ALASKA ENERGY AUTHORITY

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Wind Resource Assessment for ST GEORGE, ALASKA Site # 2401

Date last modified: 11/22/2005
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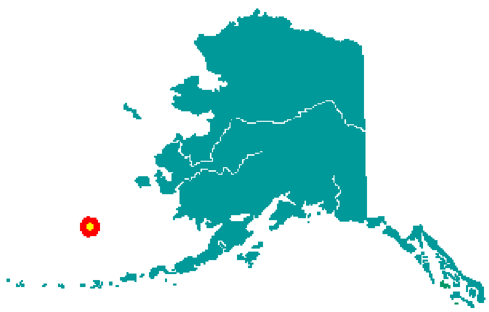


St.George Met Tower (right) and unidentified tower (left)

Latitude: (NAD27)	56˚ 35' 11.6" N 56˚ 35.193
Longitude: (NAD27)	169˚ 36' 52.7" W -169˚ 36.878

Elevation:	130 ft
Tower Type:	30-meter NRG Tall Tower
Monitor Start: Monitor End:	9/14/2004 In operation

INTRODUCTION

In September 2004 the Alaska Energy Authority, Aleutian/Pribilof Islands Association, TDX Power, and members of the community installed a 30-meter tall meteorological tower on Saint George Island. The purpose of this monitoring effort is to evaluate the feasibility of utilizing utility-scale wind energy in the community. This report summarizes the wind resource data collected to date and the long-term energy production potential of the site.

SITE DESCRIPTION

The community of Saint George is located on the northeast shore of Saint George Island. Saint George Island is located about 750 miles west of Anchorage and 250 miles northwest of Unalaska. Figure 1 shows the location of the met tower.

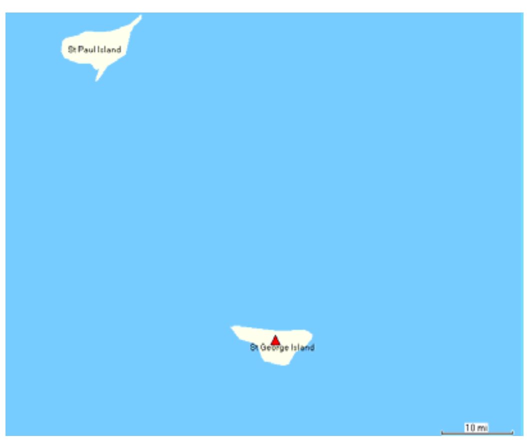


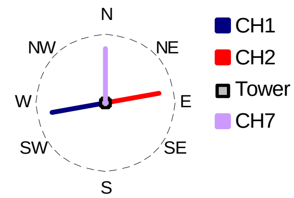
Figure 1. Map of Met Tower Site and Surrounding Area

Table 1 lists the types of sensors that were mounted on the met tower, the channel of the data logger that each sensor was wired into, and where each sensor was mounted on the tower.

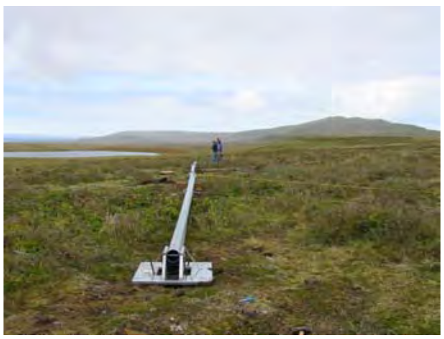
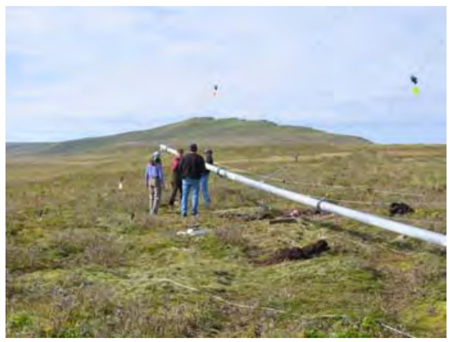
Table 1. Summary of Sensors Installed on the Met Tower

Ch #	Sensor Type	Height	Offset	Boom Orientation
1	#40 Anemometer	30 m	NRG Standard	260˚ True
2	#40 Anemometer	20 m	NRG Standard	80˚ True
7	#200P Wind Vane	30 m	True North	True North
9	#110S Temperature	5 m	0	-

Arial view of equipment on tower



The photos below illustrate the surrounding ground cover and any major obstructions, which could have an affect on how the wind flows over the terrain from a particular direction.



DATA PROCESSING PROCEDURES AND DEFINITIONS

The following information summarizes the data processing procedures that were performed on the raw measured data in order to create an annual dataset of "typical" wind speeds, which could then be used to calculate potential power production from wind turbines. There are various methods and reasons for adjusting the raw data, so the purpose of these notes is to document what was done in this situation. The raw data set is available on the Alaska Energy Authority website (www.akenergyauthority.org) so one could perform their own data processing procedures.

Units – Since most wind turbine manufacturer data is provided in metric units, those units are used here.

1 meter/second = 2.24 mph = 1.95 knots
1 meter = 3.28 feet
1 ˚C = 5/9 (˚F – 32)

Max/Min Test – All of the 10-minute data values were evaluated to ensure that none of them fell outside of the normal range for which the equipment is rated.

Tower Shadow – The tower itself can affect readings from the anemometer at times when the anemometer is located downwind of the tower. In this case, the 30-meter anemometer may record slightly lower values than the free stream velocity when the wind is coming from the east.

Icing – Anomalies in the data can suggest when the sensors were not recording accurately due to icing events. Since wind vanes tend to freeze before the anemometers, icing events are typically identified whenever the 10-minute standard deviation of the wind vane is zero (the wind vane is not moving) and the temperature is at or below freezing. Some additional time before and after the icing event are filtered out to account for the slow build up and shedding of ice.

Filling Gaps – Whenever measured met tower data is available, it is used. Two different methods are used to fill in the remaining portion of the year. First, nearby airport data is used if available. A linear correlation equation is defined between the airport and met tower site, which is used to adjust the hourly airport data recorded at the time of the gap. If neither met tower nor airport data is available for a given timestep, the software program Windographer (www.mistaya.ca) is used. Windographer uses statistical methods based on patterns in the data surrounding the gap, and is good for filling short gaps in data.

Long-term Estimates – The year of data collected at the met tower site can be adjusted to account for inter-annual fluctuations in the wind resource. To do this, a nearby weather station with a consistent historical record of wind data and with a strong correlation to the met tower location is needed. If a suitable station is not available, there is a higher level of uncertainty in the wind speed that is measured being representative of a typical year.

Turbulence Intensity – Turbulence intensity is the most basic measure of the turbulence of the wind. Turbulence intensity is calculated at each 10-minute timestep by dividing the standard deviation of the wind speed during that timestep by the average wind speed over that timestep. It is calculated only when the mean wind speed is at least 4 m/s. Typically, a turbulence intensity of 0.10 or less is desired for minimal wear on wind turbine components.

Wind Shear – Typically, wind speeds increase with height above ground level. This vertical variation in wind speed is called wind shear and is influenced by surface roughness, surrounding terrain, and atmospheric stability. The met tower is equipped with anemometers at different heights so that the wind shear exponent, α, can be calculated according to the power law formula:

$$\left(\frac{H_1}{H_2}\right)^{\alpha} = \left(\frac{v_1}{v_2}\right)$$

where H_1 and H_2 are the measurement heights and v_1 and v_2 are the measured wind speeds.

Wind shear is calculated only with wind speed data above 4 m/s. Values can range from 0.05 to 0.25, with a typical value of 0.14.

Scaling to Hub Height – If the wind turbine hub height is different from the height at which the wind resource is measured, the wind resource can be adjusted using the power law formula described above and using the wind shear data calculated at the site.

Air Density Adjustment – The power that can be extracted from the wind is directly related to the density of the air. Air density, ρ, is a function of temperature and pressure and is calculated for each 10-minute timestep according to the following equation (units for air density are kg/m^3):

$\rho = \frac{P}{R \times T}$, where P is pressure (kPa), R is the gas constant for air (287.1 J/kgK), and T is temperature in Kelvin.

Since air pressure is not measured at the met tower site, the site elevation is used to calculate an annual average air pressure value according to the following equation:

P = 1.225 – (1.194 x 10^{-4}) x elevation

Since wind turbine power curves are based on a standard air density of 1.225 kg/m3, the wind speeds measured at the met tower site are adjusted to create standard wind speed values that can be compared to the standard power curves. The adjustment is made according to the following formula:

$$V_{s\tan dard} = V_{measured} \times \left(\frac{\rho_{measured}}{\rho_{s\tan dard}} \right)^{\frac{1}{3}}$$

Wind Power Density – Wind power density provides a more accurate representation of a site's wind energy potential than the annual average wind speed because it includes how wind speeds are distributed around the average as well as the local air density. The units of wind power density are watts per square meter and represent the power produced per square meter of area that the blades sweep as they rotate around the rotor.

Wind Power Class – A seven level classification system based on wind power density is used to simplify the comparison of potential wind sites. Areas of Class 4 and higher are considered suitable for utility-scale wind power development.

Weibull Distribution – The Weibull distribution is commonly used to approximate the wind speed frequency distribution in many areas when measured data is not available. In this case, the Weibull distribution is used to compare with our measured data. The Weibull is defined as follows:

$$P(v) = \frac{k}{c}\left(\frac{v}{c}\right)^{k-1} \exp\left(\frac{-v}{c}\right)^{k}$$

Where P(v) is the probability of wind speed v occurring, c is the scale factor which is related to the average wind speed, and k is the shape factor which describes the distribution of the wind speeds. Typical k values range from 1.5 to 3.0, with lower k values resulting in higher average wind power densities.

WIND DATA RESULTS FOR ST GEORGE MET TOWER SITE
Table 2 summarizes the amount of data that was successfully retrieved from the anemometers at the met tower site. There was minimal data loss due to icing or equipment failure.

Table 2. Data Recovery Rates for St George Met Tower Data

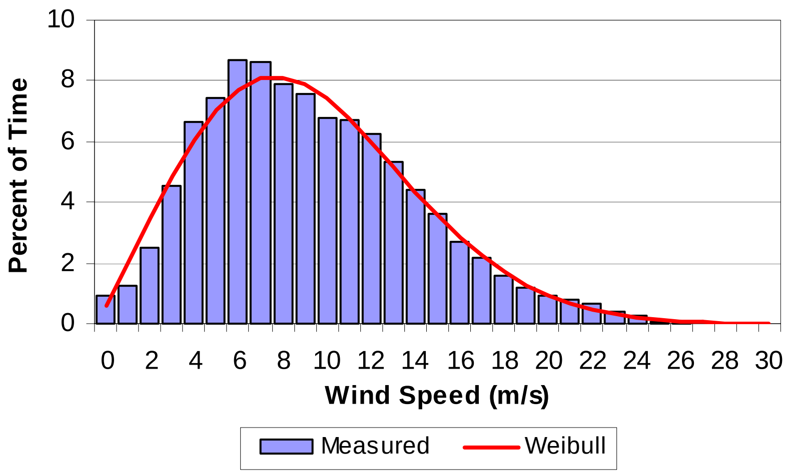
Month	% Data Recovered
January	100.0%
February	99.9%
March	99.7%
April	99.9%
May	100.0%
June	100.0%
July	100.0%
August	100.0%
September	100.0%
October	100.0%
November	100.0%
December	99.9%
Annual Avg	**100%**

Table 3 summarizes the wind resource data measured at the met tower site. As shown, the highest wind month is November and the lowest wind month is July. The annual average wind speed is 9.6 m/s (21.5 mph).

Table 3. Measured Wind Speeds at St. George Met Tower Location, 30-m Height (m/s)

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0	10.4	9.1	9.8	10.8	8.3	7.0	5.9	8.3	10.1	11.4	13.2	11.3	9.6
1	10.2	9.6	9.7	10.5	8.4	6.9	6.0	8.4	10.2	11.5	13.2	11.3	9.7
2	10.1	9.6	9.5	10.5	8.4	6.9	6.1	8.2	10.3	12.1	13.4	11.2	9.7
3	9.8	9.0	9.4	10.4	8.5	6.9	6.0	8.6	10.2	12.3	13.2	10.8	9.6
4	9.8	9.2	9.3	10.4	8.4	6.9	5.7	8.6	10.3	12.0	12.5	11.0	9.5
5	9.7	9.4	9.2	10.3	8.2	7.2	5.5	8.7	10.5	12.0	11.7	11.0	9.4
6	9.5	9.7	9.2	10.3	8.1	6.9	5.7	8.6	10.8	11.8	11.6	11.1	9.4
7	9.6	9.5	9.5	10.3	8.2	6.7	5.8	8.5	10.9	11.6	11.7	11.0	9.4
8	9.5	9.4	9.5	10.1	8.3	6.7	6.1	8.3	10.8	11.4	11.8	10.9	9.4
9	9.6	9.1	9.1	10.2	8.4	6.6	6.2	8.4	10.8	11.2	12.0	10.4	9.3
10	9.5	9.0	9.2	10.3	8.2	6.7	6.3	8.5	10.8	11.1	12.4	10.5	9.4
11	9.4	8.7	9.2	10.2	8.6	6.8	6.6	8.7	11.1	11.4	12.6	10.5	9.5
12	9.6	8.5	9.3	10.1	8.7	6.9	6.8	8.8	11.4	11.2	12.5	10.5	9.5
13	10.0	8.9	9.4	10.1	8.7	7.1	6.9	8.7	11.4	11.6	12.4	10.4	9.6
14	9.8	9.2	9.7	10.4	9.1	7.1	6.9	8.6	11.4	11.8	12.3	10.4	9.7
15	9.8	9.5	9.8	10.4	9.1	7.2	7.1	8.4	11.4	12.0	12.3	10.4	9.8
16	9.6	9.6	10.0	10.4	8.9	7.0	7.0	8.5	11.2	12.1	12.1	10.3	9.7
17	9.4	9.8	9.9	10.2	8.8	6.9	7.0	8.4	11.1	12.1	12.1	10.4	9.7
18	9.4	9.7	9.6	10.2	8.6	6.9	7.0	8.3	11.0	12.0	12.4	10.6	9.6
19	9.3	9.4	9.4	10.2	8.6	6.8	6.9	8.5	11.0	11.8	12.5	11.0	9.6
20	9.7	9.6	9.4	10.1	8.5	6.6	6.6	8.9	10.7	11.6	12.5	10.9	9.6
21	10.1	9.5	9.7	9.9	8.4	6.7	6.4	8.8	10.6	11.7	12.2	11.1	9.6
22	10.1	9.2	9.9	9.8	8.3	6.7	6.4	8.4	10.4	11.7	12.5	11.2	9.6
23	10.4	9.1	10.3	10.0	8.3	6.7	6.0	8.3	10.3	11.7	12.4	11.3	9.6
Avg	9.8	9.3	9.5	10.3	8.5	6.9	6.4	8.5	10.8	11.7	12.4	10.8	9.6

A common method of displaying a year of wind data is a wind frequency distribution, which shows the percent of the year that each wind speed occurs. Figure 2 shows the measured wind frequency distribution as well as the best matched Weibull distribution (c = 11, k= 2.13).



Bin m/s	Measured Hours
0	83
1	112
2	221
3	400
4	580
5	651
6	760
7	757
8	691
9	661
10	594
11	586
12	546
13	465
14	387
15	317
16	239
17	189

Bin m/s	Measured Hours
18	140
19	106
20	79
21	68
22	55
23	37
24	22
25	9
26	4
27	1
28	0
29	1
30	1
31	1
32	0
33	0
34	0
Total:	8,760

Figure 2. Wind Speed Frequency Distribution of St George Met Tower Data, Sept 2004 – Oct 2005

The cut-in wind speed of many wind turbines is 4 m/s and the cut-out wind speed is around 25 m/s. The frequency distribution shows that a large percentage of the wind in Saint George occurs within this operational zone.

TEMPERATURE

The air temperature can affect wind power production in two primary ways: 1) colder temperatures lead to higher air densities and therefore more power production, and 2) some wind turbines shut down in very cold situations (usually around –25°C). The monthly average temperatures measured at the met tower are shown in Figure 3. The temperature never dropped below -15°C from mid September 2004 through the end of October 2005.

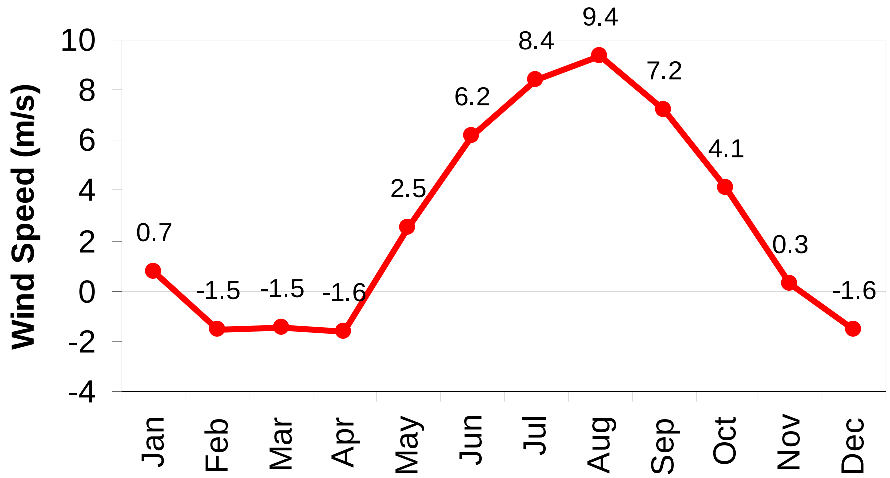
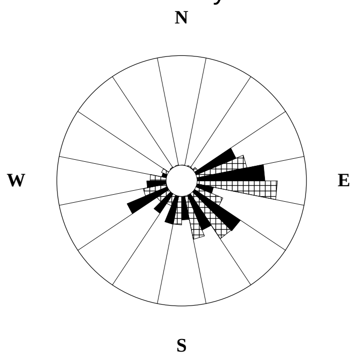
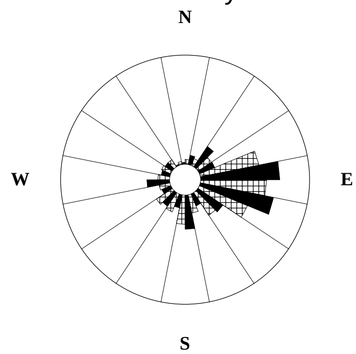


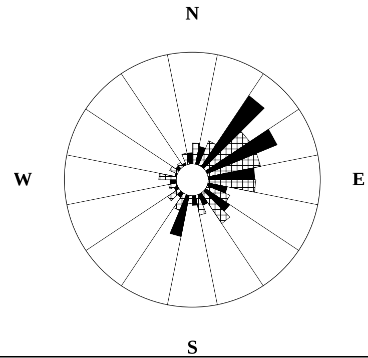
Figure 3. Monthly Average Air Temperatures at St George Met Tower Site

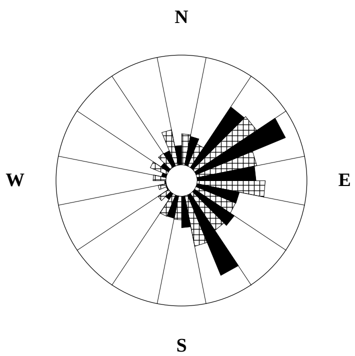
Table 4 shows the monthly wind roses for the year of data measured at the Saint George met tower.

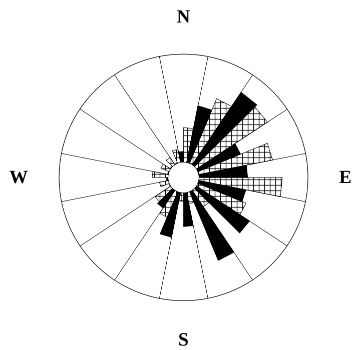
Table 4. Monthly Wind Roses for Saint George Met Tower Site

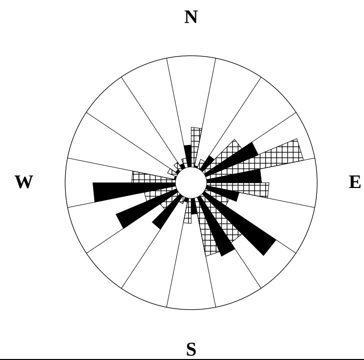
January


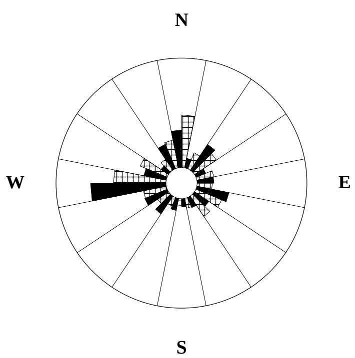
February


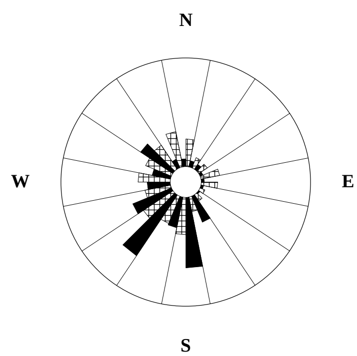
March


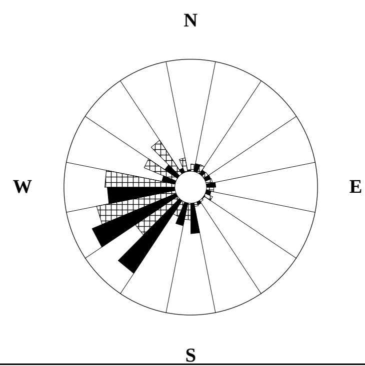
April


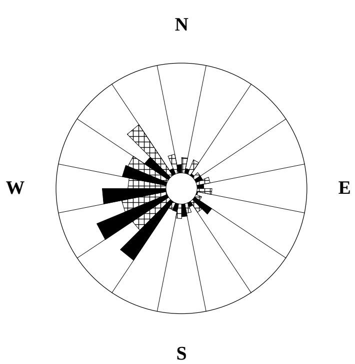
May


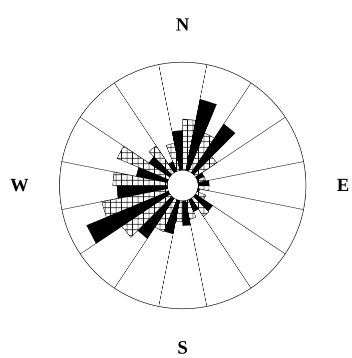
June


July


August


September


October


November


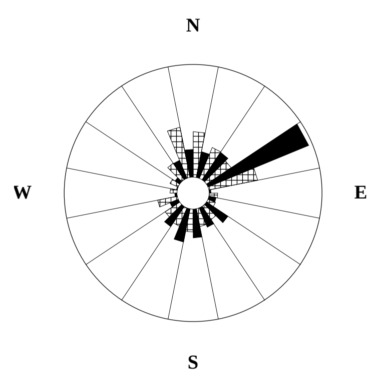
December


Table 5. Annual Wind Rose for Saint George Met Tower Site (Sept 2004 – Oct 2005)

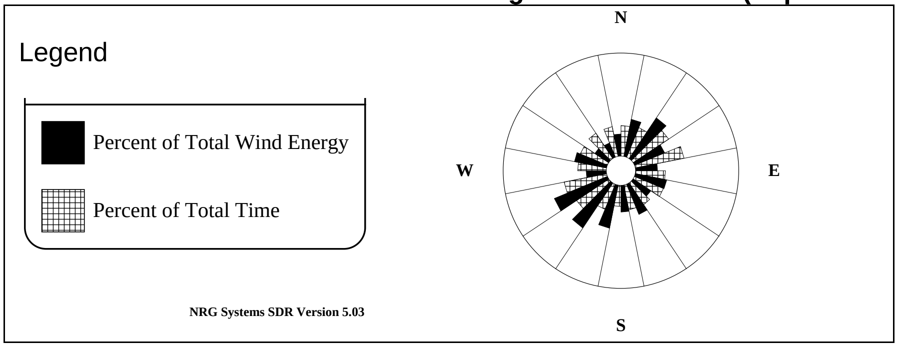


Table 6 summarizes the monthly turbulence intensity and wind shear at the met tower site. A turbulence intensity value of less than 0.10 is considered low and unlikely to contribute to excessive wear of wind turbines. Turbulence intensity is based on recordings of the 30-meter level anemometer. Wind shear is calculated between the 30-meter anemometer and the 20-meter anemometer. Due to the different directions those booms are facing, shear can only be calculated from certain directions when both anemometers are exposed to free stream wind speeds. Both turbulence intensity and wind shear are only calculated for wind speeds greater than 4 m/s. Figure 4 shows the turbulence intensity and wind shear by direction.

Table 6. Monthly Turbulence Intensity and Wind Shear at St George Met Tower Site

Month	Turbulence Intensity	20m to 30m Wind Shear
Jan	0.11	0.20
Feb	0.11	0.06
Mar	0.11	0.07
Apr	0.11	0.06
May	0.11	0.09
Jun	0.11	0.06
Jul	0.10	0.15
Aug	0.10	0.12
Sep	0.10	0.11
Oct	0.11	0.13
Nov	0.10	0.09
Dec	0.11	0.10
Annual Avg	**0.11**	**0.10**

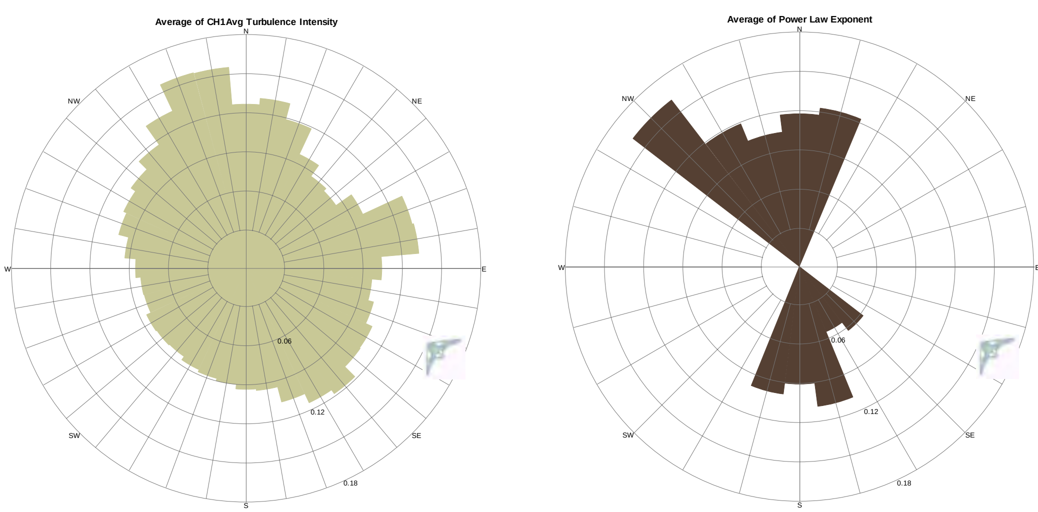


Figure 4. Turbulence Intensity and Wind Shear by Direction at St George Met Tower Site

LONG-TERM REFERENCE STATION

Wind data from the Saint George Airport weather station (shown in Figure 5), located about 15 miles southeast of the met tower site, serves as a long-term reference for the wind resource in the area. The Automated Surface Observing System (ASOS) was installed in September of 1996. The wind data is measured at a height of 10 meters above ground level and at an elevation of 38.1 meters.

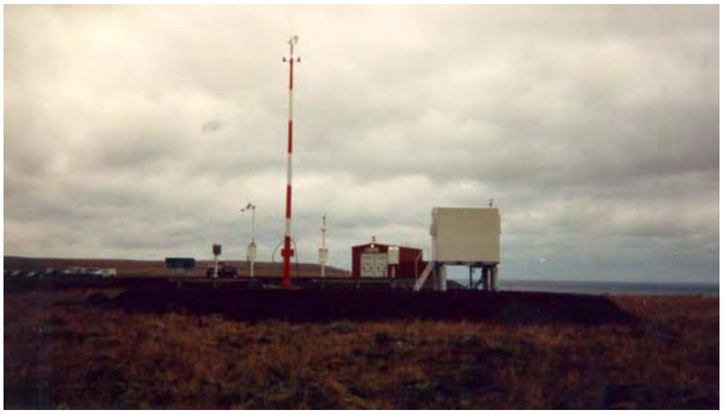


Figure 5. ASOS Equipment in Saint George (source: Ed Doerr, NOAA)

Seven years of wind speed data from the Saint George ASOS are summarized in Table 7 and Figure 6. The average wind speed over the 7-year period is 7.5 m/s. The annual wind speed rarely deviates more than 3% above or below this long-term average.

Table 7. Monthly Wind Speeds at Saint George Airport, 10-m Height (m/s)

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVE	% of long-term average
1998		7.2	7.1	8.6	6.9	6.0	4.6	6.0	7.7	7.1	8.2	9.7	7.2	96%
1999	9.0	10.2	9.5	7.8	6.5	6.6	6.1	5.6	5.8	7.5	9.1	8.2	7.6	102%
2000	9.2	10.1	8.1	7.1	5.2	6.4	5.0	5.0	7.2	7.8	8.9	7.1	7.3	97%
2001	9.4	9.9	7.2	8.1	6.3	5.9	5.5	5.3	6.5	8.0	9.1	10.9	7.7	102%
2002	9.6	7.4	8.7	8.6	7.5	5.9	4.9	6.1	7.7	8.5	7.3	6.1	7.4	98%
2003	9.6	7.9	8.2	7.7	6.9	5.4	5.9	6.0	6.4	8.7	9.6	10.0	7.7	102%
2004	9.4	9.4	6.5	7.8	7.4	5.5	4.5	5.4	6.2	10.0	10.0	9.2	7.6	101%
AVE	9.4	8.9	7.9	7.9	6.7	6.0	5.2	5.6	6.8	8.2	8.9	8.8	7.5	100%

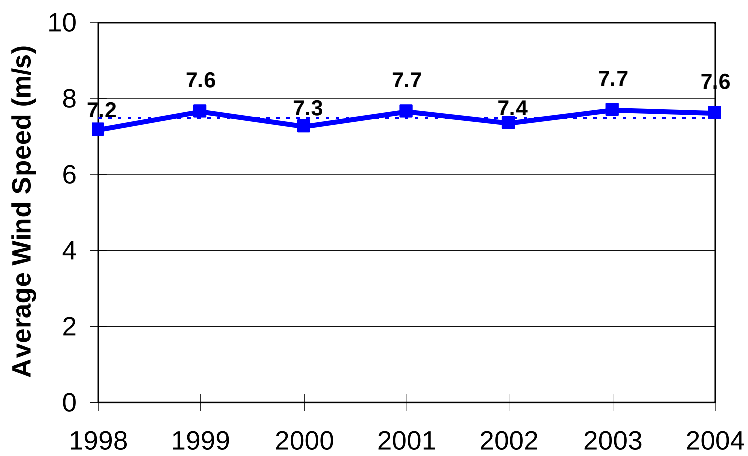


Figure 6. Annual Average Wind Speeds at Saint George Airport Weather Station, 10-m Height

Hourly wind speed measurements from the Saint George Airport weather station that are concurrent with recordings from the met tower site were purchased from the National Climatic Data Center. Data between these two sites was compared and a correlation coefficient of 0.87 was calculated (a value of 1 is perfect). This suggests that, although the actual wind speed values at the two sites are different, the pattern of wind speed fluctuations is similar between the sites. Figure 7 compares the met tower data with the ASOS data. Wind data from the Saint Paul Island ASOS, located about 45 miles to the northwest, is also included for comparison.

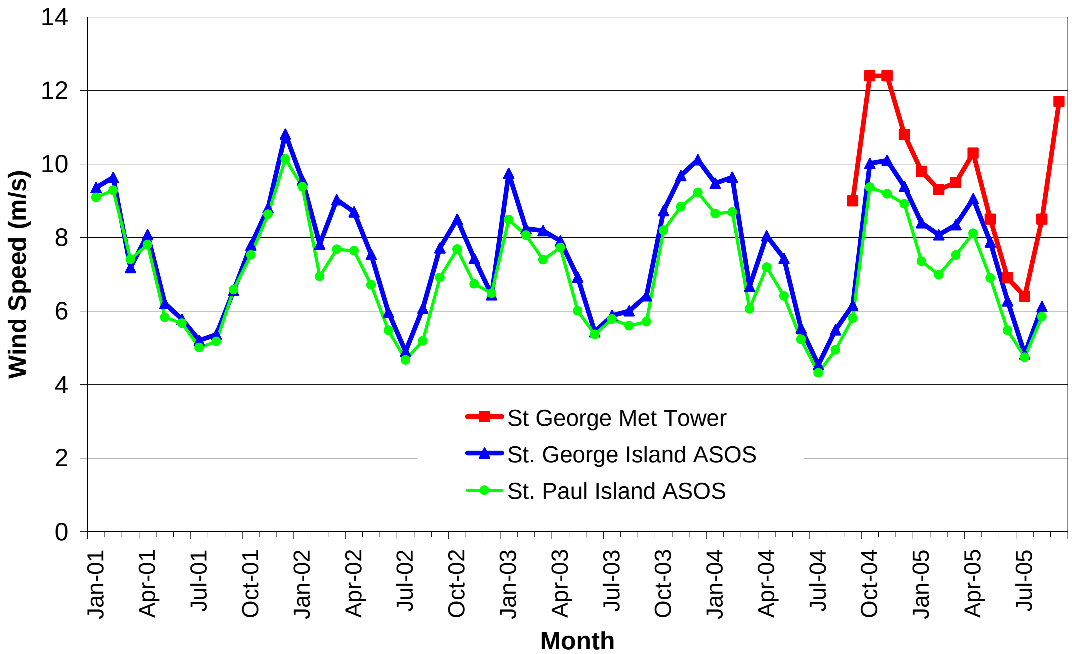


Figure 7. Comparison of Average Monthly Wind Speeds Between Met Tower and ASOS Measurements

A ratio of the short-term ASOS data to the long-term ASOS average was calculated for each month of the year. This ratio was then applied to adjust the met tower data to what could be expected at the site over the long term. Overall, the period of measured data was 3% windier than the estimated long-term average. Figure 8 and Figure 9 compare the measured data set to the long-term estimates. Table 8 presents the calculated long-term data set.

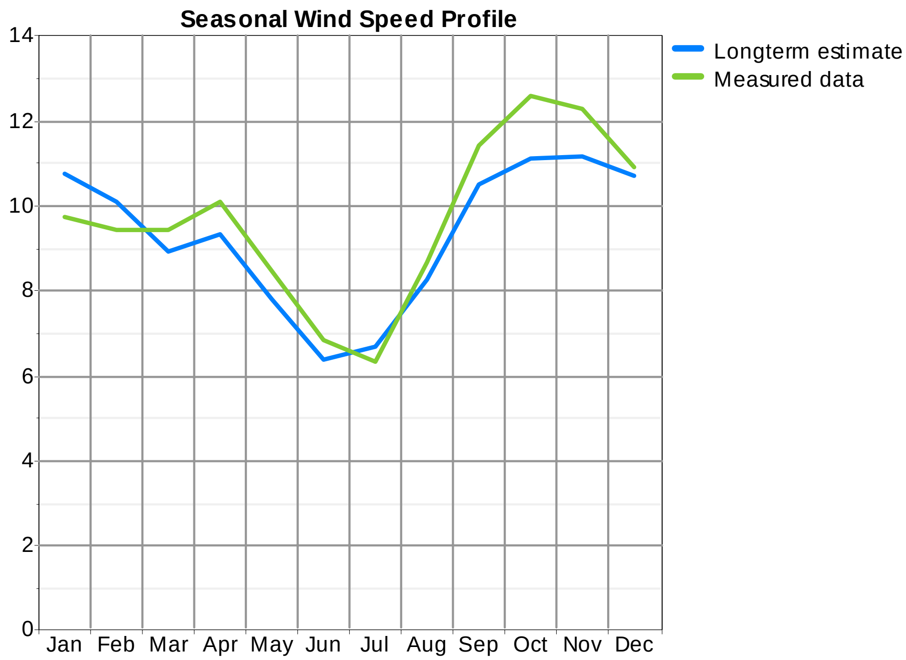


Figure 8. Monthly Average Wind Speeds at St George Met Tower Site, 30m Height

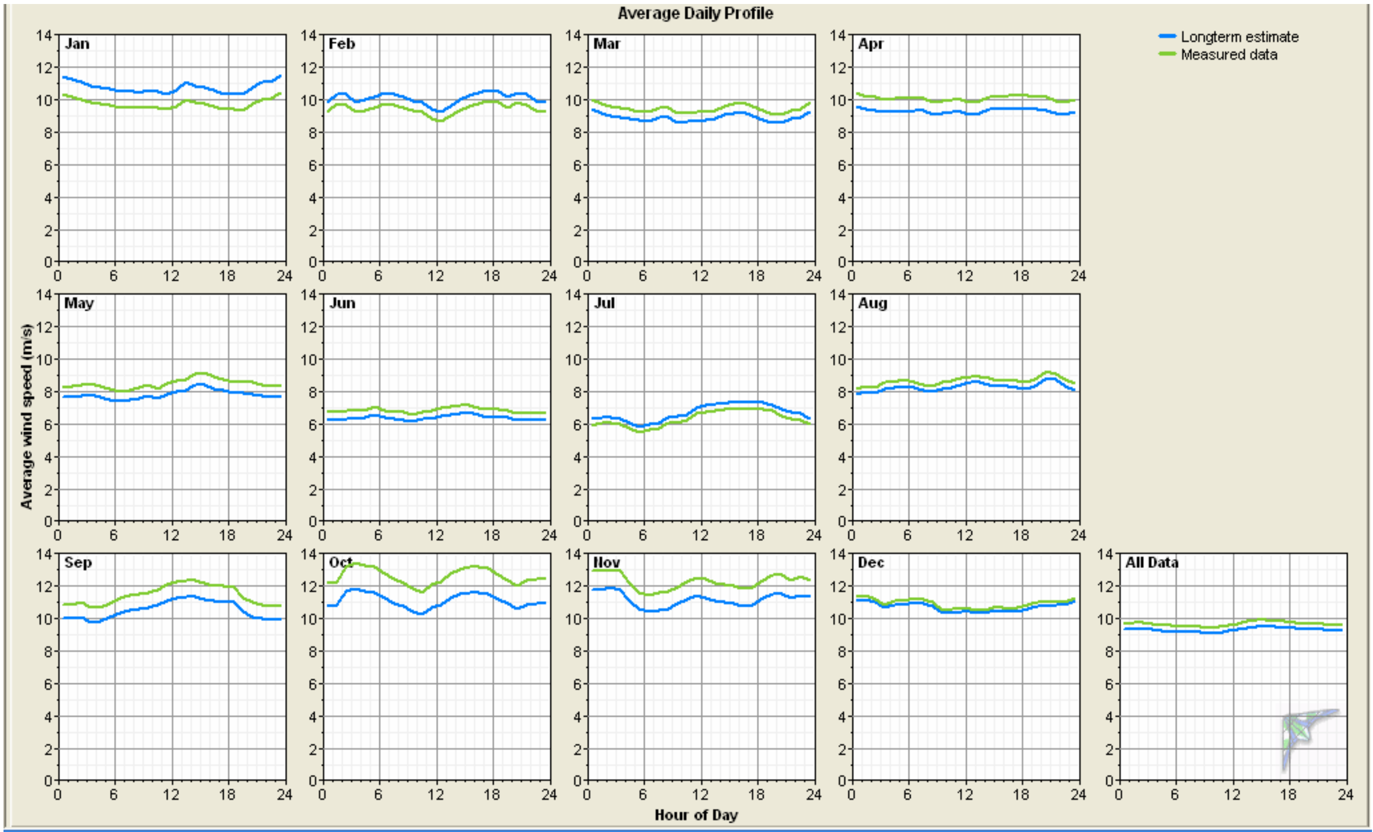


Figure 9. Diurnal Profiles of Wind Speeds at St George Met Tower Site, 30m Height

Table 8. Estimated Long-term Wind Speeds at St. George Met Tower Location, 30-m Height (m/s)

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
0	11.5	9.7	9.2	10.0	7.6	6.5	6.2	8.0	10.0	10.4	12.0	11.2	9.3
1	11.3	10.2	9.1	9.8	7.7	6.5	6.3	8.0	10.0	10.4	12.0	11.1	9.4
2	11.1	10.3	9.0	9.7	7.7	6.4	6.5	7.9	10.1	11.1	12.2	11.0	9.4
3	10.9	9.8	8.8	9.6	7.8	6.4	6.4	8.2	9.8	11.5	12.1	10.6	9.3
4	10.8	9.9	8.8	9.6	7.7	6.4	6.2	8.2	9.9	11.3	11.5	10.7	9.3
5	10.7	10.1	8.7	9.5	7.6	6.6	5.8	8.3	10.2	11.4	10.8	10.8	9.2
6	10.5	10.3	8.6	9.6	7.5	6.5	6.0	8.2	10.4	11.1	10.5	10.8	9.2
7	10.6	10.3	8.9	9.5	7.5	6.3	6.1	8.1	10.6	10.7	10.6	10.8	9.2
8	10.5	10.1	9.0	9.4	7.6	6.2	6.4	7.9	10.9	10.6	10.7	10.7	9.2
9	10.6	9.8	8.7	9.3	7.8	6.1	6.6	8.1	10.9	10.2	10.9	10.3	9.1
10	10.5	9.7	8.6	9.5	7.5	6.3	6.6	8.1	11.2	10.0	11.2	10.3	9.1
11	10.4	9.4	8.7	9.5	7.9	6.3	7.0	8.3	11.3	10.5	11.4	10.2	9.2
12	10.6	9.1	8.7	9.3	8.0	6.4	7.2	8.5	11.5	10.7	11.4	10.4	9.3
13	11.0	9.4	8.8	9.3	8.0	6.6	7.3	8.4	11.6	11.0	11.3	10.1	9.4
14	10.9	9.8	9.1	9.6	8.3	6.6	7.3	8.2	11.6	11.4	11.2	10.2	9.5
15	10.8	10.1	9.3	9.6	8.4	6.7	7.5	8.1	11.5	11.5	11.2	10.2	9.6
16	10.6	10.3	9.3	9.6	8.2	6.6	7.4	8.2	11.4	11.5	11.1	10.1	9.5
17	10.4	10.5	9.3	9.5	8.1	6.4	7.4	8.0	11.3	11.5	11.1	10.2	9.5
18	10.4	10.6	9.0	9.4	8.0	6.4	7.4	7.9	11.2	11.3	11.2	10.4	9.4
19	10.2	10.0	8.9	9.4	7.9	6.4	7.3	8.1	10.8	11.1	11.4	10.6	9.3
20	10.8	10.3	8.8	9.3	7.9	6.2	7.1	8.5	10.5	10.7	11.4	10.7	9.4
21	11.0	10.3	9.0	9.2	7.8	6.2	6.8	8.5	10.3	10.8	11.2	10.8	9.3
22	11.2	9.9	9.2	9.1	7.7	6.2	6.8	8.1	10.2	10.8	11.3	10.9	9.3
23	11.5	9.7	9.5	9.2	7.6	6.2	6.4	8.0	10.1	10.8	11.3	10.9	9.3
Avg	10.8	10.0	9.0	9.5	7.8	6.4	6.8	8.2	10.7	10.9	11.3	10.6	9.3

POTENTIAL POWER PRODUCTION FROM WIND TURBINES IN SAINT GEORGE

Table 9 lists a number of parameters that are typically used to characterize the power production potential of a particular site.

Table 9. Summary of Power Production Potential of Saint George Met Tower Site

Average Wind Power Density (30m height)	921 W/m^2
Wind Power Class	7+
Rating	Superior

Various wind turbines, listed in Table 12, were used to calculate the energy production at the met tower site based on the long-term wind resource data set. Although different wind turbines are offered with different tower heights, to be consistent it is assumed that any wind turbine rated at 100 kW or less would be mounted on a 30-meter tall tower, while anything larger would be mounted on a 50-meter tower. The wind resource was adjusted to these heights based on the measured wind shear at the site. Table 10 summarizes the estimated energy production from various wind turbines at the Saint George met tower site.

Table 10. Gross Annual Energy Production from Various Wind Turbines at St. George Met Tower Site (kWh)

Month	Proven 2.5kW	Proven 6kW	Bergey 10 kW	FL30	Entegrity	FL100	NW100	FL250	V27	V47
Jan	1,319	3,206	3,473	15,923	29,141	55,817	45,440	126,120	112,818	357,880
Feb	1,055	2,584	2,639	12,956	23,016	43,635	35,293	96,754	86,423	281,692
Mar	1,069	2,712	3,073	13,660	23,094	45,184	37,189	96,855	88,991	296,701
Apr	1,109	2,815	3,182	14,160	24,006	46,817	38,513	100,224	92,233	308,637
May	806	2,089	2,207	10,495	16,559	32,397	26,431	73,607	66,697	230,586
Jun	527	1,416	1,478	7,030	9,749	19,772	16,100	43,980	40,205	146,474
Jul	613	1,653	1,761	8,365	11,894	23,835	19,505	59,198	54,393	196,870
Aug	857	2,123	2,324	10,621	17,563	34,711	27,917	78,119	70,400	233,802
Sep	1,286	3,239	3,530	16,187	28,389	54,360	44,766	121,431	110,653	363,452
Oct	1,323	3,230	3,283	16,284	29,347	55,354	44,762	127,676	112,981	364,483
Nov	1,318	3,249	3,408	16,229	29,252	55,325	45,208	122,446	111,023	361,566
Dec	1,190	2,915	2,874	14,142	26,094	48,609	39,691	108,336	99,077	321,405
Annual	12,473	31,230	33,233	156,052	268,103	515,815	420,815	1,154,747	1,045,895	3,463,546
Annual kWh/m^2	1,299	1,312	863	1,173	1,515	1,482	1,482	1,688	1,825	1,996

Table 10 also lists the annual energy production per square meter of swept area (kWh/m^2). This allows one to directly compare the efficiency of one wind turbine against another, as shown in Figure 10.

Figure 10. Comparison of Power Production per Square Meter of Swept Area from Various Wind Turbines

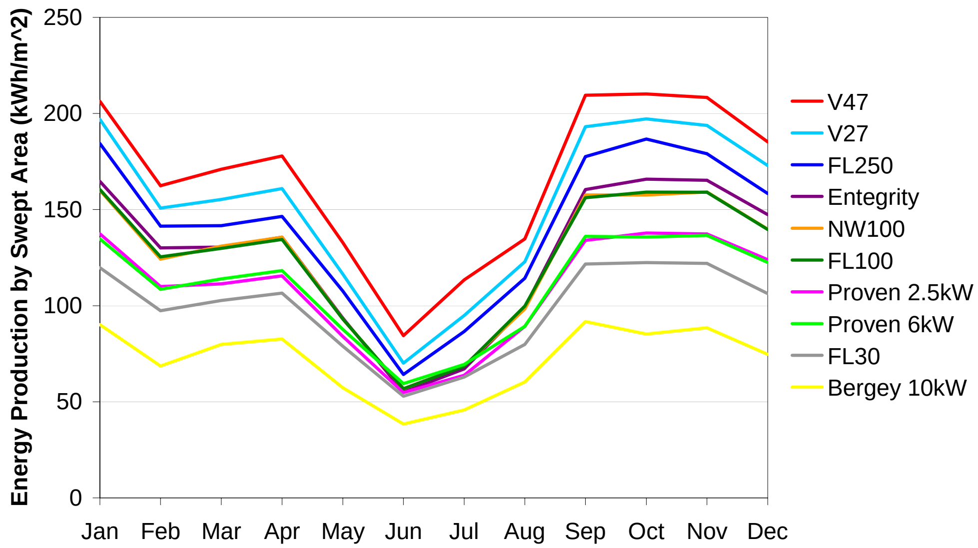


Table 11 summarizes the gross capacity factor of the different wind turbines per month. Gross capacity factor is the amount of energy produced based on the given wind resource divided by the maximum amount of energy that could be produced if the wind turbine were to operate at rated power during that entire period. The gross capacity factor could be further reduced by up to 10% to account for transformer/line losses, turbine downtime, soiling of the blades, icing of the blades, yaw losses, and extreme weather conditions.

Table 11. Gross Capacity Factor of Different Wind Turbines at Met Tower Site

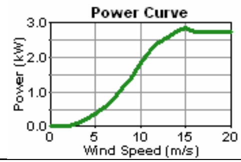
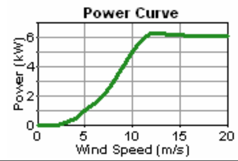
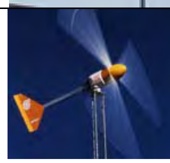
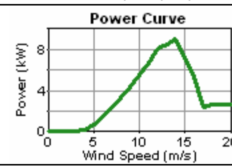
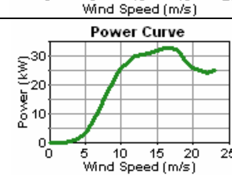
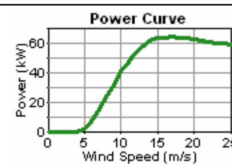
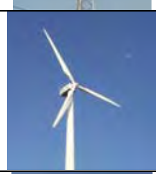
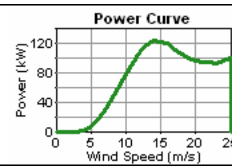
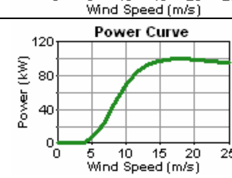
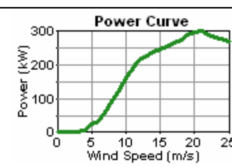
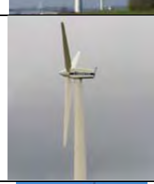
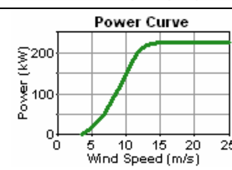
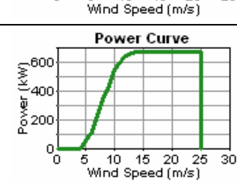
Month	Proven 2.5kW	Proven 6kW	Bergey 10 kW	FL30	Entegrity	FL100	NW100	FL250	V27	V47
Jan	71%	72%	47%	71%	59%	75%	61%	68%	67%	73%
Feb	63%	64%	39%	64%	52%	65%	53%	58%	57%	64%
Mar	57%	61%	41%	61%	47%	61%	50%	52%	53%	60%
Apr	62%	65%	44%	66%	51%	65%	53%	56%	57%	65%
May	43%	47%	30%	47%	34%	44%	36%	40%	40%	47%
Jun	29%	33%	21%	33%	21%	27%	22%	24%	25%	31%
Jul	33%	37%	24%	37%	24%	32%	26%	32%	32%	40%
Aug	46%	48%	31%	48%	36%	47%	38%	42%	42%	48%
Sep	71%	75%	49%	75%	60%	76%	62%	67%	68%	76%
Oct	71%	72%	44%	73%	60%	74%	60%	69%	67%	74%
Nov	73%	75%	47%	75%	62%	77%	63%	68%	69%	76%
Dec	64%	65%	39%	63%	53%	65%	53%	58%	59%	65%
Annual	57%	59%	38%	59%	46%	59%	48%	53%	53%	60%

CONCLUSION

This report provides a summary of wind resource data collected from mid September 2004 through October 2005 on Saint George Island, Alaska. The data was compared to long-term trends in the area. Based on correlations with the Saint George ASOS weather data, estimates were made to create a long-term dataset for the Saint George met tower site. This information was used to make predictions as to the potential energy production from various wind turbines at the site.

It is estimated that the long-term annual average wind speed at the site is 9.3 m/s at a height of 30 meters above ground level. Taking the local air density into account, the average wind power density for the site is 921 W/m^2. This information means that Saint George Island has at least a Class 7 wind resource, which is superior for wind power development.

Table 12. Wind Turbine Models Used in Power Production Analysis

Proven 2.5 kW http://www.provenenergy.com			Tower Height: 30 meters Swept Area: 9.6 m^2 Turbine Weight: 190 kg
Proven 6 kW http://www.provenenergy.com			Tower Height: 30 meters Swept Area: 23.8 m^2 Turbine Weight: 500 kg
Bergey 10 kW www.bergey.com			Tower Height: 30 meters Swept Area: 38.5 m^2 Weight: not available
Fuhrlander FL30 30 kW www.lorax-energy.com			Tower Height: 30 meters Swept Area: 133 m^2 Weight (nacelle & rotor): 410 kg
Entegrity 66 kW www.entegritywind.com			Tower Height: 30 meters Swept Area: 177 m^2 Weight (drivetrain & rotor): 2,420 kg
Fuhrlander FL100 100 kW www.lorax-energy.com			Tower Height: 30 meters Swept Area: 348 m^2 Weight (nacelle & rotor): 2,380 kg
Northern Power NW100/19 100 kW www.northernpower.com			Tower Height: 30 meters Swept Area: 284 m^2 Weight (nacelle & rotor): 7,086 kg
Fuhrlander FL250 250 kW www.lorax-energy.com			Tower Height: 50 meters Swept Area: 684 m^2 Weight (nacelle & rotor): 4,050 kg
Vestas V27 225 kW (refurbished, various suppliers)			Tower Height: 50 meters Swept Area: 573 m^2 Weight: not available
Vestas V47 660 kW www.vestas.com			Tower Height: 50 meters Swept Area: 1,735 m^2 Weight: not available