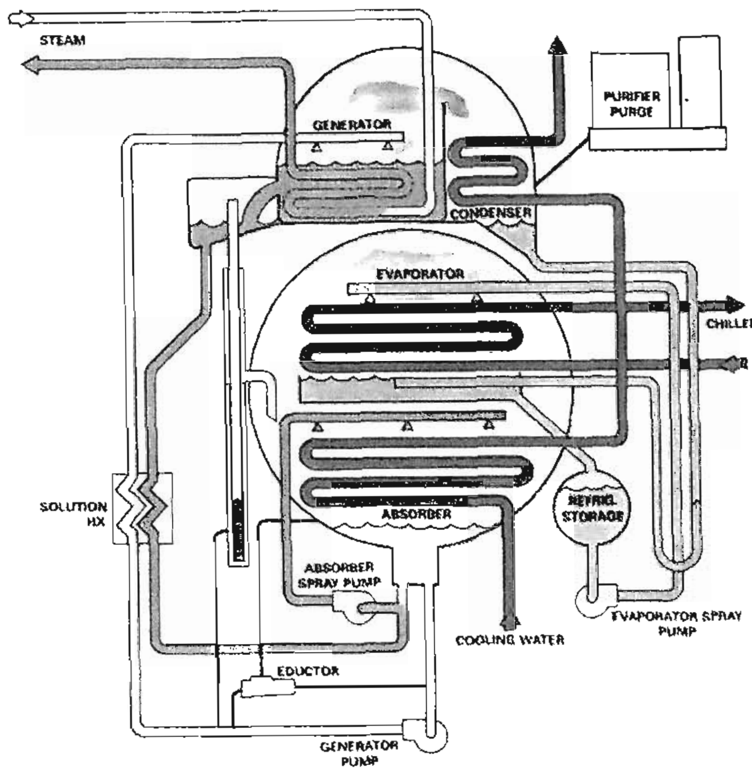
A Global Network of Absorption Expertise

When you specify a Trane Horizon chiller, you're getting the knowledge, expertise and assistance of a pool of experts with decades of absorption expertise. Making The Trane Company part of your management team gives you access to refrigeration, air conditioning and facility control system applications specialists and a unique breadth of innovative solutions to satisfy your facilities needs for today... and tomorrow.

Standard Specification For Single-Stage Horizon Chillers

- C.O.P. 0.70
- Victaulic™ water connections
- Industrial-grade tubes
  - — Generator .028 wall, 90/10 Cupro-nickel
  - — Evaporator .025 copper
  - — Absorber 500-800 tons .022" wall 95/5 Cupro-nickel, 975-1350 tons .028" wall copper
  - — Condenser 0.028" wall copper
- 150 psig pressure design on evaporator, absorber and condenser sections
- Industrial grade energy valve
- Rigging eyes for easy installation

Horizon™ Single-Stage Steam-Fired Absorption Unit



- Advanced microprocessor control system with adaptive control functions
- 2-line, 40 character clear language interface to unit functions and diagnostic information
- Fixed and floating generator tube supports help prevent thermal stress
- Efficient stainless steel brazed plate solution heat exchangers
- Long life solution pumps
- Molybdate inhibitor system
- Factory installed and commissioned controls
- All tubes individually replaceable
- Removable absorber and evaporator spray tree systems
- Disassembled unit – providing for easy disassembly and reassembly of major components at the job site
- Lithium bromide filter
- Marine style waterboxes on the condenser and absorber sections
- Cooling water crossover pipe factory installed between the absorber and condenser
- Factory mounted energy valve
- Fully automatic purge system
- Choice of tube materials and options

Optional Specification For Single-Stage Horizon Chillers

- Advanced cycle management system with Adaptive Frequency™ drive solution control
- 150 psig raised face flanges for the evaporator, condenser, and absorber water connections

Absorption Cooling – A Sound Decision

Life cycle costing has become a primary concern for chiller buyers who have long-term investment opportunity in mind. Changes in the distribution and pricing of electricity have made the absorption water chiller a popular choice when alternative energy use makes sense. Ask your local Trane representative for a comprehensive analysis of your facility and the energy saving opportunities Trane offers for the design of HVAC systems and controls.

The Trane Company
An American Standard Company
www.trane.com

For more information contact your local district office or e-mail us at comfort@trane.com

ABS-SLB003-EN
Revised
January 2001

2008 JMS Natural Gas Budget Pricing

Item	Each JMS420	Total JMS420
(3) JMS420 Natural Gas, Genset with heat recovery accessories, 480 Volt, 1428 kWe		
(3) Adder for 4160 Volt Generator, 1422 kWe rating		
(3) Monic System		
(3) Cts for Diane.xt		
(3) Generator temperature indication (bearings and windings)		
(3) Generator condensation heater		
(3) Engine vibration sensor		
(3) Exhaust gas heat exchanger, natural gas, 248F (stainless steel)		
(1) Modbus or OPC communication		
(1) License, Diane WIN		
(1) Internet Firewall for Diane WIN		
(1) Remote Monitoring Communication		
(1) HIDAT		
Origin Charges: Ocean Freight, BAF, CAF, Pre-carriage Door, AMS, Customs, BOL		
Destination Charges: Entry Fee, Import Fee, Duties 2%, Fees, Delivery to Site		
GEJ Start-Up @ 10 day/unit, includes travel expenses		
Inland Service Tech On-Site Startup and Training		
(3) Remote horizontal radiators designed for 105°F ambient and EHRU Heat		
Freight for the Radiators		
(3) Fan control panels		
(3) AC pumps 1510-2AC or equal		
(3) AC Amot valves BOCF-120-1 or equal		
(3) Flow control valves CB 2.5 or equal		
(3) Expansion tanks & bands		
(3) EM JCS-1XX-201607 TBD" Critical Grade Silencers with mounting bands		
Frt on silencers		
4160 Medium Voltage Switchgear for each genset and 1 utility section with breaker		
(3) Motor Control Centers for gensets and building loads.		
Engineering review of product design/use and review of equipment ($50/hr @ 200 hrs)		

Budget Price = $2,430,000
$/kW = $569.62

3 - 1430 KWe

Captial Cost Estimates for Energy Plant with 3 - JMS420 Units and Heat Recovery

$100,000	Engineering costs
$70,000	Civil (equipment pads, trenching of pipes and electrical)
$80,000	Concrete (equipment pads)
$225,000	Mechanical (building, gas, oil and water pipes, equipment installation and insulation)
$180,000	Electrical (equipment installation)
$20,000	Crane (equipment installation)
$2,430,000	(3) JMS420, 1422 kWe each (4,266 kWe total) with heat recovery and switchgear
$3,105,000	or $727.85 /kWe

Definitions of Services

Preventative Maintenance Contract

Includes:

- Preventative, regular maintenance according to maintenance schedule.
- Consumables which are needed for maintenance according to the maintenance schedule, including spark plugs, original Jenbacher exchange cylinder heads, etc.
- Minor overhauls per the maintenance schedule.
- Major overhaul is not included and should be accrued for separately by customer.
- Labor provided by Inland Power Group

Not Included:

- Possible repairs which may be required outside the maintenance schedule.
- Inspection, checking and operating activities.
- Supply of lubricating oil, disposal of waste oil
- Operating commodities

Corrective Maintenance Budget

Includes:

- Possible repairs which may be required outside the maintenance schedule.
- Labor provided by Inland Power Group.

Not Included:

- Preventative Maintenance scope.
- Inspection, checking and operating activities.
- Supply of lubricating oil, disposal of waste oil
- Operating commodities

Lubricating Oil Budget - Customer Provided

Includes:

- Price for lubricating oil for the operations of the engine generators.
- Estimated an engine oil change at every 1000 oph.
- Price for oil sampling every 500 oph.

Not Included:

- Oil filters, and rings. Included with Preventative Maintenance.
- Disposal of waste oil.
- Labor for oil change services

Operations Budget - NOT PROVIDED

Includes:

- Price for an operator working part-time on generator sets.
- Operation of the plant in compliance with legal and local regulations.
- Inspection, checking and operating activities
  - Acquisition of operating data
  - Keeping operating logs
  - Visual checking of the plant
  - Ignition voltage checking
  - Trouble shooting
- Documentation on the availability of the plant
- Thorough documentation of all servicing and maintenance measures
- Operating commodities

Not Included:

- Tools other than the standard tools provided by GE Jenbacher
- Preventative Maintenance scope.
- Corrective Maintenance scope.
- Supply of lubricating oil, disposal of waste oil

GE Jenbacher - 3 JMS420 Genset Modules
Producing 1422 kWe each at 4160V on Natural Gas

		2008 Pricing		3 Units	59,999 oph
				8400 hrs/year	~7 Years
	Responsibility	**$/oph**	**$/kWh**	**Year**	**Contract**
Preventive Maintenance	Inland	$7.56	$0.00532	$190,512	$1,360,777
Corrective Maintenance	Estimate (budget)	$2.66	$0.00187	$67,032	$478,792
Operations	Customer (budget)	$2.00	$0.00141	$50,400	$359,994
Lubricating Oil	Customer (budget)	$1.78	$0.00125	$44,856	$320,395
		$14.00	**$0.00985**	**$352,800**	**$2,519,958**

NOTES:
1. Preventive Maintenance terms would be for 59,999 oph, customer responsible for major overhaul accrual.
2. Estimated 2008 cost of a JMS420 major overhaul = $240,000
3. Estimates are based upon A05 Maintenance Schedule for Natural Gas.
4. Operations, provided by Customer, should include estimates for one operator to work 10-20 hours/week.
5. Operations, provided by Customer, shall provide oil changes and daily operations.
6. Gas skid PM parts/service is not included, no gas treatment H2S or Siloxane media is included above.
7. Assumes you meet GE Jenbacher gas guidelines (for example, below ~250 ppmv for H2S on average)
8. Assumes price of oil at $10/gallon and oil changes at 2000 operating hours.

Technical Description

Cogeneration Unit

JMS 420 GS-N.L

J 420

Electrical output	**1426 kW el.**
Thermal output	**5695 MBTU/hr**

Emission values

NOx < 0.6 g/bhp.hr (NO2)

0.01 Technical Data (at module)

Data at:				**Full load**	**Part Load**	
Fuel gas LHV		BTU/scft		868		
				100%	75%	50%
Energy input		MBTU/hr	[2]	12,220	9,474	6,728
Gas volume		scfhr	*)	14,078	10,915	7,751
Mechanical output		bhp	[1]	1,966	1,475	983
Electrical output		kW el.	[4]	1,426	1,068	706
Recoverable thermal output						
~ Intercooler 1st stage		MBTU/hr		716		
~ Lube oil		MBTU/hr		448		
~ Jacket water		MBTU/hr		1,637		
~ Exhaust gas cooled to 248 °F		MBTU/hr		2,894		
Total recoverable thermal output		MBTU/hr	[5]	5,695		
Heat to be dissipated						
~ Intercooler 2nd stage		MBTU/hr		345		
~ Lube oil		MBTU/hr		~		
~ Surface heat	ca.	MBTU/hr	[7]	394		
~ Balance heat		MBTU/hr		122		
Spec. fuel consumption of engine		BTU/bhp.hr	[2]	6,216		
Lube oil consumption	ca.	gal/hr	[3]	0.14		
Electrical efficiency		%		39.8%		
Thermal efficiency		%		46.6%		
Total efficiency		%	[6]	86.4%		
Hot water circuit:						
Forward temperature		°F		194.0		
Return temperature		°F		158.0		
Hot water flow rate		GPM		316.4		

*) approximate value for pipework dimensioning
[ ] Explanations: see 0.10 - Technical parameters

All heat data is based on standard conditions according to attachment 0.10. Deviations from the standard conditions can result in a change of values within the heat balance, and must be taken into consideration in the layout of the cooling circuit/equipment (intercooler; emergency cooling; ...). In the specifications in addition to the general tolerance of +/- 8% on the thermal output a further reserve of 10% is recommended for the dimensioning of the cooling requirements.

Main dimensions and weights (at module)

Length	in	~ 280
Width	in	~ 80
Height	in	~ 90
Weight empty	lbs	~ 33,040
Weight filled	lbs	~ 34,590

Connections

Hot water inlet and outlet	in/lbs	4"/145
Exhaust gas outlet	in/lbs	12"/145
Fuel gas (at gas train)	in/lbs	3"/232
Fuel Gas (at module)	in/lbs	5"/145
Water drain ISO 228	G	½"
Condensate drain	in/lbs	2"/145
Safety valve - jacket water ISO 228	in/lbs	2x1½"/2.5
Safety valve - hot water	in/lbs	2½"/232
Lube oil replenishing (pipe)	in	1.1
Lube oil drain (pipe)	in	1.1
Jacket water - filling (flex pipe)	in	0.5
Intercooler water-Inlet/Outlet 1st stage	in/lbs	4"/145
Intercooler water-Inlet/Outlet 2nd stage	in/lbs	2½"/145

0.02 Technical data of engine

Manufacturer		GE Jenbacher
Engine type		J 420 GS-A86
Working principle		4-Stroke
Configuration		V 70°
No. of cylinders		20
Bore	in	5.71
Stroke	in	7.28
Piston displacement	cu.in	3,728
Nominal speed	rpm	1,800
Mean piston speed	in/s	437
Filling capacity lube oil	gal	121
Filling capacity water	gal	61
Length	in	148
Width	in	62
Height	in	80
Weight dry	lbs	14,551
Weight filled	lbs	16,094
Moment of inertia	lbs-ft²	276.26
Direction of rotation (from flywheel view)		left
Flywheel connection		SAE 18"
Radio interference level to VDE 0875		N
Starter motor output	kW	9
Starter motor voltage	V	24

Thermal energy balance

Energy input	MBTU/hr	12,220
Intercooler	MBTU/hr	1,061
Lube oil	MBTU/hr	448
Jacket water	MBTU/hr	1,637
Exhaust gas total	MBTU/hr	3,688
Exhaust gas cooled to 356 °F	MBTU/hr	2,386
Exhaust gas cooled to 212 °F	MBTU/hr	3,063
Surface heat	MBTU/hr	259
Balance heat	MBTU/hr	122

Exhaust gas data

Exhaust gas temperature at full load	°F [8]	844
Exhaust gas mass flow rate, wet	lbs/hr	18,183
Exhaust gas mass flow rate, dry	lbs/hr	16,907
Exhaust gas volume, wet	scfhr	229,980
Exhaust gas volume, dry	scfhr	205,440
Max.admissible exhaust back pressure after engine	psi	0.870

Combustion air data

Combustion air mass flow rate	lbs/hr	17,615
Combustion air volume	SCFM	3,637
Max. admissible pressure drop in front of intake-air filter	psi	0.145

base for exhaust gas data: natural gas: 100% CH_4; biogas 65% CH_4, 35% CO_2

Output / fuel consumption

ISO standard fuel stop power ICFN	bhp	1,966
Mean effe. press. at stand. power and nom. speed	psi	232
Fuel gas type		Natural gas
Based on methane number	MN d)	70
Compression ratio	Epsilon	12.50
Min./Max. fuel gas pressure at inlet to gas train	psi	1.8 - 2.9 c)
Allowed Fluctuation of fuel gas pressure	%	± 10
Max. rate of gas pressure fluctuation	psi/sec	0.145
Maximum Intercooler 2nd stage inlet water temperature	°F	122
Spec. fuel consumption of engine	BTU/bhp.hr	6,216
Specific lube oil consumption	g/bhp.hr	0.22
Max. Oil temperature	°F	185
Jacket-water temperature max.	°F	194

c) Lower gas pressures upon inquiry
d) based on methane number calculation software AVL 3.1

Sound pressure level

Aggregate b)	dB(A) re 20µPa	97
31,5 Hz	dB	79
63 Hz	dB	87
125 Hz	dB	98
250 Hz	dB	95
500 Hz	dB	91
1000 Hz	dB	86
2000 Hz	dB	88
4000 Hz	dB	92
8000 Hz	dB	89
Exhaust gas a)	dB(A) re 20µPa	115
31,5 Hz	dB	95
63 Hz	dB	117
125 Hz	dB	115
250 Hz	dB	113
500 Hz	dB	108
1000 Hz	dB	105
2000 Hz	dB	108
4000 Hz	dB	109
8000 Hz	dB	107

Sound power level

Aggregate	dB(A) re 1pW	117
Measurement surface	ft²	1,152
Exhaust gas	dB(A) re 1pW	123
Measurement surface	ft²	67.60

a) average sound pressure level on measurement surface in a distance of 3.28ft according to DIN 45635, precision class 2.
b) average sound pressure level on measurement surface in a distance of 3.28ft (converted to free field) according to DIN 45635, precision class 3.
Operation with 1200 rpm see upper values, operation with 1800 rpm add 3 dB to upper values.
Engine tolerance ± 3 dB

0.03 Technical data of generator

Manufacturer		STAMFORD e)
Type		PE 734 E2 e)
Type rating	kVA	2,300
Driving power	bhp	1,966
Ratings at p.f.= 1.0	kW	1,426
Ratings at p.f. = 0.8	kW	1,416
Rated output at p.f. = 0.8	kVA	1,770
Rated current at p.f. = 0.8	A	2,129
Frequency	Hz	60
Voltage	V	480
Speed	rpm	1,800
Permissible overspeed	rpm	2,160
Power factor lagging		0,8 - 1,0
Efficiency at p.f.= 1.0	%	97.3%
Efficiency at p.f. = 0.8	%	96.6%
Moment of inertia	lbs-ft²	1055.93
Mass	lbs	7,729
Radio interference level to VDE 0875		N
Construction		B3/B14
Protection Class		IP 23
Insulation class		H
Temperature rise (at driving power)		F
Maximum ambient temperature	°F	104
Total harmonic distortion	%	1.5

Reactance and time constants

xd direct axis synchronous reactance	p.u.	2.47
xd' direct axis transient reactance	p.u.	0.15
xd'' direct axis sub transient reactance	p.u.	0.11
Td'' sub transient reactance time constant	ms	20
Ta Time constant direct-current	ms	20
Tdo' open circuit field time constant	s	2.46

e) GE Jenbacher reserves the right to change the generator supplier and the generator type. The contractual data of the generator may thereby change slightly. The contractual produced electrical power will not change.

0.04 Technical data of heat recovery

General data - Hot water circuit

Total recoverable thermal output	MBTU/hr	5,695
Return temperature	°F	158.0
Forward temperature	°F	194.0
Hot water flow rate	GPM	316.4
Design pressure of hot water	psi	145
Pressure drop hot water circuit	psi	13.05
Maximum Variation in return temperature	°F	+0/-36
Max. rate of return temperature fluctuation	°F/min	18

Mixture Intercooler (1st stage)

Type		gilled pipes
Design pressure of hot water	psi	145
Pressure drop hot water circuit	psi	4.35
Hot water connection	in/lbs	4"/145

Mixture Intercooler (2nd stage) (Intercooler separate)

Type		gilled pipes
Design pressure of hot water	psi	145
Pressure drop hot water circuit	psi	10.15
Hot water connection	in/lbs	2½"/145

Heat exchanger lube oil

Type		plate heat exchanger
Design pressure of hot water	psi	145
Pressure drop hot water circuit	psi	2.90
Hot water connection	in/lbs	4"/145

Heat exchanger engine jacket water

Type		plate heat exchanger
Design pressure of hot water	psi	145
Pressure drop hot water circuit	psi	2.90
Hot water connection	in/lbs	4"/145

Exhaust gas heat exchanger

Type		shell-and-tube
PRIMARY:		
Exhaust gas pressure drop approx	psi	0.22
Exhaust gas connection	in/lbs	12"/145
SECONDARY:		
Design pressure of hot water	psi	87
Pressure drop hot water circuit	psi	2.90
Hot water connection	in/lbs	4"/145

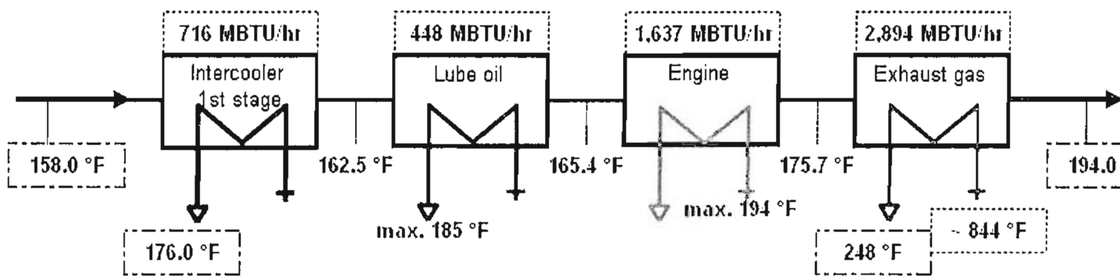
Hot water circuit

J 420 J 420 GS-A86

Recoverable thermal output = 5,695 MBTU/hr

(±8% tolerance +10% reserve for cooling requirements)

Hot water flow rate = 316.4 GPM

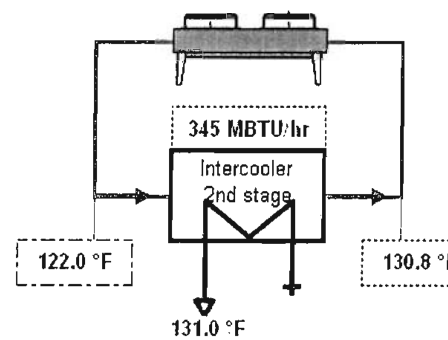


Low Temperature circuit (calculated with Glykol 37%)

Heat to be dissipated = 345 MBTU/hr

(±8% tolerance +10% reserve for cooling requirements)

Cooling water flow rate = 88.1 GPM



0.10 Technical parameters

All data in the technical specification are based on engine full load (unless stated otherwise) at specified temperatures as well as the methane number and subject to technical development and modifications. For isolated operation an output reduction may apply according to the block load diagram. Before being able to provide exact output numbers, a detailed site load profile needs to be provided (motor starting curves, etc.).

All pressure indications are to be measured and read with pressure gauges (psi.g.).

(1) At nominal speed and standard reference conditions ICFN according to DIN-ISO 3046 and DIN 6271, respectively
(2) According to DIN-ISO 3046 and DIN 6271, respectively, with a tolerance of + 5 %
(3) Average value between oil change intervals according to maintenance schedule, without oil change amount
(4) At p. f. = 1.0 according to VDE 0530 REM / IEC 34.1 with relative tolerances
(5) Total output with a tolerance of +/- 8 %
(6) According to above parameters (1) through (5)
(7) Only valid for engine and generator; module and peripheral equipment not considered
(8) Exhaust temperature with a tolerance of +/- 5 %

Radio interference level
The ignition system of the gas engines complies the radio interference levels of CISPR 12 and EN 55011 class B, (30-75 MHz, 75-400 MHz, 400-1000 MHz) and (30-230 MHz, 230-1000 MHz), respectively.

Definition of output

- ISO-ICFN continuous rated power:
  Net break power that the engine manufacturer declares an engine is capable of delivering continuously, at stated speed, between the normal maintenance intervals and overhauls as required by the manufacturer. Power determined under the operating conditions of the manufacturer's test bench and adjusted to the standard reference conditions.
- Standard reference conditions:

Barometric pressure:	14.5 psi (1000 mbar) or 328 ft (100 m) above sea level
Air temperature:	77°F (25°C) or 298 K
Relative humidity:	30 %

- Volume values at standard conditions (fuel gas, combustion air, exhaust gas)

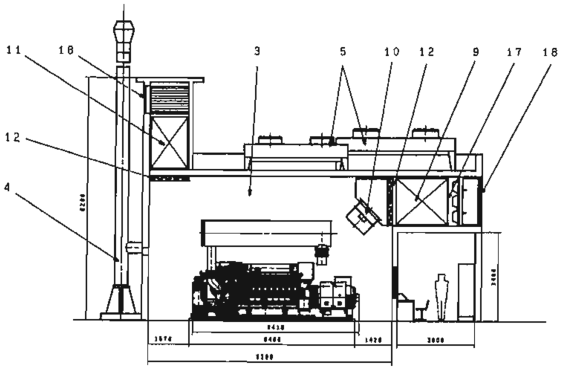
Pressure:	1 atmosphere (1013.25 mbar)
Temperature:	60°F (15.56°C)

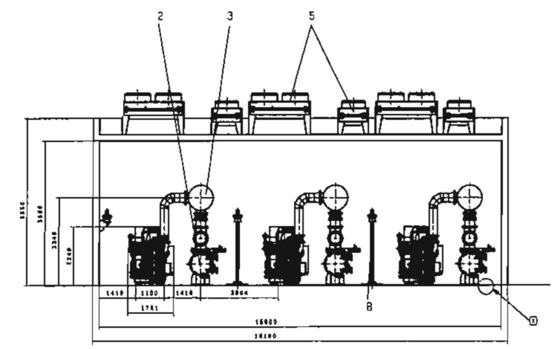
Output adjustment for turbo charged engines
Standard rating of the engines is for an installation at an altitude ≤ 1640.5 ft (500 m) and an air intake temperature ≤ 86°F (30°C).
Derating:

> 1640.5 ft (500 m): up to 1.2% / 328 ft (1.2 % / 100 m)
> 86°F (30°C): up to 0.89% / °F (1.6% / °C) and over 104°F (40°C) 1.11% / °F (2% / °C)

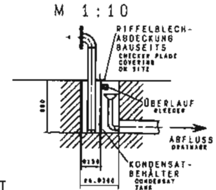
If the actual methane number is lower than the specified, the knock control responds. First the ignition timing is changed at full rated power. Secondly the rated power is reduced. These functions are done by the engine management.

Parameters for the operation of GE Jenbacher gas engines
The following "Technical Instruction of GE JENBACHER" forms an integral part of a contract and must be strictly observed: **TI 1100-0110 – TI 1100-0112**

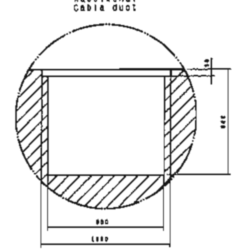




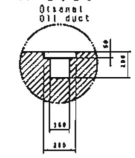
DETAIL X:
M 1:10

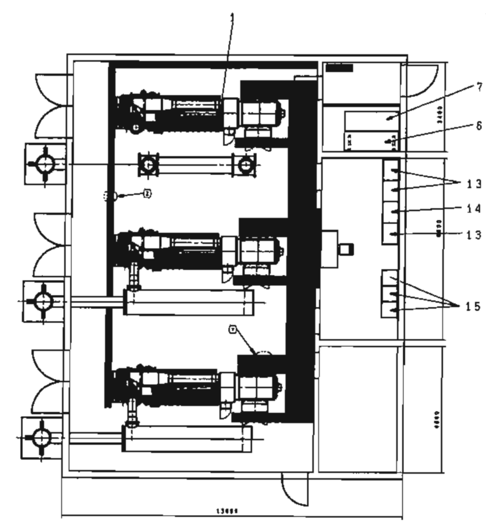


DETAIL Y:
M 1:10
Kabelkanal
Cable duct



DETAIL Z:
M 1:10
Ölkanal
Oil duct





1	MODUL JMS 420 GS	1	MODULE JMS 420 GS
2	ABHITZEKESSEL	2	EXHAUST GAS HEAT EXCHANGER
3	ABGASSCHALLDAEMPFER	3	EXHAUST GAS SILENCER
4	ABGASKAMIN	4	CHIMNEY
5	TISCHKUEHLER	5	RADIATOR
6	FRISCHOELTANK (2000l)	6	FRESH OIL TANK (2000l)
7	ALTOELTANK (2000l)	7	WASTE OIL TANK (2000l)
8	GASDRUCKREGELSTRECKE	8	GAS TRAIN
9	ZULUFTSCHALLDAEMPFER	9	AIR INTAKE SILENCER
10	ZULUFTVENTILATOR	10	AIR INTAKE FAN
11	ABLUFTSCHALLDAEMPFER	11	AIR OUTLET SILENCER
12	KLAPPENJALOUSIE	12	JALOUSIE FLAP
13	MODULSTEUERSCHRANK	13	MODULE CONTROL PANEL
14	SYNCHRONISIERSCHRANK	14	SYNCHRONISING PANEL
15	GENERATORFELD	15	POWER CUBICLE
17	ZULUFTFILTER	17	AIR INTAKE FILTER
18	WETTERSCHUTZGITTER	18	WEATHER PROTECTION

NUR ZUR INFORMATION

STANDARD AUFSTELLUNGSPLAN
3 x JMS 420 GS-N. LC

DESIGN SUBJECT TO CHANGE
TECHNISCHE AENDERUNGEN VORBEHALTEN

1:50
AUFSTELLUNGSPLAN
Layout
GE Jenbacher
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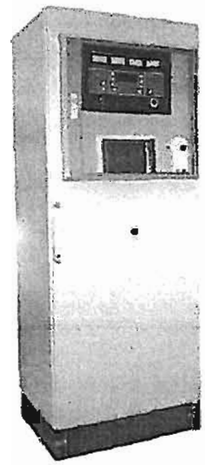
356924

Power Generation

Gas Genset Controls

Genset Control Panel (GCP2) with PCS™ (PowerCommand Supervisor)



Description

The Cummins Power Genset Control Panel (GCP2) is an integrated monitoring and control system for the Cummins Lean Bum Natural Gas Gensets. It is a free standing control panel consisting of a Human Machine Interface (HMI), the Cummins PowerCommand Supervisor (PCS™), and a Programmable Logic Controller. The GCP2 can be located either with the genset or remotely up to 40 m (130 ft) from the genset.

The Control is designed and tested to operate the generator set in single unit isolated bus, multiple unit isolated bus (load share) and utility parallel modes.

The PowerCommand control is UL508 Listed. All Cummins Power Generation systems are backed by a comprehensive warranty program and supported by a worldwide network of 170 distributors and service branches to assist with warranty, service, parts, and planned maintenance support.

Features

Cummins PowerCommand Supervisor (PCS) – The PowerCommand Supervisor Genset Control and protection system includes both analog and digital metering, digital voltage regulation, Power Command Digital Paralleling controls including synchronizing, load sharing, and import/export controls, Amp Sentry overcurrent protection, and genset fault monitoring.

Color Touchscreen Interface – Displays both engine and generator information. The touchscreen is provided to allow operator monitoring and control of the generator set and includes all information for the complete generator set including the alternator, engine, and auxiliary devices.

Programmable Logic Controller (PLC) – Functions as the communications gateway between the engine control, generator control, touchsrcreen, and auxiliary systems.

Network Capability – Standard Modbus Plus communications allow remote monitoring and control of the genset.

Emergency Stop Switch – Two position "mushroom" head switch for immediate shutdown in an emergency condition. Capability for additional remote Emergency Stop Switches.

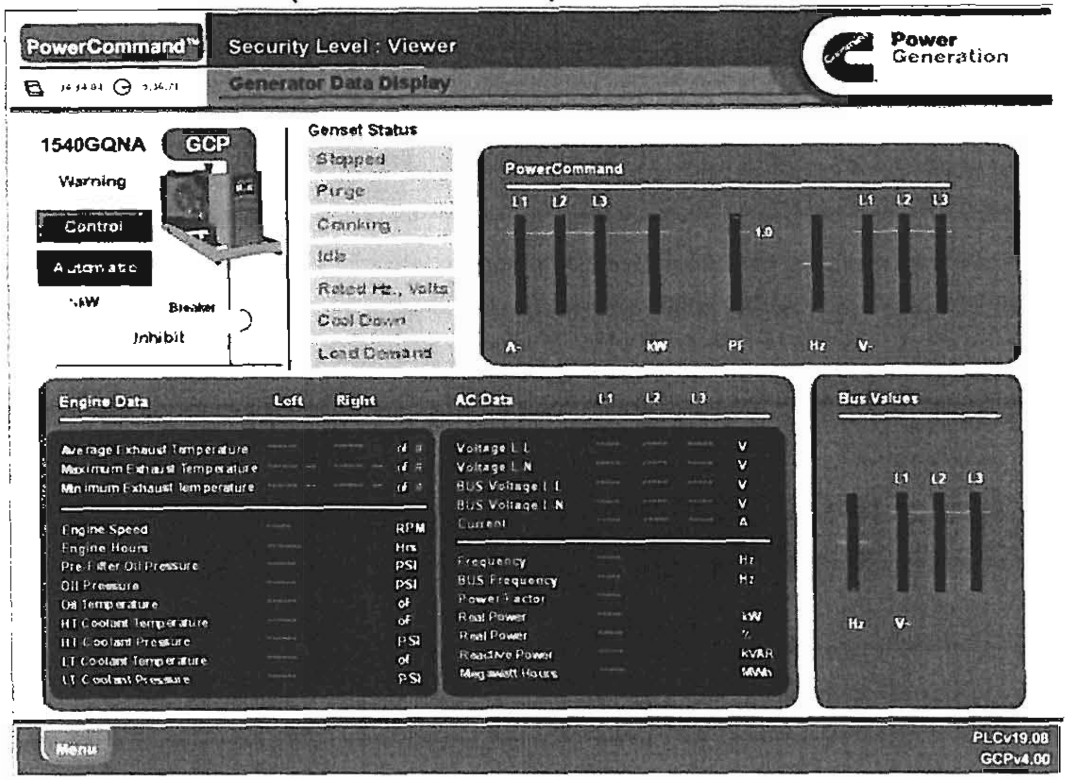
Temperature Rated – Designed to operate in between 0-50°C (32-122°F)

Genset to GCP Harness – Standard 5 meter (10, 15, 20, 30, and 40 meter harnesses optional)

Enclosures – Steel enclosure minimum 14 gauge sheet metal with window for access to operation and monitoring of the generator set. It is environmentally protected to IP54/NEMA 3R

Warranty and Service - Backed by a comprehensive warranty and worldwide distributor service network.

PC Based HMI (Touchscreen)



The HMI is a combined industrial PC and 10.4" (264 mm) color touchscreen for monitoring and control of the generator set. The screen is mounted on a console on the front of the GCP2 with gaskets between the touchscreen and the enclosure for environmental protection. It is complete with a real time clock, with separate battery backup and incorporates flash memory.

The HMI's main role is to read and display data, the genset is still available and fully protected in the unlikely event of any loss of communication or function. Fault information and real-time data originates from the PCS, engine controller or PLC. The screens HMI will display a mixture of data from some or all of these devices.

There is one genset summary screen (with a popup control screen) and also an alarm summary and history screen. All the principle data required by an operator is available for these three screens.

There is a popup menu providing access to the genset summary screen, alarm screens, units selection, security access, operator display languages (English, French, German, Portuguese, Spanish and Dutch) and also restricted access to eight service screens.

The main screen is designed to enable the operator to determine the current genset status. It further allows access to the data embedded in the layered screens.

Programmable Logic Controller (PLC)

The PLC uses a DIN rail mounted card and rack arrangement to allow easy servicing and identification of system components.
Other features to enhance serviceability include:

- Capability for on-line program/data changes using a personal computer directly connected to the PLC,
- LED status indicators on each board for use in diagnosis of system condition and board level service,
- I/O cards include integral surge suppressors for greater system reliability,

PowerCommand Supervisor

The PCS is a microprocessor based genset monitoring, metering and control system. It is integrated into the GCP2 and incorporates the following key features ;

- Voltage Regulator
- Synchronizer (Freq, Phase & Volts)
- Iso-Bus kW and kVAR load sharing
- Utility Paralleling kW Load Control
- Utility Paralleling Power Factor Control
- Alternator Metering
- AmpSentry™ Alternator Protection
    - Overload,
    - Overcurrent [51],
    - Short circuit [50],
    - High AC Volts [59],
    - Low AC Volts [27],
    - Under frequency [81u],
    - Sync Check, Fail to Sync,
    - CB Fail to Close,
    - Reverse Power [32],
    - Loss of Excitation [40],
    - Phase Rotation

Environmentally Hardened Enclosure

The front panel of the unit is formed by a single membrane that covers the entire surface. The front face is easy to clean and impervious to water spray, dust and oil/exhaust residue. Switches for control are incorporated into the door which is gasketted with a dual moisture and RFI/EMI gasket to protect internal components from air born contaminants.

Control Switches and Functions

RUN/OFF/AUTO Mode Control Switch

An oil tight three position switch starts and stops the generator set locally or enables start/stop control from a remote position.
It provides the following functions:

- The 'OFF' position de-energizes all primary DC circuits. When the switch is in this position, the non-automatic indicator will flash continuously.
- The 'RUN' position energizes the control and initiates the genset starting operation.
- The 'AUTO' position enables the control to receive a start signal from a remote location.

Note : The non-automatic indicator will flash when the switch is in the "RUN" or "OFF" position.

System Control

Control arrows on the screen lead the operator to information. The control switches provide the operator with a positive indication that the switch is operated. The switches are totally sealed and designed to provide reliable service.

Menu selection Switches

These four switches allow the operator to select menu-driven control and monitoring information.

Menu 'HOME' Switch

Returns to the main menu selections screen regardless of the position in the menu logic.

Panel Lights Switch

Turns the back-lit panel illumination on and off for easy reading of the entire fascia in dark conditions. This feature automatically switches off after 5 minutes.

Test Switch

Prompts the PowerCommand Control to perform a self test and displays all fault messages.

Reset Switch

Clears the digital display and status panel and allows the genset to start after a fault condition has been corrected.

Adjustment Menu

Allows the operator to set basic genset parameters. Adjustments are limited to help prevent operator error and potential damage to equipment. Critical parameters are adjustable only via a security access code.
Adjustments include:

- Voltage (+/- 5%)
- Automatic Voltage Regulator Gain (access code protected)

Critical service level adjustments are possible only after entering an access code. All adjustments are made through digital raise/lower switches from the front of the facia.
The adjustment being digitally displayed.

External Control Adjustments

Adjustments for automatic voltage regulation are performed directly at the control facia by using the security code without the need to enter the GCP2 enclosure.

Alarm and Status Message Display

To compliment the HMI screen displays, PCS check data displays are provided for all critical genset parameters.
Digital messages provide a clear indication of potential problems. A two line 16 character-per-line, LED alphanumeric screen displays alarm and status messages along with data regarding AC output.

Status Indicators

Three dual element LED indicating lamps provide basic genset status data on the facia. Solid state indicators on internal circuit boards provide further status and diagnostic data.

Non-Automatic Indicator

When the Run/Off/Auto switch is in the OFF or RUN position the red non-automatic indicator will flash on and off.

Warning Indicator

The amber light indicates the status screen is displaying a warning condition. The reset switch is used to clear the message after the warning condition is corrected.

Shutdown Indicator

A red light indicates the status screen is displaying a shutdown condition. The reset switch is used to clear the message after the shutdown condition is corrected.

Generator Set Monitoring - Warning and Shutdown Messages

The digital display provides status of the following critical engine functions :

- Battery voltage
- Speed
- Overspeed
- Magnetic pick up failure (shutdown)

On sensing a warning or shutdown condition the control displays the warning or shutdown message, lights the warning or shutdown indicator lamp on the front of the facia and displays a code number which is interpreted by the PLC and displayed at the HMI in an easy to understand format. These codes are also displayed on the PCC facia and can be cross-referenced using the genset manual.

The control has provisions for four programmable fault conditions. These may be either warning or shutdown conditions. Labels for customer faults can be programmed into the control.
The control maintains an historical data log of the latest alarm and status conditions on the genset.

Historical data

The control displays the last 20 alarm and/or shutdown messages.

AC Output Metering

Combines digital and analog metering to provide accurate digital readouts plus analog indication of trends and operating conditions.

Analog Meters

Analog metering on the control facia provides clear indication of generator set stability from a 'walk by' perspective to avoid the requirement to start the HMI screen if it is in screen save mode.

The kilowatt meter and ammeter are scaled in percent of AC output for easy recognition of genset status and load level
0 - 90% of rating ; green, 90 - 100% of rating ; amber =100% of rating ; red.)

Kilowatt Meter
Indicates 3-phase AC power output as a percent of rated load. Provides a true indication of total kW load on the genset, regardless of the load power factor.

Scale 0-125% of rated
Accuracy is +/-5%

Frequency Meter
Indicates genset output frequency in hertz. Calculated frequency is based on engine speed and alternator voltage zero-crossing and is not affected by voltage waveform distortion caused by non-linear loads.

Scale is 45 - 65 Hz.
Accuracy is +/- 5%.

AC Voltmeter
Dual scale AC voltmeter indicates alternator output voltage.
Accuracy is +/- 2%

Scales are 0 - 300VAC, 0 - 600VAC, 0 - 400 VAC, 0 - 750VAC, 0 - 5260VAC,
0 - 15,000VAC.

AC Ammeter
Indicates current output in percent of maximum rated standby current.
Accuracy is +/- 2%
Scale is 0 - 125%

Phase Select Switch
Allows the operator to select the phase monitored by the analogue ammeter and voltmeter. LED indicators display which phase is being monitored and which voltage scale is applied.

Digital Metering

The digital metering display provides access to alternator performance data and a more accurate readout of the AC output information displayed on the analogue meters. The following outputs are displayed:

- Genset Output Voltage (3-phase, line to line or line to neutral)
- Genset output current (3-phase)
- Power factor (0 to 1, leading or lagging)
- AC kilowatts
- AC kilowatt-hours
- Alternator exciter duty and governor duty (%)
- Genset output frequency (Hz)

The voltage and current data for all three phases is displayed simultaneously on a single screen so lead and voltage balance is readily apparent.

Digital Voltage Regulation, Synchronizing and Load Sharing Controls

The PCS module includes all voltage regulation, synchronizing and load sharing control required for isolated or infinite bus paralleling applications, including demanding UPS and non-linear load applications.

Applications and Performance

Paralleling
Isolated Bus Paralleling control (set to set synchronising, isochronous kW and kVAR load sharing) and Base Load Utility Paralleling (synchronising to utility, base load kW control, VAR/PF control) features are provided.

Isochronous Real Load Sharing
Load sharing to within as low as 1% of equal. Load sharing controls operate directly on the engine governor actuator to provide zero droop in frequency for loads rom zero to 100% of rated genset capacity.

Droop Real Load Sharing
Control may be configured for operation in droop mode, adjustable for no load to full load droop from 1% to 10%

Isochronous Reactive Load Sharing
Load sharing to within as low as 1% of equal. Load sharing controls operate directly on the excitation system to provide zero droop in voltage for loads to 100% of rated genset capacity.

Droop Reactive Load Sharing
Control may be configured for operation in droop mode, adjustable for no load to full load droop from 1% to 10%.

Synchronizer

Range:
The synchroniser can drive the genset frequency and voltage to a bus value which is -10% to +10% of selected voltage and frequency. The ramp speed for matching is 4% per second.

Frequency differential :
the set is controlled to match the bus frequency.

Voltage differential :
the set voltage is controlled to within 1% of system bus voltage with checks for correct phase rotation to bus.

Permissive protection :
Adjustable for a phase difference of 5 to 20 degrees with phase difference decreasing. Time delay is adjustable from 0.5 to 5 seconds.

Control System :
Automatically resets bus frequency and voltage to preset values after the paralleling breaker closes.

'Dead Bus' Sensor :
Allows closure of the generator set to an inactive system bus.

Battery Monitoring System

The control continually monitors the battery charging system for low and high DC voltage and runs a battery load test every time the engine is started. Functions and messages include:

- Low DC voltage (battery voltage less than 25VDC except during engine cranking)
- High DC voltage (battery voltage greater than 32 VDC)
- Weak battery (battery voltage less than 14.4 VDC for more than 2 seconds during engine cranking).

Warning and Shutdown Messages

Overload

When total kW load exceeds 100% of the standby rating of the genset (110% of prime rating) for 5 seconds a load shed signal is issued and a warning alarm activated.

Overcurrent (51)

When the current on any phase exceeds 110% of the genset rated current for more than 60 seconds a warning alarm is activated.

Overcurrent (51)

The genset is shutdown when the current on any phase is between 110 - 175% of rated and the time/current integral approaches alternator thermal limits.

Short Circuit (50)

The genset is shutdown when the current on any phase exceeds 175% of rated and the time/current integral approaches alternator thermal limits.

High AC Voltage (59)

Genset is shutdown when AC voltage exceeds 110% for 10 seconds or with no delay when voltage exceeds 130% of nominal.

Low AC Voltage (27)

Genset is shutdown when AC voltage falls below 85% of rated voltage for more than 10 seconds.

UnderFrequency (81U)

Genset is shutdown when AC frequency fals below 90% of rated frequency for more than 20 seconds.

Reverse Power (32)

Genset is shut down when kW flow into the genset exceeds an adjustable set point (5 - 15% of genset rating) for an adjustable amount of time (1 - 15 seconds).

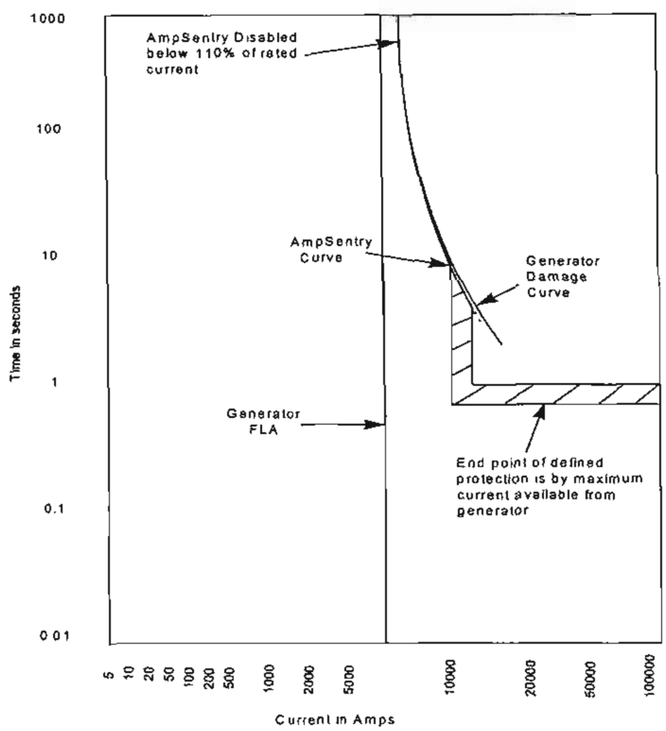
Loss of Excitation (40)

Genset is shut down when kVAR is less than 0.16 - 0.41 per unit kVAR (adjustable) for more than 2 - 10 seconds (adjustable).

AmpSentry Protection

AmpSentry protection is a comprehensive power monitoring and control system integral to the PCC that guards the electrical integrity of the alternator and power system from the effects of overcurrent, short circuit, over/under voltage, underfrequency and overload. Current is regulated to 300% for both single phase and 3 phase faults when a short circuit condition is sensed. An overcurrent alarm will sound if the genset is operating for an extended period at a potentially damaging current level, to warn the operator of an impending problem before it causes a system failure. If an overcurrent condition persists for the time pre-programmed in the time current characteristic for the alternator, the PMG excitation system is de-energised to avoid alternator damage.

The overcurrent protection is time delayed in accordance with the alternator thermal capacity allowing current to flow until secondary fuses or circuit breakers operate, isolating the fault and thus achieving selective co-ordination (discrimination). This enhances power service continuity by eliminating the need for a main line breaker mounted on the genset for genset protection and the possibility of nuisance tripping of that breaker.

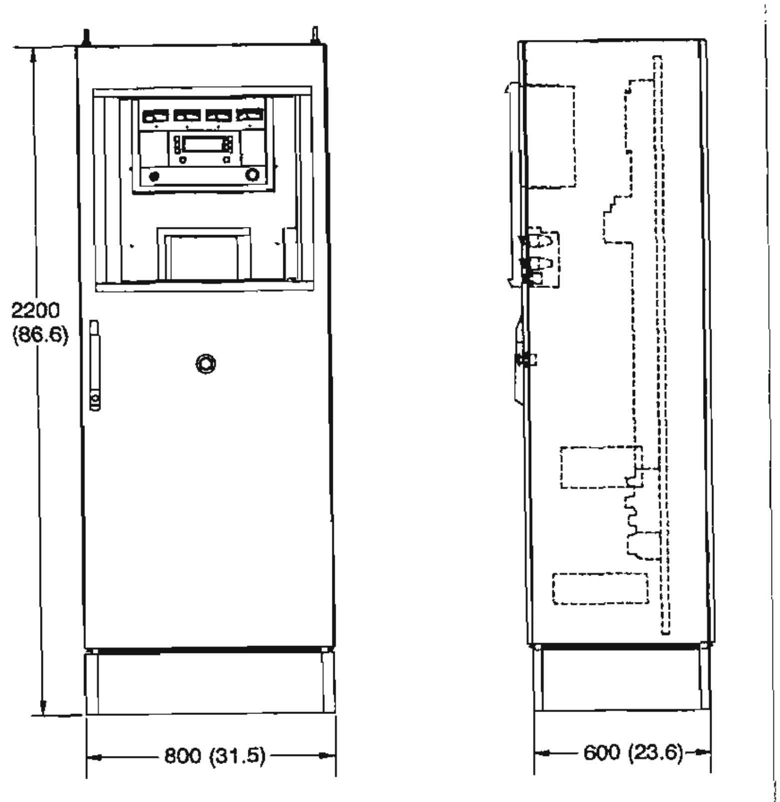


AmpSentry provides excellent, matched protection for the alternator without the danger of nuisance tripping. The exact time current characteristics of AmpSentry are shown in the PowerCommand Control AmpSentry Time-Over-Current Characteristic Curve, Form Number R-1053.

After the fault is cleared AmpSentry Protection softly loads the genset by a controlled ramping of output voltage to rated level, allowing the genset to resume normal operation without potentially damaging voltage overshoot.

Fixed over/under voltage and under frequency time delayed set points also provide a degree of protection for lead equipment. Over/under voltage conditions trigger a shutdown message on the digital display screen. Under frequency condition prompts both a warning and shutdown message depending upon the length of time and magnitude of variance under rated frequency.

AmpSentry Protection includes an overload signal that can be used in conjunction with proprietary transfer switches to automatically shed load, preventing a potential genset shutdown. The overload signal is programmable for operation at a specific kW level, on the basis of an under frequency condition, or both.



See your distributor for more information.

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Important: Back feed to a utility system can cause electrocution and/or property damage. Do not connect to any building's electrical system except through an approved device or after building main switch is open.

 Specifications subject to change without notice

Generator set specifications

Governor regulation class	ISO 8528 Part 1, Class G1 with exceptions - see PTS (Prototype Test Support) Data Sheet
Voltage regulation, no load to full load	± 0.5%
Random voltage variation	± 0.5%
Frequency regulation	Isochronous
Random frequency variation	± 0.25%
Radio frequency emissions compliance	IEC 801.2 through IEC 801.5; MIL STD 461C, Part 9
Single step load pickup	See PTS data sheet for details

Engine specifications

Design	4 cycle, V-block, turbocharged low temperature aftercooled
Bore	180 mm (7.09 in)
Stroke	200 mm (7.87 in)
Displacement	91.6 liters (5590 in3)
Cylinder block	Cast iron, V18
Battery charging alternator	None
Starting voltage	24 volt negative ground
Fuel system	Lean burn
Ignition system	Individual coil on plug
Air cleaner type	Dry replaceable element
Lube oil filter type(s)	Full flow and bypass filters
Breather	Breather filter

Alternator specifications

Design	Brushless, 4 pole, revolving field
Stator	2/3 pitch
Rotor	Two bearing
Insulation system	Class F or H see ADS (Alternator Data Sheet) for details
Standard temperature rise	105 °C (221 °F) Continuous @ 40 °C (104 °F) ambient
Exciter type	PMG (Permanent Magnet Generator)
Phase rotation	A (U), B (V), C (W)
Alternator cooling	Direct drive centrifugal blower fan
AC waveform total harmonic distortion	< 5% no load to full linear load, < 3% for any single harmonic
Telephone influence factor (TIF)	< 50 per NEMA MG1-22.43
Telephone harmonic factor (THF)	< 3

Available voltages

60 Hz Three phase line–neutral/line-line				**50 Hz Three phase line–neutral/line-line**			
• 240/416	• 254/440	• 277/480	• 347/600	• 220/380	• 230/400	• 240/415	• 254/440
• 2400/4160	• 7200/12470	• 7620/13200	• 7970/13800	• 1905/3300	• 3640/6300	• 3810/6600	• 5775/10000
				• 6060/10500	• 6350/11000		

Note: Some voltages may not be available on all models. Consult factory for availability.

Generator set options and accessories

Engine
- ☐ NO_x 250 mg/Nm³ (0.5 g/hp-hr)
- ☐ NO_x 350 mg/Nm³ (0.9 g/hp-hr)
- ☐ NO_x 500 mg/Nm³ (1.2 g/hp-hr)
- ☐ Natural gas fuel methane index as low as 52 for some models
- ☐ High temperature cooling circuit outlet up to 110 °C (230 °F)
- ☐ Air starter
- ☐ Low BTU Gas

Alternator
- ☐ 80 °C (176 °F) rise alternator
- ☐ 105 °C (221 °F) rise alternator

Control panel
- ☐ Paralleling bus PTs (69 V, 120 V, 240 V, 346 V)

Generator set
- ☐ CE Certification

Accessories
- ☐ Exhaust silencers
- ☐ Gas Train
- ☐ Radiators
- ☐ Bladder Expansion Tank
- ☐ Heat Exchanger
- ☐ Exhaust Heat Recovery

Note: Some options may not be available on all models - consult factory for availability.

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S-1463f (3/08)

Power Generation

Generator control panel

Stand alone remote mounted cabinet

PC based HMI

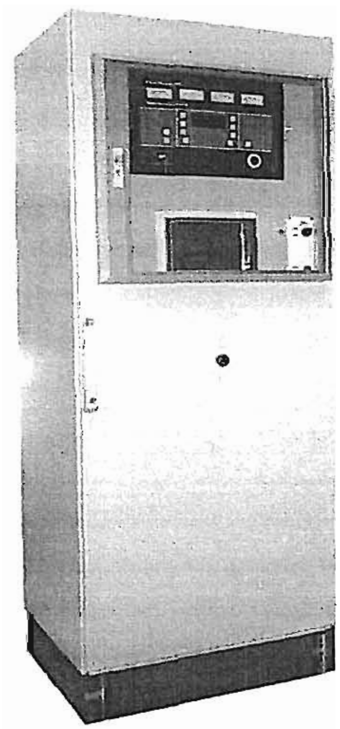
- Micro-processor based graphic interface (touchscreen)
- Layered menus for ease of operation

PLC based auxiliary control

- Communication handling procedures
- Protocol interfaces
- Control of plant auxiliaries

Stand alone or parallel operation

- Single or multi-set isolated bus operations
- Single set base load utility paralleling
- Base load utility paralleling control



PowerCommand Supervisor (PCS)

Features

- Integrated automatic voltage regulator
- Speed/load bias to engine governor control
- AmpSentry protection guards the electrical integrity of the alternator and power system from the effects of over current, over/under voltage, under frequency and overload conditions.
- Control components are designed to withstand the vibration levels typical in generator sets

Standard control description

- Analog % of current meter (amps)
- Analog % of load meter (kW)
- Analog AC frequency meter
- Analog AC voltage meter
- Cycle cranking control
- Digital display panel
- Emergency stop switch
- Idle mode control
- Menu switch
- Panel backlighting
- Remote starting, 12 V, 2 wire
- Reset switch
- Run-off-auto switch
- Sealed front panel, gasketed door
- Self diagnostics
- Separate customer interconnection box
- Voltmeter/ammeter phase selection

Standard protection functions

Warnings

- High coolant temperature
- High DC voltage
- Low coolant temperature
- Low DC voltage
- Low fuel-day tank
- Low oil pressure
- Oil pressure sender fault
- Over current
- Overload load shed contacts
- Temperature sender fault
- Up to four customer fault inputs
- Weak battery

Shutdowns

- Emergency stop
- Fail to crank
- High AC voltage
- High coolant temperature
- Low AC voltage
- Low coolant level (option for alarm only)
- Low oil pressure
- Magnetic pickup failure
- Overcrank
- Over current
- Overspeed
- Short circuit
- Underfrequency

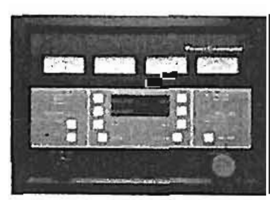
Standard performance data

AC alternator

- Current by phase
- Kilowatts
- Kilowatt hours
- Power factor
- Voltage line to line
- Voltage line to neutral

Engine data

- Battery voltage
- Coolant temperature
- Engine running hours
- Engine starts counter
- Oil pressure
- Oil temperature
- RPM



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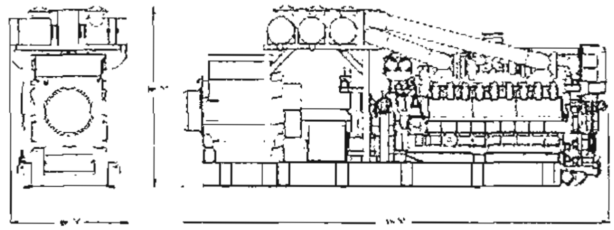
S-1463f (3/08)

Power Generation

Base load (continuous) rating definition

Applicable for supplying power continuously to a constant load up to the full output rating for unlimited hours. No sustained overload capability is available for this rating. Consult authorized distributor for rating. (Equivalent to Continuous Power in accordance with ISO 8528, ISO 3046, AS2789, DIN6271, and BS5514).



This outline drawing is to provide representative configuration details for Model series only.

See respective model data sheet for specific model outline drawing number.

Do not use for installation design

Generator set data sheets

60 Hz low BTU

Model	Data sheet	CR*	Emissions g/hp-hr	LT (°C)	HT (°C)
1750 GQPB	D-3364	11.4:1	500	50	103
1750 GQPB	D-3365	12:1	500	50	103

50 Hz low BTU

Model	Data sheet	CR*	Emissions mg/NM³	LT (°C)	HT (°C)
1750 GQNB	D-3362	11.4:1	500	50	103
1750 GQNB	D-3363	12:1	500	50	103

60 Hz pipeline gas

Model	Data sheet	MN**	Emissions g/hp-hr	LT (°C)	HT (°C)
1250 GQNA	D-3282	60	500	50	95
1250 GQNA	D-3283	56	350	50	95
1250 GQNA	D-3284	63	500	50	110
1250 GQNA	D-3285	59	350	50	110
1250 GQNA	D-3286	70	500	50	95
1250 GQNA	D-3287	66	350	50	95
1250 GQNA	D-3288	73	500	50	110
1250 GQNA	D-3289	69	350	50	110
1750 GQPB	D-3307	67	500	50	95
1750 GQPB	D-3308	63	350	50	95
1750 GQPB	D-3311	77	500	50	95
1750 GQPB	D-3312	73	350	50	95
1750 GQPB	D-3313	80	500	50	110
1750 GQPB	D-3314	76	350	50	110
2000 GQPC	D-3325	78	1.2	45	92
2000 GQPC	D-3339	76	0.5	50	92

* CR = Compression ratio **MN = Methane

50 Hz pipeline gas

Model	Data sheet	MN**	Emissions mg/NM³	LT (°C)	HT (°C)
1540 GQNA	D-3290	52	500	50	95
1540 GQNA	D-3291	60	500	50	95
1540 GQNA	D-3292	56	350	50	95
1540 GQNA	D-3293	63	500	50	110
1540 GQNA	D-3294	59	350	50	110
1540 GQNA	D-3295	70	500	50	95
1540 GQNA	D-3296	66	350	50	95
1540 GQNA	D-3297	73	500	50	110
1540 GQNA	D-3298	69	350	50	110
1750 GQNB	D-3299	67	500	50	95
1750 GQNB	D-3300	63	350	50	95
1750 GQNB	D-3303	77	500	50	95
1750 GQNB	D-3304	73	350	50	95
1750 GQNB	D-3305	80	500	50	110
1750 GQNB	D-3306	76	300	50	110
2000 GQNC	D-3322	73	500	40	92
2000 GQNC	D-3323	70	350	40	92
2000 GQNC	D-3338	75	250	50	92
2000 GQNC	D-3359	80	500	50	92

Dimensions and weights

Model	Dim "A" mm (in)	Dim "B" mm (in)	Dim "C" mm (in)	Weight* wet kg (lbs)
1250 GQNA	5971 (235.1)	1720 (67.7)	3136 (123.5)	17595 (38709)
1750 GQPB	7302 (287.5)	1720 (67.7)	3136 (123.5)	22100 (48620)
1540 GQNA	5603 (220.6)	1720 (67.7)	3136 (123.5)	17057 (38515)
1750 GQNB	5921 (233.1)	1720 (67.7)	3136 (123.5)	19633 (43192)

* Weights represent a set with standard features. See outline drawings for weights of other configurations.

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Warning: Back feed to a utility system can cause electrocution and/or property damage. Do not connect to any building's electrical system except through an approved device or after building main switch is open.

Our energy working for you.™

www.cumminspower.com

Power Generation

Model: 2000GQPC
Frequency: 60 Hz
Fuel Type: Natural Gas MI 78 +
Emissions Performance NOx: 1.0 g/hp-h
LT Water Inlet Temperature: 45°C (113°F)
HT Water Outlet Temp: 92°C (198°F)

Generator set data sheet
2000 kW continuous

Our energy working for you.™

Power Generation

Measured Sound Performance Data Sheet:	MSP - 1039
Prototype Test Summary Data:	PTS - 269
Remote Radiator Cooling Outline:	0500-5093

Fuel Consumption (ISO3046/1)	See Note	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Fuel Consumption (LHV) ISO3046/1, kW (MMBTU/hr)	2,4,6,7	5001 (17.08)	4555 (15.56)	3876 (13.24)	2832 (9.67)
Mechanical Efficiency ISO3046/1, percent	2,4,7	42.2%	41.7%	40.9%	37.8%
Electrical Efficiency ISO3046/1, percent	2,4,6,7	40.0%	39.5%	38.7%	35.3%

Engine	
Engine Manufacturer	Cummins
Engine Model	QSV91G
Configuration	V18
Displacement, L (cu.in)	91.6 (5591)
Aspiration	Turbocharged (1)
Gross Engine Power Output, kWm (hp)	2108 (2826)
BMEP, bar (psi)	18.5 (268)
Bore, mm (in)	180 (7.09)
Stroke, mm (in)	200 (7.87)
Rated Speed, rpm	1514
Piston Speed, m/s (ft/min)	10 (1968
Compression Ratio	12.5
Lube Oil Capacity, L (qt)	550 (581)
Overspeed Limit, rpm	1800
Regenerative Power, kW	N/A
Full Load Lubricating oil consumption, g/kWe-hr (g/hp-hr)	0.4 (0.3)
Fuel	
Gas supply pressure to engine inlet, bar (psi)	.15-.20 (2.2-2.9)
Minimum Methane Index	78
Starting System(s)	
Electric starter voltage, volts	24
Minimum battery capacity @ 40 deg.C (104 deg.F), AH	780
Air Starter Pressure, barg (psig)	10.3 (150)
Air Starter Flow Nm^3/s (scfm)	0.37 (780)
Genset Dimensions (see note 1)	
Genset Length, m (ft)	7.12 (23.4)
Genset Width, m (ft)	2.16 (7.1)
Genset Height, m (ft)	2.78 (9.1)
Genset Weight (wet), kg (lbs)	20705 (45,644)

	See Notes	100% of Rated Load	90% of Rated Load	75% of Rated Load	50% of Rated Load
Energy Data					
Continuous Shaft Power, kWm (bhp)	2,10	2108 (2826)	1900 (2546)	1586 (2126)	1071 (1436)
Continuous Generator Electrical Output kWe	6,10	2000	1800	1500	1000
Heat Dissipated in Lube Oil Cooler, kW (MMBTU/h)	5	277 (0.95)	267 (0.91)	249 (0.85)	208 (0.71)
Heat Dissipated in Block, kW (MMBTU/h)	5	503 (1.71)	488 (1.66)	445 (1.52)	418 (1.43)
Total Heat Rejected in LT Circuit, kW (MMBTU/h)	5	219 (0.75)	200 (0.68)	168 (0.57)	127 (0.43)
Total Heat Rejected in HT Circuit, kW (MMBTU/h)	5	1096 (3.74)	1007 (3.44)	855 (2.92)	664 (2.26)
Unburnt, kW (MMBTU/h)	13	111 (0.38)	104 (0.35)	93 (0.32)	66 (0.23)
Heat Radiated to Ambient, kW (MMBTU/h)	13	368 (1.26)	337 (1.15)	288 (0.98)	218 (0.74)
Available Exhaust heat to 105C, kW (MMBTU/h)	5	1259 (4.30)	1169 (3.99)	1016 (3.47)	818 (2.79)
Intake Air Flow					
Intake Air Flow Mass, kg/s (lb/hr)	4	3.16 (24992)	2.84 (22514)	2.39 (18903)	1.66 (13117)
Intake Air Flow Volume, m3/s @ 0°C (scfm)	4	2.44 (5449)	2.20 (4909)	1.85 (4122)	1.28 (2860)
Maximum Air Cleaner Restriction, mmHG (in H_2O)		22.07 (11.8)	22.07 (11.8)	22.07 (11.8)	22
Exhaust Air Flow					
Exhaust Gas Flow Mass, kg/s (lb/hr)	4	3.27 (25866)	2.94 (23311)	2.47 (19583)	1.72 (13607)
Exhaust Gas Flow Volume, m3/s (cfm)	4	6.76 (14315)	6.18 (13080)	5.30 (11225)	3.90 (8264)
Exhaust Temperature After Turbine, °C (°F)	2	458 (856)	468 (875)	484 (903)	529 (985)
Max Exhaust System Back Pressure, mmHG (in H_2O)	6,14	37.3 (20.0)	37.3 (20.0)	37.3 (20.0)	37.3 (20.0)
Min Exhaust System Back Pressure, mmHG (in H_2O)	6,14	18.7 (10.0)			
HT Cooling Circuit					
HT Circuit Engine Coolant Volume, l (gal)		424 (112)	424 (112)	424 (112)	424 (112)
HT Coolant Flow @ Max Ext Restriction, m^3/h (gal/min)		70 (308)	70 (308)	70 (308)	70 (308)
Maximum HT Engine Coolant Inlet Temp, °C (°F)	8	75 (167)	75 (167)	75 (167)	75 (167)
HT Coolant Outlet Temp, °C (°F)	8	92 (198)	92 (198)	92 (198)	92 (198)
Max Pressure Drop in External HT Circuit, bar (psig)		1.5 (22)	1.5 (22)	1.5 (22)	1.5 (22)
HT Circuit Maximum Pressure, bar (psig)		6.0 (87)	6.0 (87)	6.0 (87)	6.0 (87)
Minimum Static Head, bar (psig)		0.5 (7)	0.5 (7)	0.5 (7)	0.5 (7)
LT Cooling Circuit					
LT Circuit Engine Coolant Volume, l (gal)		295 (78)	295 (78)	295 (78)	295 (78)
LT Coolant Flow @ Max Ext Restriction, m^3/h (gal/min)		50.00 (220)	50.00 (220)	50.00 (220)	50.00 (220)
Maximum LT Engine Coolant Inlet Temp, °C (°F)	9	45 (113)	45 (113)	45 (113)	45 (113)
LT Coolant Outlet Temp, øC (°F) Reference Only	9	47.9 (118)	47.7 (118)	47.2 (117)	46.7 (116)
Max Pressure Drop in External LT Circuit, bar (psig)		1.5 (22)	1.5 (22)	1.5 (22)	1.5 (22)
LT Circuit Maximum Pressure, bar (psig)		6.0 (87)	6.0 (87)	6.0 (87)	6.0 (87)
Minimum Static Head, bar (psig)		0.5 (7)	0.5 (7)	0.5 (7)	0.5 (7)
Emissions					
NO_x Emissions wet, ppm	5	168	177	177	176
NO_x Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	5	493 (1.00)	511 (1.00)	505 (1.00)	490 (1.00)
THC Emissions wet, ppm	13	1382	1431	1524	1571
THC Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	1473	1517	1605	1607
CH_4 Emissions wet, ppm	13	1101	1133	1202	1247
CH_4 Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	1190 (2.53)	1217 (2.60)	1284 (2.77)	1292 (3.00)
NMHC Emissions wet, ppm	13	279	298	324	324
NMHC Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	298	315	341	331
CO Emissions (dry), ppm	13	582	575	575	580
CO Emissions, mg/Nm^3 @5% O_2 (g/hp-h)	13	975 (2.07)	958 (2.05)	950 (2.05)	927 (2.15)
O2 Emissions (dry), percent	13	9.1	9.0	8.9	8.5
Particulates PM10, g/hp-h	13	<0.06	n/a	n/a	n/a

Genset De-rating

Altitude and Temperature Derate Multiplication Factor

Barometer		Altitude		Table A *								
In Hg	mbar	Feet	Meters	Derate Multiplier with Grid Parallel Operation								
20.7	701	9843	3000	0.75	0.75							
21.4	723	9022	2750	0.80	0.80							
22.1	747	8202	2500	0.85	0.85	0.75						
22.8	771	7382	2250	0.90	0.90	0.80						
23.5	795	6562	2000	0.95	0.95	0.85	0.75					
24.3	820	5741	1750	1.00	1.00	0.90	0.80					
25.0	846	4921	1500	1.00	1.00	0.95	0.85	0.75				
25.8	872	4101	1250	1.00	1.00	1.00	0.90	0.80				
26.6	899	3281	1000	1.00	1.00	1.00	0.95	0.85	0.75			
27.4	926	2461	750	1.00	1.00	1.00	1.00	0.90	0.80			
28.3	954	1640	500	1.00	1.00	1.00	1.00	0.95	0.85			
29.1	983	820	250	1.00	1.00	1.00	1.00	1.00	0.90			
29.5	995	492	150	1.00	1.00	1.00	1.00	1.00	0.95	0.75		
30.0	1012	0	0	1.00	1.00	1.00	1.00	1.00	1.00	0.75		
			°C	20	25	30	35	40	45	50	55	60
			°F	68	77	86	95	104	113	122	131	140
			Air Filter Inlet Temperature									

* Based on SAE standard ambient pressure vs. altitude. Assumes LT return temperature is 10C above air filter inlet.

Temperature & Altitude Derate

1. Determine derate multiplier vs. temperature and altitude in Table A or B depending upon your operating condition.
2. Assumes the LT return temperature is 10 deg C above the air filter inlet with a maximum LT temperature of 45 deg C.
3. If the LT temperature exceeds 45 deg C, consult factory for recommendations.
4. Altitude is based upon SAE standard ambient pressure vs. altitude. For low barometric conditions add 150m (500 ft) to site altitude.

Barometer		Altitude		Table B *								
In Hg	mbar	Feet	Meters	Derate Multiplier Off Grid (Island or Load Share)								
20.7	701	9843	3000	0.75	0.75							
21.4	723	9022	2750	0.80	0.80							
22.1	747	8202	2500	0.85	0.85	0.75						
22.8	771	7382	2250	0.90	0.90	0.80						
23.5	795	6562	2000	0.95	0.95	0.85	0.75					
24.3	820	5741	1750	1.00	1.00	0.90	0.80					
25.0	846	4921	1500	1.00	1.00	0.95	0.85	0.75				
25.8	872	4101	1250	1.00	1.00	1.00	0.90	0.80				
26.6	899	3281	1000	1.00	1.00	1.00	0.95	0.85	0.75			
27.4	926	2461	750	1.00	1.00	1.00	1.00	0.90	0.80			
28.3	954	1640	500	1.00	1.00	1.00	1.00	0.95	0.85			
29.1	983	820	250	1.00	1.00	1.00	1.00	1.00	0.90			
29.5	995	492	150	1.00	1.00	1.00	1.00	1.00	0.95	0.75		
30.0	1012	0	0	1.00	1.00	1.00	1.00	1.00	1.00	0.75		
			°C	20	25	30	35	40	45	50	55	60
			°F	68	77	86	95	104	113	122	131	140
			Air Filter Inlet Temperature									

* Based on SAE standard ambient pressure vs. altitude. Assumes LT return temperature is 10C above air filter inlet.

Methane Number Capability

Load (Percent of Rated)			
100%	90%	75%	50%
78	72	n/a	n/a

Heat Rejection Factor (altitude and ambient) for HT and LT Circuits

Barometer		Altitude		Table C								
In Hg	mbar	Feet	Meters	Multiplier for HT & LT Heat Rejection vs Alt & Temp.								
20.7	701	9843	3000	1.11	1.13	1.14	1.15	1.17	1.18	1.19	1.20	1.22
21.4	723	9022	2750	1.10	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.21
22.1	747	8202	2500	1.09	1.10	1.12	1.13	1.14	1.16	1.17	1.18	1.20
22.8	771	7382	2250	1.08	1.09	1.11	1.12	1.13	1.14	1.16	1.17	1.18
23.5	795	6562	2000	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.17
24.3	820	5741	1750	1.06	1.07	1.08	1.10	1.11	1.12	1.14	1.15	1.16
25.0	846	4921	1500	1.05	1.06	1.07	1.09	1.10	1.11	1.12	1.14	1.15
25.8	872	4101	1250	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14
26.6	899	3281	1000	1.02	1.04	1.05	1.06	1.08	1.09	1.10	1.12	1.13
27.4	926	2461	750	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.10	1.12
28.3	954	1640	500	1.00	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.11
29.1	983	820	250	0.99	1.00	1.02	1.03	1.04	1.06	1.07	1.08	1.10
29.5	995	492	150	0.99	1.00	1.01	1.03	1.04	1.05	1.06	1.08	1.09
30.0	1012	0	0	0.98	0.99	1.01	1.02	1.03	1.05	1.06	1.07	1.08
			°C	20	25	30	35	40	45	50	55	60
			°F	68	77	86	95	104	113	122	131	140
			Air Filter Inlet Temperature									

LT & HT Circuit Heat Rejection Calculation

1. Determine derate multiplier vs. temperature derate per above.
2. Using the multiplier from #1 above as the percent load factor determine the Heat rejection from the previous page.
3. From Table C find the HT and LT circuit multiplier.
4. Multiply the result of step 2 by the result of step 3 to obtain the heat rejection at your altitude and temperature.

Alternator Data

Voltage Range	Connection Configuration	Temp Rise Degrees C	Duty[11] Cycle	Single Phase Factor	Maximum Surge kVA[12]	Alternator Data Sheet	Feature Code
380	Wye, 3 Phase	105	C	N/A	7960	515	B597-2
416-480	Wye, 3 Phase	80	C	N/A	9700	517	B587-2
416-480	Wye, 3 Phase	105	C	N/A	8400	516	B654-2
416-480	Wye, 3 Phase	125	C	N/A	7200	515	B627-2
480	Wye, 3 Phase	80	C	N/A	8400	516	B653-2
480	Wye, 3 Phase	105	C	N/A	7200	515	B583-2
600	Wye, 3 Phase	80	C	N/A	8250	516	B589-2
600	Wye, 3 Phase	105	C	N/A	7200	515	B582-2
4160	Wye, 3 Phase	80	C	N/A	6300	518	B590-2
12470-13800	Wye, 3 Phase	80	C	N/A	8000	523	B591-2
12470-13800	Wye, 3 Phase	105	C	N/A	6800	522	B484-2
13200-13800	Wye, 3 Phase	105	C	N/A	5000	521	B657-2
13800	Wye, 3 Phase	80	C	N/A	6800	522	B565-2

Continuous Rating Definition

Applicable for supplying power continuously to a constant load up to the full output rating for unlimited hours. No sustained overload capability is available for this rating. Consult authorized distributor for rating. (Equivalent to Continuous Power in accordance with ISO8528, ISO3046, AS2789, DIN6271, and BS5514). This rating is not applicable to all generator set models.

Notes

1) Weights and set dimesions represent a generator set with its standard features only. See outline drawing for other configurations.
2) At ISO3046 reference conditions, altitude 1013 mbar (30in Hg), air inlet temperature 25°C (77°F)
3) Nominal performance ± 2 1/2%.
4) According to ISO 3046/I with fuel consumption tolerance of +5% -0% or efficiency tolerance of +0% -5%.
5) Production variation/tolerance ±5%.
6) At electrical output of 1.0 Power Factor.
7) Tested using pipeline natural gas with LHV of 33.44mJ/Nm3 (905BTU/ft3)
8) Outlet temperature controlled by thermostat. Inlet temperature for reference only.
9) Inlet temperature controlled by thermostat, outlet temperature for reference only.
10) With engine driven coolant pump.
11) Standby (S), Prime (P), Continuous (C)
12) Maximum rated starting kVA that results in minimum of 90% of rated sustained voltage during starting.
13) Tolerance +/- 15%
14) Exhaust system back pressure is a rated load and will decrease at lower loads.

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Web: www.cumminspower.com

Power Generation

2000GQPC	Genset-Spark Ignited, 60 Hz, 2000 kW
	Continuous Rating
	Fuel System-PipeNatGAS
	Emissions-Exhaust
	Thermostat-EngineCooling
	Voltage 480 vac
	SetCntl-PwrCommSupervisor,ShipLoose
	Display Language-English
	User Interface-Control,Graphical
	Interface-CommunicationsNetworkGCP
	Temp Sens-Stator,2RTD/Ph
	Temp Sens-Bearing RTDs
	Transformer-Bus Potential,240V
	AuxSupplyVolts 480,3Ph,4W,120V1Ph2W
	Heater-Alternator,W/Thermostat
	Heater-Alternator,W/Thermostat
	Cooling Control Module - w/ Engine Pumps
	Coolant Connections-Flanged(ASA Flanges)
	Oil Heater-40F MinAmbient Temp
	Engine Air Cleaner - Heavy Duty
	ExhaustConnector-ASA Flange
	Crankcase Breather Filter
	Oil Sump Makeup Valve
	Literature-English
	Natural Gas Fuel Train
	Packing-None
* Estimate	Freight to USA Port
* Estimate	Duty into US
* Estimate	Freight port to jobsite
	Vibration Isolators
	GCP Calbe and Harness 5 meters

Cummins Digital Paralleling
Low Voltage Proposal Summary

Job Name: Northern Michigan Cogen **Cummins Distributor:** Cummins Bridgeway
Address:

Quotation ID:
Proposal for: Bruce Otte
Control Type: PCUL300, 2-3 Gensets controlled, 1 to 2 Load Sheds, Generator Data Display, Extended Paralleling/Utility Tracking Feature

System Voltage: 277/480v, 3Ø, 4-wire
Section Depth: 78 inches **Section height:** 90 inches
Approx. total lineup length: 12.5 feet
Approximate weight: 4800 Lbs

Other Features:
Manuals, Freight, Start-up,
Standard Interrupting Ratings
All breakers are Square D Masterpact type.

Section Detail $352,700

1	**Utility Main** Breaker Size(s): 4000 amps, 1 Ground Fault(s) E/O - L, S, I, Relays: 86, 81-O/U, 47/27/59, 32R, O/C Lamps, PT's & CT's, Aux Switch
2	**Distribution** Breaker Size(s): , , , 4000 amps, 1 Ground Fault(s) M/O - L, S, I
3	**Generator Paralleling** Breaker Size(s): , 3000, , 3000 amps, 2 Ground Fault(s) E/O - L, S, I, PT's & CT's, Aux Switch
4	N/A*
5	N/A*
6	N/A*
7	N/A*
8	N/A*
9	N/A*

(*) - AIC rating will be lower in 600v applications *Cummins Switchgear Configurator 1.2*
"P" at the end of a Breaker size means no breaker, Prepared only.
Other Products/Services:

$352,700

Appendix J. Phase One Screening Report – Environmental

Phase One Screening Report:

Saginaw Chippewa Windpower Sites

Arenac and Isabella Counties, Michigan

March 18, 2005

Prepared for:

Distributed Generation Systems, Inc (DISGEN)
200 Union Blvd, Suite 304
Lakewood, Colorado 80228

On Behalf of:

Saginaw Chippewa Indian Tribe
770 East Broadway
Mount Pleasant, Michigan 48858

Prepared by:

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WEST, Inc.

INTRODUCTION:

When exploring prospective windpower sites, knowledge of wildlife and other biological resource issues helps the wind industry identify and avoid potential ecological problems early in the development process. The purpose of this report is not to define impacts of the proposed windpower project, rather, the purpose is to alert project proponents to potential conflicts with wildlife and habitat. WEST, Inc. was asked by DISGEN to evaluate potential wildlife occurrence and habitat issues at two prospective windpower sites for the Saginaw Chippewa Nation in Michigan. The areas are located within Arenac and Isabella Counties near Mount Pleasant and Standish, Michigan (Figure 1). The area evaluated for potential biological resources includes the proposed project areas, additional potential development areas, and a two mile buffer. This report focuses on the following potential areas of concern:

- Raptors
  1. Identify areas of potentially high nesting density
  2. Identify areas of potentially high prey density
  3. Examine topography to determine the potential for high use and potential nest locations
  4. Determine the species likely to occur in the area
  5. Determine the potential for migratory pathways
- Candidate, Proposed, Threatened, Endangered, and USFWS Birds of Conservation Concern
  1. Identify the potential occurrence of federally listed or state protected species through existing literature and database searches
  2. Evaluate the suitability of habitat at the wind plant site for protected species
- State Wildlife Issues (using existing state wildlife agency information)
  1. Examine habitat during site visits to determine the potential for use by state protected species
- Unique Habitat
  1. Evaluate the uniqueness of the site relative to the surrounding area.
- Wetlands
  1. Determine the potential for wetlands at the site through a cursory site visit and examination of available data
- Bats
  1. Determine the proximity to potential feeding sites and hibernacula
  2. Determine species likely to occur in the area
- Avian Migratory Pathways of Passerines, Waterfowl and Shorebirds

METHODS:

Biological resources within the vicinity of the project were evaluated through a search of existing data and a site visit. The project areas were examined on December 20, 2004 by foot and vehicle. During the site visit, biological features and potential wildlife habitat including plant communities, topography features, and potential raptor nest structures were identified.

Several sources of available data were used to identify biological resources within the project areas, including requesting data from the Michigan Department of Natural Resources, the Michigan U.S. Fish and Wildlife Service (USFWS), Michigan Natural Features Inventory, and searching published literature, field guides etc. Letters requesting information on the proposed projects were sent to the USFWS and the Michigan Department of Natural Resources (DNR) on February 9, 2005 and December 30, 2004 respectively (Appendix A). Correspondence was received from the Michigan DNR and the U.S. Fish and Wildlife Service dated February 24, 2005.

After biological resources within the project areas were identified, we analyzed the potential for conflicts with the proposed windpower project based, in part, upon studies conducted at other wind plants throughout the U.S. We also calculated Potential Impact Scores based on the Interim USFWS guidelines for the proposed project areas and one reference area (See Appendix B for score calculations).

Study Area. The two project areas are located within central and east-central Michigan. Both project areas are a mixture of private and Saginaw Chippewa lands. The project areas consist of active and formerly tilled agriculture and scattered woodlots composed of Box Elder (*Acer negundo*) and Eastern Cottonwood (*Populus deltoides*). Scattered rural residences are present within both areas. The Mount Pleasant site is located approximately two miles east of Mount Pleasant, Michigan in Isabella County (Figure 2). The Standish site located approximately four miles southeast of the town of Standish and within one mile of Saginaw Bay (Figure 3). The Saganing River flows through the Standish Project Area to the Saginaw Bay.

RESULTS:

Raptor Issues

Nesting density and species breeding in area. Nesting habitat in both project areas for above ground nesting raptors is limited to deciduous forest. Patches of woodlots are present within two miles of both project areas. Based upon available habitat, the following species are most likely to nest within two miles of the project areas (Chartier and Ziarno 2004): red-tailed hawk (*Buteo jamaicensis*), red-shouldered hawk (*Buteo lineatus*), broad-winged hawk (*Buteo platypterus*), American kestrel (*Falco sparverius*), Cooper's hawk (*Accipiter cooperii*) and sharp-shinned hawk (*Accipiter striatus*). Due to the presence of Saginaw Bay near the Standish site, the potential exists for osprey

(*Pandion haliaetus*) to nest within two miles of the project area. Although the bald eagle (*Haliaeetus leucocephalus*) has been documented as nesting on Saginaw Bay, the proposed Standish project area generally lack mature forests required for bald eagle nests, and the potential for the species to nest in the project areas is considered low. The potential for bald eagles nesting within the potential development area is greater due to the closer proximity to the shoreline of the Saginaw Bay.

Nesting raptors are generally territorial and do not nest in high densities unless certain factors are limiting, such as nesting habitat. Scattered woodlots are present throughout Isabella and Arenac Counties, and there is no available evidence to suggest that habitat within the project areas support extraordinary high densities of nesting raptors.

The proposed project areas also provide habitat for wintering raptors. Raptor species most likely to winter in the project areas include northern harrier (*Circus cyaneus*), sharp-shinned hawk, Cooper's hawk, red-tailed hawk, rough-legged hawk (*Buteo lagopus*), and American kestrel (Chartier and Ziarno 2004). A lower potential exists for gyrfalcon (*Falco rusticolus*), northern goshawk (*Accipiter gentilis*), and great gray owl (*Strix nebulosa*) to utilize the project areas.

Potential for prey densities. No obvious signs of colonial rodents were observed due to the preponderance of tilled agriculture in the project area. Prey densities and prey availability of species such as *Peromyscus* may be very high in agricultural fields immediately after harvest as mice forage on leftover seeds.

Overall, it is very difficult to assess potential prey densities during a single site visit. Prey densities can fluctuate rapidly based on habitat and climatic factors. However, overall prey densities are expected to be low in the project area based on the large amount of tilled agriculture in the area.

Does the topography of the site increase the potential for raptor use? The proposed project is located on almost entirely flat agricultural fields that generally lack defined topographic edges. At other windpower facilities located on prominent ridges with defined edges (e.g., rims of canyons, steep slopes), raptors fly along the rim edges, using updrafts to maintain altitude while hunting, migrating or soaring. Turbines are often placed on prominent ridges in order to use higher wind speeds and updrafts that raptors also use. In Wyoming, raptors most often used areas within 50 m of the rim edge (Johnson et al. 2000b). Raptor use is not expected to be heavily influenced by the topography in the project area because its general lack of defined ridges and rim edges. However, due to the presence of the Saginaw Bay near the Standish site, there is the potential for increased use of the Standish site by migrating raptors. Raptor species generally avoid migrating over large bodies of water (Kerlinger 1995).

Federal and State Protected Species

A total of 82 federally or state listed threatened or endangered species and 133 species of concern occur within the state of Michigan (MNFI 1999). Most species groups are included, such as birds, mammals, amphibians, reptiles, mussels, fish and various types of insects. The vast majority of these species occur primarily in non-agricultural native habitats and streams or lakes. The proposed project areas occur primarily within habitats that are actively or formerly tilled, thus there is limited potential for most listed species or species of concern to occur within the project areas. The potential development areas containing greater amounts of native habitat in the form of deciduous woodlands and wetlands, thus there is a greater potential for species to occur within the potential development areas and two mile buffers. The MNFI has records for only two species occurring within approximately two miles of either project area. The wood turtle and the Blanding's turtle were documented within two miles of the Mount Pleasant Project area (Figure 2). The MNFI also has records for Hayden's Sedge (extirpated), Ram's head lady slipper, and riverine snaketail occurring within areas surrounding the Mount Pleasant project. In correspondence dated February 24, 2004, the U.S. Fish and Wildlife Service determined "there are presently no federally-listed threatened, endangered or proposed species within the project area."

MNFI data should be interpreted with caution. Surveys have not been conducted in many areas of Michigan, and the absence of records does not necessarily indicate a species does not occur. Due to the lack of records in many areas, we examined records of species occurring within Isabella and Arenac Counties to determine the potential for other listed species or species of concern to occur within the proposed project and development areas (Tables 1-2).

Table 1. A list of species tracked by the MNFI with records in Isabella County. The list is current as of January 4, 2005, and contains all plant and animal species except birds. E = Endangered, T = Threatened, SC = Species of Concern, and X = Extirpated.

Common Name	Federal Status	State Status	Potentially Present at Mt Plesant?	Notes
Calypso or Fairy-slipper		T	No	Lacks Habitat
Hayden's Sedge		X	No	Extirpated
Ram's Head Lady's-slipper		SC	No	Lacks Coniferous Habitat
Blanding's Turtle		SC	Yes	Records within 2 miles of project
Wood Turtle		SC	Yes	Records within 2 miles of project
Splendid Clubtail		SC	Yes	Wetland habitat present near project area
Rapids Clubtail		SC	Yes	Wetland habitat present near project area
Twinleaf		SC	Yes	Potential to occur in forested areas
Blue-eyed-grass		SC	No	Lack of Habitat
Eastern Box Turtle		SC	Yes	Suitable Habitat Present

Table 2. A list of species tracked by the MNFI with records in Arenac County. The list is current as of January 4, 2005, and contains all plant and animal species except birds. E = Endangered, T = Threatened, SC = Species of Concern, and X = Extirpated.

Common Name	Federal Status	State Status	Potentially Present at Standish?	Notes
Pitcher's Thistle	LT	T	Yes	Only in sandy areas on lakeshore
Large Toothwort		T	Yes	In Mesic forested areas
Wood Turtle		SC	Yes	Near streams in project area
Doll's Merolonche		SC	Yes	May fly through project area
American Burying Beetle	LE	E	No	The USFWS does not list as potentially occurring in Arenac County
Channel Darter		E	Yes	In streams
Eastern Massasauga	C	SC	Yes	In wetlands

Because windpower projects typically pose a greater risk to birds and bats than other species, we examined the potential for all listed and species of concern of birds to occur within the project areas (Tables 3-4). Only two bat species, the Indiana bat (Endangered) and the eastern pipistrelle (Species of Concern) are listed by the MNFI as mammals of special concern in the state of Michigan. The proposed project areas occur outside of the potential range of these two species.

WETLANDS

The number of wetlands differs between the two project areas (Figures 2-3). Forested wetlands are present within and surrounding the Mount Pleasant potential development area (Figure 2). Wetlands present within the Standish project area are associated with the Saganing River. The Saginaw Chippewa Nation has designated a nature preserve located on the Saganing River that is composed largely of wetlands. Within two miles of the Standish site several emergent wetlands are present along Saginaw Bay. Some forested and scrub-shrub wetland are present within woodlots west of the proposed project area (Figure 3).

STATE WILDLIFE ISSUES AND UNIQUE HABITAT

Based on correspondence from the Michigan DNR, no natural features should be impacted by the proposed project (see attached correspondence). The DNR's largest concern was the potential impact of the proposed project on migrating birds. The DNR describes Michigan's flyways as concentrated along the Great Lakes shorelines.

Both project areas are dominated by agriculture and have some woodlots present (Figures 4-5). The potential development area for Mount Pleasant contains more deciduous forest and forested wetlands. These habitats, while not unique in Central Michigan, provide more suitable habitat for several native bird and mammal species than areas dominated by agriculture.

BATS

The proposed project areas occur within the potential ranges of the following bat species (BCI 2002): Big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), silver-haired bat (*Lasionycteris noctivagans*), little brown myotis (*Myotis lucifugus*) and northern myotis (*Myotis septentrionalis*). Both proposed project and potential development areas contain potential roosting and foraging habitat for bats in the form of woodlots and wetlands.

Bat casualties have been reported from most windpower facilties where post-construction fatality data are publicly available. Reported estimates of bat mortality at windpower facilities have ranged from 0.01 – 47.5 per turbine per year (0.9 – 43.2 bats / MW / Year) in the U.S. with an average of 3.4 per turbine or 4.6 per MW (NWCC 2004). Most of the bat casualties at windpower facilities to date are migratory species which conduct long migrations between summer roosts and winter hibernacula. Examples of these species commonly found as fatalities at windpower facilities include hoary bats, silver-haired bats and eastern red bats. A recent report of bat fatalities at a windpower facility in West Virginia includes relatively high numbers of red bats, hoary bats, eastern pipistrelle (*Pipistrellus subflavus*) and little brown bat over the course of one year. The West Virginia site is located on a prominent, relatively narrow ridge in the Appalachian Mountains and is surrounded almost entirely by deciduous forest. The causes of the relatively high number of migratory bat deaths at windpower facilities are not well understood. Some have suggested it may be related to the lack or reduction of echolocation during migration (Johnson 2003). Furthermore, strong field methods to provide quantitative predictions of migratory bat use are lacking.

Due to a lack of information concerning bat migration habits, it is difficult to predict if the proposed project areas are located within a bat migration corridor. The proposed project will likely result in the mortality of some bat species, including red bats, hoary bats and silver-haired bats. The magnitude of these fatalities and the degree to which other bats species will be affected is difficult to determine. However, unlike the West Virginia site, the proposed project areas are relatively flat and do not appear to contain topographic features that may funnel migrating bats (Figures 1-2).

AVIAN MIGRATORY PATHWAYS

The seasonal migration of birds through Michigan appears to be generally widespread thoughout Michigan. However, radar ornithology research focusing on nocturnal songbird migration in this region suggested that the shorelines of the Great Lakes may be important stopover sites (Diehl et al. 2003). The Great Lake's shorelines and peninsulas are also believed to concentrate the migration of raptors (Kerlinger 1989, Kerlinger 1995).

Although night-migrating songbirds typically migrate between 91 and 610 m altitude, they occasionally collide with lit communication towers and other tall human-made structures (Erickson et al. 2001, Kerlinger 1995). Research suggests that birds become attracted to the lights of structures and fly around them in circular patterns, eventually becoming exhausted, and/or colliding with the structure, supporting guy wires or other birds (Avery et al. 1976, Larkin and Frase 1988). Bird collisions with tall structures, including communication towers, appear to occur more frequently on nights with overcast skies, fog, or otherwise low-visibility. Similar to communication towers, many wind turbines are equipped with obstruction lighting. Typically turbines are only lit with one flashing red or white strobe light on the turbine nacelle compared to the flashing light - steady burning light combinations of communication towers (FAA 2000). Although the turbine lighting systems may attract some night-migrating songbirds, mortality at turbines is significantly lower than what has been documented at lit communication towers. Bird mortality events involving hundreds of birds have occurred at communication towers, but no large mortality events have ever been documented at wind turbines (Erickson et al. 2001).

The proposed Standish project area is located within one mile of the shore of Saginaw Bay. In general, the proximity of the site to the shoreline could be associated with higher densities of both nocturnal and diurnal migrating birds. Although the proposed project area provides very little of the vegetation necessary for songbird stopovers, waterfowl may use the agricultural fields for feeding. Areas managed for breeding Kirtland's Warbler (*Dendroica kirtlandii*), are present 31 miles north of the proposed turbine site. Although the potential for a Kirtland's warbler to utilize deciduous forest in the project area for stopover habitat is considered low, the potential exists and should be recognized.

The proposed project area near Mount Pleasant, Michigan had been used for agricultural purposes in the past but has since become fallow, and is currently dominated by grass and other herbaceous vegetation. East and northeast of the proposed turbine site is a shelterbelt and wooded areas that are contiguous with the Au Sable State Forest (i.e., State Forest boundary 4 miles east of site). According to the National Wetlands Inventory much of the forested areas near the proposed turbine sites are wet, and Onion Creek flows due south and east of the site. Although this site is significantly farther from the shoreline than the Standish site, it is possible that migratory birds may use the area as stopover habitat.

DISCUSSION:

The largest issue facing both proposed project areas is the potential impact to migrating birds, especially nocturnal migrants. To date overall fatality rates for birds at windpower projects have ranged from 0.6 – 7.7 bird fatalities / turbine / year (0.9 – 11.7 / MW / year), with an average of 2.3 bird fatalities / turbine / year or 3.1 bird fatalities / MW / year (NWCC 2004). Outside of California, fatality rates for raptors have ranged from 0.0 – 0.07 fatalities / turbine / year (0.00 – 0.09 / MW / year), with an average of 0.03 per turbine and 0.04 per MW. The largest single fatality event at a windpower project was 30 songbirds on a foggy night near a lighted substation in West Virginia (NWCC 2004). Bird mortality at turbines in the eastern United States is typically much lower than what is expected at communication towers. Ongoing bird collision research in Michigan has found higher bird mortality at communication towers >305 m Above Ground Level (AGL) than at towers <146 m AGL (Gehring 2005). It is possible that bird mortality may increase as turbine height increases.

The proposed projects may potentially occur within the migratory pathway of the Endangered Kirtland's warbler. The U.S. Fish and Wildlife Service places a high priority on protecting this species, and the potential exists for individuals of this species to collide with the proposed turbines in the project area. It is very difficult to evaluate the level of risk due to the lack of understanding of specific migratory pathways in the proposed project areas. Assuming bird migration is concentrated along the Great Lakes shoreline, the Standish project area may pose a greater risk to migrating Kirtland's warblers than the Mount Pleasant project area. While the overall risk to the Kirtland's warbler is considered low due to 1) the low songbird mortality observed at other windpower projects and 2) the expected small size of the project, the potential exists for individuals of the species to collide with turbines in the project area and should be realized. It should also be noted that other existing tall structures in central Michigan, such as tall buildings and communication towers pose potentially greater threats to migrating Kirtland's warblers.

The presence of Saginaw Bay within one mile of the proposed Standish site causes a greater potential for biological issues versus the Mount Pleasant Site (Tables 5-6 and Appendix B). This is primarily due to the potential for migrating songbirds and raptors to more heavily utilize areas along shorelines for stopover habitat as well as for potential migration routes. Little is known concerning bat migrations, and it is not clear if bats avoid migrating over large bodies of water and thus also concentrate along shorelines.

The proposed project areas are dominated by active and former agriculture, and provide limited habitat value to wildlife species. The potential development areas surrounding each project area contain greater amounts of native habitats, such as deciduous forest and wetlands. If the proposed project impacts these native habitats, the potential exists for species protected under the Michigan Endangered Species Act to occur within these habitats. If the proposed project moves forward, the MI DNR and the USFWS should be consulted again once turbine and other infrastructure locations have been decided to determine the need for biological surveys.

Table 3. A list of bird species protected under the federal or state Endangered Species Act that occur within Michigan. B = Breeding, M/W = Migration and or Winter. Occurrence is based on Brewer et al. 1991, Chartier and Ziarno 2004, Breeding Bird Survey Data, Christmas Bird Count Data, and available habitat within the project areas.

Common Name	Federal Status	State Status	Potentially Present in Mt Pleasant? (B, M/W or Both)	Potentially Present in Standish? (B, M/W or Both)	Notes on Occurrence
Short-eared owl		E	migration/winter	migration/winter	
Piping plover	LE	E	Potentially migration	migration	Most migration in Michigan believed to be along shoreline
Prairie warbler		E	Potentially migration	Potentially migration	
Kirtland's warbler	LE	E	Migration	migration	Standish site within 31 miles of breeding areas, migration route potentially includes both sites
Peregrine falcon		E	Migration/winter	Migration/winter	
Migrant loggerhead shrike		E	Migration/winter	Migration/winter	
King rail		E	Not likely	Not likely	
Barn owl		E	Not likely	Not likely	
Henslow's sparrow		T	Both	Both	No confirmed nests within 2 miles but habitat present
Long-eared owl		T	Migration/winter	Migration/winter	
Red-shouldered hawk		T	Migration/winter	Migration/winter	"probable nest" in Chippewa River, Tittabawassee River, and Au Sable State Forests 3-5 miles east of Mount Pleasant site.
Yellow rail		T	Not likely	Not likely	
Trumpeter swan		T	Migration	migration	
Yellow-throated warbler		T	Not likely	Not likely	
Merlin		T	Migration/winter	Migration/winter	
Common loon		T	Migration/winter	Migration/winter	
Bald eagle	PS:LT,PDL	T	Migration/winter	Migration/winter	Confirmed nest approximately 9 miles from Standish site on shoreline
Least bittern		T	Migration	Migration	Confirmed nest in Au Sable State Forest area 3-5 miles east of Mount Pleasant site.
Osprey		T	Migration/winter	Migration/winter	Nest approximately 8 miles southwest of Mount Pleasant site
Caspian tern		T	Migration	Migration	
Common tern		T	Migration	Migration	
Lark sparrow		X	Not likely	Not likely	

Table 4. A list of bird species of concern that occur within Michigan. B = Breeding, M/W = Migration and or Winter. Occurrence is based on Brewer et al. 1991, Chartier and Ziarno 2004, Breeding Bird Survey Data, Christmas Bird Count Data, and available habitat within the project areas.

Common Name	Federal Status	State Status	Potentially Present in Mt Pleasant? (B, M/W or Both)	Potentially Present in Standish? (B, M/W or Both)	Notes on Occurrence
Cooper's hawk		SC	Both	Both	"Confirmed nest" in Chippewa River, Tittabawassee River, and Au Sable State Forest area 3-5 miles east of Mount Pleasant site.
Northern goshawk		SC	Migration/winter	Migration/winter	
Grasshopper sparrow	PS	SC	both	Both	"Possible nest" approximately 6 miles southwest of Mount Pleasant site.
American bittern		SC	Migration/winter	Migration/winter	Probable nest in Au Sable State Forest area 3-5 miles east of Mount Pleasant site.
Black tern		SC	Migration	Migration	
Northern harrier		SC	Migration/winter	Migration/winter	
Marsh wren		SC	Migration/winter	migration	
Cerulean warbler		SC	Not likely, possibly migration	Not likely, possibly migration	
Spruce grouse		SC	Not likely	Not likely	
Common moorhen		SC	Not likely, possibly migration	Not likely	
Black-crowned night-heron		SC	migration/winter	migration/winter	
Wilson's phalarope		SC	possibly migration	possibly migration	
Black-backed woodpecker		SC	migration	migration	
Prothonotary warbler		SC	Not likely	Not likely	
Louisiana waterthrush		SC	Not likely	Not likely	
Dickcissel		SC	migration	migration	
Forster's tern		SC	Not likely	possibly migration	
Western meadowlark		SC	possibly migration	Not likely	
Sharp-tailed grouse		SC	Not likely	Not likely	
Hooded warbler		SC	Not likely	Not likely	
Yellow-headed blackbird		SC	Migration/winter	Migration/winter	

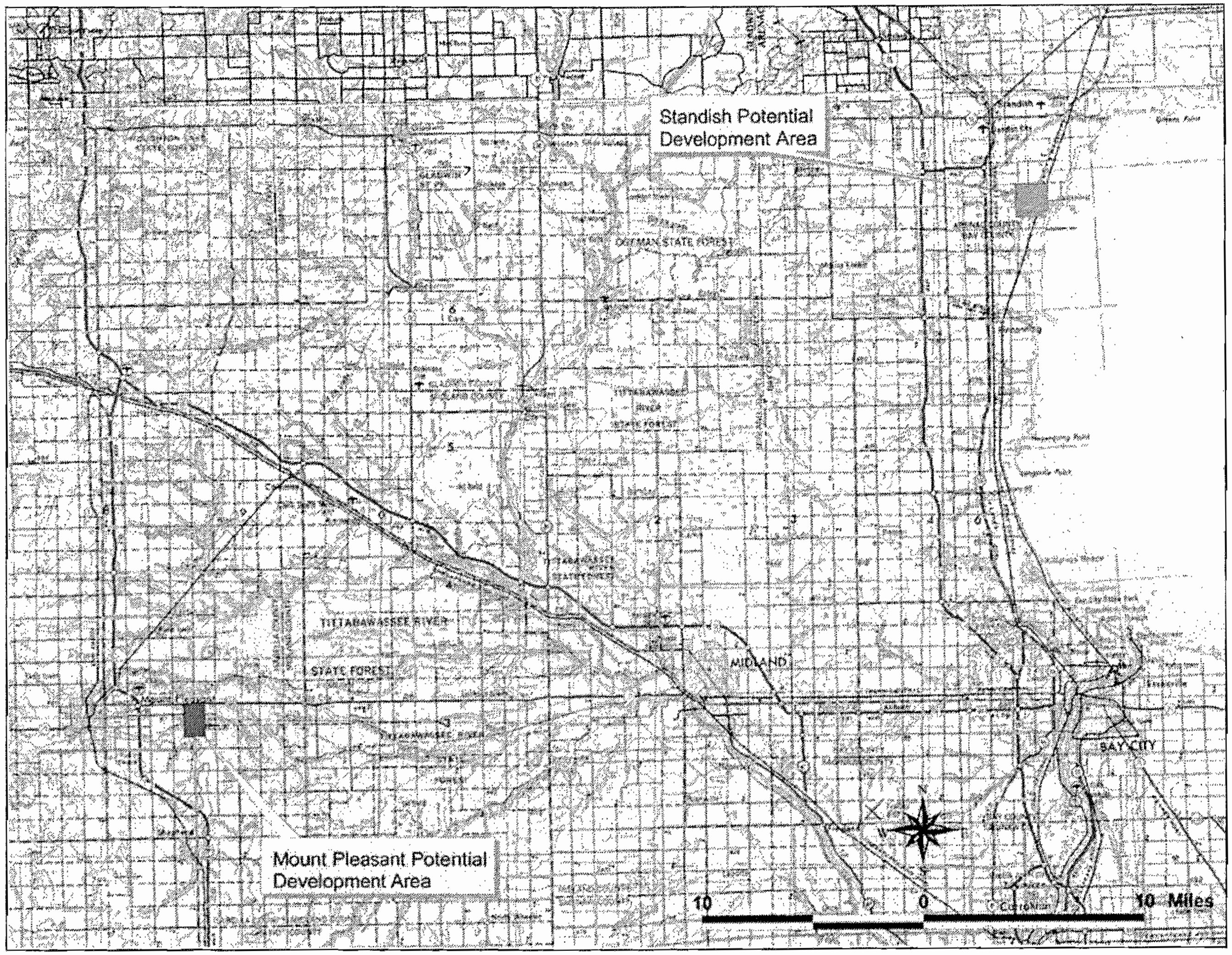

Figure 1. Locations of the potential development areas in central Michigan.

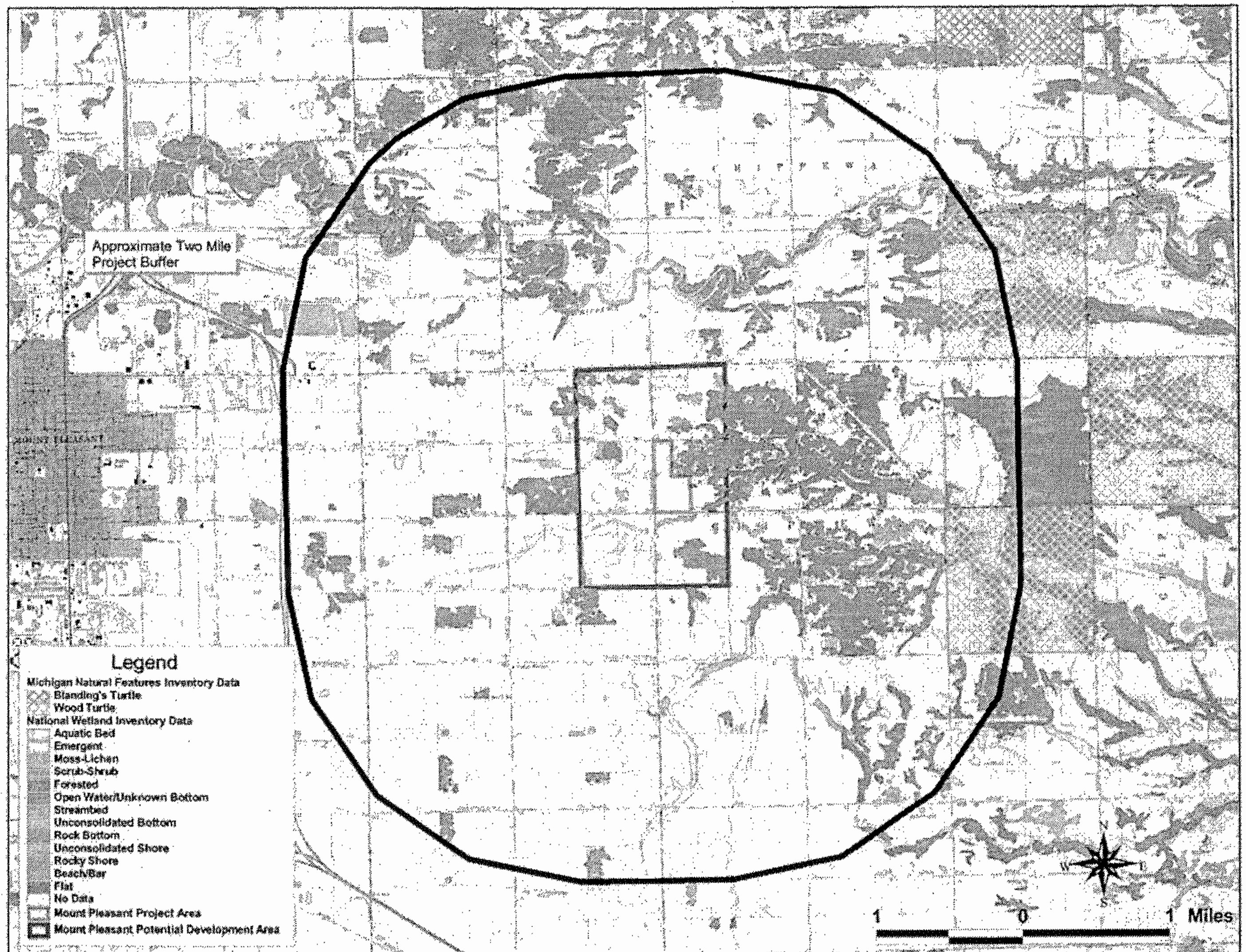

Figure 2. A map of the Mount Pleasant project area showing wetland and rare species locations.

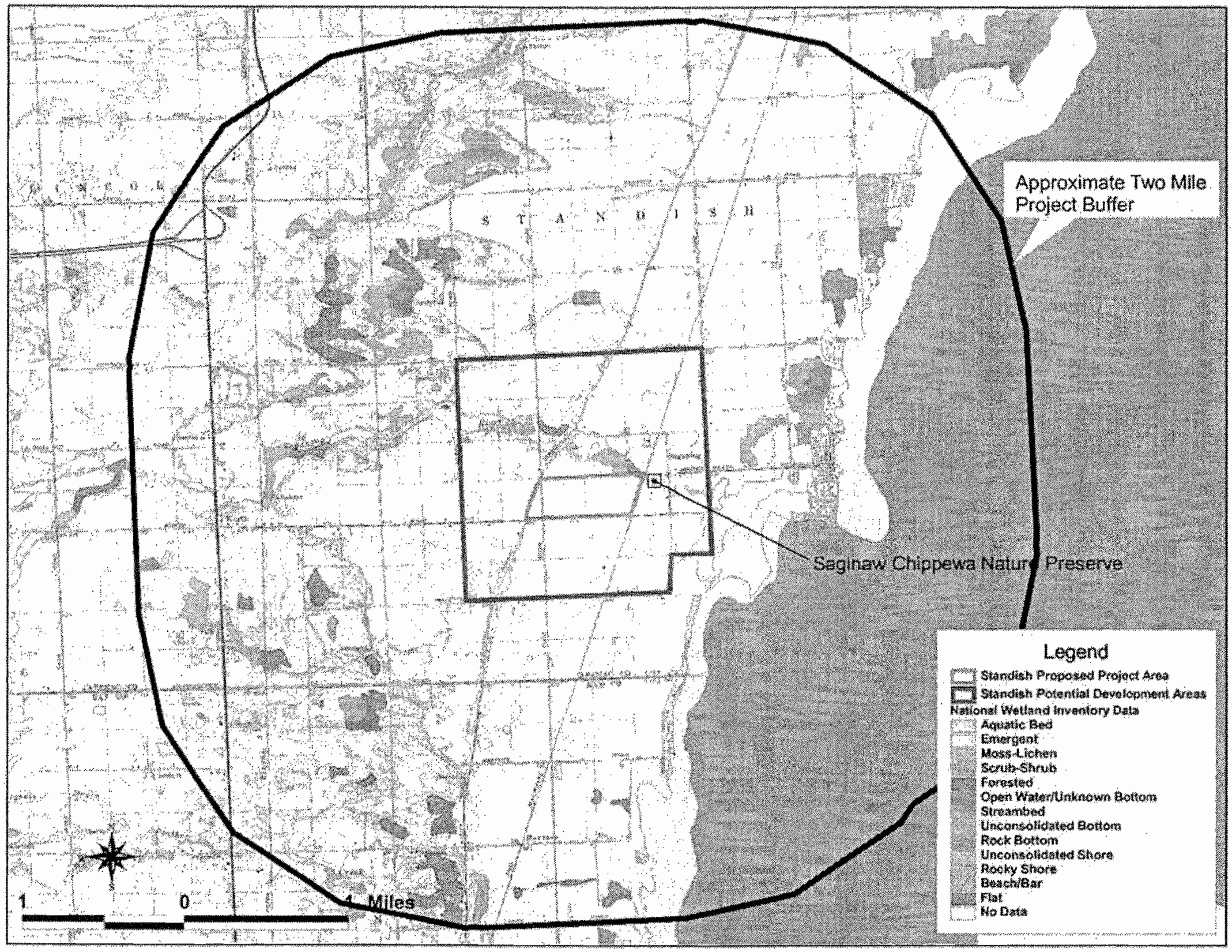

Figure 3. A map of the Standish project area showing wetland locations. The Michigan Natural Features Inventory had no records of rare species near the project area.

Figure 4. A 1998 aerial photo of the Mount Pleasant proposed project and potential development areas.

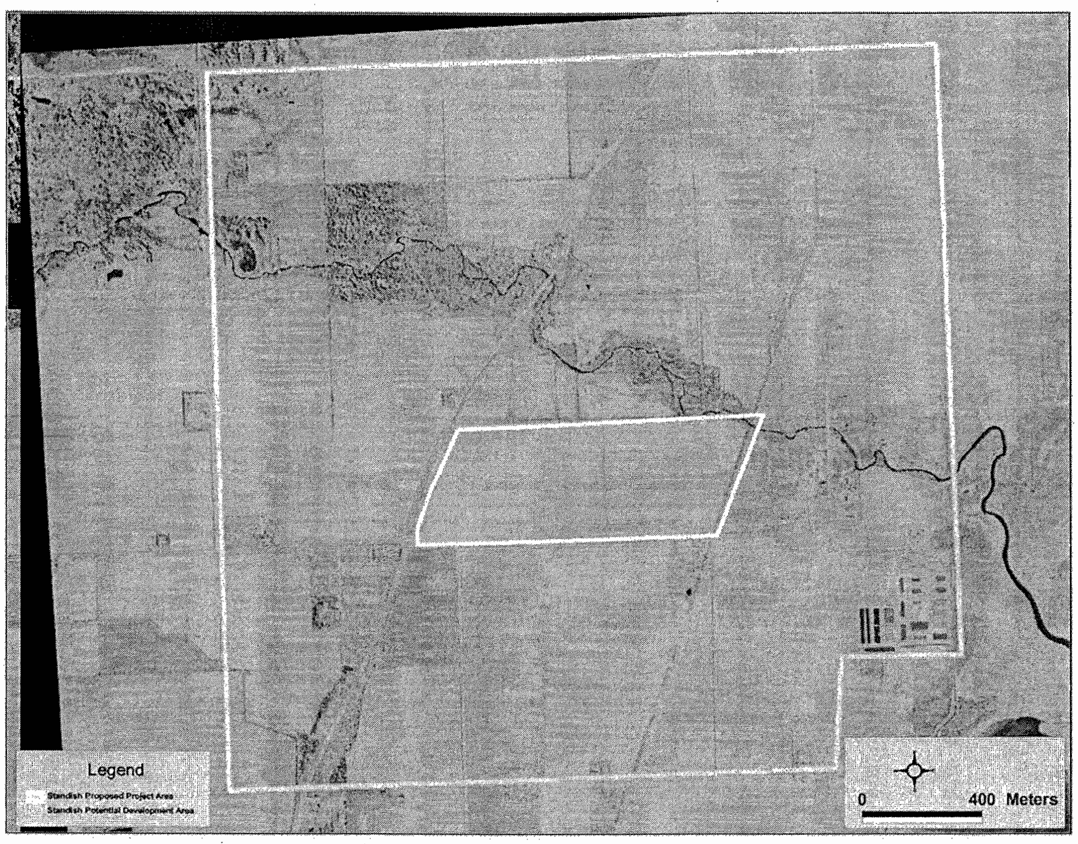

Figure 5. A 1998 aerial photograph the Standish proposed project and potential development areas.

Table 5. A summary of the potential for wildlife conflicts in the proposed Mount Pleasant wind development area[1]. VH = Very High, H = High, M = Medium, and L = Low.

Issue	VH	H	M	L	Notes
Potential for raptor nest sites			✓		The presence of forested wetlands in the potential development area provides raptor nesting habitat.
Raptor flight potential				✓	The general lack of stark topography decreases the potential for concentrated raptor use.
Potential for migratory pathway			✓		Birds likely migrate though the project area.
Potential for raptor prey species			✓		Prey densities were difficult to assess.
Potential for protected species to occur			✓		Blanding's and Wood Turtles may be present within wetland areas.
Potential for State issues			✓		Some state protected species likely migrate through the project area.
Uniqueness of habitat at wind plant			✓		Forested wetlands within the potential development area provide more suitable habitat than agriculture.
Potential for rare plants to occur				✓	Low potential to occur within agricultural habitats
Potential for use by bats		✓			Presence of forest and wetlands may increase local bat use
Other issues				✓	

[1] Summarized for the project area as a whole but the habitat of the project area varies throughout in its ability to support species of concern.

Table 6. A summary of the potential for wildlife conflicts in the proposed Standish wind development area[1]. VH = Very High, H = High, M = Medium, and L = Low.

Issue	VH	H	M	L	Notes
Potential for raptor nest sites			✓		Some deciduous woodlots are present within two miles of the development area.
Raptor flight potential			✓		The presence of Saginaw Bay may result in increased migratory raptor use.
Potential for migratory pathway		✓			Areas near the Saginaw Bay Shoreline may be used as stopover sites by migrating birds.
Potential for raptor prey species			✓		Prey densities were difficult to assess.
Potential for protected species to occur			✓		Due to proximity to Saginaw Bay some potential exists for Bald Eagle Use
Potential for State issues			✓		Some state protected species likely migrate through the project area.
Uniqueness of habitat at wind plant			✓		With the exception of some wetlands, project area largely dominated by agriculture and is not unique.
Potential for rare plants to occur				✓	Low potential to occur within agricultural habitats.
Potential for use by bats		✓			Presence of forest and wetlands may increase local bat use
Other issues				✓	

[1] Summarized for the project area as a whole but the habitat of the project area varies throughout in its ability to support species of concern.

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Appendix A – USFWS and Michigan DNR Correspondence

United States Department of the Interior

FISH AND WILDLIFE SERVICE
East Lansing Field Office (ES)
2651 Coolidge Road, Suite 101
East Lansing, Michigan 48823-6316

IN REPLY REFER TO:

February 24, 2005

Rhett E. Good
Western Ecosystems Technology, Inc.
2003 Central Avenue
Cheyenne, Wyoming 82001

Re: Threatened and Endangered Species Information Request

Dear Mr. Good:

We are in receipt of your letter dated February 9, 2005, requesting our review of potential impacts to threatened and endangered species or critical habitat for two sites that may be developed for windpower projects. The two sites are located in Isabella (T14N, R3W, Section 16) and Arenac Counties (T18N, R5E, Section 30), Michigan.

Endangered Species Act Comments:

We have determined that there are presently no federally-listed threatened, endangered or proposed species within the project area. This precludes the need for further action on this project as required by the Endangered Species Act of 1973, as amended. However, if the project is modified or new information about the project becomes available that indicates listed or proposed species may be present and/or affected, consultation with this Service office should be reinitiated.

We further advise that should any species occurring in the project area become federally-listed or proposed, the federal action agency for the work would also be required to reevaluate its responsibilities under the Act. Since threatened and endangered species data is continually updated, we suggest the lead federal agency annually request an updated federal list of the species occurring in the project area.

We appreciate the opportunity to provide these comments and look forward to any future endangered species consultation if necessary. Please direct questions to Burr Fisher, of this office, at 517/351-8286.

Sincerely,

Craig A. Czarnecki
Field Supervisor

g: admin/archives/feb05/chippewatribewindpower.bdf.doc

STATE OF MICHIGAN
JENNIFER M. GRANHOLM
GOVERNOR
DEPARTMENT OF NATURAL RESOURCES
LANSING
REBECCA A. HUMPHRIES
DIRECTOR

February 24, 2005

Mr. Rhett E. Good
Western Ecosystems Technology, Inc.
2003 Central Avenue
Cheyenne, WY 82001

RE: **Proposed windpower system for the Saginaw Chippewa Tribe in Michigan**

Dear Mr. Good:

The location of the proposed windpower system was checked against known localities for natural features. Unique natural features are recorded in a statewide database. This continuously updated database is a comprehensive source of existing data on Michigan's endangered, threatened, or otherwise significant plant and animal species, natural plant communities, and other natural features. Records in the database indicate that a qualified observer has documented the presence of special natural features at a site. The absence of records in the database for a particular site may mean that the site has not been surveyed. Records are not always up-to-date, and may require verification. In some cases, the only way to obtain a definitive statement on the status of natural features is to have a competent biologist perform a complete field survey.

Under Act 451 of 1994, the Natural Resources and Environmental Protection Act, Part 365, Endangered Species Protection, "a person shall not take, possess, transport, …fish, plants, and wildlife indigenous to the state and determined to be endangered or threatened," unless first receiving an Endangered Species Permit from the Department of Natural Resources, Wildlife Division. *Responsibility to protect endangered and threatened species is not limited to the list below, her species may be present that have not been recorded in the database.*

The presence of threatened or endangered species does not preclude activities or development, but may require alterations in the project plan. Special concern species are not protected under endangered species legislation, but recommendations regarding their protection may be provided. Protection of special concern species will help prevent them from declining to the point of being listed as threatened or endangered in the future.

If the project is located on or adjacent to wetlands, inland lakes, or streams, additional permits may be required. Contact the Michigan Department of Environmental Quality, Geological and Land Management Division, P.O. Box 30473, Lansing, MI 48909 (517-241-1515) for wetlands permits. Contact the Michigan Department of Environmental Quality, Water Division for inlands lakes and streams permits (517-241-1300).

The following is a summary of the results for the project in Isabella & Arenac Counties, Section 16, T14N R3W and Section 30, T18N R5E.

The project should have no impact on rare or unique natural features, although, wind turbines present collision hazards in the paths of birds during spring and fall migration periods. The extent of the hazard is greatest at night and during periods of low cloud ceiling and/or fog.

The Wildlife Division recognizes the negative effects of wind turbines on migratory birds. In order to reduce impacts the Wildlife Division recommends the following:

1) Collocation of wind turbines on existing towers or other structures is highly encouraged.

2) Wind turbines should not be sited in known bird concentration areas, in known migratory or daily movement flyways. In Michigan, migration flyways are concentrated along the Great Lakes shorelines, peninsulas, and points extending into large bodies of water. Towers should not be sited in areas with a high incidence of fog, mist, and low ceilings.

3) If lights are installed, white strobe lights are preferred in lieu of red lights, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes). The use of solid red or pulsating red warning lights at night should be avoided. Current research indicates that solid or pulsating red lights attract night-migrating birds at a much higher rate than white lights.

Thank you for your advance coordination in addressing the protection of Michigan's natural resource heritage. Responses and correspondence can be sent to:

Michigan Department of Natural Resources
Wildlife Division – Natural Heritage Program
PO Box 30180
Lansing, MI 48909

If you have further questions, please call me at 517-373-1263.

Sincerely,

Lori G. Sargent

Lori G. Sargent
Endangered Species Specialist
Wildlife Division
SargenL2@michigan.gov

APPENDIX B

POTENTIAL IMPACT INDEX CHECKLISTS

PHYSICAL ATTRIBUTE CHECKLIST

Physical Attribute				Site: Mount Pleasant	Standish	Tawas Point	Nayanquing Point
Topography	Mountain Aspect*	Side	W				
			E				
			N				
			S				
		Top					
		Foothill	W				
			E				
			N				
			S				
	Valley*						
	Pass*						
	Gap*						
	Ridge*						
	Bluff*						
	Spit*					X	X
Wind* Direction	S						
	N						
	E						
	W			X	X	X	X
	Updrafts*						
Migratory* Corridor Potential	Latitudinal (N • •S)				X	X	X
	Longitudinal (E • •W)						
	Wide Approaches (>30 km)*						
	Funnel Effect*	Horizontal			X	X	X
		Vertical					
Site Size (acres) & Configuration*	<640			X	X	X	X
	>640 <1000						
	>1000 <1500						
	Turbine Rows not Parallel to Migration						
Infrastructure To Build	Transmission			X	X	X	X
	Roads			X	X	X	X
	Buildings*	Storage		X	X	X	X
		Maintenance		X	X	X	X
		Daily Activity		X	X	X	X
	Substation			X	X	X	X
Increased Activity*				X	X	X	X
			Totals	9	11	12	12

PHYSICAL ATTRIBUTE CRITERIA - 36 categories, max • •= 36.

Topography - Terrain characteristic within the ecological influence of the proposed wind farm, generally, but not restricted to ± 8 km.

Mountain Aspect - Aspect of topography for site of proposed development. Multiple categories may be checked.

Valley Pass Gap Ridge Bluff Butte

Wind Direction - Compass direction *from* which prevailing winds approach. Multiple categories may be checked.

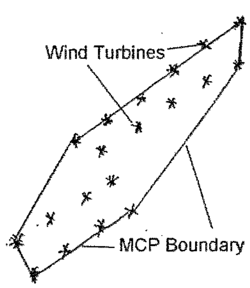
Updrafts - Do updrafts/upslope winds prevail?

Migratory Corridor Potential - Subjective estimate of area to be a potential avian/bat migratory corridor based strictly on topographical characteristics. Multiple categories may be checked.

Wide (>30 km) - Terrain characteristics of approaches to site from each migratory direction, i.e., a large plain, river corridor, long valley. The larger the area that migrant birds/bats are drawn from, the more may be at risk

Funnel Effect - Is the site in or near an area where migrant birds/bats may be funneled (concentrated) into a smaller area, either altitudinally, laterally, or both?

Site Size & Configuration – Size is estimated as if a minimum convex polygon (MCP) were drawn around peripheral turbines.



Successive boxes are checked to convey relationship of larger size = increased impact to birds/bats, *e.g.*, a 700 acre site will have 2 categories checked while a 1200 acre site will have all 3 categories checked.

Configuration of turbine rows is usually perpendicular to prevailing wind direction. Rows aligned perpendicular or oblique to route of migration intuitively presents more risk to birds than rows aligned parallel to movement.

Buildings – Building are categorized by relative size and visitation frequency, *i.e.,* structures that are visited daily are usually larger and present more impact than those that are not. If a "Daily Activity" building is required, all Building categories are checked. If a maintenance structure is required, Storage is also checked.

Increased Activity - Will any type of human activity increase? Sites in urban-suburban or otherwise developed areas (oil, gas, mines) will have less impact on vertebrate wildlife than those in remote or undeveloped areas.

Avian Species of Special Concern Checklist
(Complete prior to SPECIES OCCURRENCE & STATUS CHECKLIST)

Birds (n = 21)	**Site**											
	Mount Pleasant			Standish			Tawas Point			Nayanquing Point		
Occurrence[1]	**B**	**M/W**	**• •**	**B**	**M/W**	**• •**	**B**	**M/W**	**• •**	**B**	**M/W**	**• •**
Cooper's hawk	X	X	2	X	X	2		X	1		X	1
Northern goshawk												
Grasshopper sparrow	X	X	2	X	X	2		X	1		X	1
American bittern		X	1		X	1		X	1	X	X	2
Black tern		X	1		X	1		X	1		X	1
Northern harrier		X	1		X	1		X	1		X	1
Marsh wren		X	1		X	1		X	1	X	X	2
Cerulean warbler								X	1		X	1
Spruce grouse												
Common moorhen								X	1	X	X	2
Black-crowned night-heron		X	1		X	1		X	1	X	X	2
Wilson's phalarope								X	1	X	X	2
Black-backed woodpecker		X			X			X	1		X	1
Prothonotary warbler												
Louisiana waterthrush												
Dickcissel		X	1		X	1		X	1		X	1
Forster's tern								X	1		X	1
Western meadowlark												
Sharp-tailed grouse												
Hooded warbler								X	1		X	1
Yellow-headed blackbird		X	1		X	1				X	X	2
Subtotals	2	10	12	2	10	12	0	14	14	6	15	21
Total			12			12			14			21

Avian Species of Special Concern Checklist (21 species, max • ═ 42)

Column totals of this list are added to appropriate cells in the SPECIES OCCURRENCE & STATUS CHECKLIST. Appropriate avian field guides and species accounts should be consulted for confirmation of species distribution and habitat associations.

In addition to species lists (rows), season of occurrence is also indicated (columns). "B" indicates breeding or summer occurrence and "M/W" indicates presence during migration or as wintering species. The USFWS guidelines for windpower development suggests that if occurrence within or in the vicinity (• •7 km) of a proposed site is confirmed or suspected, an "X" is entered. However, due to sharp differences in habitat and topography within 7 km of the proposed project, and X was only entered if it was likely the species would occur or fly through the project area based on topography and habitat features.

NOTE: These species were selected because they are listed as species of concern by the Michigan Department of Natural Resources Determinations of occurrence were based on the geographical location of the project area, habitat, Chartier and Ziarno 2004, Breeding Bird Survey Data, Christmas Bird Count data, and the 1991 edition of the Atlas of Breeding Birds of Michigan

Bat Species Of Special Concern Checklist

(Complete prior to SPECIES OCCURRENCE & STATUS CHECKLIST)

Bats (*n* = 2)	**Site** Mount Pleasant			Standish			Tawas Point			Nayanquing Point		
Occurrence	**B**	**M/W**	**• •**	**B**	**M/W**	**• •**	**B**	**M/W**	**• •**	**B**	**M/W**	**• •**
Indiana Bat	0	0	0	0	0	0	0	0	0	0	0	0
Eastern Pipistrelle	0	0	0	0	0	0	0	0	0	0	0	0
Subtotals	0	0	0	0	0	0	0	0	0	0	0	0
Total			0			0			0			0

Bat Species Of Special Concern Checklist (2 species, max • ← 4).

Column totals of this list are added to appropriate cells in the SPECIES OCCURRENCE & STATUS CHECKLIST. Appropriate bat field guides and references should be consulted for confirmation of species distribution and habitat associations.

In addition to species lists (rows), season of occurrence is also indicated (columns). "B" indicates breeding or summer occurrence and "M/W" indicates presence during migration or as wintering species. If occurrence within or in the vicinity (• •7 km) of a proposed site is confirmed or suspected, an "X" is entered.

NOTE: These species were selected because they are listed on the Michigan Endangered Species List or are a species of concern. Occurrence in each area was based on bat distribution data available from Bat Conservation International (2003).

SPECIES OCCURRENCE & STATUS CHECKLIST

	Species	Site: Mount Pleasant			Standish			Tawas Point			Nayanquing Point		
	Occurrence	**B**	**M/W**	**• •**	**B**	**M/ W**	**• •**	**B**	**M/W**	**• •**	**B**	**M/W**	**• •**
Threatened & Endangered	Short-eared owl		X	1		X	1						
	Piping plover					X	1	X	X	2			
	Prairie warbler								X	1		X	1
	Kirtland's warbler		X	1		X	1		X	1		X	1
	Peregrine falcon		X	1		X	1		X	1		X	1
	Migrant loggerhead shrike		X	1		X	1		X	1		X	1
	King rail										X	X	2
	Barn owl												
	Henslow's sparrow	X	X	2	X	X	2		X	1		X	1
	Long-eared owl		X	1		X	1		X	1		X	1
	Red-shouldered hawk		X	1		X	1		X	1		X	1
	Yellow rail												
	Trumpeter swan												
	Yellow-throated warbler								X	1		X	1
	Merlin		X	1		X	1		X	1		X	1
	Common loon		X	1		X	1		X	1		X	1
	Bald eagle		X	1	X	X	2		X	1		X	1
	Least bittern		X	1		X	1				X	X	2
	Osprey		X	1		X	1					X	1
	Caspian tern		X	1		X	1		X	1		X	1
	Common tern		X	1		X	1		X	1		X	1
	Lark sparrow												
Candidate*													
Special Concern*	Birds (max • =42)	2	10	12	2	10	12	0	14	14	6	15	21
	Bats (max • =4)	0	0	0	0	0	0	0	0	0	0	0	0
Bats*		X	X	2	X	X	2		X	1		X	1
	Subtotals	4	25	29	5	26	31	1	29	30	8	32	40
	Total			29			31			30			40

SPECIES OCCURRENCE & STATUS CHECKLIST (46 categories, max • = 92)

Checklist totals for each column in "Avian Species of Special Concern List" and "Bat Species of Special Concern List are inserted in this checklist.

Threatened & Endangered Species - Species include in the Federal List of Endangered and Threatened Species. Only bird species were included. Bat species are included within the Bat section. Other groups such as mollusks, amphibians, reptiles and insects may be present, however, they are assumed to not be impacted if only agricultural habitats are targeted for development.

Candidate Species - Species being investigated for inclusion in the Federal List of Endangered and Threatened Species.

Species of Special Concern – Birds of concern list obtained from the Michigan Natural Features Inventory website.

Bats (other than bat Species of Special Concern) are included due to generally unknown impacts of wind farms on individual and populations.

ECOLOGICAL ATTRACTIVENESS CHECKLIST

Ecological Attractor			Mount Pleasant	Standish	Tawas Point	Nayanquing Point
Migration Route*	Local				X	X
	Continental*	N	X	X	X	X
		S	X	X	X	X
		E				
		W				
Ecological Magnets*	Lotic System					
	Lentic System			X	X	X
	Wetlands		X	X	X	X
	Native Grassland					
	Forest		X	X		
	Food Concentrated				X	X
	Energetic Foraging				X	X
	Vegetation/ Habitat	Unique			X	X
		Diverse			X	X
Significant Ecological Event*					X	X
Site of Special Conservation Status*					X	X
Total			4	5	11	11

ECOLOGICAL ATTRACTIVENESS CRITERIA - 16 categories, max• •= 17.

Migration Route - Indicates predominate direction of movement of seasonal migrations. Multiple categories may be checked.

Local - Some avian populations move only altitudinally & direction may be East-West (sage grouse, owls, bald eagles).

Continental - Some migratory corridors experience mass movements in only one season/direction annually (*e.g.*, Bridger Mountains autumn eagle migration).

Ecological Magnets - Special, unique, unusual, or super ordinary habitats or conditions within the vicinity of the site that may attract vertebrate wildlife. Lotic systems include small perennial or seasonal creeks to major rivers. Lentic systems include stock ponds to lakes. Multiple categories may be checked.

Vegetation/Habitat - Unique or exceptionally diverse vegetation or habitat in the vicinity may indicate exceptional diversity and abundance of avian species or bats.

Significant Ecological Event - Special, unique, unusual, or super ordinary events that occur or are suspected to occur in the vicinity of the site, *e.g.*, up to one third of the Continental population of Trumpeter Swans visit Ennis Lake, < 4 km from a proposed Wind Resource Area; the Continental migration of shorebirds passes over (many stop) @ Benton Lake National Wildlife Refuge) and up to 2000 golden eagles pass over the Bridger Mountains in autumn. If unknown but suspected a "?" is entered. Specifics regarding the cell are then addressed in the appropriate box of the SITE SPECIFIC COMMENTS sheet to focus follow-up investigation and assist in definition of study objectives.

Site of Special Conservation Status - Any existing or proposed covenants, conservation easements, or other land development limitations intended to conserve, protect, or enhance wildlife or habitat. This criterion is weighted (2 entered if true) because of previous financial or other investment in ecological values. Specifics regarding the easement are then addressed in the appropriate box of the SITE SPECIFIC COMMENTS sheet to focus follow-up attention.

POTENTIAL IMPACT INDEX

Checklist (p)[1]	Site: Mount Pleasant		Standish		Tawas Point		Nayanquing Point	
	• •	• /p	• •	• /p	• •	• /p	• •	• /p
Physical (36 boxes = 36/145 = 0.25)	9	36	11	44	12	48	12	48
Species Occurrence & Status (92 boxes = 92 / 145 = 0.63)	29	46	31	49	30	48	40	63
Ecological (17 boxes = 17 / 145 = 0.12)	4	33	5	42	11	92	11	92
Totals		115		135		188		203

[1]Proportion of total (145) checklist scores.

Appendix K. Preliminary Cultural Assessment

PRELIMINARY CULTURAL ASSESSMENT

FOR PROPOSED

WIND TURBINE SITES

FOR THE

SAGINAW CHIPPEWA INDIAN TRIBE

OF MICHIGAN

PREPARED BY

Anita Heard, Research Center Coordinator
and
Robin L. Spencer, Research Center Specialist

INTRODUCTION:

Background

The Saginaw Chippewa Indian Tribe (Tribe) is a federally recognized sovereign nation, whose tribal lands are located in both Isabella and Arenac Counties in the State of Michigan. The Isabella Reservation in Isabella County has 138,240 acres within the boundaries, of which 2000 acres are held by the Tribe in fee simple and trust status. Another approximately 700 acres are designated as allotted lands. The Isabella Reservation in Arenac County has 70 acres of trust land. The Tribe also owns approximately 430 acres of land in fee simple as off reservation lands.

The Tribe was awarded a United States Department of Energy (DOE) grant DE-FC36-04GOI4252 for funding a feasibility study designed to investigate the possibility of developing a wind power facility on two sites on or near the Isabella reservations. Part of the deliverable task was to investigate any potential cultural impacts that may affect a wind energy development sites. Disgen contracted with the Ziibiwind Center of Anishinabe Cultural & Lifeways to conduct this study. The cultural study includes the following:

Scope of Work for proposed Wind Turbine Sites

- Historical Review of Past use of the site
- Records search of existing archeological/cultural items on proposed site.
- Interviews with knowledgeable tribal elders regarding cultural significant about the past and present activities undertaken within the proposed site.
- Report of findings and recommendation from the Tribal Historic Preservation office, if any.

Two sites were chosen for proposed wind turbines for the Saginaw Chippewa Indian Tribe of Michigan, one within the reservation boundaries in Mt. Pleasant, Michigan that consists of 39 acres and the other within the reservation boundaries on the Saganing reservation, in Standish, Michigan consisting of 97 acres. (See B-1 & B-2)

PROPOSED SITES AREAS:

The first proposed site location is in Mt. Pleasant, Isabella County, Union Township, section 16 at the corner south of Remus Rd. and west of Shepard Rd., with the exception of the 1 acre right at the corner. The GIS coordinates for the site are (Longitude 43* 35.951' N and Latitude 84* 41.193' W). This site consists of 39 acres of tribally owned property known as the Benzinger II site. (Maps included, B-3, B-4)

Legal description: part of the SW ¼ of Section 16, T14N-R3W, Chippewa Township, Isabella County, Michigan, described as beginning at a point on the West Section line, which is N 00* - 12' – 15" W, 176.00 feet from the Southwest Section corner; thence N 00*-12'-15" W, 1,151.89 feet; thence N 89*-48'-45" E, 1,312.94 feet along the South – E & W 1/8 line as occupied; thence S 00*-15'-05" E, 1,329.99 feet along the West – N & S 1/8 line; thence S 89*-54'-15" W, 1114.03 feet along the South Section line; thence N 00* 12'-15" W, 176.00 feet; thence S 89* - 54'-15" W, 200.00 feet to the point of beginning, containing 39.31 acres, more or less.

The second proposed site location is in Saganing, Arenac County, Standish Township, section 30, north of Worth Rd. and west of the tracks of the Detroit and Mackinac Railroad line. The GIS coordinates for this site are (Longitude 43* 55.625' N and Latitude 83* 54.989' W). This site consists of 97 acres of tribally owned property known as the Noffsinger site. (Maps included N-1, N-2)

Legal description: that part of the Southwest ¼ of the Southwest ¼ of Section 30, T18 N –R5E, Standish Township, Arenac County, Michigan, lying West of the Detroit Mackinaw Railway right-of-way, and also a piece of land with point of beginning located at the Southeast corner of the Southeast ¼ of the Southwest ¼ of Section 30, T18N –R5E, Standish Township, Arenac County, Michigan; thence North 80 rods; thence West 63 rods; thence South 80 rods; thence East 83 rods to the point of beginning.

SEARCH AND RESEARCH OF MATERIALS, BOOKS AND MAPS:

The Ziibiwing Center of Anishinabe Culture & Lifeways has an extensive collection of Tribal research materials, historical and rare books and maps available for staff research. Some of the resources utilized for the research on these property sites were books. The following books were researched: ***The First People of Michigan*** by W.B. Hinsdale, ***Primitive Man in Michigan*** by W.B. Hinsdale, ***Archeological Atlas of Michigan*** by W. B. Hinsdale, ***The Territory of Michigan*** by Alec R. Gilpen, ***Atlas of Great Lakes Indian History*** by Helen Hornbeck Tanner and ***Diba Jimooyung*** by the Saginaw Chippewa Indian Tribe of Michigan. The above authors did not refer to any historical or cultural significance to either of these two proposed sites. The Hinsdale maps from 1931 and USGS maps from 1973 were also utilized and showed no historical significance to these two proposed sites. (Maps included B-5, N-3) Included in our research was Appendix A, (***List of Documented Cultural Resources in Arenac, Bay, Isabella, Midland and Saginaw Counties*** from Andrews Cultural Resources. This report was prepared for the Saginaw Chippewa Indian Tribe of Michigan, March 19, 1997). This report addresses no historical or cultural significance to those proposed site areas. A review of Tribal records indicates that no previous archaeological surveys or cultural studies have been conducted within the proposed site areas. A physical site visit was conducted on each proposed site area and photos are included (B-8, N-7).

ELDER CONSULTATION:

Site 1, Mt. Pleasant, Michigan-Robin Spencer conducted an oral interview with Bea Colwell, a Tribal elder and Dr. Benjamin Ramirez Shkwegnaabi, PhD., Associate Professor of History at Central Michigan University, Mt. Pleasant, Michigan and community member. During the interview both could not remember or did not know of any historical or cultural significance such as burial sites, village sites, seasonal camp (hunting and gathering) or pre-reservation land use. Both remembered that the tribe now owns the property and that it was placed in trust. Don Seal, Community Engineer of the Planning Department for the Saginaw Chippewa Indian Tribe of Michigan also confirmed the fact that the property is in trust and tribally owned.

Site 2, Standish, Michigan- Anita Heard and Robin Spencer conducted an oral interview with a group of community members at the Saganing Out-reach center on June 16, 2006 at their daily luncheon. During our interview no one recalled any historical or cultural significance such as burial sites, village sites, seasonal camp (hunting and gathering) or pre-reservation land use could not be recalled. To the best of their knowledge it had always been farm land. Anita Heard and Robin Spencer were told by Carol Tally, Assistant Director, and Don Nelson, Director of the Saganing Outreach Center, that located at the back of the proposed site area there was a creek with a huge rock that the natives once used to wash their clothes on. You can see the grooves or lines in the rock. (Photos included N-6)

The property adjacent to the proposed site area had much historical and cultural significance. There are Native cemeteries and burial grounds, a prominent trail, and lands where the Native families would have meetings and places they gathered and hunted.

PAST USE OF THE PROPOSED SITE AREA:

Before ca. 1580: *This period is marked primarily by the fact that the Ojibwa have not yet had contact with Europeans. Culture is centered on hunting, fishing, gathering and planting trade. Settlements are small and seasonal with some larger intertribal gatherings for ceremonial purposes. The material culture does not yet have items of European origin.*

Ca. 1580-1650: *Period of initial contact with Europeans primarily through their goods being obtained in trade with other tribes. Some pandemic disease episodes may have occurred. First face to face contact with Europeans occurs ca. 1615 with Champlain arriving along the east shore of Lake Huron. Ojibwas culture is still centered around hunting, fishing and gathering.*

Ca. 1650-1830: *Period of sustained contact with Europeans following the dislocation and destruction of many tribes as a result of the Iroquois wars and pandemic disease episodes. The period is marked by a greater amount of European objects being introduced into Ojibwa lifestyles.*

Ca. 1830-1900: *Period of intense pressure upon Ojibwa culture as a result of large numbers of Euro-Americans migrating into their homeland. The period is marked by conversions to Christianity; changes in subsistence activities due to the destruction of the ecosystems by such things as logging and farming; changes to log and wood frame housing; relocation to other areas; indoctrination of Ojibwa children with Euro-American culture through government and private (religious) schools.* (Taken from "A Cultural Resources Inventory Project Report prepared by Andrews Cultural Resources)

In the preliminary physical site visit of Benzinger II, Robin Spencer and Anita Heard walked directly from the east side of Shepherd road out to the test tower. In our brief assessment we noted the following plants and their typical cultural usefulness. (see append. B-8)

In review of the map entitled: Vegetation circa 1800 of Isabella County, Michigan, and interpretation of the General Land Office Surveys, produced by Michigan Department of Natural Resources, Michigan State University Extension Office and Michigan Natural Features

Inventory, the Benzinger II Site was a hemlock – white pine forest bordering a beech and sugar maple forest. The resources offered in both of these environments would have provided a great many typical foods and medicines. The same map source as indicated above entitled: Land Coverage Change, 1800's -1978, Isabella County states the most recent survey shows change to aspen bordering urban and agriculture areas, which is consistent with our physical site review.

Remaining consistent with the review of archival and historic preservation documentation we found no indication of significant past use of this property even though a branch of the Onion Creek is noted on several maps to begin on this property, no evidence was noticed. The history of this general area has been addressed below as this property lies with in the six township border of the historical reservation as defined in the 1855 Treaty of Saginaw.

In the physical visit of the Noffsinger site Robin Spencer and Anita Heard, walked the east border (railroad tracks) and the north border of parcel 3. Noted were the following plants and their typical cultural usefulness. (see append. N-7)

In this assessment it was exceptional the number and quantity of food source plants. In light of the plant materials evidenced, this general area most likely was an important site for gathering food and fiber materials. This would indicate a prime location for a settlement or seasonal camping area.

To support this theory a foot path well known to the community had run along the shoreline which is located approximately four miles east of this site. This trail comes off of the Mackinaw Saginaw Trail at Saginaw (cited in Hinsdale's Michigan Archaeological Atlas, map numbers 9, 12, and 14 and figure 1). Recent interviews of community members revealed that the Saganing River which borders this property on the northern side was very important. In the past it not only provided fishing, fresh water, and a water way for travel but had been abundant with wild rice, a staple food of the Ojibwa. The river was also mentioned several times with a reference to a "washing rock". We were given the general location and did find it. (See photo N-6) The interviews also lead us to two cemetery sites with few stones. It has not been until recent times that markers were set for graves. The early dates observed where mid- 1800's.

In review of the map entitled Vegetation circa 1800 of Arenac County, Michigan and interpretation of the General Land Office Surveys, produced by Michigan Department of Natural Resources, Michigan State University Extension Office and Michigan Natural Features Inventory, the Noffsinger Site was a cedar swamp bordering an aspen-birch forest. The resources offered in both of these environments would have provided a significant cultural resource. These environments would have produced a great many typical foods, medicines and housing materials. The same map source entitled Land Coverage Change, 1800's -1978, Arenac County states the most recent survey shows change to urban and agriculture areas, which is consistent with our physical site review.

It has been confirmed through our research, elder consultations and physical inspection that the only recent past use of both proposed site properties was farming or just left to grow.

ISABELLA COUNTY RESERVATION:

The reservation located within Isabella County was created in 1855 by the Treaty with the Chippewa of Saginaw, Swan Creek, Black River and the United States; it is located within the present-day townships of Chippewa, Deerfield, Denver, Isabella and Nottawa, Union, Wise. The number of cultural resources within the reservation and general area of Isabella County increases after ca. 1855 when members of various bands of the Saginaw, Swan Creek and Black River Chippewa's chose to relocate there. (Portions taken from "A Cultural Resources Inventory Project Report prepared by Andrews Cultural Resources)

ARENAC COUNTY RESERVATION (SAGANING):

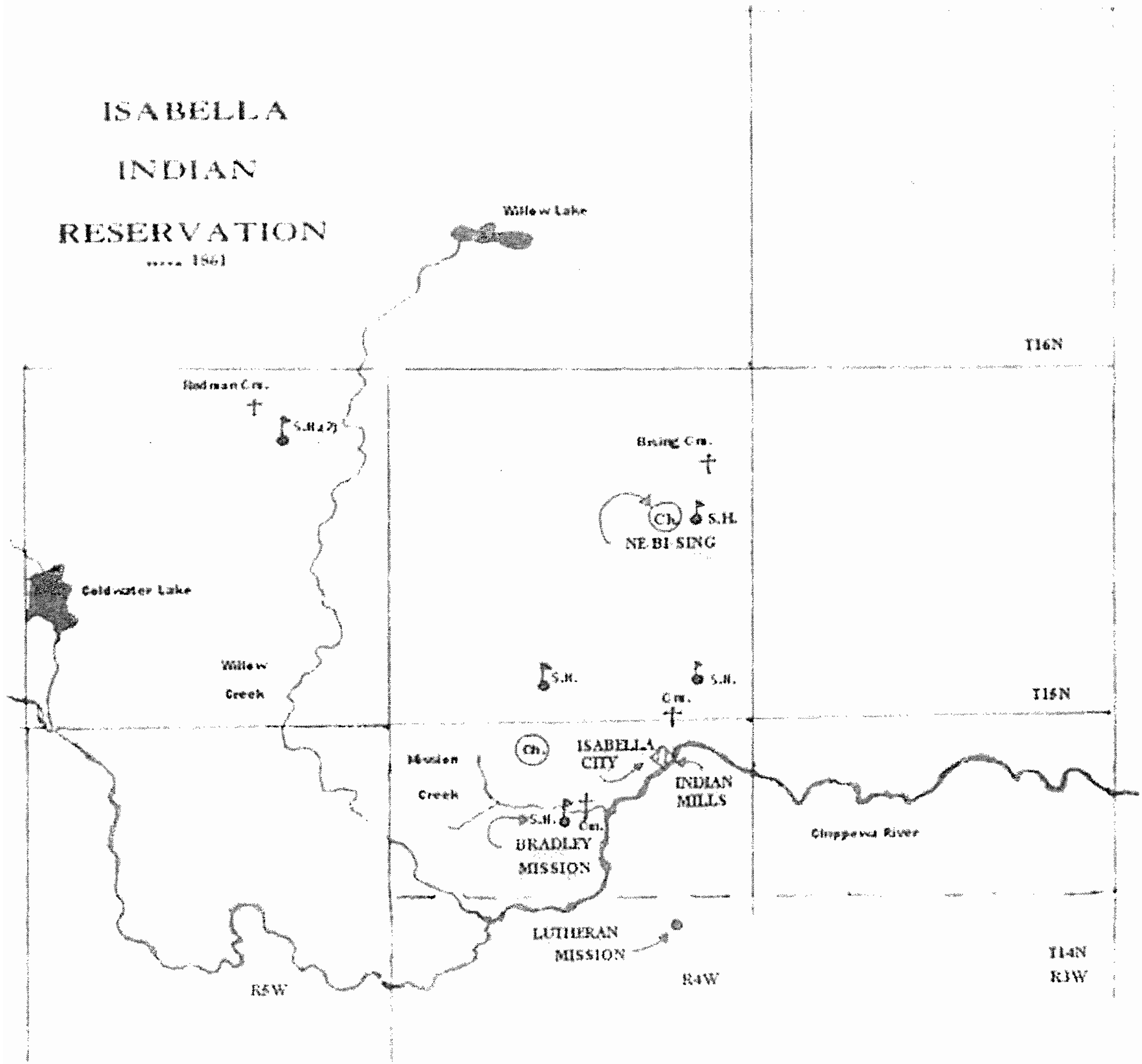
No previously recorded sites are known for the present-day land associated with the original Saganing Reservation. The reservation has been occupied by a band affiliated with the Saginaw, Swan Creek and Black River Chippewa since at least the early nineteenth century. It is known that cultural resources associated with that occupation exist within and near the reservation however they have not been systematically identified or assessed. (Portions taken from "A Cultural Resources Inventory Project Report prepared by Andrews Cultural Resources)

Recommendations:

Regarding the Benzinger II Site and the historic and archival references, placing a tower in the same spot the test tower is located would pose no threat to cultural resources. Chances that plants found on the endangered, protected or special consideration plant list identified by the State of Michigan, could be found at this site would appear minimal. No recommendation to discontinue plans of construction.

Regarding the Noffsinger Site and the archaeological references, placing a tower in the same spot the test tower is located would pose no threat to any cultural resources. However awareness and further investigation should be under taken if the project moves forward because there were several plants which could possibly be found on the endangered, protected or special consideration plant list identified by the State of Michigan. No recommendation to stop construction but a recommendation of identification and awareness of the area of habitat should be noted and avoided.

B-1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INDIAN
RESERVATION
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Willow Lake
T16N
Rodman Cm.
S.H.(?)
Bring Cm.
Ch.
S.H.
NE-BI-SING
Coldwater Lake
Willow
Creek
S.H.
S.H.
Cm.
T15N
Ch.
ISABELLA
CITY
Mission
Creek
INDIAN
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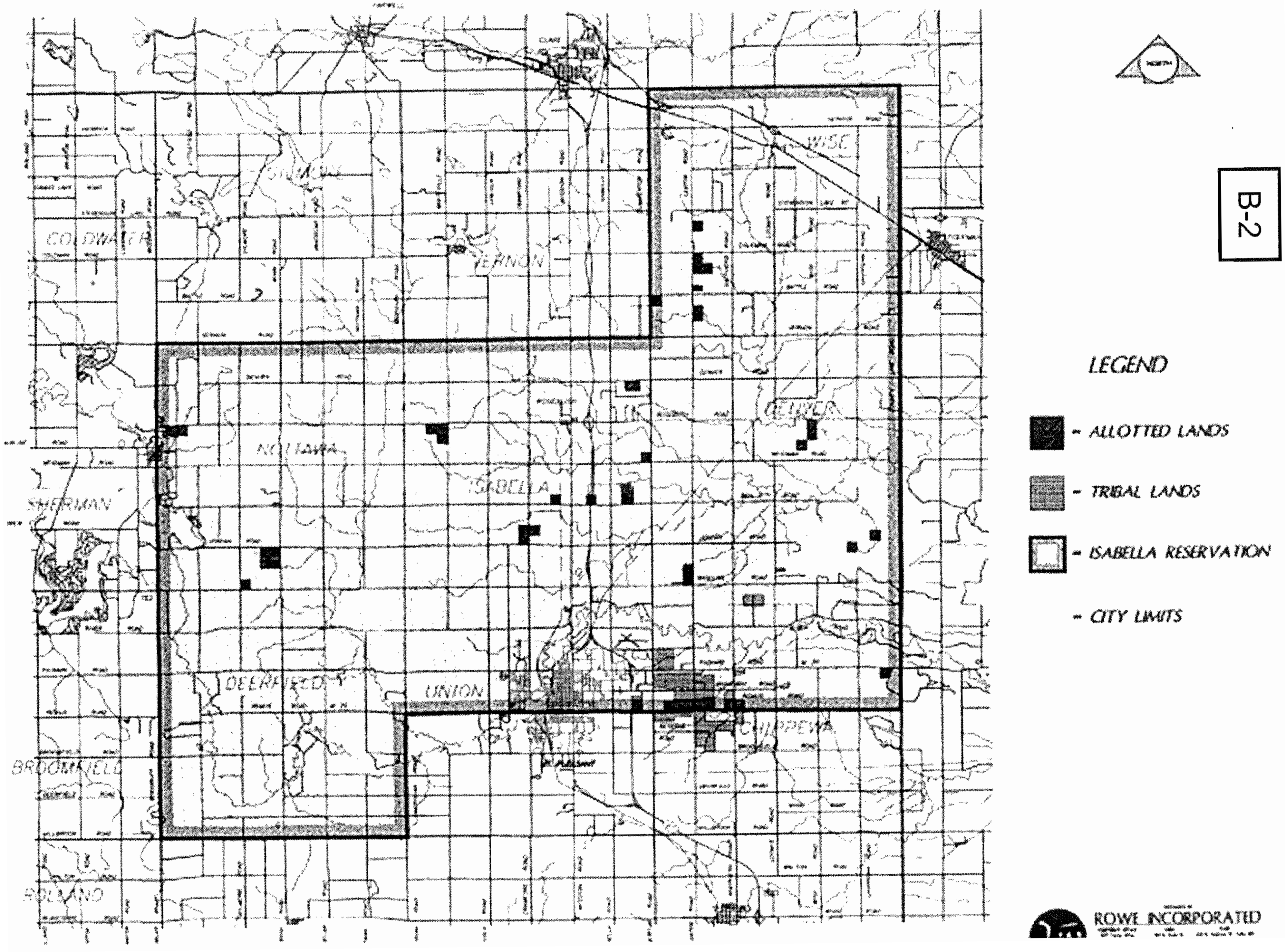

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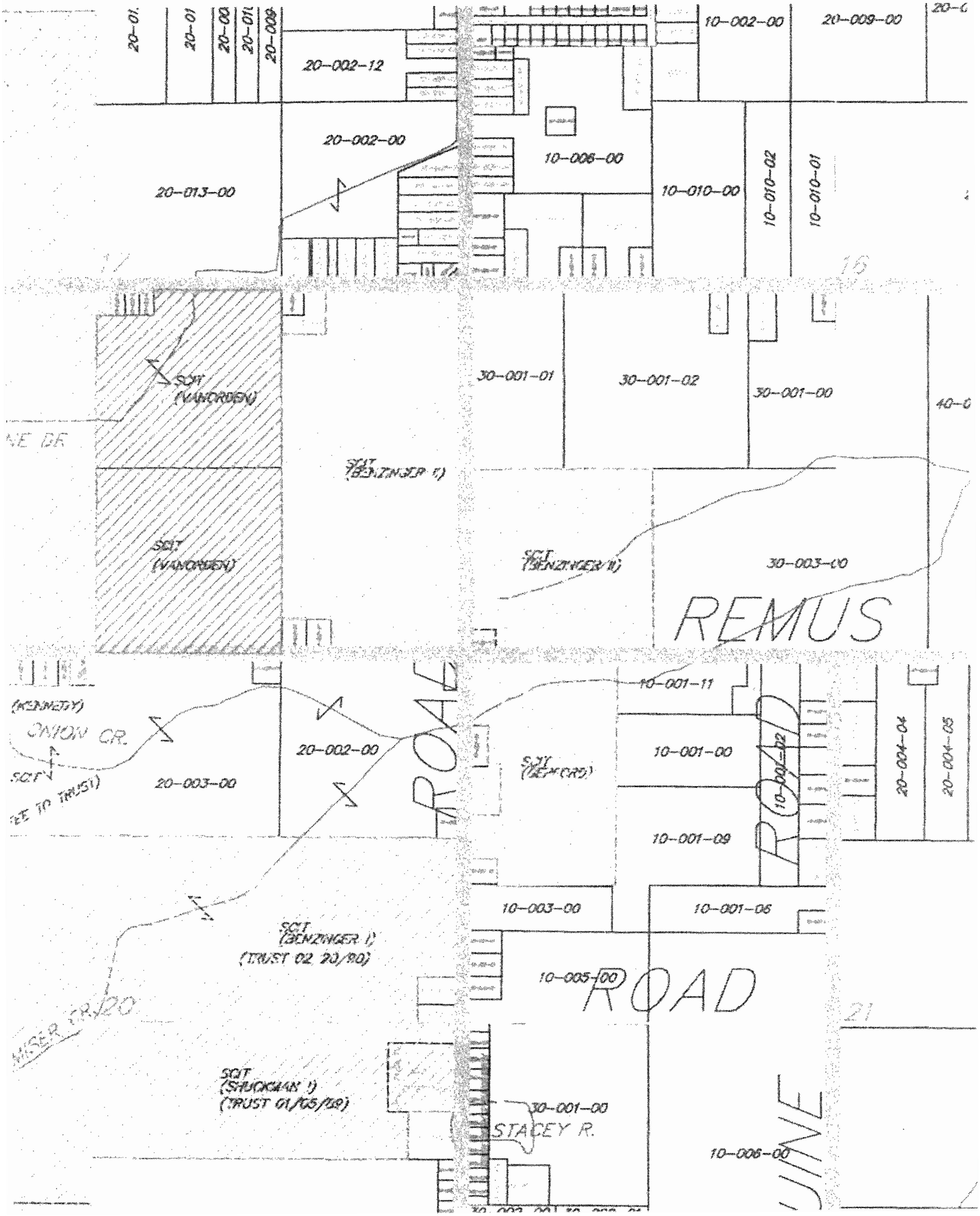

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ONION CR.
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20-003-00
ROAD
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20-004-04
20-004-05
10-003-00
10-001-06
SCIT
(BENZINGER I)
(TRUST 02/20/90)
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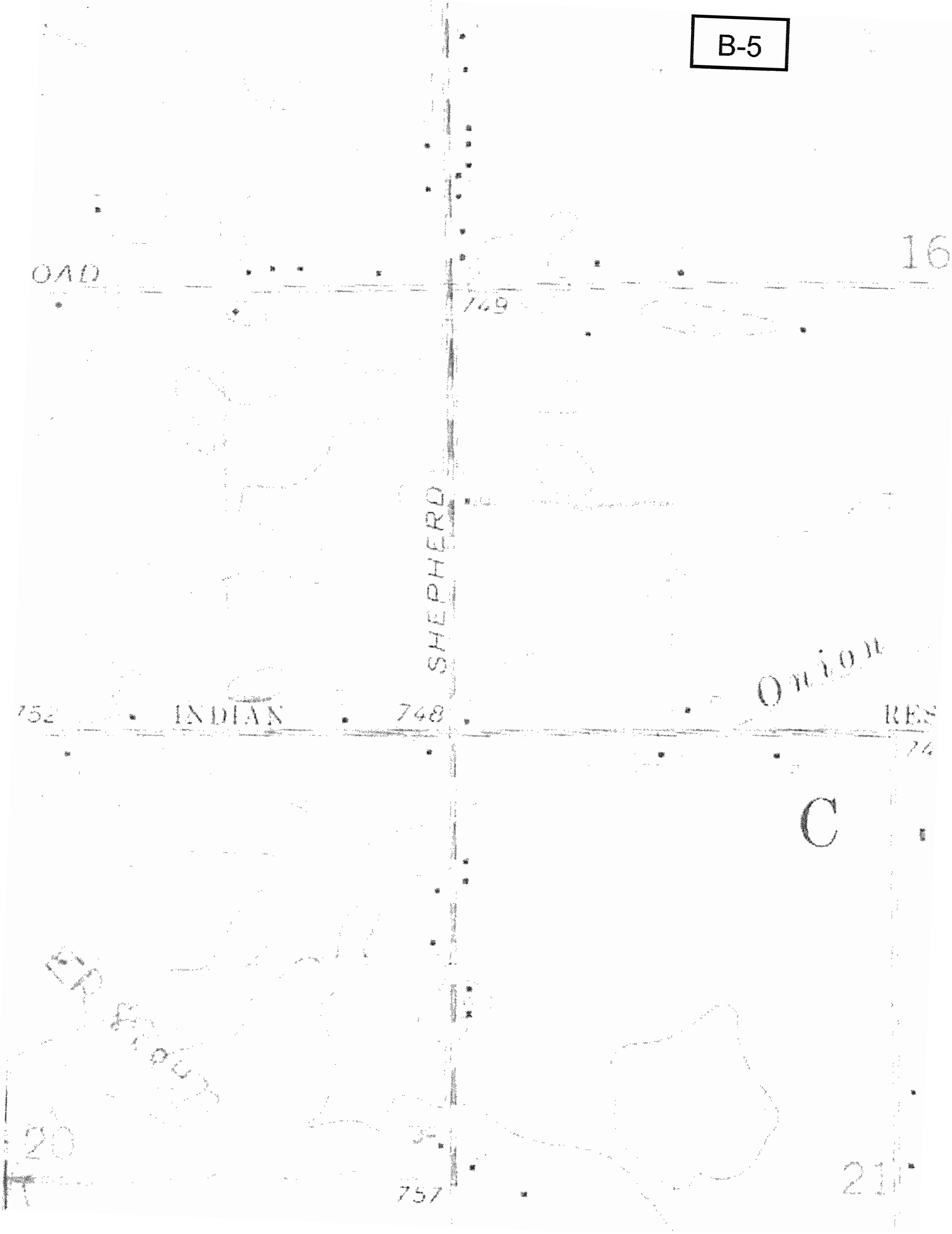
STACEY R.
10-006-00

B-5



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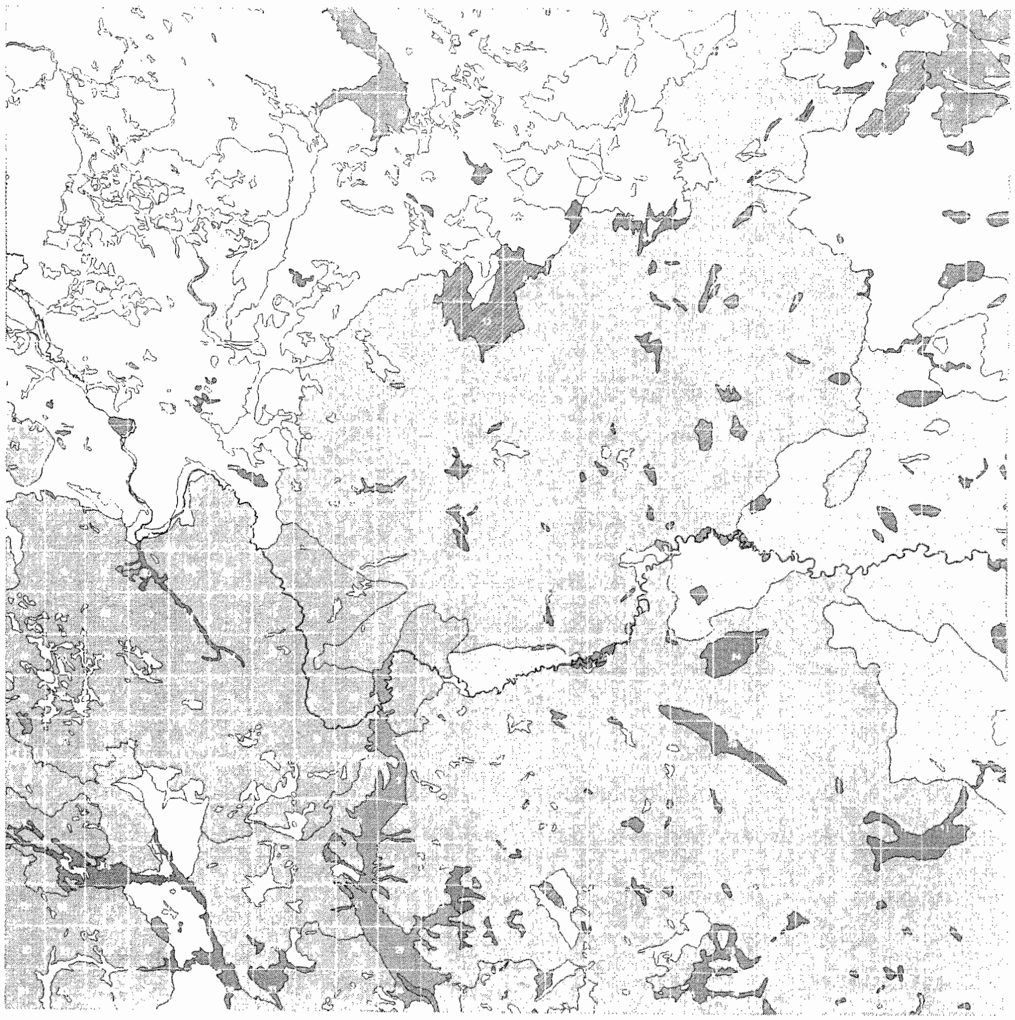

Vegetation circa 1800 of Isabella County, Michigan

An Interpretation of the General Land Office Surveys

By P. J. Comer and D. A. Albert
Michigan Natural Features Inventory
1997

Legend

- ✓ ASPEN-BIRCH FOREST
- ✓ BEECH-SUGAR MAPLE FOREST
- ✓ BEECH-SUGAR MAPLE-HEMLOCK FOREST
- ✓ BLACK ASH SWAMP
- BLACK OAK BARREN
- ✓ CEDAR SWAMP
- GRASSLAND
- ✓ HEMLOCK-WHITE PINE FOREST
- HEMLOCK-YELLOW BIRCH FOREST
- JACK PINE-RED PINE FOREST
- ✓ LAKE/RIVER
- ✓ MIXED CONIFER SWAMP
- ✓ MIXED HARDWOOD SWAMP
- MIXED OAK FOREST
- MIXED OAK SAVANNA
- MIXED PINE-OAK FOREST
- ✓ MUSKEG/BOG
- OAK-HICKORY FOREST
- OAK-PINE BARREN
- PINE BARREN
- SAND DUNE
- ✓ SHRUB SWAMP/EMERGENT MARSH
- SPRUCE-FIR-CEDAR FOREST
- WET PRAIRIE
- ✓ WHITE PINE-MIXED HARDWOOD FOREST
- ✓ WHITE PINE-RED PINE FOREST
- ✓ WHITE PINE-WHITE OAK FOREST

✓ = LAND COVER TYPE PRESENT ON THIS MAP

Scale 1:75,000

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 7 8 Kilometers

Map Projection: Lambert Conformal Conic

SOURCE: Comer, P.J., D.A. Albert, H.A. Wells, B.L. Hart, J.B. Raab, D.L. Price, D.M. Kashian, R.A. Comer, D.W. Schuen (Map Interpretation). M.B. Austin, T.R. Leibfreid, K.M. Korroch, L. Prange-Gregory, J.G. Spitzley, C.J. DeLain, L.J. Scrimger, (Digital Map Production). 1995. Michigan's Presettlement Vegetation, as Interpreted from the General Land Office Surveys 1816-1856. Michigan Natural Features Inventory, Lansing, MI. Digital Map.

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Department of Natural Resources
Wildlife Division

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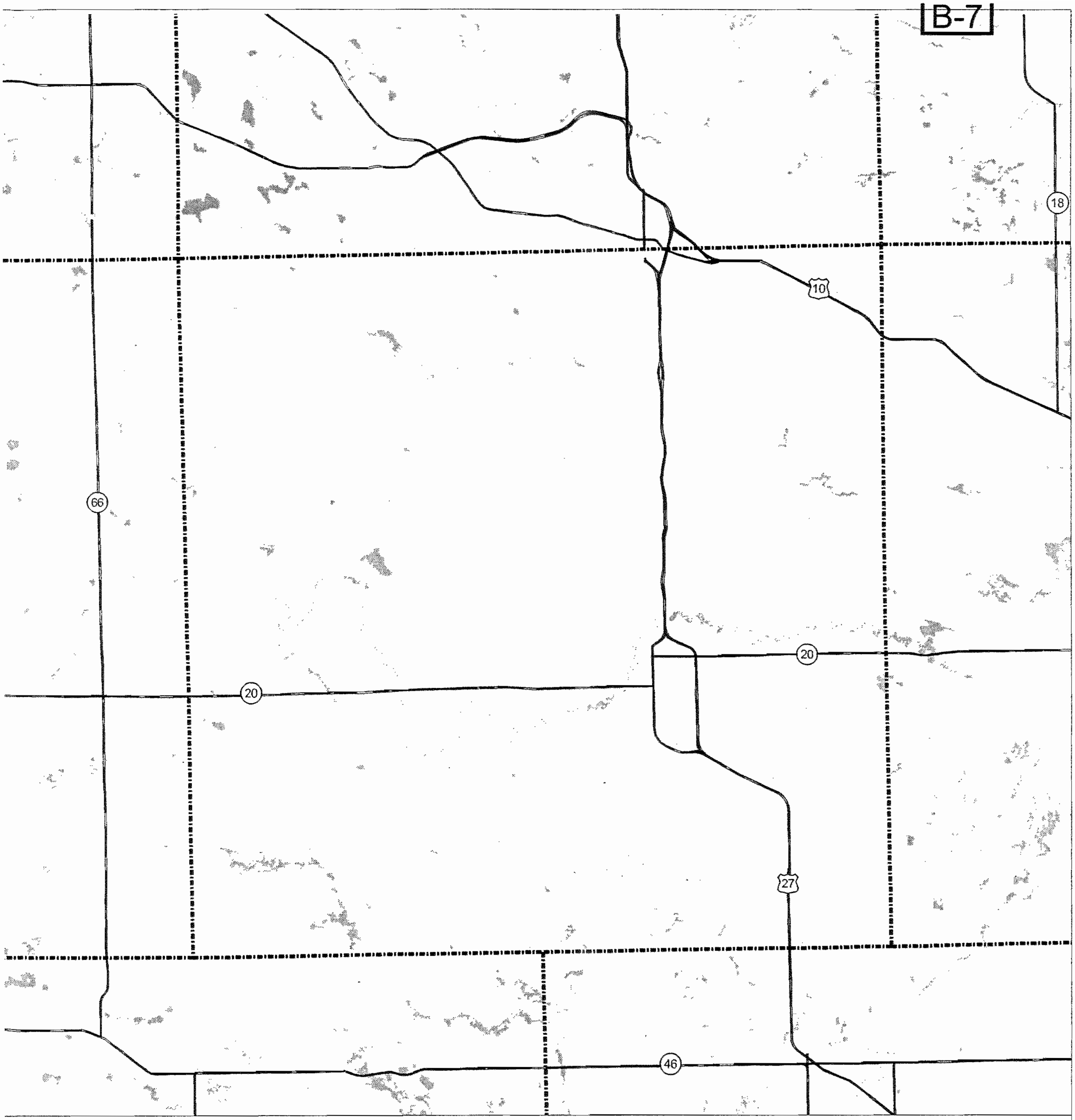
Michigan Natural Features Inventory



Land Cover Change, 1800s - 1978

Isabella County

- Major Roads
- County Lines

Land Cover Change Class

- Herbaceous Openland Unchanged
- Savanna Unchanged
- Aspen/Birch Unchanged
- Central Hardwood Unchanged
- Northern Hardwood Unchanged
- Other Upland Conifer Unchanged
- Pine Unchanged
- Lowland Conifer Unchanged
- Lowland Deciduous Unchanged
- Emergent Wetland Unchanged
- Shrub Wetland Unchanged
- Water Unchanged
- Sparsely Vegetated Unchanged
- Bedrock Unchanged
- Changed to Aspen
- Changed to Urban or Agriculture
- Other Change

Data Sources:
Circa 1800 wetlands from Michigan's Native Landscape: As Interpreted fr[illegible]e General Land Office Surveys 1816-1856. 1995. Comer, P.J., e[illegible]NFI. Lansing, MI. 78 pp. + digital map. Roads and county lines a[illegible]n the 1990 USGS 100K DLG files.

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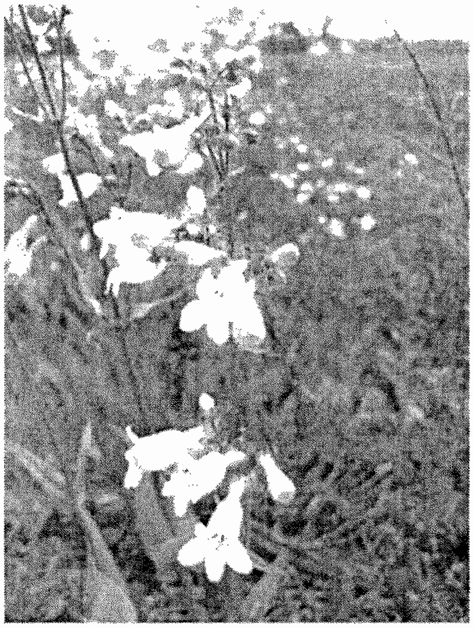
Michigan Natural Features Inventory

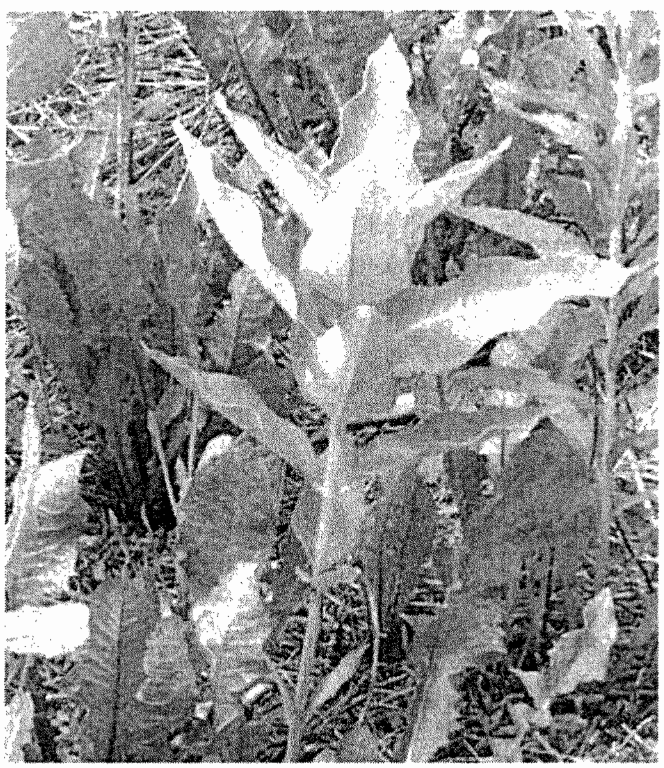
Benzinger II Site Plant Sample



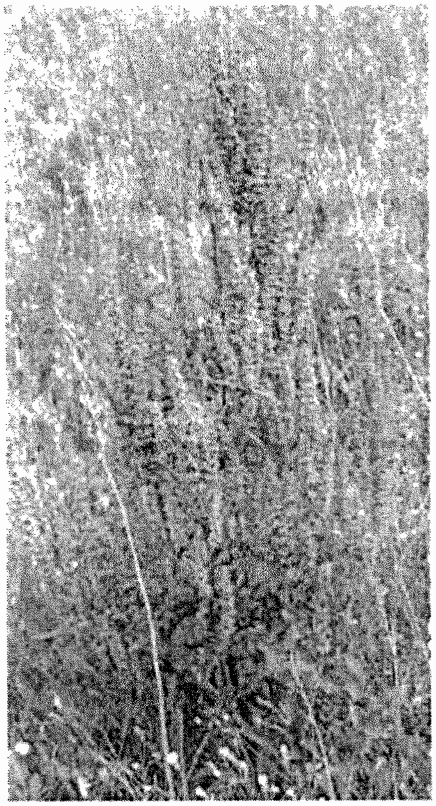
Beard tongue, foxglove beardtongue, tall white beardtongue (*Penstemon digitalis)* – uncommon to the area

Broad leaf plantain, common plantain (*Plantago major L.)*- useful in the treatment of insect stings and bites, poultice for rheumatism, inflammation and swelling, known to be antibacterial, poultice for snake bite, the root used as snake bite protection medicine, and provides food as greens

Butter cup, Meadow Buttercup, Common Buttercup *(Ranunculus acris)* useful as counter irritant for arthritis, seeds used for hunting medicine, plant combined with oak for red dye, and combined with flag leaf for yellow dye



Common Milkweed *(Asclepias syriaca L. Asclepiadaceae)* the sap is useful in combating warts, the root useful in the treatment of female problems, the flowers, young shoots and seed pods an excellent food source

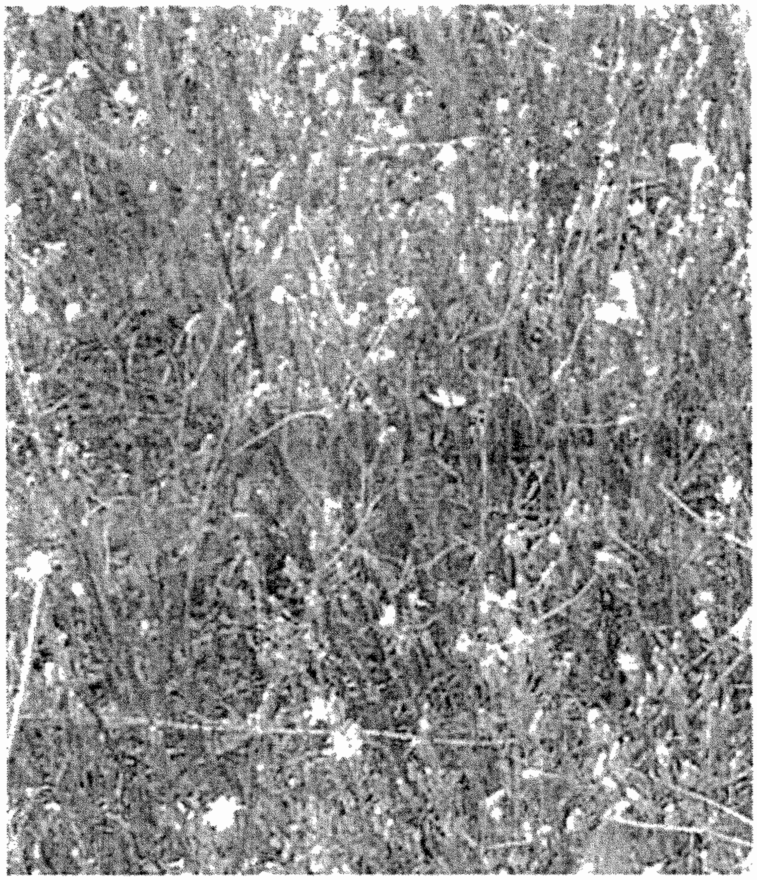


Curly Dock *(Rumex crispus L. Polygonaceae)* Poultice of moistened, dried, powdered root applied to cuts or itches.

Mullein, common mullein *(Verbascum thapsus L.)* upper portion useful in treatment of respiratory illness, root used as a heart stimulant

Sheep Sorrel *(Rumex acetosella L.)* Vitamin C, spring tonic, greens

Wild Strawberry, woodland strawberry *(Fragaria vesca L.)* leaf and berry used for Vitamin C, spring tonic, urinary illness, useful in ceremonial context



Yellow Hawkweed *(Hieracium fendleri Schultz-Bip. Asteraceae)* Hunting and fishing medicine

Red Osier Dogwood *(Cornus sericea L.)*, inner bark used for ceremonial pipe smoking and offerings- ingredient of Kinnikinnick, twigs used for basket making

Raspberry, grey leaf raspberry *(Rubus idaeus L. ssp. Strigosus (Michx.) Focke)* Food, anti-diarrhea, back pain, eye wash, treatment for measles

Yarrow, Milfoil, Thousand-leaf, Arrow-root, Bloodwort, Greenarrow, Soldier's Woundwort, Nosebleed Weed, Devil's Nettle *(Achillea millefolium)* Leaves useful as insect repellant, stop bleeding, digestive tonic, wash infected wounds, eye wash, reduce blood pressure, tooth ache and protection medicine

Dandelion, Common dandelion *(Taraxacum officinale)* spring tonic, blood purifier, greens

Golden rod – late and Canada *(Solidago altissima L. and Salidago canadesis L.)* Sore throat, flower used as a poultice for burns and boils, treatment for convulsions, cramps, fever and stomach ache

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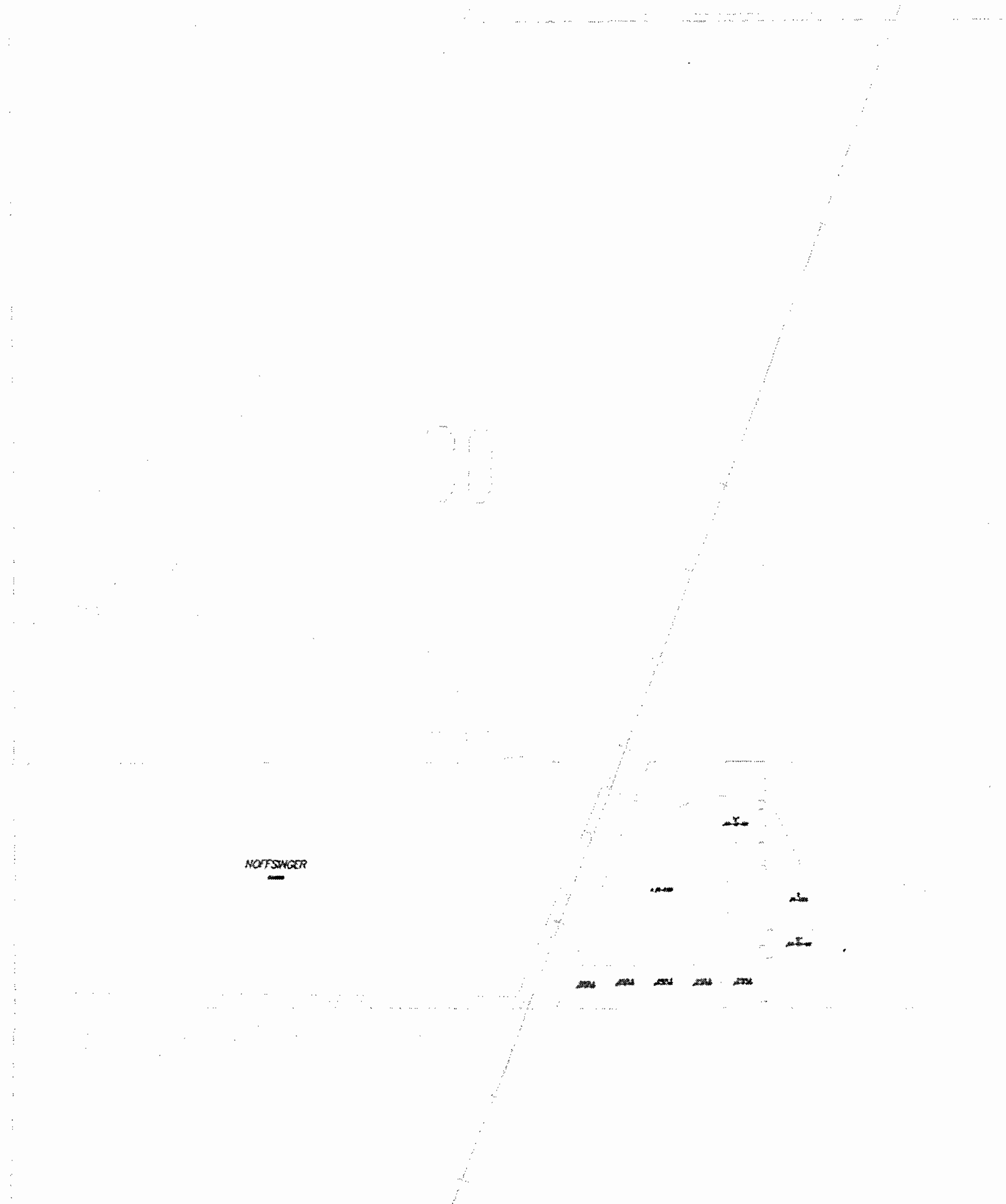
SAGINAW CHIPPEWA INDIAN TRIBE
SAGANING BASE MAP



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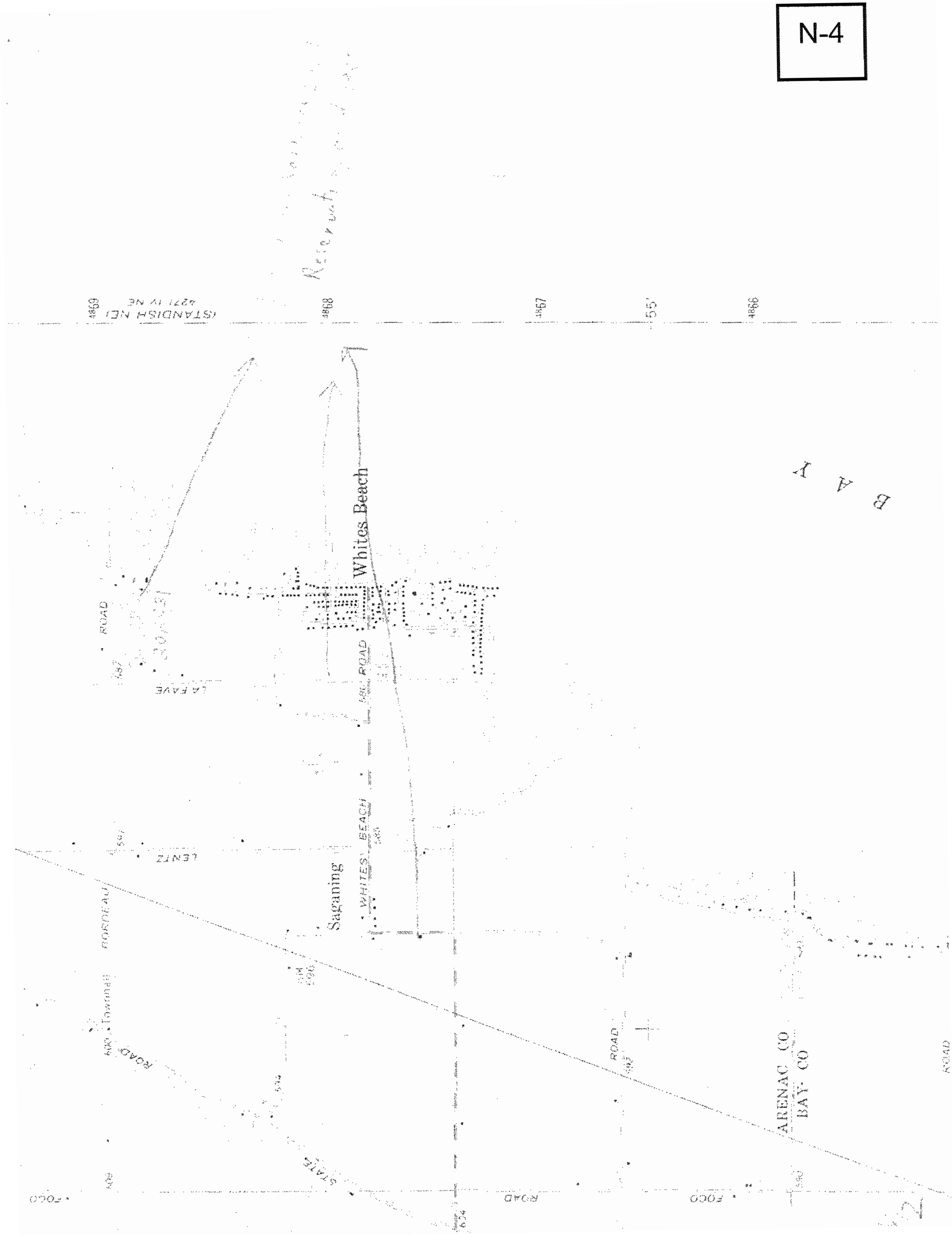
Whites Beach
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WHITES BEACH
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LAFAVE
BORDEAU
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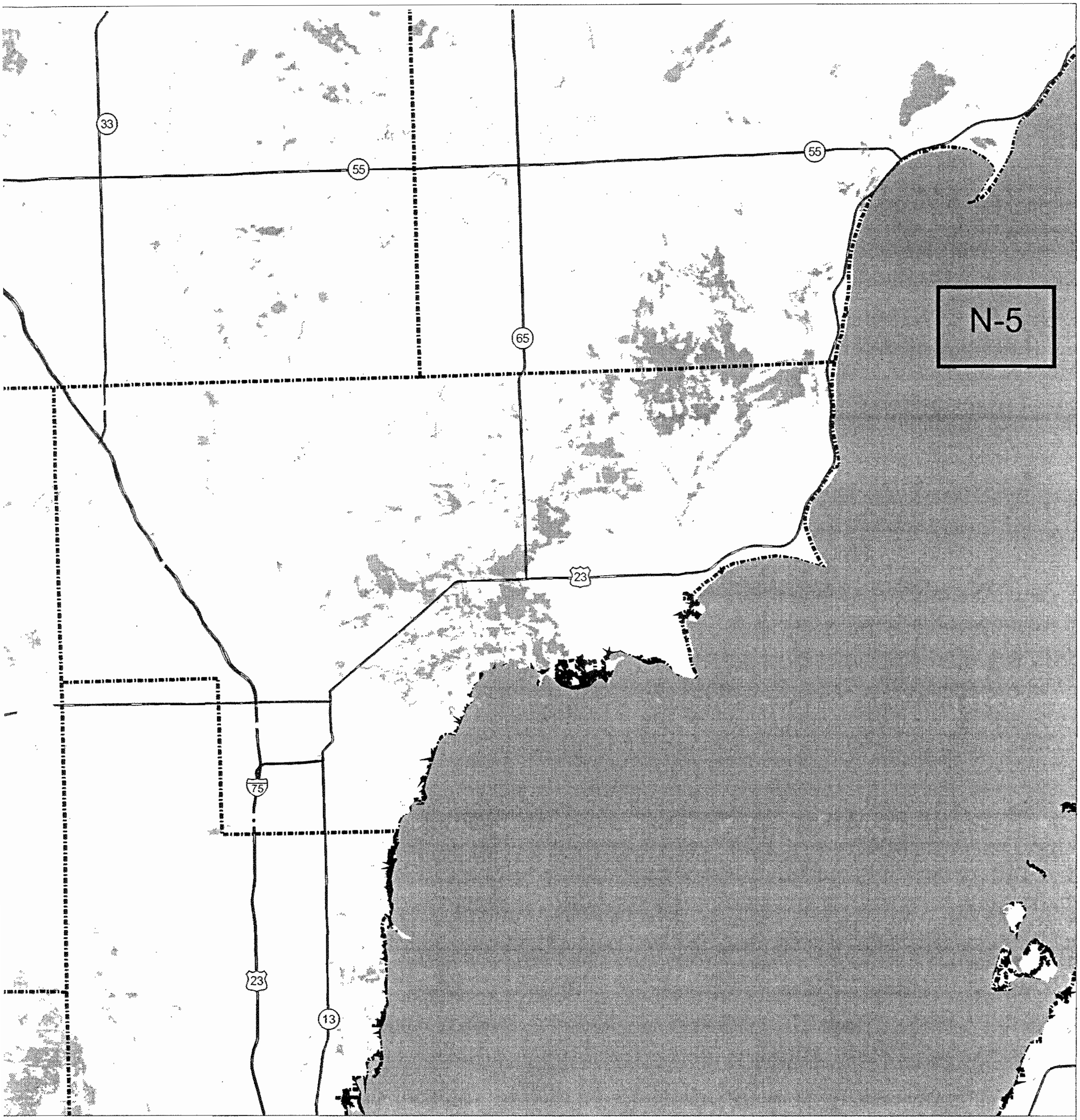

Land Cover Change, 1800s - 1978

Arenac County

Major Roads
County Lines
Land Cover Change Class
Herbaceous Openland Unchanged
Savanna Unchanged
Aspen/Birch Unchanged
Central Hardwood Unchanged
Northern Hardwood Unchanged
Other Upland Conifer Unchanged
Pine Unchanged
Lowland Conifer Unchanged
Lowland Deciduous Unchanged
Emergent Wetland Unchanged
Shrub Wetland Unchanged
Water Unchanged
Sparsely Vegetated Unchanged
Bedrock Unchanged
Changed to Aspen
Changed to Urban or Agriculture
Other Change

Data Sources:
Circa 1800 wetlands from Michigan's Native Landscape: As Interpreted fr[illegible]e General Land Office Surveys 1816-1856. 1995. Comer, P.J., e[illegible]NFI. Lansing, MI. 78 pp. + digital map. Roads and county lines a[illegible]n the 1990 USGS 100K DLG files.

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0 2 4 Miles

Michigan Natural Features Inventory

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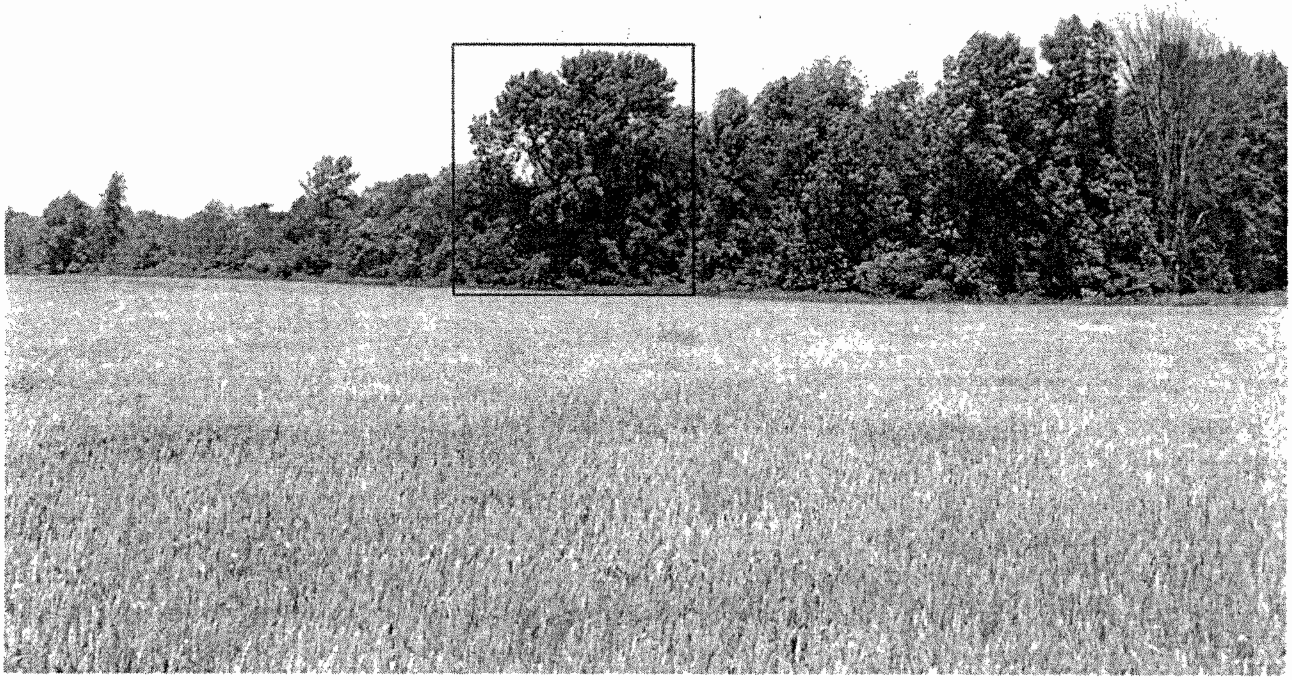
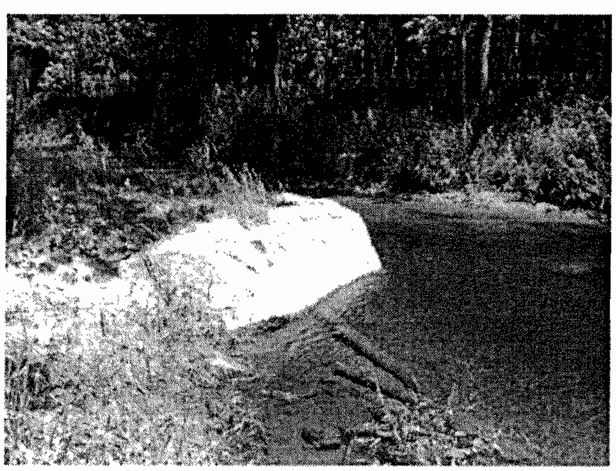
Saganing River Washing Rock

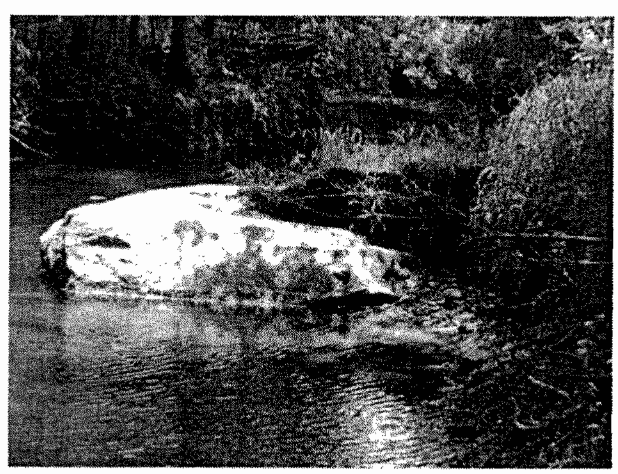
This tree on the Saganing River West of the RR tracks and North of Worth Rd. marks the general area of the washing rock



View from east side



View from west side



Noffsinger Site plant sample

Marsh Horsetail (Equisetum palustre) and Scouring Rush (*Equisetum hyemale* L.) both useful in treating urinary illness and use as an abrasive

Choke Cherry (*Prunus virginiana* L.) and Pin Cherry (*Prunus pensylvanica* L. f. var. *pensylvanica)* both useful as a cough and cold remedy and a food resource

Elm tree either slippery elm (*Ulmus rubra* Muhl.) or American Elm (*Ulmus americana* L.) the former used for sore throat and soothing mucus membranes and both barks used for cover of lodges, containers and rattles

Virginia Creeper (*Parthenocissus quinquefolia* (L.) Planch.) used as a food and dye source, as well as a politice used for swellings

An undermined Hawthorn (*Crataegus)* used as a food source

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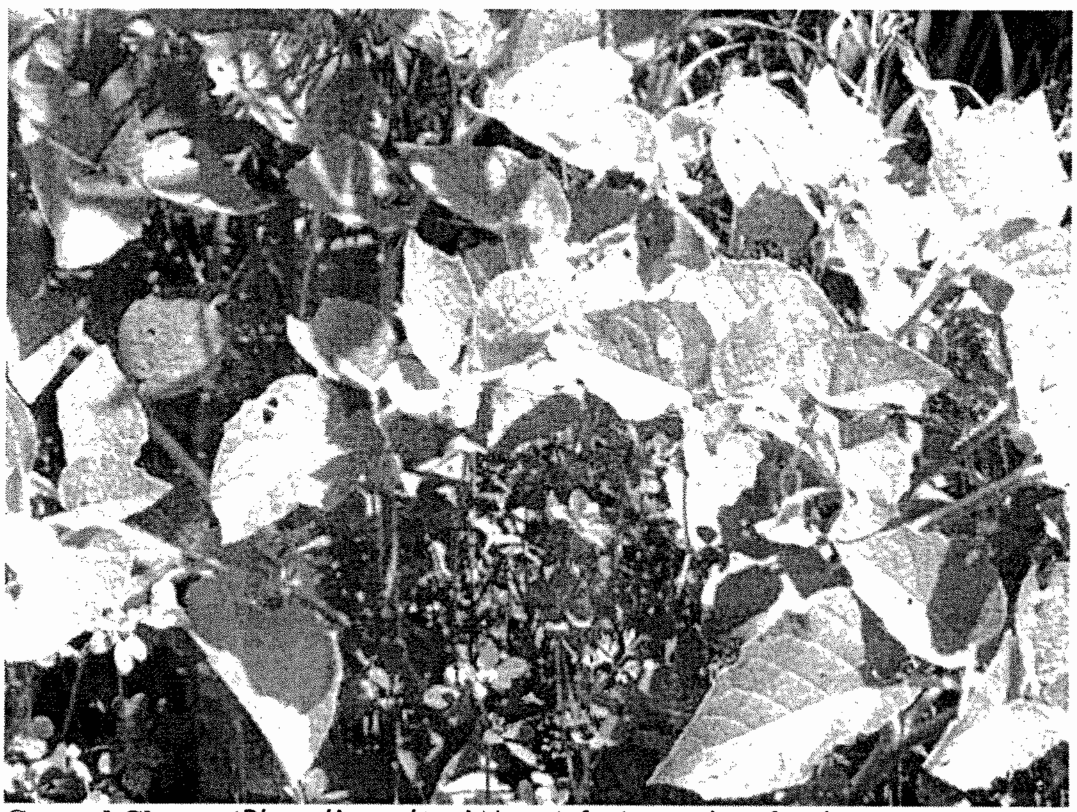
Common Elderberry (*Sambucus nigra* L. ssp. *canadensis* (L.) R. Bolli), berry used as food, making toy flutes and as a medication to produce vomiting

Raspberry (Rubus idaeus L. ssp. Strigosus (Michx.) Focke) berry used as food, leaf used to promote health during pregnancy and root used as intestinal medicine

Northern Black Currant (*Ribes hudsonianum* Richards.) berry food source

Mullein (Verbascum thapsus L.) leaf used for respiratory illness and root used as a stimulant

Groundnut (*Apios americana* Medik.) root/tubers used as food



Ground Cherry (*Physalis walteri* Nutt.) fruit used as food source

Stinging Nettle (*Urtica dioica* L.) young shoots used as food and stem used for fiber in fish nets, sewing and cordage

Riverbank Grape vine (*Vitis riparia* Michx.) fruit used as a food source, vine used as cordage and root used for rheumatism

Burdock (*Arctium lappa* L.) poltice used for brusies and sprains and food source

Red Osier Dogwood (Cornus sericea L.) basket making and inner bark smoked in ceremony

White Ash (*Fraxinus americana* L.) canoe and tool building material

Wild Swamp Rose (*Rosa palustris* Marsh.) hips/fruit used as source of vitamin C

Appendix L. Transmission Study

TRANSMISSION ASSESSMENT

for

THE SAGINAW CHIPPEWA TRIBE OF MICHIGAN

submitted on

21 February, 2006

by

Distributed Generation Systems, Inc. (Disgen)
Author: Krista Jo Gordon, Manager of Engineering

Table of Contents

Introduction

In May, 2004 Distributed Generation Systems, Inc. (Disgen) signed an Energy Services Contract with the Saginaw Chippewa Tribe of Michigan (Tribe) to explore and develop the Tribe's renewable energy resources. Shortly after, Disgen applied to the Department of Energy (DoE) for funding for the development of its wind and solar renewable resources. The total amount of the grant was $222,188. Two meteorological ("met") towers were installed at two sites on reservation lands in December, 2004. At the time of writing, 14 months of wind data had been collected. This Transmission Assessment will discuss the interconnection options available to the Tribe for wind projects in both locations.

The first met tower is located approximately three miles east of the Town of Mount Pleasant, Michigan in Isabella County. It is near the intersection of Shepherd Road and Remus Road as shown below in Figure 1. It is on a site selected by a professional meteorologist as having potential for a wind project. The wind turbine(s) will be located in close proximity to the met tower.

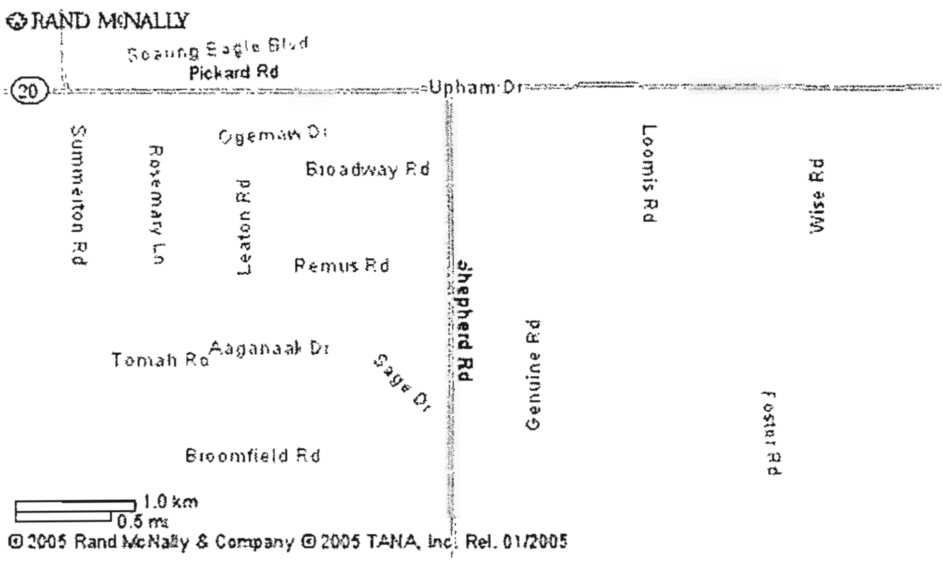


Figure 1, "Mount Pleasant Road Map"

The second met tower is located approximately two miles west of Whites Beach in Arenac County, Michigan. It is near the intersection of Worth Road and State Road as shown below in Figure 2. The closest town larger than Whites Beach is Standish, MI. This site was also selected by a professional meteorologist. This met tower is also close to where the wind turbines will eventually be situated.

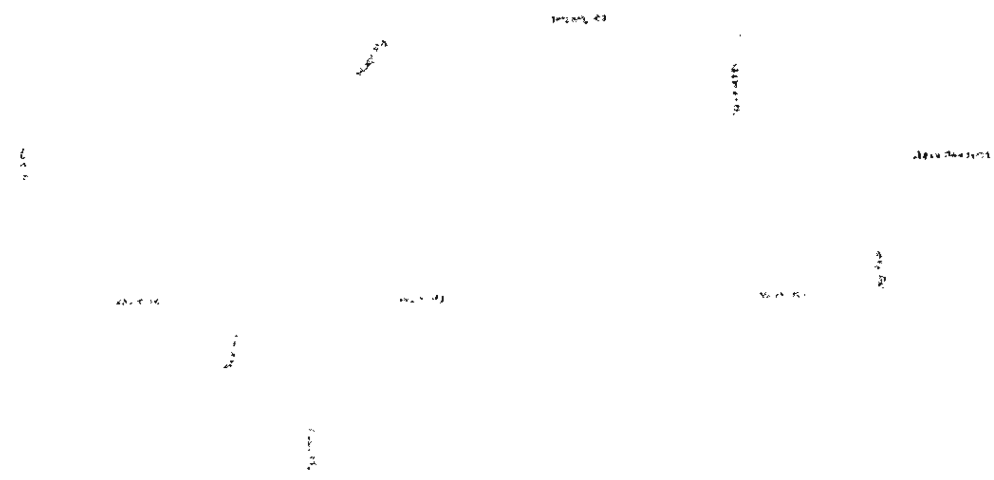


Figure 2, "Standish Road Map"

Both sites have a small amount of developable reservation land, so accordingly the wind projects will be small. This report will determine the maximum amount of wind turbines that can reasonably be interconnected in both locations. If it is determined later that there is less land than can accommodate the maximum project size with regards to interconnection, then the project sizes will probably have to be decreased.

The nature of the wind resources at the two sites will not be addressed in this Assessment since Disgen was contracted to perform this Transmission Assessment regardless of the economic viability of the wind power projects.

Transmission System

The Tribe has not designated minimum, maximum, or target project sizes. This report will explore the feasibility of interconnecting small projects in both areas and will attempt to offer insight as to the most appropriate size of project that can be interconnected to the local electric power system without requiring extensive upgrades and expansions. Both thermal limits and voltage drops will be considered. There are many factors that determine the feasibility of interconnecting a new generator to an existing transmission system. Chief among these are equipment voltages, size ratings, other regional loads and generators, and market. All of these will be discussed herein. However, it is worth noting that this report is *not* an official interconnection study since it has not been written or reviewed by any transmission agency, although it was written with input and interviews with relevant regional utilities.

Standish

From Disgen's telephone interviews with Consumers Energy ("Consumers") Disgen has learned that the Duquite Substation is the closest substation to the met tower location. It is located just northwest of the intersection of Palmer Road and Foco Road, approximately three miles north of the met tower. The street address for the Duquite

Substation is 3755 East City Limits Road, Standish, MI. The Duquite Substation has buswork at138kV, 46kV, and 24.9kV.

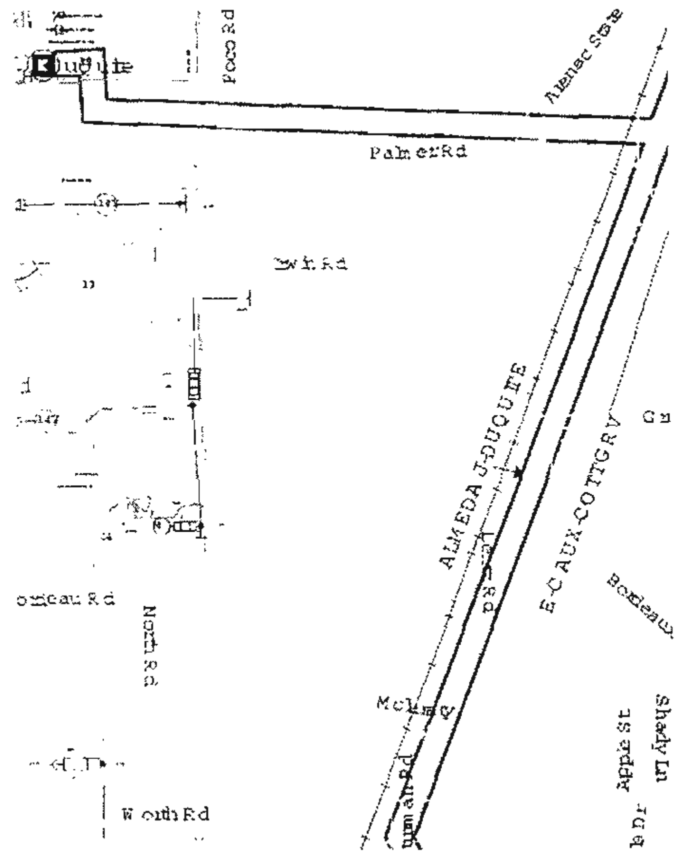


Figure 3, "Standish Area Transmission"

The second and third options for interconnection at the Standish site are two 138kV transmission lines that pass less than one mile from the met tower. One connects the Carn Generating Station with Cottage Grove and East Tawas. The other connects Saginaw River, Duquite, and Twining. For either of these two interconnections, the formal request for study work would go to the Michigan Electric Transmission Company (METC). For both of these two options, the size of the wind project near Standish would be far less than the thermal limit of the lines since there is not sufficient land to support a project that would appreciably impact these lines. However, similarly there may not be enough land to build a project large enough to absorb the cost of interconnecting at a high voltage.

– NOW ITC

Also in close proximity to the project site is a two-phase distribution line running about four miles along Worth Road. It would have to be changed to three-phase in order to connect to the 24.9kV bus at Duquite. It is estimated that this line could be rebuilt for less than $100,000 per mile.

Voltage drop is another consideration for the project. It is a function of conductor size, length, and current flow. Since the distance from the project to the interconnection is relatively short (3 – 4 miles) and since the project would build this feeder to its own specifications, the voltage drop can be minimized in the feeder's design. It is not expected that the full-load voltage drop will exceed 2 – 3%, and this is well within a range considered reasonable by most utilities.

Based on market considerations discussed below and the state of the existing electrical infrastructure near Standish, Disgen recommends interconnection to either the 24.9kV bus or the 46kV bus at the Duquite Substation. In either case, the project will build a small step-up substation on the project area to increase the voltage from that of the wind turbine generator(s) to either 24.9kV or 46kV. From there a 3 – 4 mile feeder will be necessary as well as a new recloser, meter, and telemetry equipment at the Duquite Substation. The size of the project would be capped at approximately 10MW.

Mount Pleasant

For the Mount Pleasant site, there is no high voltage transmission nearby. Instead, the two options are the Tribe's Casino or a 46kV distribution line nearby. They are roughly equidistant from the project area. If a connection at the Casino is made, then it should be "behind the meter". In other words, the wind project should connect to the Casino side of the meter rather than the grid side. This way, the output of the wind project can directly serve the load at the Casino and offset its retail electricity rate. The cap for net metering on the Consumers Energy system is 30kW, so any excess beyond 30kW more than the Casino's spot load would be sold back to Consumers at a specially negotiated rate. The other option is to connect directly to the 46kV distribution feeder in which case the output would be sold at Consumers' wholesale rate for wind energy. Given that this is lower than the Casino's retail rate, Disgen recommends direct connection to the Casino.

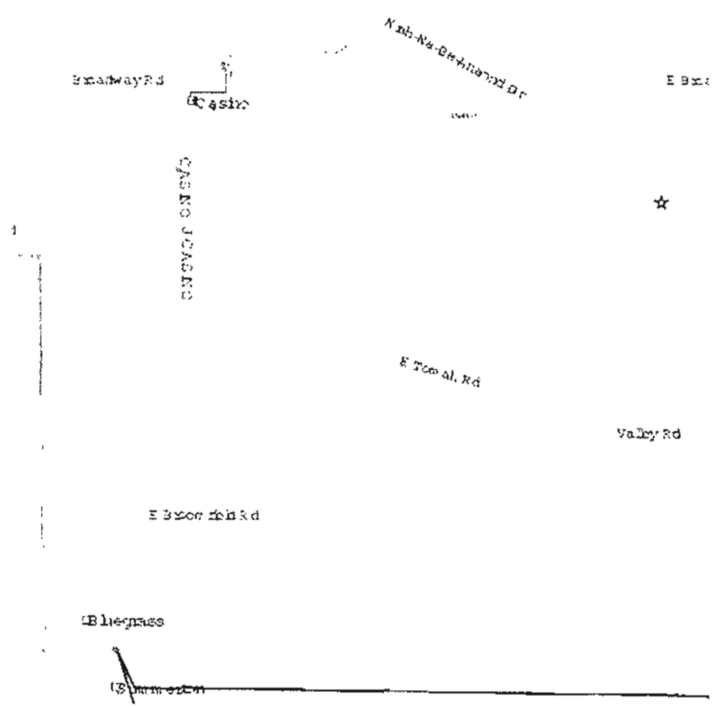


Figure 4, "Mount Pleasant Area Distribution"

The precise size of the project is best determined after conducting a load analysis of the Casino, which is beyond the scope of this assessment. However, Disgen is well-qualified to perform such an analysis and would be pleased to offer its services to the Tribe. It is expected that the total size of the wind project will stay under approximately 5MW.

Interconnection Procedure

Once the Tribe receives its final wind assessment report from Disgen and if it decides that it wishes to pursue a wind power project, it will be appropriate to file an Interconnection Application with Consumers Energy. A blank Interconnection Application form is included as Appendix 1. This applies as long as the total project size is at least 2MW and requires a fee of $500 to be submitted at the same time as the Interconnection Application form. It is important to know many technical aspects of the generator(s) selected for interconnection when this form is completed. Disgen is experienced in both selecting the most appropriate wind turbines for a given wind site and providing detailed electrical information as required. Disgen would be pleased to assist the Tribe in completing both of these activities when the time comes. The same form and procedure apply to both the Mount Pleasant and Standish sites. They should not be combined into one Interconnection Application since they will be viewed by Consumers as two separate and distinct projects.

The interconnection study and agreement procedure is separate from the process to request and obtain transmission service.

The total cost for the interconnection study will not exceed $10,000 and the time is not to exceed 18 weeks. The 18-week period is meant to start the date a queue position is issued, which is the same as the date Consumers accepts a compliant Interconnection Application form from the customer. It is meant to end when the interconnection agreement is signed. This is a relatively brief and inexpensive interconnection process compared with that of other utilities in the US.

Part of the information required in order to start the interconnection study is the identity of the wind turbine(s) to be used for the project. The study will be specific to that wind turbine, so it is not advised to change models after the study. Otherwise the study may have to be repeated. The selection of a wind turbine for a project involves several determining factors. Among them are purchase price, electrical accessories available for purchase with the turbine, and most importantly the project-specific energy output in accordance with the wind data collected on the site and the air density calculated at the site. Disgen has close relationships with all of the major wind turbine suppliers currently selling equipment in the US today and is well-qualified to assist the Tribe in selecting the best wind turbine for the site(s) when the time comes.

The specific electrical requirements of the wind project and its interconnection point will be determined in the course of the interconnection study, but certain system-wide requirements have been published by Consumers that shall apply to all new generators seeking interconnection service. A generic "one line" diagram of a tentative interconnection for a wind project is shown below. Depending on the voltage of the line to which the project will connect, the Power Transformer on the right might not be necessary.

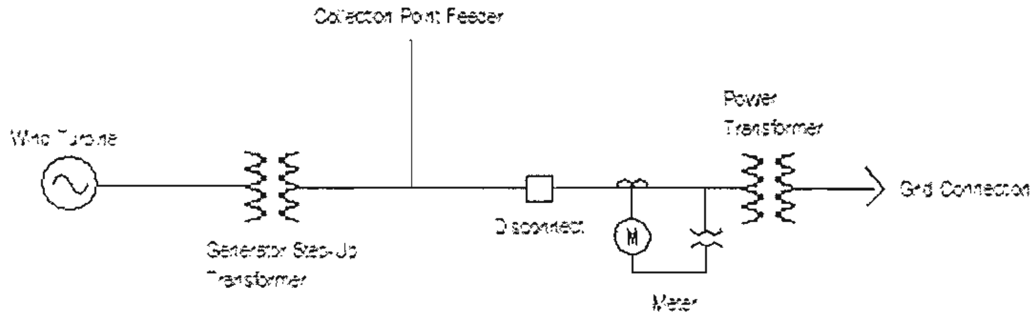


Figure 5, "Tentative One-Line Drawing"

In particular, the elements in the drawing in Figure 5 will most likely have the following capabilities and attributes as stipulated by Consumers. All equipment will be required to have adequate ratings to ensure the safe operation of the wind project and local electric power system. All equipment must also be approved by Consumers Energy.

- Transformers: Load tap changing on the low and/or high voltage side to accommodate minor fluctuations in line voltage. Also may not have a grounded-wye : ungrounded-wye connection configuration.
- Disconnect: Load break capability. Also gang operation if so designated by Consumers.
- Wind Turbine(s): Voltage regulation capability.

In addition to the equipment shown in the one line drawing in Figure 5, a relay will be necessary to allow the protective equipment at the interconnection point to operate. A current transformer and potential transformer will be necessary for the relay as shown below in Figure 6. They will be limited to 5 Amperes and 120 Volts respectively. A back-up power source for the relay will be required to ensure that it continues to operate properly even in the event of a grid failure. The relay must be designed to prevent the wind project from re-energizing after a fault without the rest of the grid first re-energizing. Consumers must be closely involved in establishing the settings for the relay system. In particular, they will require under/over voltage and under/over frequency protection relaying. For undervoltage, the relay shall operate in less than 1 second if the voltage falls below 90% of line voltage. Comparably, the relay shall operate in less than 1 second for overvoltage events above 110%. For overfrequency and underfrequency events falling outside the range of 58.5 – 60.5 Hertz the relay shall operate within 0.2 seconds. Inverse time characteristics are not acceptable by Consumers. The project will also be required to manage its own internal faults. Direct Transfer Tripping will not be required as it is unlikely that the wind projects in question would use synchronous generators. This is good since DTT is typically an expensive configuration.

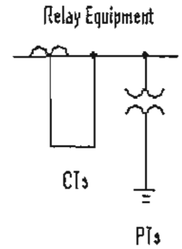


Figure 6, "Relay Equipment"

The wind project will be required to supply its own reactive power needs sufficient to maintain a steady state power factor of unity. This can be accomplished through switched capacitors. Consumers Energy does not currently require induction and inverter-type generators to supply reactive power into the grid beyond their own needs.

To study the stability of the local grid system after the introduction of the wind project, a fault current contribution of five times rated kVA of the wind project shall be used as a standard limit for design purposes. The interconnection study will determine whether or not the wind project meets this guideline.

The basic scope of the interconnection study will include all steady-state power flow, short circuit, and system stability analysis. The power flow analysis covers the basic thermal results of interconnecting the new generator. An analogy might be to think of the transmission system as a network of pipes, valves, pumps, etc. As additional water is inserted into the pipe network, an examination must be conducted to ensure that the existing elements are not overstressed. A typical analysis would include "system intact" as well as "N-1" conditions. System intact means that all elements are in service and functioning properly. N-1 means that one element is not working, so the other parts must work harder to maintain the same system performance. This one element could be any element: transmission line, transformer, circuit breaker, etc.

The purpose of the short circuit analysis is to see what happens when a fault occurs. This is different than N-1. Whereas in N-1 something is simply taken out of service, in a short circuit situation current flows where it is not supposed to go. This generally means it will either flow from one phase to another (from one wire to another) or from one or more phases to ground. This can result in severe interruption of proper flows, so care must be taken to address these potential faults. Since local faults are typically the focus of this portion of the study, and since fault current contribution varies from one generator to the next, it is important that the specific wind turbine model be chosen no later than at this stage. It is also important to specify the intended power purchaser or "sink" for the study. That way system analyzers can schedule the output of the project to a specific utility or load in the models.

The system stability analysis addresses the behavior of the wind project when there are faults on other parts of the transmission system. For example, if there is a fault on a line 200 miles away, will the wind project stay on-line or trip off-line? It will be at the discretion of the transmission service provider to decide whether it is desirable for the project to ride through a fault or briefly go off-line.

The final portion of the study is where Consumers makes estimates for the project as to the new or upgraded facilities required to interconnect the generator. The estimates will include both those facilities to be provided and owned by the project and those to be provided and owned by Consumers and/or other affected utilities.

Following the completion of the interconnection study, negotiations will begin on the Interconnection and Operating Agreement with Consumers. A copy of this agreement is available on the Consumers Energy website at www.consumersenergy.com.

Markets

As noted above, it is commonly beneficial to connect to the same utility that will buy the output of the project. Therefore, since the owner of the facilities at the two interconnection locations is Consumers Energy, it is the natural first choice for a power purchaser. Close second choices would be any of their others customers who could accept the power from the wind project into their remote systems even thought they would have to transmit the power over facilities owned by Consumers without paying transmission charges to Consumers. Third choices would be any utilities that could be reached by way of the Consumers Energy transmission system even transmission charges would be applied.

The rules for selling wind energy in Michigan are already fairly well established. If connecting to the distribution system, the sale would be to Consumers Energy at its then-current renewable energy rate. If connecting to the 46kV system or up, the power would be sold into the MISO market at a wholesale rate. This would increase the number of options for power purchasers for the Tribe's project(s), but it would not necessarily increase the price. In the case of distribution transformers where the high side is at least 46kV, a project can connect to the low side of the transformer and still qualify for the wholesale market. This is the case with the Standish project.

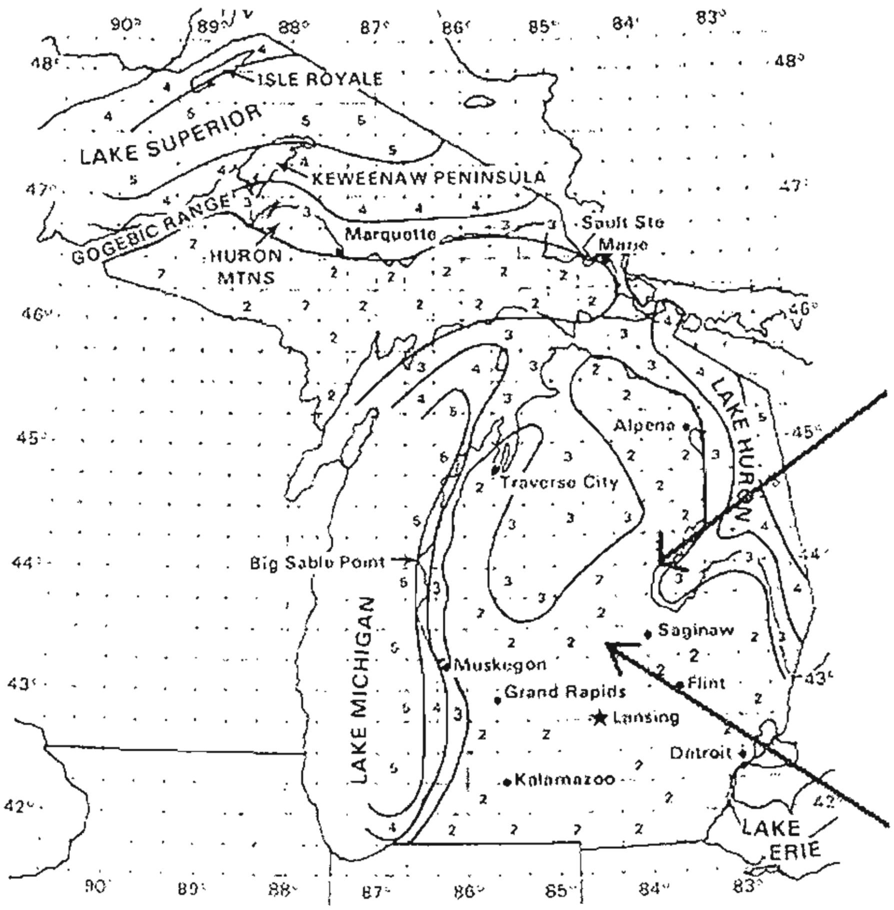


Figure 7, "Michigan Wind Map"

As shown in Figure 8 below, the State of Michigan does not currently have any large wind projects installed within its borders. However, there are three small projects installed that total 2.6MW of generation. 600kW is installed near Traverse City, 1800kW is installed near Mackinaw City, and 195kW is installed in Huron County. At least two additional larger projects are proposed in Bingham and Oceana County for a total of 78MW. However, even if these two projects are built the total installed wind capacity in Michigan will be less than 100MW. Considering the fact that Michigan is ranked 14th in the nation in terms of wind development potential and as evidenced by the Michigan state wind map in Figure 7, its present ranking in the lower half of the states in terms of wind projects installed suggests that there is a reasonable market for the purchase of wind energy.

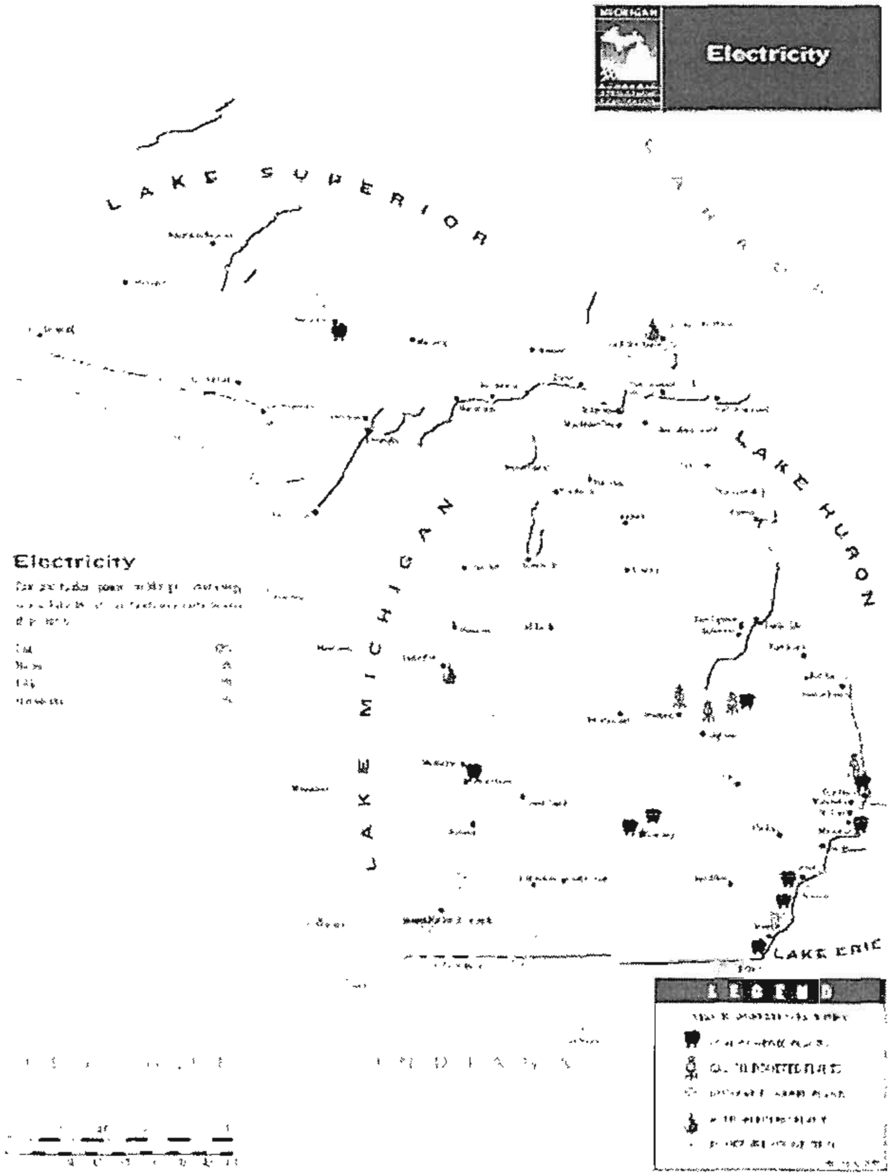


Figure 8, "Major Michigan Power Plants"

Conclusion

It is possible to avoid wasting months of time and thousands of dollars in the late development stages by making a few prudent decisions in the early stages. These include the selection of the interconnection point, target power purchaser, and basic project size. For the Standish site, a connection to one of the two distribution voltages (24.9kV or 46kV) is recommended at the Duquite Substation. The target project size should be in the neighborhood of 10MW. For the Mount Pleasant site, a connection to the low side of the Casino's meter is recommended. The optimum project size has not been determined at this stage, but it will likely not exceed 5MW. For both projects Consumers Energy will be the target power purchaser.

Disgen is confident of its abilities to guide the Tribe deftly and efficiently through the complicated interconnection process and thus help make a wind project on the Saginaw Chippewa Reservation a reality.

APPENDIX 1

INTERCONNECTION APPLICATION FORM

GENERATOR INTERCONNECTION APPLICATION

AGGREGATE GENERATOR OUTPUT OF 2 MW OR MORE

1. The undersigned Project Developer submits this Generator Interconnection Application and appropriate filing fee to interconnect a new Project to the Utility Electric System or to increase the capacity of an existing Project interconnected to the Utility Electric System.

2. A Project Developer requesting interconnection or an increase in the capacity of an existing Project to the Utility Electric System must provide the following information:

   a. Completed Interconnection Application Data sheet appropriate for the capacity rating and type of generating unit(s), as found in the Utility's Generator Interconnection Requirements
   (Interconnection Application Data sheet, found in Appendix B or C, must be attached to this Interconnection Application).

   b. Description of the equipment configuration and proposed interconnection one-line diagram (one-line diagram must be attached to this Interconnection Application).

   c. Project Developer (Single Point of Contact):

   Name: ______________________________

   Address: ______________________________

   ____

   Phone Number: ______________________________

   Fax Number: ______________________________

   e-mail Address: ______________________________

   Project Site Address: ______________________________

3. This Generator Interconnection Application shall be directed to the Utility representative as indicated below:

   Director - Electric System Planning and Protection
   Consumers Energy Company
   1945 West Parnall Road
   Jackson, MI 49201

4. I, the undersigned and authorized representative of the Project, submit this Generator Interconnection Application and required technical data for the Utility's review. I understand that upon acceptance, the Utility shall subsequently provide an Interconnection Study Agreement. The Interconnection Study Agreement will include the Scope of the Interconnection Study. I also understand that I shall be required to furnish certain required technical data as requested by the Utility in support of this study and reimburse the Utility for its study expenses.

   Authorized Signature: ______________________

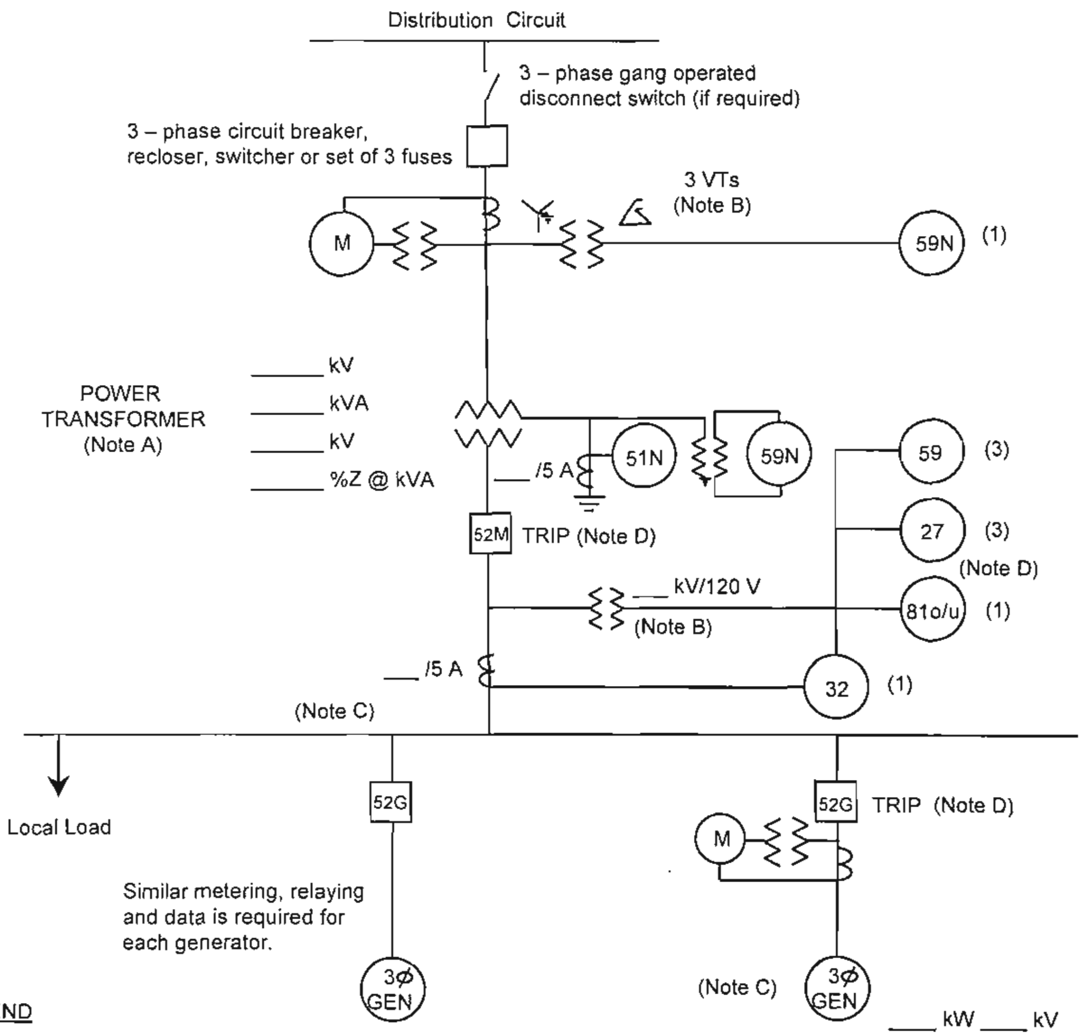
   Printed Name: ______________________

   Title: ______________________

   Company Name: ______________________

   Date: ______________________

ONE-LINE REPRESENTATION
TYPICAL ISOLATION AND FAULT PROTECTION FOR INDUCTION GENERATOR INSTALLATIONS
2 MW OR LARGER



LEGEND

27	Undervoltage
32	Reverse Power (not required for sellback)
51N	Neutral overcurrent (required for grounded secondary)
59	Overvoltage
59N	Zero sequence overvoltage (assuming ungrounded secondary on power transformer)
81o/u	Over/Underfrequency

NOTES

A) See technical requirements for permissible connection configurations and protection. Transformer connections proposed shall be shown on the one-line diagram by the Project Developer. Transformer connection and secondary grounding to be approved by Utility.

B) Protection alternatives for the various acceptable transformer connections are shown. Only one protection alternative will ultimately be used, depending on the actual transformer winding connections. VTs for 59, 27, 81o/u and 32 are shown connected on the primary (Project side) of the power transformer, but may instead be connected on the secondary (Utility side). VTs are required on the secondary of the power transformer if a 59N is required for an ungrounded secondary connection. IEEE std 1547 requirements for voltage and frequency must be met at the PCC. IEEE Std. 1547 permits the VTs to be connected at the point of generator connection in certain cases.

C) Main breaker protection, generator protection and synchronizing equipment are not shown.

D) Trip of all 52G breakers or the 52M breaker is acceptable, depending upon whether the Project Developer wants to serve its own isolated load after loss of Utility service.

SYNCHRONOUS OR INDUCTION GENERATORS - AGGREGATE ≥ 2 MW
INTERCONNECTION APPLICATION DATA FOR: ____________________
PROVIDED BY: ____________________________ DATE: __________

Instructions: Attach data sheets as required. Indicate in the tables below the page number of the attached data (manufacturer's data where appropriate) on which the requested information is provided. Provide one table for each unique transformer.

General Information

Item No	Data Description	Attached Page No
1	Flow-back or Non-Flow-back	
2	Project Type (Base load, peaking, intermediate)	
3	Site Plan	
4	Simple One-Line Diagram(s) for Project and Project Load	
5	Detailed One-Line Diagram(s) for Project	
6	Energization Date for Project Interconnection Facilities	
7	First Parallel Operation Date for Testing	
8	Project Commercial Operation Date	
9	Estimated Project Cost	

Isolating Transformer(s) between Project Developer(s) and Utility: Transformer No ____

Item No	Data Description	Attached Page No
1	Rated kV and connection (delta, wye, wye-gnd) of each winding	
2	kVA of each winding	
3	BIL of each winding	
4	Fixed taps available for each winding	
5	Positive/negative range for any LTC windings	
6	%Z Impedance on transformer self cooled rating	
7	Percent excitation current at rated kV	
8	Load Loss Watts at full load or X/R ratio	

The following information on these system components shall appear on the preliminary One-Line Diagram, including manufacturer make and model for the items listed below:

- Breakers - Rating, location and normal operating status (open or closed)
- Buses - Operating voltage
- Capacitors - Size of bank in kVAR
- Circuit Switchers - Rating, location and normal operating status (open or closed)
- Current Transformers - Overall ratio, connected ratio
- Fuses - normal operating status, rating (Amps), type
- Generators - Capacity rating (kVA), location, type, method of grounding
- Grounding Resistors - Size (ohms), current (Amps)
- Isolating transformers - Capacity rating (kVA), location, impedance, voltage ratings, primary and secondary connections and method of grounding
- Potential Transformers - Ratio, connection
- Reactors - Ohms/phase
- Relays - Types, quantity, IEEE device number, operator lines indicating the device initiated by the relays.
- Switches - Location and normal operating status (open or closed), type, rating
- Tagging Point - Location, identification

SYNCHRONOUS GENERATORS - AGGREGATE ≥ 2 MW
INTERCONNECTION APPLICATION DATA FOR: ______________________
PROVIDED BY: ______________________________ DATE: ___________

Instructions: Attach data sheets as required. Indicate in the table below the page number of the attached data (manufacturer's data where appropriate) on which the requested information is provided. Provide one table for each unique generator.

Electric Generator(s) at the Project: **Generator No _____**

Item No	Data Value	Data Description	Attached Page No
1		Generator Type (synchronous or induction)	
2		Generator Nameplate Voltage	
3		Generator Nameplate Watts or Volt-Amperes	
4		Generator Nameplate Power Factor (pf)	
5		RPM	
6		Minimum and Maximum Acceptable Terminal Voltage	
7		Direct axis reactance (saturated)	
8		Direct axis reactance (unsaturated)	
9		Quadrature axis reactance (unsaturated)	
10		Direct axis transient reactance (saturated)	
11		Direct axis transient reactance (unsaturated)	
12		Quadrature axis transient reactance (unsaturated)	
13		Direct axis sub-transient reactance (saturated)	
14		Direct axis sub-transient reactance (unsaturated)	
15		Leakage Reactance	
16		Direct axis transient open circuit time constant	
17		Quadrature axis transient open circuit time constant	
18		Direct axis subtransient open circuit time constant	
19		Quadrature axis subtransient open circuit time constant	
20		Open Circuit saturation curve	
21		Reactive Capability Curve showing overexcited and underexcited limits (Reactive Information if non-synchronous)	
22		Excitation System Block Diagram with values for gains and time constants (Laplace transforms)	
23		Short Circuit Current contribution from Generator at the Point of Common Coupling	
24		Rotating inertia of overall combination Generator, prime mover, couplers and gear drives	
25		Station Power load when generator is off-line, Watts, pf	
26		Station Power load during start-up, Watts, pf	
27		Station Power load during operation, Watts, pf	
28		National Recognized Testing Laboratory Certification (if applicable)	
29		Written Commissioning Test Procedure	

INDUCTION GENERATORS - AGGREGATE ≥ 2 MW
INTERCONNECTION APPLICATION DATA FOR: ______________________
PROVIDED BY: _____________________________ DATE: ___________

Instructions: Attach data sheets as required. Indicate in the table below the page number of the attached data (manufacturer's data where appropriate) on which the requested information is provided. Provide one table for each unique generator.

Electric Generator(s) at the Project: Generator No _____

Item No	Data Value	Data Description	Attached Page No
1		Generator Type (synchronous or induction)	
2		Generator Rated Voltage	
3		Generator Rated Volt-Amperes	
4		Generator Rated Power kW	
5		Number of Poles	
6		Synchronous Rotational Speed	
7		Rotation Speed at Rated Power	
8		Slip at Rated Power	
9		Minimum and Maximum Acceptable Terminal Voltage	
10		Motoring Power (kW)	
11		Neutral Grounding Resistor (If Applicable)	
12		I_2^2t or K (Heating Time Constant):	
13		Rotor Resistance	
14		Stator Resistance	
15		Stator Reactance	
16		Rotor Reactance	
17		Magnetizing Reactance	
18		Short Circuit Reactance	
19		Exciting Current	
20		Temperature Rise	
21		Frame Size	
22		Design Letter	
23		Reactive Power Required in Vars (No Load)	
24		Reactive Power Required in Vars (Full Load)	
25		Total Rotating Inertia, H:___________Per Unit on KVA Base	
26		Short Circuit Current contribution from generator at the Point of Common Coupling	
27		Rotating inertia of overall combination generator, prime mover, couplers and gear drives	
28		Station Power load when generator is off-line, Watts, pf	
29		Station Power load during start-up, Watts, pf	
30		Station Power load during operation, Watts, pf	
31		National Recognized Testing Laboratory Certification (if applicable)	
32		Written Commissioning Test Procedure	

Appendix M. "Power Point" Presentation Slides

Appendix M. "Power Point" Presentation Slides

Saginaw Chippewa Indian Tribe

July 28, 2008

Final Report

Renewable Energy Feasibility Study

Wind – Solar – Biomass

US Department of Energy Grant

Presented by Don Seal, Tribal Planning Eng.
Sally Kniffen, Tribal Environmental Steward
Steven B. Smiley, Consultant- Renewable Energy Economist

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The Vision*

- "The Tribe is seeking to become self-sufficient in their energy needs...."
- The Tribe wishes to maintain its culture by protecting Mother Earth and look ahead seven generations...
- Green energy sources are the best way...
- The Tribe's objectives are to provide power for its facilities and potentially create economic development and employment opportunities in its depressed areas...
- "These efforts are to help the Tribe become sufficient in providing their own energy for the various buildings, cultural centers, schools and residences on Tribe land."

*From "Statement of Objectives" submitted by Sally Kniffen to the US Department of Energy, July 2004

"An Inconvenient Truth"
Al Gore illuminates the PROBLEM

- The Greenhouse Effect: Greenhouse gases
  - Highest CO2 levels 650,000 years and past
  - Highest temperatures in 1000 year ice core
  - USA emissions up 20%

No doubt, we're in deep, deep, do-do...

Hermann Scheer illuminates the SOLUTION:
"Our farmers will be the oil sheiks of tomorrow."

"The farmers will become combined food, energy and raw material producers, and they will be ecologically integrated. Ruralisation will lead to new forms of settlements and revitalization of the primary economy with increased local employment and less commuting."

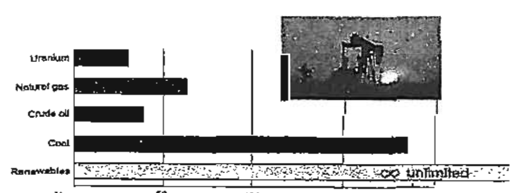
Dr. Hermann Scheer is a Member of Parliament for the German Government, the Deutsche Bundestag. In addition, he is President of EUROSOLAR, the European Association for Renewable Energies, and General Chairman of the World Council for Renewable Energy. He has been awarded several prizes in recognition of his work and achievements, receiving the Alternative Nobel Prize in 1999, the World Solar Prize in 1998 and the World Prize for Bioenergy in 2000.

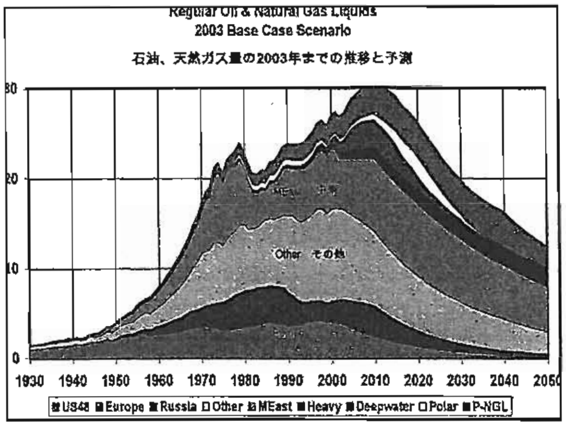
Publications:
A Solar Manifesto
The Solar Economy, &
Energy Autonomy.

The Problem
The Seven Crises Related to Nuclear & Fossil Energy Use

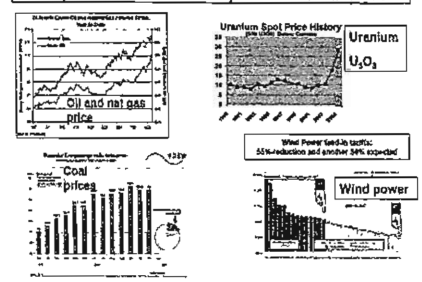
- The global climate crisis
- The exhaustion & dependence crisis
- The poverty crisis
- The nuclear crisis
- The water crisis
- The farming crisis
- The health crisis

GLOBAL ENERGY RESOURCES





The turning point: all energies more expensive – except renewables!

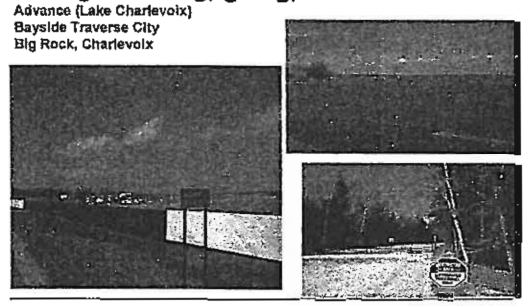


Nuclear Power: NO SOLUTION

- Too expensive, especially with decommissioning costs
- Too dangerous: nuclear proliferation
- Too dirty: no storage solution
- Too long to build

Nuclear Power and Coal in NW Lower Michigan: Going, going, GONE

Advance (Lake Charlevoix)
Bayside Traverse City
Big Rock, Charlevoix



Towards A 100% Renewable Energy Economy

- Local Production of energy
- Creation of jobs in the local economy
- Improved Living Conditons
- Industrial development, new Technologies
- Soil Conservation
- Saving Foreign Currencies
- Replacement of Fossil & Nuclear Fuels
- Climatic and Environmental Benefits

Energy Autonomy: The New Standards

- From 100 major fossil energy depots worldwide to millions of energy suppliers at farms with biomass;
  facades and building roofs with solar energy;
  seas and plains with wind energy.
- From gigawatt- to kilowatt-size energy supply technologies.
- From centralized power generation to on-site and distributed generation and bi-directional flow of energy NOT unidirectional (The war over centralized versus decentralized energy!)
- From large national structures and power monopolies to local and individual supply.
- From big scale supply technologies (oil refineries, natural gas networks, power stations) to mass-produced, small size renewable energy devices.

The Conceptual New Energy Approach for the Tribe: Integrated Renewables

- Electricity: "the fuel of the future," --so make your own electricity!
- District heating: piping hot water (and some chilled water) to all Tribal consumers; residential, public and commercial (in addition to the SECR)
- Utilization of biomass and biogas for heat and electric supply (as at CMU)
- Distributed solar thermal (hot water) and solar electric systems
- Energy storage for heat and electricity from wind, biomass and sun
- Electric transport: "New Vision" electric tram, electrical rental vehicles, Tribal service vehicles, local Tribal traffic
- Energy management and controls for these systems
- Energy efficiency, including combined heat and power, insulation, weatherization, new energy codes..
- Expand water and sewer utility services to include energy and require all new facilities, such as a hotel at Saganing, to include renewable energy systems as part of the mortgage: "own your energy, don't rent"
- Conduct a community technical, administrative, operational and educational exchange with those already doing integrated renewable systems, ie. Danish neighbors.

Electricity: "The fuel of the future"

- Electricity infrastructure is in place and can be upgraded easily
- Organized and efficient distribution
- Electricity provides flexibility with low-cost controls and storage, including options for electric storage using hot water from wind power and other batteries
- Electric vehicles will replace gasoline and other fossil fuel powered engines, including the "New Vision" electric tram, electric service vehicles, rentals for visitors and other local transportation

District Heat: "The heat distribution system of the future"

- District Heat from Biomass (sustainable wood waste, wood chips, agricultural waste, etc. replaces natural gas)
- Distribution of hot water is metered just like electricity and water
- Will replace >1000 fossil fuel chimneys with two chimneys--with much lower environmental impacts
- Significantly eliminate homeowner and Tribal furnace and boiler service costs

Tribe Profile

- Tribe member population ~ 3,300
- Isabella ~ 138,240 ac total area (1788 ac in trust)
- Saganing ~ 500 acres (184 ac in trust)
- Residential: ~ 500 homes and apartments (trust and non-trust lands) ~ 600,000 sq.ft.
- Public Facilities: ~ 24 ~ 320,000 sq. ft.
- Commercial: 5 + ~ 550,000 sq. ft.

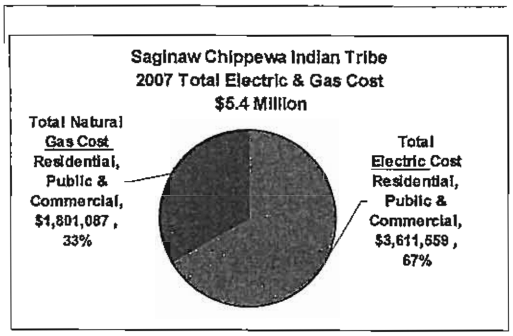
Energy Profile

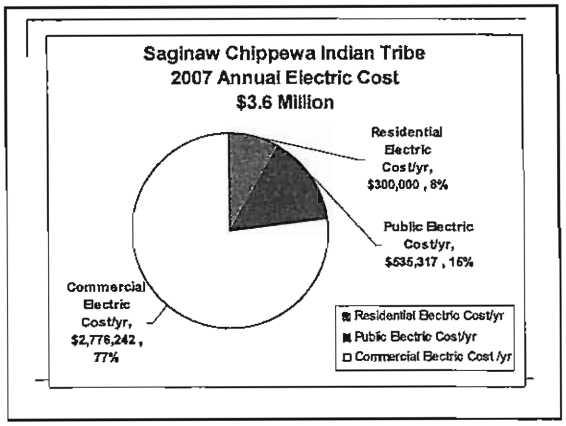
Summary:

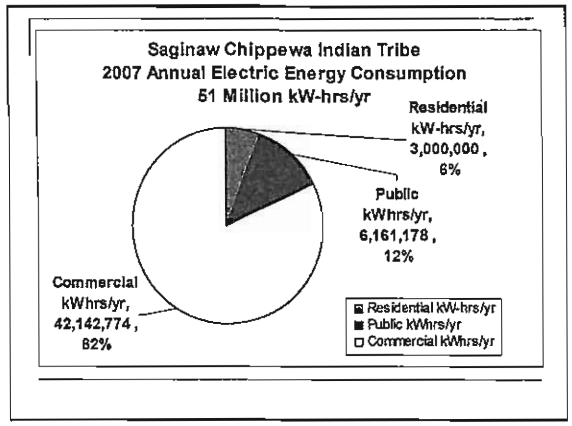
Total Residential, Public & Commercial Cost:
$5,412,646 /yr

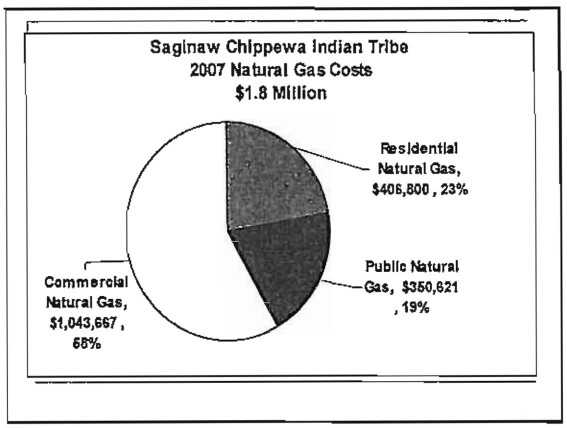
Electric: $3.6 million/yr - 51 million kilowatt- hrs
Peak Electric Demand: 8,000 kW

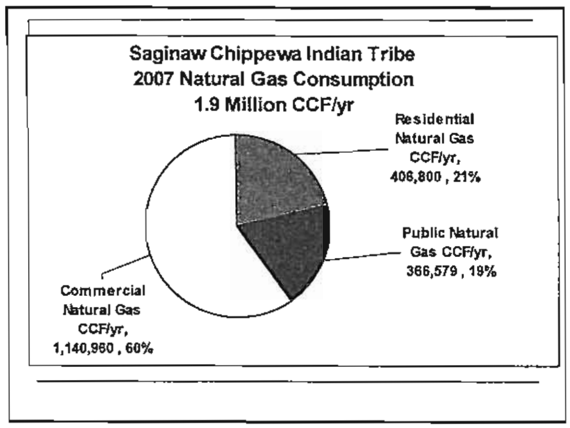
Natural Gas: $1.8 million/yr - 1.9 million ccf's per year











Energy Profile 2007

Electric

Residential Electric Use:	3,000,000 kWhr/yr
Public Electric Use:	6,161,178 kWhr/yr
Commercial Electric Use:	42,142,774 kWhr/yr
Total R, P & Commercial	51,303,952 kWhr/yr

Residential Electric Cost:	$ 300,000 /yr (10 cents/ kWh)
Public Electric Cost:	$ 535,317 /yr (8.7 cents/ kWh)
Commercial Electric Cost:	$2,776,242 /yr (6.6 cents/ kWh)
Total R,P & C Electric Cost:	$3,611,559 /yr (7 cents/kWh avg)

Energy Profile

Natural Gas

Residential Natural Gas	406,800 ccf/yr
Public Natural Gas	366,579 ccf/yr
Commercial Natural Gas	1,140,960 ccf/yr
Total Natural Gas	1,914,339 ccf/yr

Residential Natural Gas Cost	$ 406,800 /yr ($1.00/ccf)
Public Natural Gas Cost	$ 350,621 /yr ($.96 / ccf)
Commercial Natural Gas Cost	$1,043,667 /yr ($.91 / ccf)
Total Natural Gas Cost	$1,801,087 /yr ($.94 / ccf)

Goals to Consider...

- 100% Integrated Renewable Energy – "Energy Sovereignty"
- Key emphasis on wind power (Electric & Heat?)
- Biomass district heat for main commercial and public facilities – Stage 1, Residential – Stage 2
- Biomass plants for new developments at Saganing and SECR
- Additional stand-by power at SECR (CHP?)
- Solar thermal for spring, summer and fall hot water.
- Solar electric
- Electric vehicles
- Tribal Energy Utility
- New revenue producing energy sales from wind power and biomass heat and electricity

Technologies Analyzed

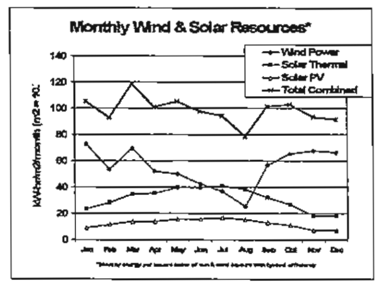
- Wind Power: small and large commercial (including wind farms)
- Biomass: small scale and large scale district heat
- Solar Thermal: small and large scale
- Solar Electric (photovoltaic): small and large
- Natural gas combined heat & power with SECR stand-by capacity

The Renewable Resources

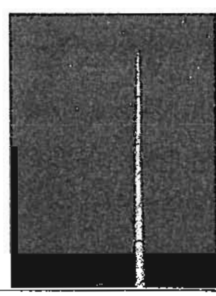
- Wind resources at Isabella and Saganing sites
- Solar resources
- Biomass and biogas resources

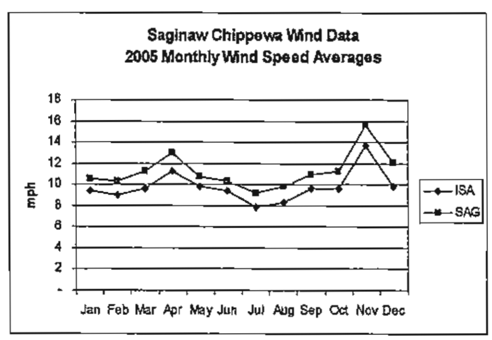
Wind and Solar Comparison

Wind & Solar power combined together works in Michigan with <u>more wind in the winter</u> and <u>more sun in the summer</u>



Isabella & Saganing Wind Met Towers (30, 40 & 50 meter measurements)



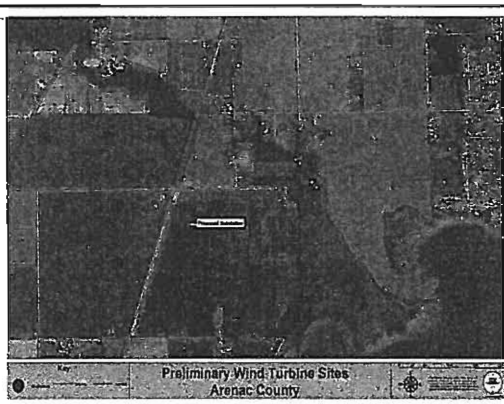


Detailed Wind Data Analysis: Saganing 2005 Summary results

- Measured mean wind speed @ 50 meters: 5.1 m/s or 11.42 mph (west sensor boom)
- Estimated conservative wind shear exponent = 0.2 (actual measurements from 8 sensor comparisons ranged from 0.17 to .35 with average of .26)
- Annual mean wind speed at 80 meters (262 ft.) (Above Ground Level) AGL: 6.2 m/s or 13.9 mph
- Annual mean wind speed at 100 meters (328 ft.) AGL: 14.6 mph
- Wind power density for standard Class III wind turbine:
  - 80 m AGL – 613 kWhr/m2/yr
  - 100 m AGL – 692 kWhr/m2/yr
- NCAR (National Center..) Data indicates 2005 was one of lowest wind years in region since 1998
- Therefore: Wind energy output projections, and resulting economics from this measured data should be conservative

Detailed Wind Data Analysis: Isabella 2004-08 Summary results

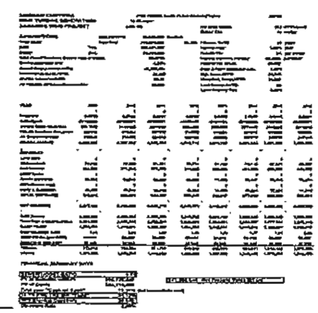
- Measured mean wind speed @ 50 meters: 4.5 m/s or 10.03 mph (west sensor boom #1)
- Estimated conservative wind shear exponent = 0.2
- Annual mean wind speed at 80 meters (262 ft.) AGL: 5.4 m/s or 12.0 mph
- Annual mean wind speed at 100 meters (328 ft.) AGL: 5.8 m/s or 13 mph
- Wind power density for standard Class III wind turbine:
  - 80 m AGL – 490 kWhr/m2/yr
  - 100 m AGL – 550 est. kWhr/m2/yr
- NCAR (National Center..) Data indicates 2005 was one of lowest wind years in region since 1998
- Therefore: Wind energy output projections, and resulting economics from this measured data should be conservative

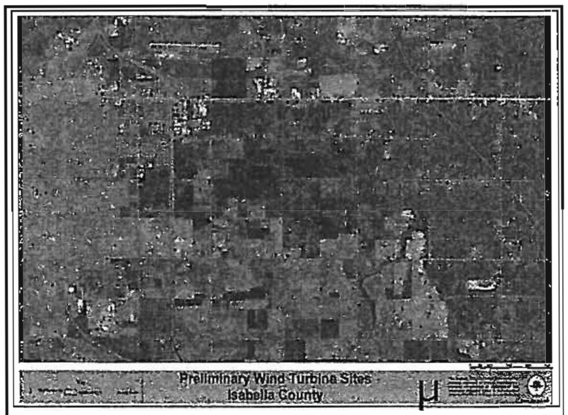


Saganing Wind Project Economics:

13 Wind Turbines

- Total Cost: $35 Million
- Gross Income per year $4 million
- Cost of Electricity 4.5 cents per kWh
- Net Present Value: $41 million

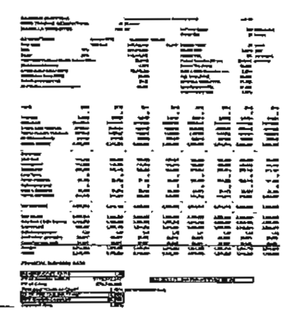




Isabella Wind Project:

19 Wind Turbines

- Total Project Cost: $49 Million
- Gross Income per year: $5.1 million
- Cost per kWh: 5.7 cents / kWh
- Net Present Value: $39.3 million



Wind Power Economic Sensitivity Analysis

Net Present Value (NPV) From Generating approximately 100% of Annual Electric Consumption of 51 million kWhr/yr. Assumes 7 cent per kW-hr cost avoidance, with avoided electric costs projected to increase either 2%, 4% or 6% over a 25 year period. (see attached preliminary pro forma spreadsheets)

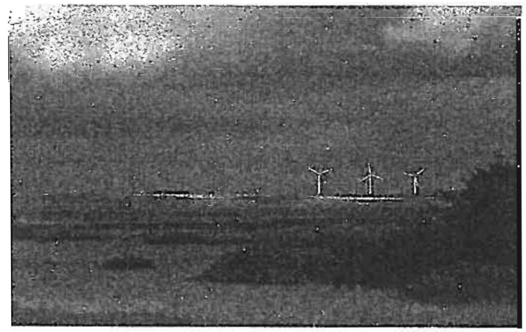
Saganing: 13 Wind Turbines - Project Cost - $34,996,000

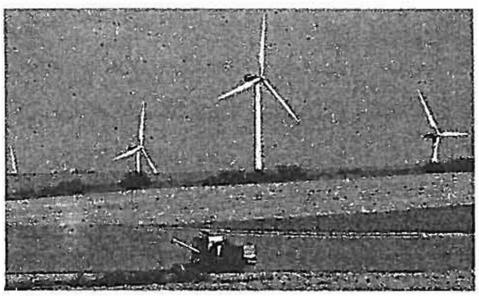
Avoided Cost Inflation	NPV(25 yr)
2%	$23,847,290
4%	$41,008,646
6%	$64,160,560

Isabella: 19 Wind Turbines - Project Cost - $49,780,000

	NPV (25 yr)
2%	$17,875,602
4%	$39,323,111
6%	$68,302,951

Is There Enough Wind Energy? S. Thy, Denmark: 130% Wind Power, 85% Biomass Population 10,000 +





Windmills in farmland with barley fields

Off-Shore Wind Power?

Offshore windfarm at Middelgrunden between Sweden and Denmark

スウェーデンとデンマークの間においての洋上発電

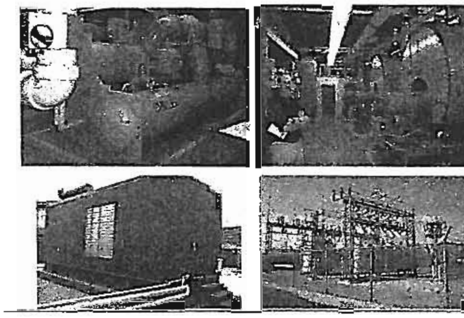
Biomass District Heat

- Main fuel source: wood chips, delivered in semi-tractor trailers (30 to 40 tons per load)
- Isabella County has 35,000 cubic yards per year
- Established market for delivery @$20 - $26 per ton
- CMU has operation of district heat and electric steam turbine plant since mid 1980's.

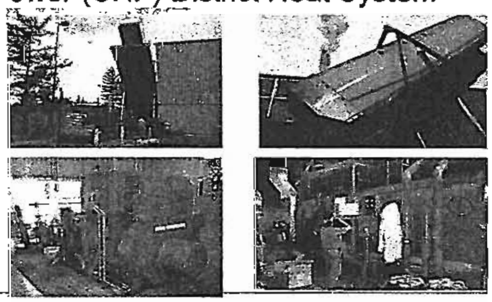
Larger Scale District Heating Plants for 1,000 homes... Install 2 Chimneys to Displace >1,000 Chimney's

Interface With Existing Heating Capacity (Provides Auxiliary & Peaking Energy)

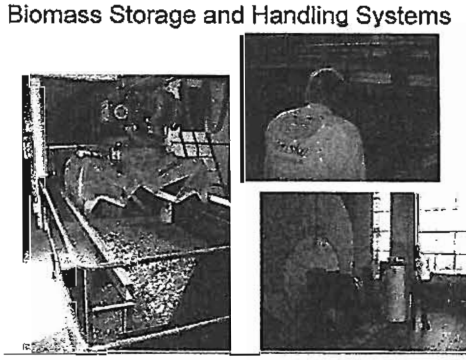
Existing SECR Energy Systems



CMU Biomass Combined Heat & Power (CHP) District Heat System



Biomass Storage and Handling Systems



Distribution System

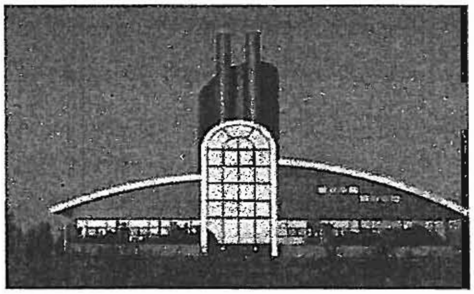
- Buried Supply and Return Pipelines
- Pre-Insulated Twin-Pipe
- Use Sidewalks and Some Roads
- Individually Metered

Photo courtesy of Force Technology

Residential Connection

Photo courtesy of Force Technology

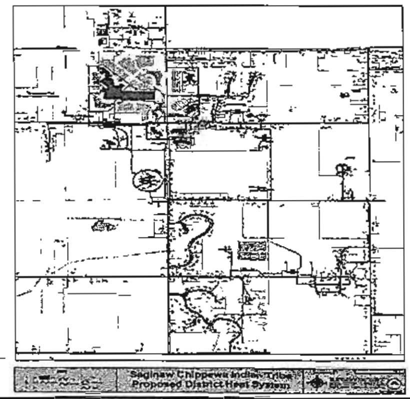
Power Plants Can Look Good!!



Biomass District Heat Preliminary Concept Plan

Stage I: Central Commercial and Public District

Stage II: Residential and remote facilities



Biomass District Heat: Present Cost $13 /mmbtu

Stage 1: $11,770,000
Heat: $6.65/mmbtu

Stage 2: $20,320,000
Heat: $8.99 /mmbtu

Stand-by Combined Heat & Power (CHP) w/ Natural Gas Fuel

- Quick way to start the district heat system while adding SECR stand-by electric power to cover hotel
- Use the existing natural gas capacity efficiently (80% + efficient) for both heat and electricity.
- Can be directly interfaced with the existing heating and cooling systems.

CHP Natural Gas Stand-by Con't

- Installed cost: $2.4 million (w/o heat or chilled water storage)
- Peak electric capacity 3,500 to 4,000 kW (depending on system choice) from two or three gas reciprocating engines)
- May require additional heat and possible chilled water storage (approx: $500,000) with total of $2.9 million
- Using same amount of present natural gas consumption, generate 25% of SECR electricity, 2/3rds of heat, and save $500,000 per year while having 100% SECR stand-by electric capacity.
- Provide infrastructure basis for biomass CHP installation and district heat system.

Solar Thermal

- Small systems for each home and building
- Large commercial systems for casino resort
- A large solar thermal system can provide most of the "domestic hot water and process water (cleaning, etc.) for the casino and hotel to displace natural gas)

Solar Thermal: Commercial SECR

- Estimated Cost: $4.8 million
- Annual Natural Gas Savings: $400,000
- Large array on parking deck or adjacent field of up to 200,000 sq. ft.
- Provide nearly 100% of domestic hot water for SECR during spring, summer and fall.

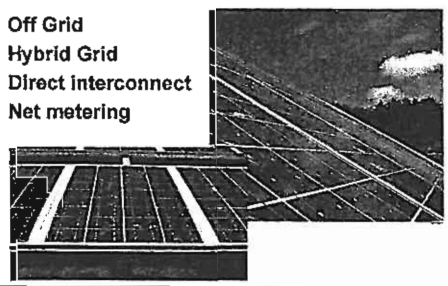
Solar Thermal: Just face south without shade!


Solar Electric

- Small and large systems
- Home, commercial and public applications based on the solar resource
- Most expensive, but most reliable electric power source. More analysis to follow.

Solar electric (photovoltaics): Peak power when we need it.

- Off Grid
- Hybrid Grid
- Direct interconnect
- Net metering



Combined Capital and Energy Values

Saginaw Chippewa Summary Costs Apr-06

Integrated Renewable Energy & Stand-by CHP

	Capital Cost	Energy $ Value / Year	Fuel & O&M Expenses Per Year	Electric kWh/yr	Heat MMBTU/Yr
Wind - Saganing	$ 34,996,000	$ 4,096,255	$ 523,218	43,109,001	-
Wind - Isabella	$ 49,760,000	$ 5,126,260	$ [illegible]	63,960,633	-
Biomass CHP Stage 1	$ 11,770,000	$ 2,862,120	$ 924,263	21,900,000	157,000
Biomass CHP Stage 2	$ 20,320,000	$ 2,862,120	$ 940,314	21,900,000	157,000
Solar Thermal Commercial	$ 4,800,000	$ 420,000	$ 24,000	-	43,200
CHP Natural Gas Stand-by SECR	$ 2,900,000	$ 1,848,178	$ 1,398,900	10,056,430	68,634
Solar PV	$ -	$ -	$ -	-	
Total	$ 124,566,000	$ 17,394,034	$ 4,707,653	150,925,064	425,836

Next Steps

- Continuing tasks under the grant
- Guidance from the Council

Energy Cost Comparison 2008

Ranked By Lowest to Highest	Unit	Unit Cost	Energy Only Cost / kWh	All Costs / kW-hr	W / Enviro Costs/kWh
Efficiency /Passive Solar	**kW-hr**	**$ -**	**$ -**	**$ 0.03**	**$ 0.03**
Wood Chips	**US Ton**	**$ 26.00**	**$ 0.007**	**$ 0.03**	**$ 0.04**
Large Wind	**kW-hr**	**$ -**	**$ -**	**$ 0.06**	**$ 0.06**
Cord Wood	**Face Cord**	**$ 70.00**	**$ 0.065**	**$ 0.06**	**$ 0.07**
Dryed Cherry Pits or Pellets	**Ton**	**$ 200.00**	**$ 0.067**	**$ 0.08**	**$ 0.08**
Natural Gas CHP (electric)	CCF	$ 1.20	$ 0.055	$ 0.07	$ 0.09
Natural Gas CHP (heat)	CCF	$ 1.20	$ 0.055	$ 0.07	$ 0.09
Natural Gas Large	CCF	$ 1.20	$ 0.055	$ 0.08	$ 0.10
Natural Gas Res /Comm	CCF	$ 1.25	$ 0.057	$ 0.09	$ 0.11
Lg Commercial Grid Electricity	kW-hr	$ 0.070	$ 0.070	$ 0.09	$ 0.13
Solar Hot Water	**kW-hr**	**$ -**	**$ -**	**$ 0.15**	**$ 0.15**
Sm Commercial Electricity	kW-hr	$ 0.100	$ 0.100	$ 0.11	$ 0.15
Residential Electricity	kW-hr	$ 0.100	$ 0.100	$ 0.11	$ 0.15
LP Gas	Gallons	$ 2.50	$ 0.121	$ 0.14	$ 0.18
New Coal Fired Electricity	kW-hr	$ 0.170	$ 0.170	$ 0.17	$ 0.19
Gasoline	Gallons	$ 3.90	$ 0.160	$ 0.18	$ 0.22
Heating Oil	Gallons	$ 4.85	$ 0.162	$ 0.18	$ 0.23
New Atomic Electricity	kW-hr	$ 0.23	$ 0.230	$ 0.23	$ 0.25
Small Wind	**kW-hr**	**$ -**	**$ -**	**$ 0.28**	**$ 0.28**
Solar PV Electric	**kW-hr**	**$ -**	**$ -**	**$ 0.60**	**$ 0.60**