

Wind Resource Assessment for AMBLER, ALASKA

Date last modified: 4/6/2006
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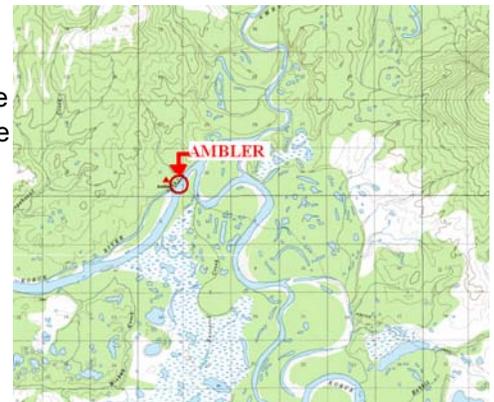
SITE SUMMARY

ICAO Station ID: PAFM
 NCDC Data Set: 701718
 Latitude (NAD27): 67.1
 Longitude (NAD27): - 157.85
 Magnetic Declination: 18° 23' East
 Tower Type: AWOS
 Sensor Heights: 7 meters above ground level
 Elevation: 102 meters
 Monitor Start: Dec 31, 1994
 Monitor End: Jan 14, 2006



This report summarizes wind resource data collected from the Automated Surface Observing System (AWOS) in Ambler, Alaska. The hourly data set from 1994-2006 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 Ambler.

The Ambler AWOS equipment and surrounding terrain are shown to the right. Ambler is located on the north bank of the Kobuk River in the Northwest Arctic Borough 45 miles above the Arctic Circle.



WIND RESOURCE SUMMARY

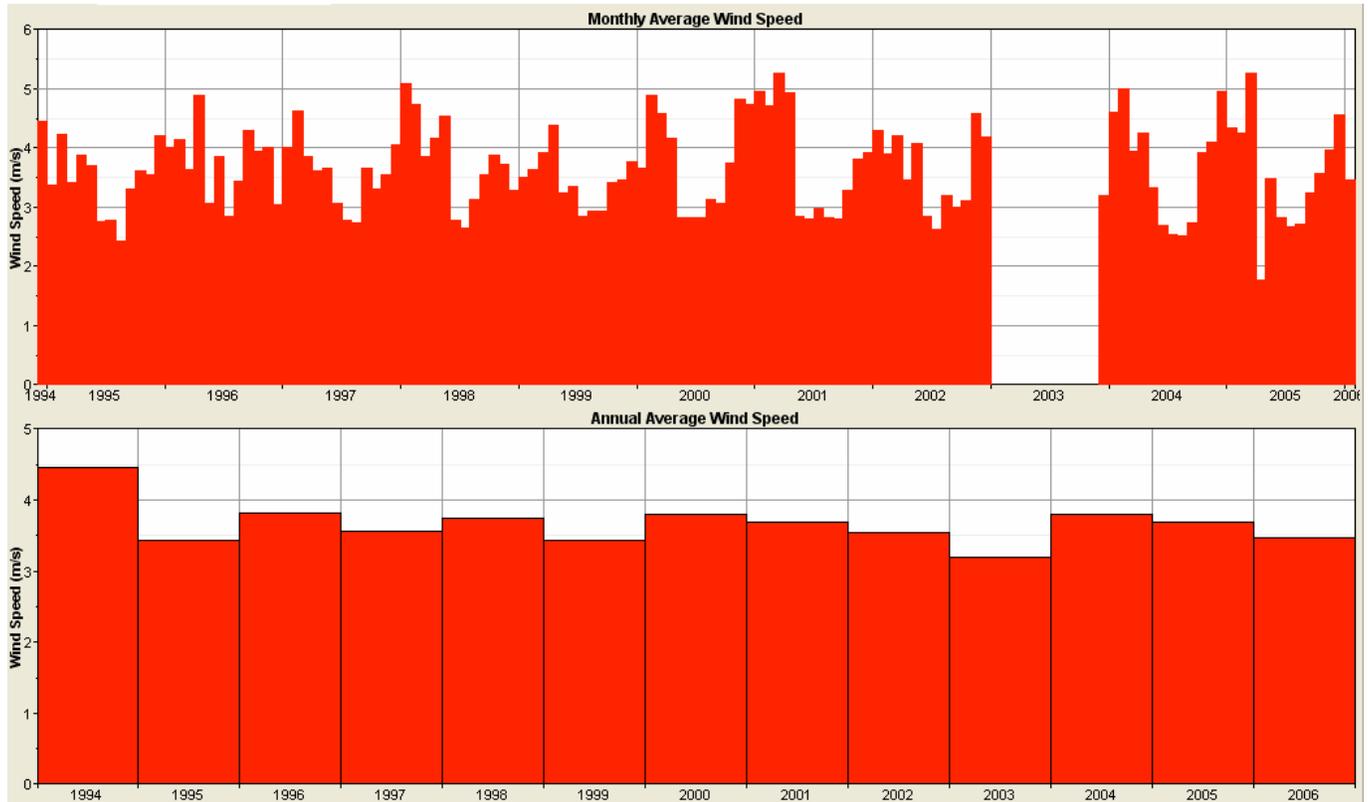
Annual Average Wind Speed (10m height):	3.8 m/s (11.9 mph)
Annual Average Wind Speed (30m height, estimated):	4.3 m/s (16.6 mph)
Average Wind Power Density (10m height):	63 W/m ²
Average Wind Power Density (30m height, estimated):	88 W/m ²
Wind Power Class (range = 1 to 7):	Class 1
Rating (Poor, Marginal, Fair, Good, Excellent, Outstanding):	Poor
Prevailing Wind Direction:	Northeast



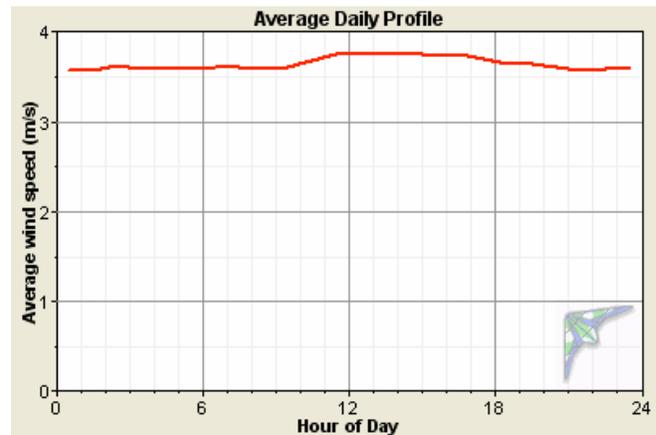
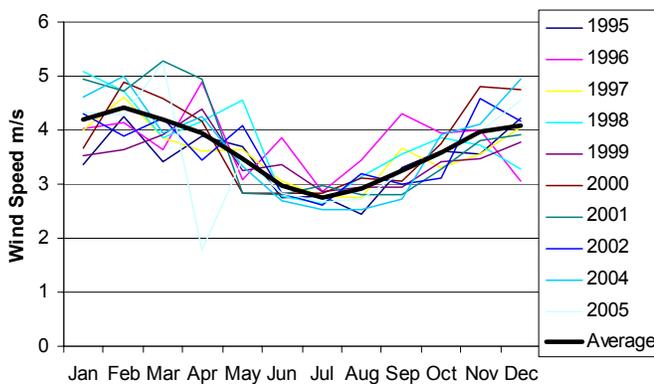
Based on data collected at the AWOS site, Ambler has a Class 1 wind resource, which is rated as "poor" for wind power development.

WIND DATA RESULTS FOR AMBLER AWOS SITE

Wind speeds from December 1994 through January 2006 are summarized below. The average wind speed over the 12-year period is 3.7 m/s at a height of seven meters above ground level excluding the years of 1994, 2003, and 2006 because of a month of data or less. The annual wind speed rarely deviates more than 5% above or below this average.

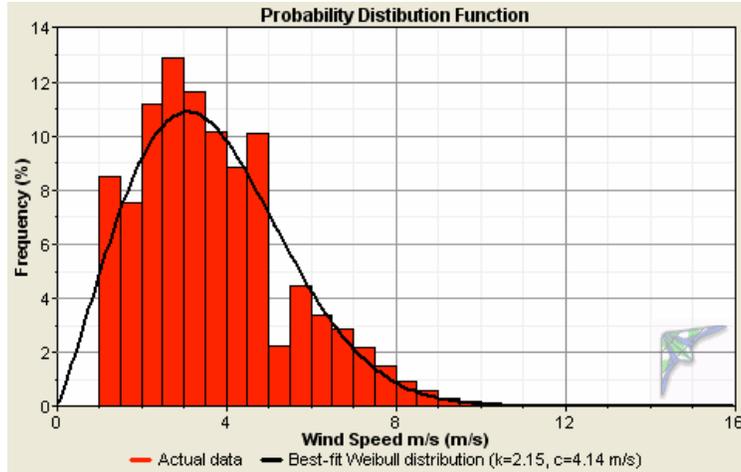


As shown, the highest wind month is typically February and the lowest wind month is typically July. Winds are typically lowest in the morning and increase in the afternoon.



Average Monthly and Daily Wind Speeds from Ambler AWOS, 7-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 92% of the wind in Deering occurs within this operational zone.



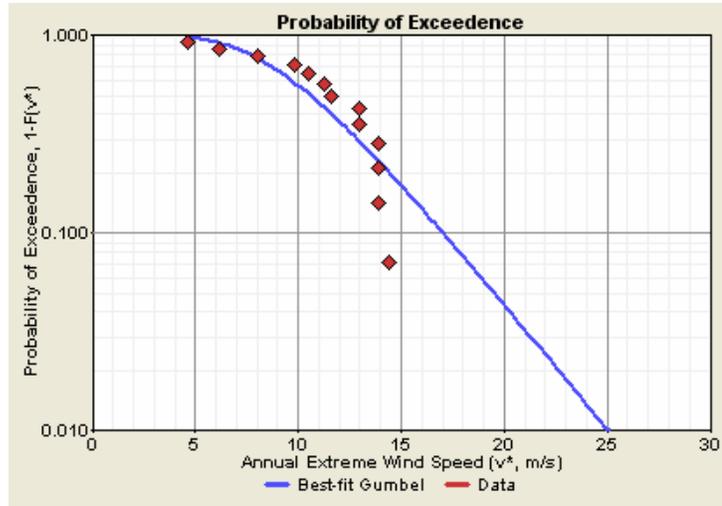
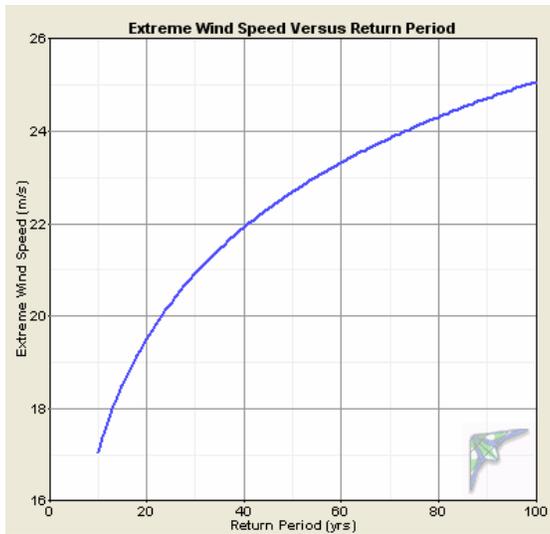
Wind Frequency Distribution for Ambler ASOS

Average Wind Speeds at Ambler ASOS, 7-m Height (m/s)

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
0	4.0	4.4	4.2	4.2	3.5	2.5	2.6	2.9	3.1	3.6	3.9	4.1	3.6
1	4.1	4.2	4.1	4.3	3.4	2.5	2.5	2.7	3.2	3.6	3.9	4.2	3.6
2	3.9	4.6	4.1	4.3	3.4	2.5	2.6	2.8	3.2	3.7	4.0	4.2	3.6
3	3.9	4.3	4.2	4.3	3.4	2.5	2.6	2.8	3.2	3.8	3.8	4.1	3.6
4	3.9	4.4	3.9	4.1	3.3	2.7	2.6	2.7	3.2	3.7	4.0	4.2	3.6
5	4.0	4.5	4.1	4.2	3.3	2.6	2.5	2.9	3.3	3.6	3.9	4.2	3.6
6	4.1	4.5	4.1	4.2	3.5	2.5	2.5	2.8	3.2	3.6	4.0	4.2	3.6
7	3.9	4.5	4.1	4.2	3.5	2.6	2.5	2.9	3.4	3.6	3.8	4.3	3.6
8	4.0	4.3	4.2	4.0	3.4	2.7	2.5	3.0	3.3	3.4	3.8	4.5	3.6
9	3.9	4.4	3.9	4.1	3.5	2.7	2.6	3.0	3.3	3.9	3.9	4.3	3.6
10	3.9	4.2	4.1	4.0	3.6	2.9	2.9	3.1	3.5	3.7	3.9	4.3	3.7
11	4.1	4.6	4.1	4.1	3.7	3.0	2.9	3.0	3.7	3.8	4.0	4.4	3.8
12	4.0	4.5	4.0	4.2	3.7	3.1	2.9	3.2	3.6	3.8	4.1	4.3	3.8
13	4.0	4.4	4.0	4.2	3.7	3.2	3.0	3.1	3.6	3.8	4.2	4.2	3.8
14	4.1	4.7	4.1	4.0	3.7	3.3	3.0	3.0	3.7	3.6	4.2	4.2	3.8
15	4.0	4.4	4.2	4.0	3.8	3.2	3.1	3.1	3.6	3.5	4.0	4.0	3.8
16	4.2	4.4	4.1	4.1	3.8	3.3	3.0	3.0	3.5	3.5	4.1	4.1	3.8
17	4.0	4.7	4.1	4.0	3.7	3.4	3.1	3.0	3.2	3.3	4.1	4.2	3.7
18	3.8	4.6	4.1	4.0	3.7	3.3	3.1	2.9	3.1	3.4	4.0	4.2	3.7
19	4.1	4.5	4.3	4.0	3.6	3.2	2.9	2.7	3.2	3.4	4.1	4.1	3.7
20	4.2	4.5	3.9	4.1	3.5	2.9	2.7	2.7	3.1	3.5	4.0	4.3	3.6
21	4.0	4.6	4.1	4.1	3.4	2.7	2.5	2.7	3.1	3.6	4.0	4.3	3.6
22	4.0	4.4	4.1	4.4	3.4	2.5	2.5	2.8	3.2	3.6	3.9	4.3	3.6
23	4.2	4.3	4.2	4.2	3.6	2.5	2.5	2.9	3.1	3.5	4.1	4.3	3.6
Ave	4.0	4.4	4.1	4.1	3.5	2.8	2.7	2.9	3.3	3.6	4.0	4.2	3.7

EXTREME GUST ANALYSIS

Using the Windographer software program (www.mistaya.ca), a Gumbel distribution is fit to the 12 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 25.1 m/s.



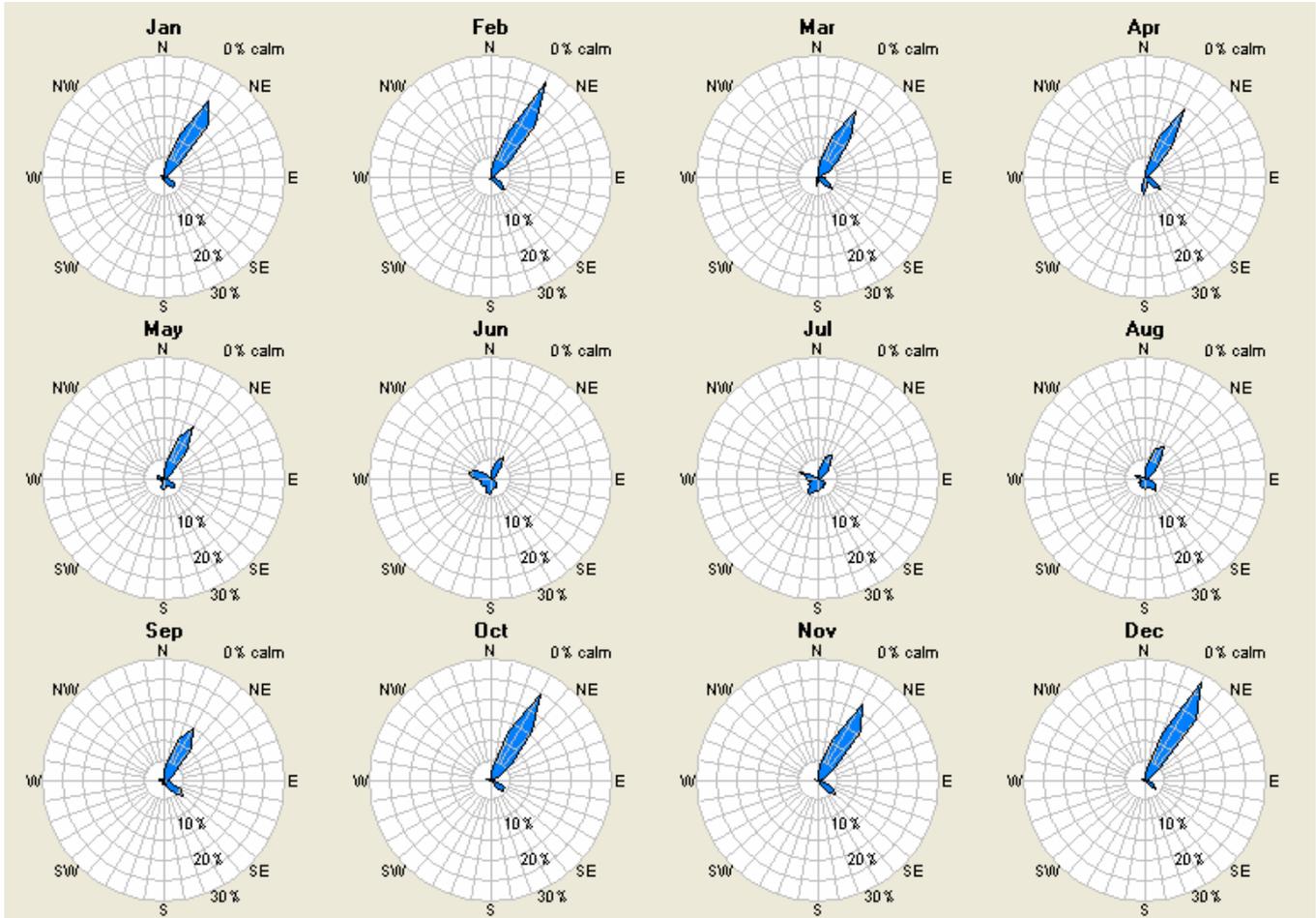
Return Period (yr)	Extreme Wind Speed (m/s)
20	19.5
25	20.3
50	22.7
100	25.1

Gumbel distribution parameters —

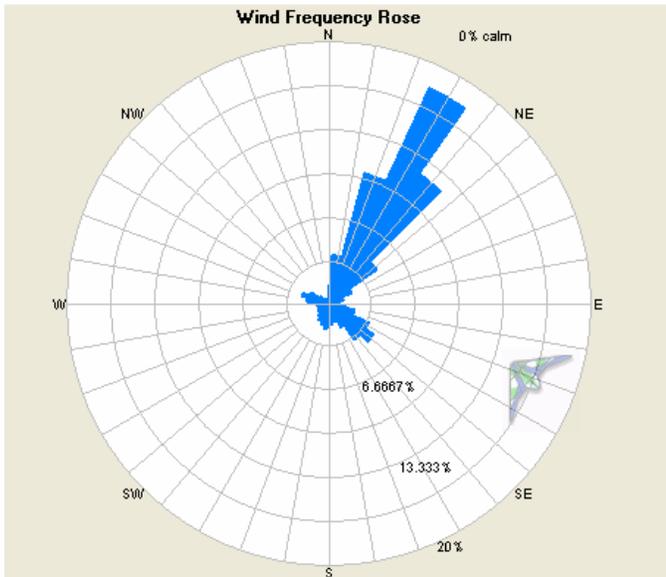
- Scale: 3.42 m/s
- Mode: 9.35 m/s
- r^2 : 0.793

WIND DIRECTION

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

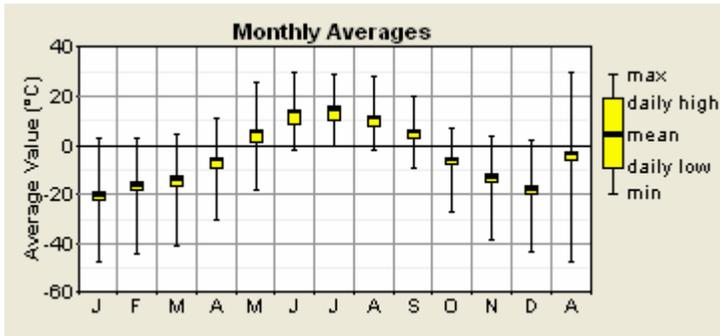


The annual wind power rose is shown below. Primary wind direction is the Northeast.



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 12 year period, the temperature dropped below -25°C during 14.1% of the time, or 1235 hours per year.



Monthly Average Temperatures at Ambler AWOS, 1994-2006

POTENTIAL POWER PRODUCTION FROM WIND TURBINES IN AMBLER

The power curves from various wind turbines were used to calculate potential energy production in Ambler. 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 December 1994 through January 2006 at the airport AWOS site in Ambler, Alaska. The long-term annual average wind speed at the site is 3.8 m/s at a height of 7 meters above ground level. Taking the local air density into account, the average wind power density for the site is 63 W/m². Ambler has a Class 1 wind resource, which is rated “poor” for wind power development. The net capacity factor for wind turbines would range from 6% to 11%.

Based on this initial review, the community of Ambler appears to be a poor candidate for wind power. 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	Entegriy 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	705	3,587	4,183	9,088	7,119	22,994	20,431	75,706
Feb	837	4,219	5,321	11,107	8,832	27,056	24,277	90,062
Mar	721	3,695	4,358	9,399	7,365	23,665	21,022	77,924
Apr	712	3,627	4,295	9,252	7,251	23,130	20,562	76,265
May	439	2,292	2,316	5,518	4,168	14,536	12,564	44,914
Jun	179	1,029	714	2,222	1,506	6,612	5,367	16,937
July	150	888	540	1,858	1,209	5,609	4,467	13,452
Aug	200	1,135	818	2,475	1,699	7,238	5,910	18,849
Sep	330	1,763	1,609	4,085	3,010	11,223	9,522	33,147
Oct	475	2,484	2,560	5,987	4,545	16,008	13,888	50,439
Nov	659	3,382	3,922	8,540	6,658	21,594	19,128	70,773
Dec	814	4,146	5,048	10,707	8,444	26,617	23,733	88,307
Annual	6,221	32,246	35,686	80,234	61,805	206,277	180,872	656,772
Annual Average Capacity Factor								
Gross CF	7%	12%	6%	9%	7%	9%	9%	11%
Net CF	6%	11%	6%	8%	6%	9%	8%	10%

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.