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Wind Resource Assessment for KOTZEBUE, ALASKA

Date last modified: 2/24/2006
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SITE SUMMARY

ICAO Station ID:	POAT
NCDC Data Set:	701330
Latitude (NAD27):	66.867
Longitude (NAD27):	- 162.633
Magnetic Declination:	15° 41' E
Tower Type:	AWOS
Sensor Heights:	8 meters above ground level
Elevation:	3.4 meters
Monitor Start:	Jan 1, 1995
Monitor End:	Dec 31, 2004

This report summarizes wind resource data collected from the Automated Weather Observing System (AWOS) in Kotzebue, Alaska. The hourly data set from January 1995 and January 2006 was purchased from the National Climatic Data Center. The purpose of providing this analysis is to assist the community in evaluating the feasibility of utilizing wind energy in Kotzebue.

The Kotzebue AWOS equipment and surrounding terrain are shown to the right. Kotzebue is on the Baldwin Peninsula in Kotzebue Sound, on a 3-mile-long spit, which ranges in width from 1,100 to 3,600 feet. It is located near the discharges of the Kobuk, Noatak and Ssezawick Rivers.

Image courtesy of Ed Doerr, NOAA

WIND RESOURCE SUMMARY

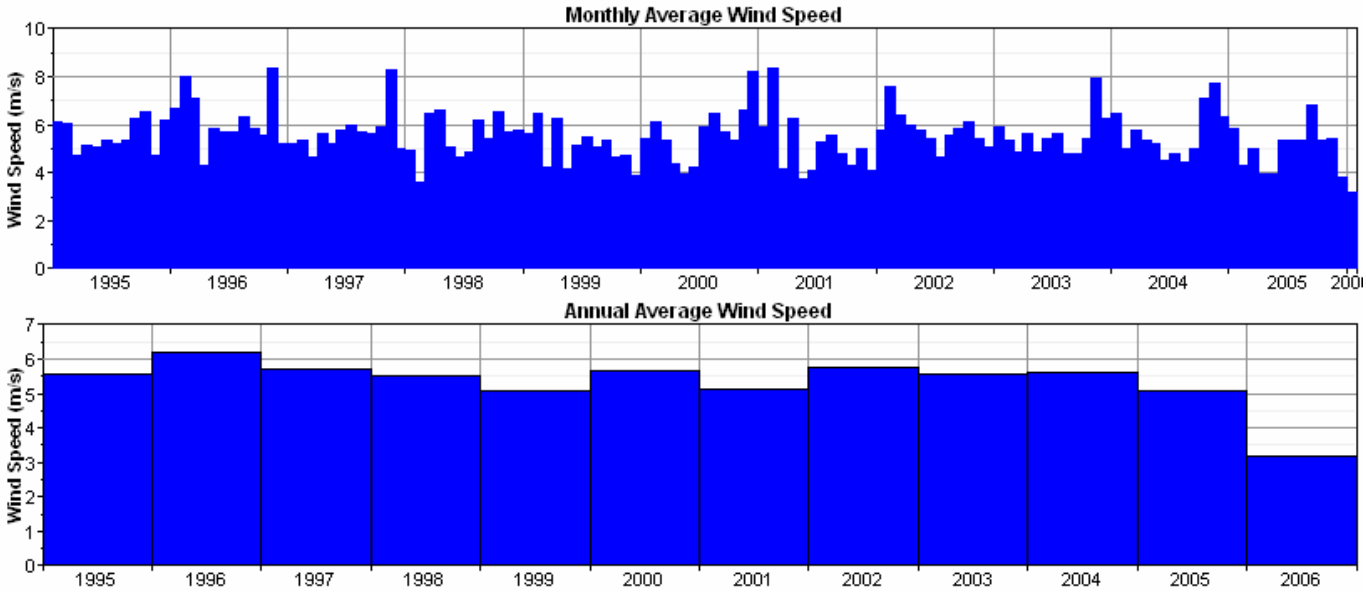
Annual Average Wind Speed (8m height):	5.5 m/s (12.3 mph)
Annual Average Wind Speed (30m height, estimated):	6.5 m/s (14.1 mph)
Average Wind Power Density (8m height):	250 W/m^2
Average Wind Power Density (30m height, estimated):	370 W/m^2
Wind Power Class (range = 1 to 7):	Class 4-5
Rating (Poor, Marginal, Fair, Good, Excellent, Outstanding):	Good
Prevailing Wind Direction:	East

Image taken from:
http://www.alaska.faa.gov/fai/airports.htm

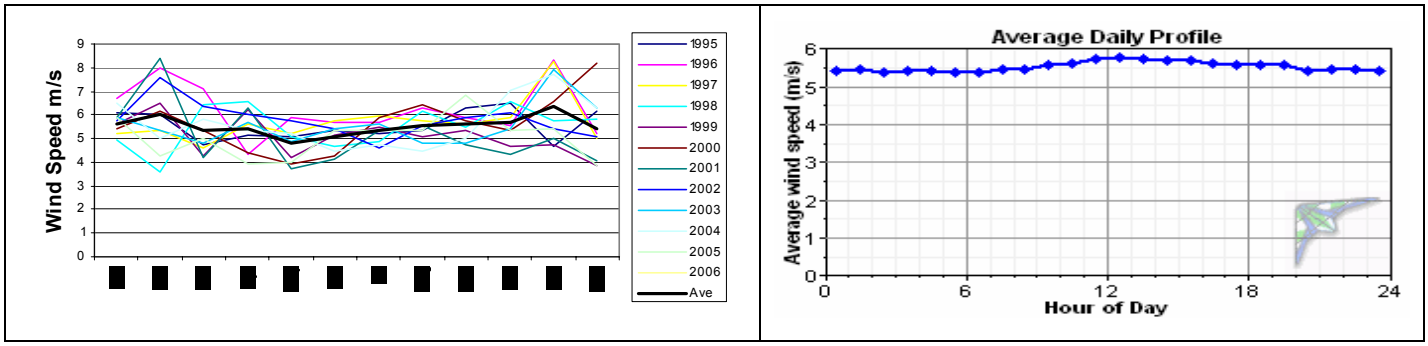
Based on data collected at the AWOS site, Kotzebue has a Class 4-5 wind resource, which is rated as “good” for wind power development.

WIND DATA RESULTS FOR KOTZEBUE AWOS SITE

Wind speeds from January 1995 through January 2006 are summarized below. The average wind speed over the 11-year period is 5.5 m/s at a height of 8 meters above ground level. The annual wind speed rarely deviates more than 8% above or below this average.

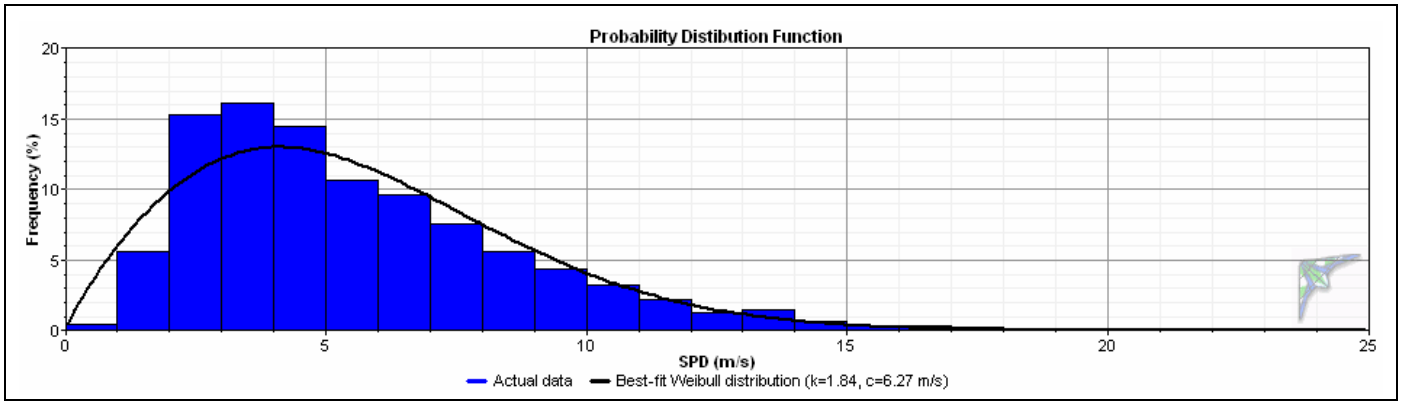


As shown, the highest wind month is typically February and the lowest wind month is typically May. Winds are typically highest in the afternoon.



Average Monthly and Daily Wind Speeds from Kotzebue AWOS, 8-m Height

The wind frequency distribution below shows the percent of the year that each wind speed occurs. The measured distribution as well as the best matched Weibull distribution is displayed. 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 62% of the wind in Kotzebue occurs within this operational zone at a height of 8 meters.

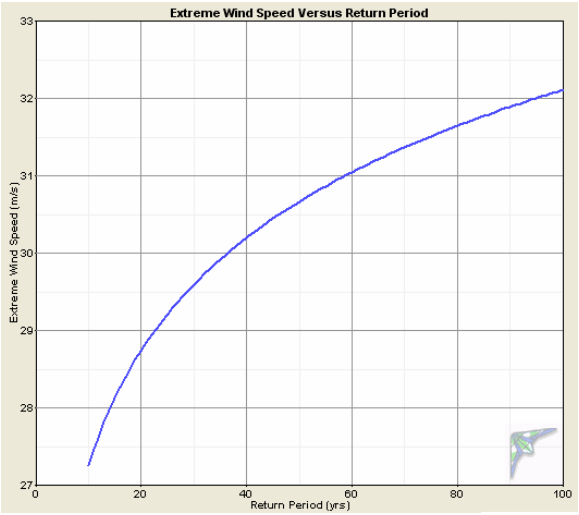


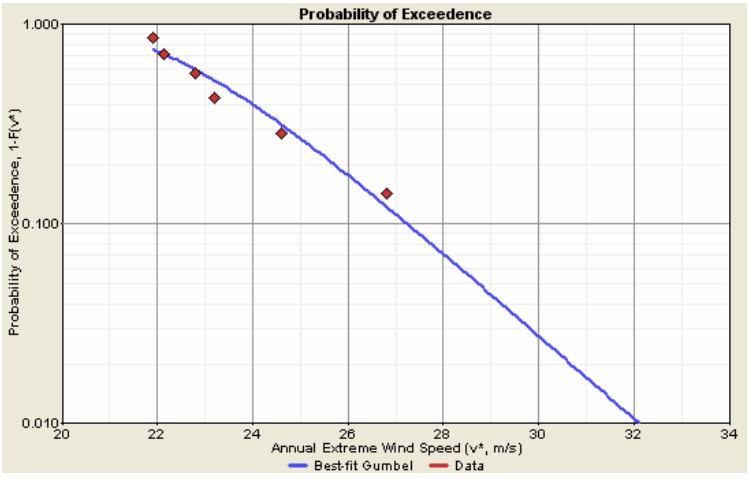
Average Wind Speeds at Kotzebue AWOS, 8-m Height (m/s)

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
0	6.1	6.0	5.3	5.7	4.7	5.1	5.2	5.0	5.2	4.8	6.1	5.6	5.4
1	5.9	5.6	5.3	5.6	4.8	5.1	5.0	4.8	5.4	5.5	5.6	5.7	5.3
2	5.5	5.3	5.6	5.5	4.8	4.9	4.9	5.1	5.2	5.8	5.3	5.6	5.3
3	5.5	5.1	5.1	5.5	4.8	4.7	4.9	5.1	5.3	5.6	5.5	5.4	5.2
4	5.6	5.2	4.7	5.7	4.7	4.7	5.0	5.5	5.4	5.9	5.9	5.7	5.3
5	5.8	5.4	5.2	5.9	4.8	4.3	5.1	5.8	5.6	5.9	5.9	5.8	5.5
6	5.9	5.7	5.1	5.4	4.8	4.6	5.4	5.7	5.9	5.7	5.9	5.8	5.5
7	6.0	5.9	4.9	5.5	4.8	4.6	5.5	5.6	5.6	6.1	5.5	5.9	5.5
8	5.8	6.0	5.3	5.5	4.9	4.8	5.3	5.6	5.8	6.3	6.0	6.1	5.6
9	5.7	6.0	5.4	5.4	4.7	4.9	5.1	6.3	6.2	6.5	6.1	6.1	5.7
10	5.5	6.1	5.3	5.4	4.5	5.0	5.3	6.2	6.1	6.5	6.3	5.9	5.7
11	5.4	6.3	5.5	5.5	4.9	5.0	5.3	6.1	6.1	6.5	6.6	5.5	5.7
12	5.9	6.2	5.5	5.3	5.0	5.3	5.5	5.7	5.7	6.1	7.2	5.4	5.7
13	6.1	6.2	5.7	5.3	4.7	5.5	5.5	6.1	5.6	6.0	7.2	5.5	5.8
14	6.0	6.0	5.7	5.3	4.9	5.3	5.5	5.9	5.7	5.7	6.8	5.5	5.7
15	6.1	7.0	5.6	5.3	5.0	5.4	5.7	5.8	6.2	5.5	6.7	5.2	5.8
16	6.2	6.8	5.4	5.2	5.0	5.2	5.3	5.9	5.8	5.5	6.8	5.5	5.7
17	6.5	6.4	5.7	5.3	5.0	5.0	6.1	5.8	5.5	5.3	6.9	5.6	5.7
18	6.2	6.5	5.7	5.2	4.9	5.3	5.9	5.4	5.6	5.5	7.0	5.3	5.7
19	5.7	6.4	5.7	5.0	4.9	5.2	5.5	5.3	5.4	5.0	6.9	5.2	5.5
20	5.4	6.3	5.5	5.0	5.0	5.2	5.6	5.0	5.4	5.3	6.4	5.0	5.4
21	5.0	6.3	5.4	5.1	5.0	5.5	5.2	5.1	5.3	5.5	6.4	4.8	5.4
22	5.2	6.3	5.2	5.2	4.6	5.4	5.0	5.1	5.3	5.3	6.5	5.4	5.4
23	5.7	6.5	5.2	5.6	4.6	5.4	5.3	4.8	5.2	4.9	6.4	5.4	5.4
Ave	5.8	6.1	5.4	5.4	4.8	5.1	5.3	5.5	5.6	5.7	6.3	5.5	5.5

EXTREME GUST ANALYSIS

Using the Windographer software program (www.mistaya.ca), a Gumbel distribution is fit to the 11 years of wind data to determine the expected extreme wind speed over various periods of time. For example, the maximum gust that can be expected at a height of 10 meters above ground level over the next 100 years is 32.1 m/s.





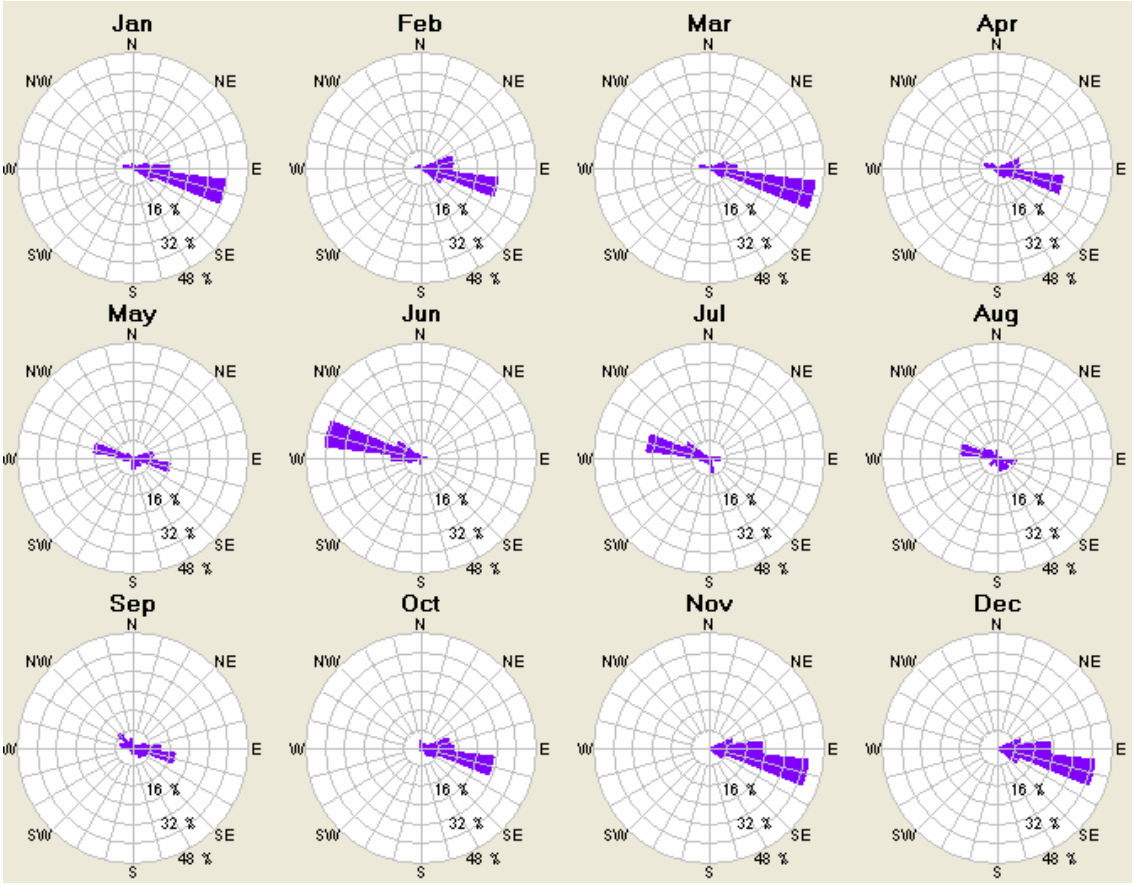
Return Period (yr)	Extreme Wind Speed (m/s)
20	28.7
25	29.2
50	30.7
100	32.1

Gumbel distribution parameters

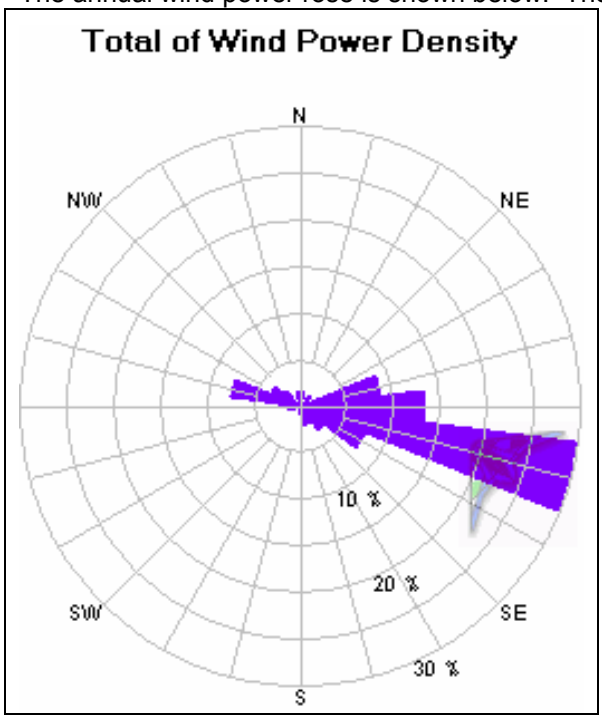
Scale:	2.07 m/s
Mode:	22.6 m/s
r^2	0.944

WIND DIRECTION

The monthly wind power roses, which show the percent of total power available in the wind from each direction, are shown below.

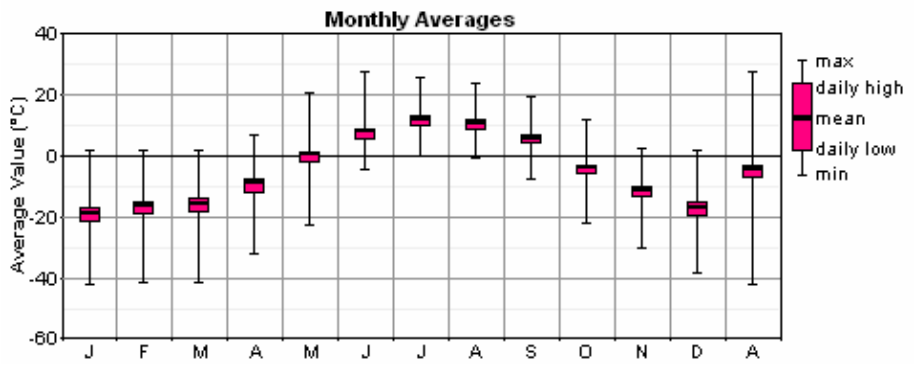


The annual wind power rose is shown below. The primary wind direction is the East.



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 AWOS site are shown below. Over the 11 year period, the temperature dropped below -25°C during 6.4% of the time, or 564 hours per year.



Monthly Average Temperatures at Kotzebue AWOS, 1995-2006

POTENTIAL POWER PRODUCTION FROM WIND TURBINES IN KOTZEBUE

The power curves from various wind turbines were used to calculate potential energy production in Kotzebue. Although different wind turbines are available 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 a wind shear value of 0.10. Results are shown below.

Among the results is the gross capacity factor, which is defined as the actual amount of energy produced divided by the maximum amount of energy that could be produced if the wind turbine were to operate at rated power for the entire year. Inefficiencies such as transformer/line losses, turbine downtime, soiling of the blades, icing of the blades, yaw losses, array losses, and extreme weather conditions can further reduce turbine output. To account for these factors the gross capacity factor is multiplied by about 0.90, resulting in the net capacity factor listed.

CONCLUSION

This report provides a summary of wind resource data collected from January 1995 through January 2006 at the AWOS weather station in Kotzebue, Alaska. The long-term annual average wind speed at the site is 5.5 m/s at a height of 8 meters above ground level. Taking the local air density into account, the average wind power density for the site is 250 W/m^2. Kotzebue has a Class 4-5 wind resource, which is rated “good” for wind power development. The net capacity factor for wind turbines would range from 20% to 31%.

Based on this initial review, the community of Kotzebue appears to be a good candidate for wind power. However, before additional investment in wind turbines, the actual wind resource at the potential wind turbine location should be verified, as the wind resource can be highly variable between sites. Also, available power production data from existing wind turbines should be evaluated. The information in this report is based on the site of the AWOS equipment. If the topography of the potential wind turbine location varies from the AWOS location, the information provided in this report cannot be used with certainty. The level of turbulence of the wind also cannot be determined from the AWOS data.

Power Production Analysis of Various Wind Turbine Models

Wind Turbine Options								
Manufacturer Information	Bergey 10 kW	Fuhrlander FL30 30 kW	Entegrity 15/50 65 kW	Fuhrlander FL100 100 kW	Northern Power NW100 100 kW	Fuhrlander FL250 250 kW	Vestas V27 225 kW	Vestas V47 660 kW
Tower Height	30 meters	30 meters	30 meters	50 meters	50 meters	50 meters	50 meters	50 meters
Swept Area	38.5 m^2	133 m^2	177 m^2	348 m^2	284 m^2	684 m^2	573 m^2	1,735 m^2
Weight (nacelle & rotor)	N/A	410 kg	2,420 kg	2,380 kg	7,086 kg	4,050 kg	N/A	N/A
Gross Energy Production (kWh/year)								
Jan	1,832	8,488	13,158	26,071	21,297	59,098	53,935	186,729
Feb	1,764	8,172	12,894	25,429	20,802	57,519	52,716	181,178
Mar	1,582	7,331	10,971	21,954	17,960	49,955	45,960	161,448
Apr	1,547	7,227	10,838	21,655	17,655	49,328	45,081	158,055
May	1,243	5,915	8,380	16,998	13,794	39,706	36,177	129,074
Jun	1,294	6,051	8,796	17,765	14,471	40,833	37,300	132,820
July	1,492	6,984	10,307	20,674	16,869	47,536	43,412	153,162
Aug	1,601	7,463	11,210	22,386	18,275	51,550	47,047	164,911
Sep	1,602	7,455	11,277	22,496	18,367	51,408	46,930	163,969
Oct	1,740	8,095	12,402	24,647	20,132	56,314	51,395	178,663
Nov	2,004	9,319	14,917	29,300	23,935	65,996	60,197	205,324
Dec	1,689	7,825	11,904	23,732	19,392	53,849	49,481	172,633
Annual	19,389	90,323	137,054	273,105	222,949	623,089	569,630	1,987,964
Annual Average Capacity Factor								
Gross CF	22%	34%	24%	31%	25%	29%	29%	34%
Net CF	20%	31%	21%	28%	23%	26%	26%	31%

Notes: The sizes of Vestas turbines listed are no longer available new. Remanufactured turbines are available from various suppliers.
Energy estimates are based on the long-term wind resource measured at the airport ASOS site.