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Wind Resource Assessment for HOOPER BAY, ALASKA

Date last modified: 2/21/2006
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SITE SUMMARY

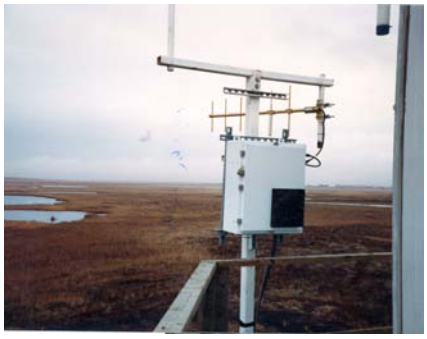
ICAO Station ID:	PAHP
NCDC Data Set:	702186
Latitude (NAD27):	61.533
Longitude (NAD27):	- 166.15
Magnetic Declination:	13˚ 46' East
Tower Type:	AWOS
Sensor Heights:	10 meters above ground level
Elevation:	5 meters
Monitor Start:	Jan 1, 1995
Monitor End:	Dec 31, 2004

This report summarizes wind resource data collected from the Automated Weather Observing System (AWOS) in Hooper Bay, Alaska. The hourly data set from 1995-2004 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 Hooper Bay.

The Hooper Bay AWOS equipment and surrounding terrain are shown to the right. The Askinuk Mountains, with a peak elevation of 2,000 feet, are located about 15-20 miles to the north and northeast of Hooper Bay. The Bering Sea lies to the west and south, while flat terrain lies to the east of Hooper Bay.

WIND RESOURCE SUMMARY

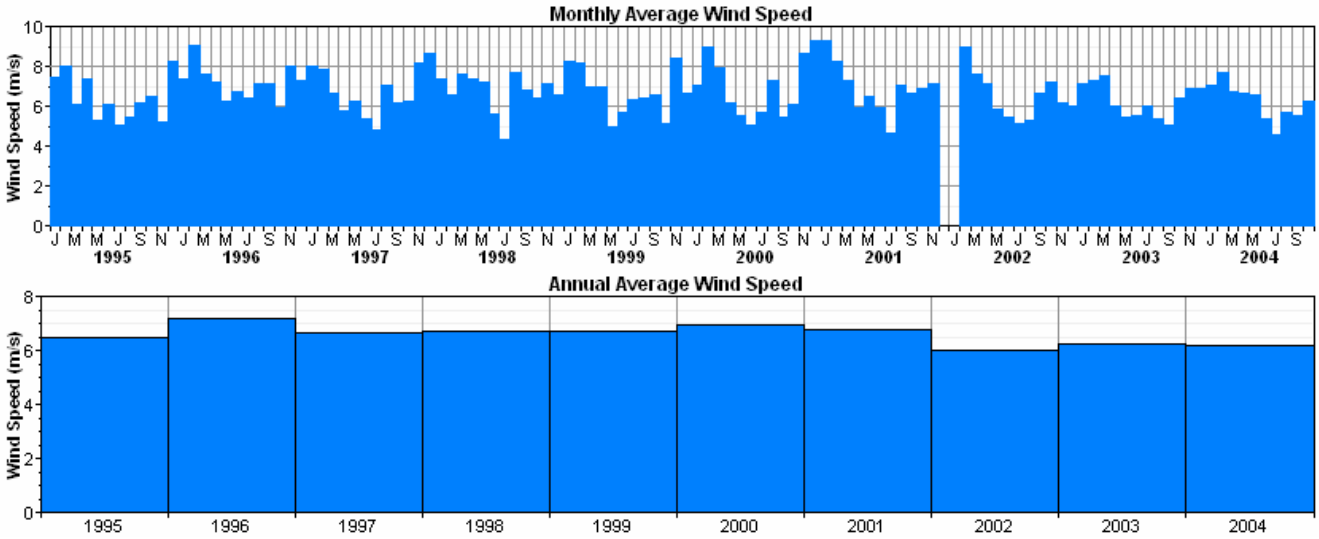
Annual Average Wind Speed (10m height):	6.7 m/s (15.0 mph)
Annual Average Wind Speed (30m height, estimated):	7.4 m/s (16.6 mph)
Average Wind Power Density (10m height):	340 W/m^2
Average Wind Power Density (30m height, estimated):	480 W/m^2
Wind Power Class (range = 1 to 7):	Class 6
Rating (Poor, Marginal, Fair, Good, Excellent, Outstanding):	Outstanding
Prevailing Wind Direction:	North, East



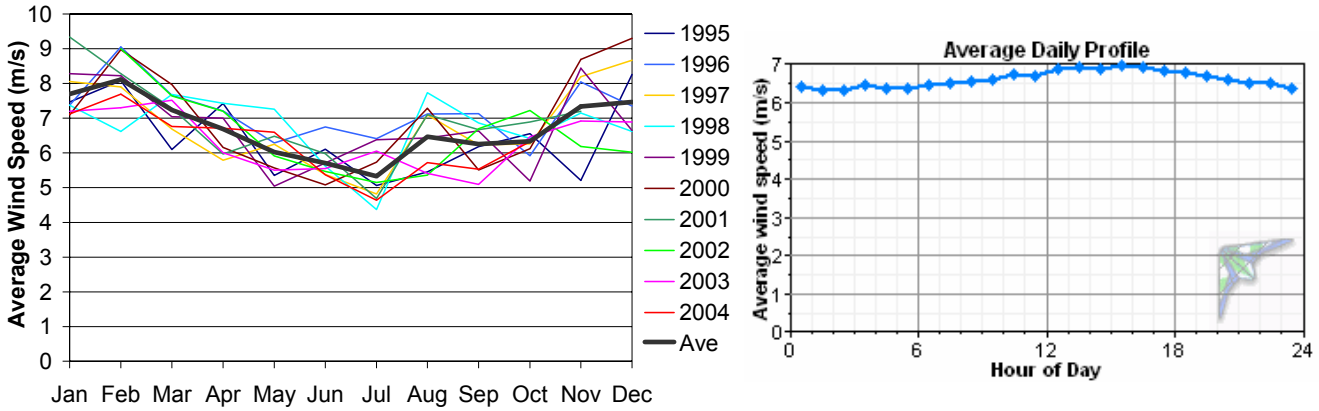
Based on data collected at the AWOS site, Hooper Bay has a Class 6 wind resource, which is rated as "outstanding for wind power development.

WIND DATA RESULTS FOR HOOPER BAY AWOS SITE

Wind speeds from January 1995 through December 2004 are summarized below. The average wind speed over the 10-year period is 6.7 m/s at a height of 10 meters above ground level. The annual wind speed rarely deviates more than 5% above or below this average.

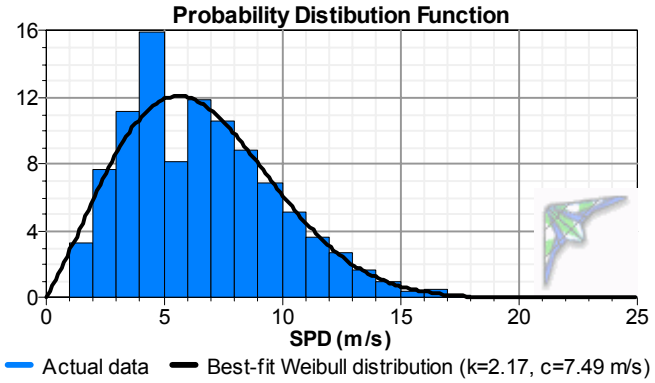


As shown, the highest wind month is typically February and the lowest wind month is typically July. Winds are typically lowest in the morning and increase in the afternoon.



Average Monthly and Daily Wind Speeds from Hooper Bay AWOS, 10-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 78% of the wind in Hooper Bay occurs within this operational zone.

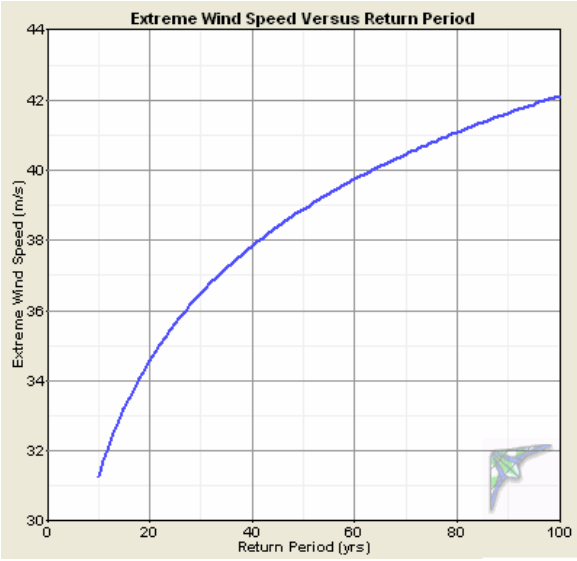


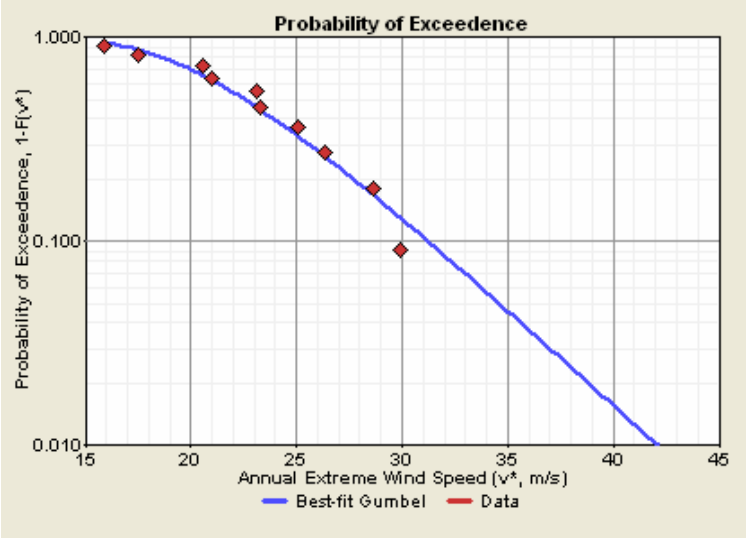
Average Wind Speeds at Hooper Bay AWOS, 10-m Height (m/s)

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
0	7.6	7.6	7.1	6.7	5.6	5.0	5.0	6.0	5.9	6.1	7.7	7.4	6.5
1	7.3	7.8	6.9	6.4	5.6	5.0	5.0	6.0	5.8	6.0	7.6	7.2	6.4
2	7.6	7.9	7.1	6.5	5.6	5.0	5.0	5.9	5.7	6.1	7.4	7.3	6.4
3	7.6	8.2	7.2	6.4	5.7	5.1	5.1	6.0	5.8	6.1	7.7	7.3	6.5
4	7.5	8.0	6.9	6.6	5.5	5.1	5.1	6.1	5.8	6.0	7.6	7.4	6.4
5	7.3	8.0	7.0	6.5	5.6	5.1	5.1	6.0	5.8	5.9	7.8	7.3	6.4
6	7.4	8.0	7.0	6.7	5.8	5.3	5.1	6.0	5.8	6.3	7.6	7.2	6.5
7	7.6	8.0	7.2	6.8	6.0	5.4	5.1	6.0	5.9	6.0	7.7	7.4	6.6
8	7.4	8.3	7.2	6.8	6.0	5.6	5.3	6.1	6.0	5.9	7.7	7.3	6.6
9	7.3	8.2	7.2	6.7	6.0	5.6	5.2	6.2	6.2	6.1	7.6	7.6	6.7
10	7.5	8.2	7.4	6.9	6.2	5.7	5.4	6.3	6.5	6.4	7.5	7.5	6.8
11	7.4	8.3	7.3	6.7	6.2	5.8	5.6	6.4	6.6	6.4	7.2	7.1	6.8
12	7.4	8.4	7.4	7.1	6.3	6.0	5.7	6.6	6.7	6.6	7.3	7.5	6.9
13	7.5	8.4	7.4	7.1	6.4	6.2	5.8	6.6	6.7	6.6	7.5	7.5	7.0
14	7.4	8.2	7.5	7.0	6.2	6.3	5.9	6.7	6.7	6.8	7.4	7.5	7.0
15	7.3	8.3	7.4	7.0	6.2	6.3	5.9	6.8	6.8	6.8	7.3	7.9	7.0
16	7.5	8.1	7.4	7.0	6.2	6.5	5.9	6.7	6.8	6.3	7.5	7.6	7.0
17	7.6	8.0	7.1	6.8	6.2	6.3	5.7	6.8	6.5	6.3	7.5	7.6	6.9
18	7.5	8.0	7.3	6.8	6.1	6.3	5.7	6.5	6.3	6.4	7.8	7.5	6.8
19	7.5	7.8	7.1	6.7	6.1	6.1	5.5	6.6	6.0	6.2	7.7	7.6	6.7
20	7.7	7.6	7.0	6.7	5.8	6.0	5.4	6.2	6.0	6.3	7.8	7.4	6.7
21	7.9	7.8	7.0	6.7	5.8	5.6	5.2	6.1	5.9	6.0	7.7	7.3	6.6
22	7.7	7.9	7.0	6.7	5.5	5.4	5.1	6.2	6.0	6.1	7.7	7.5	6.6
23	7.5	7.6	7.0	6.6	5.5	5.3	5.2	6.1	5.8	6.1	7.6	7.4	6.5
Ave	7.5	8.0	7.2	6.7	5.9	5.7	5.4	6.3	6.2	6.2	7.6	7.4	6.7

EXTREME GUST ANALYSIS

Using the Windographer software program (www.mistaya.ca), a Gumbel distribution is fit to the 10 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 42.1 m/s.





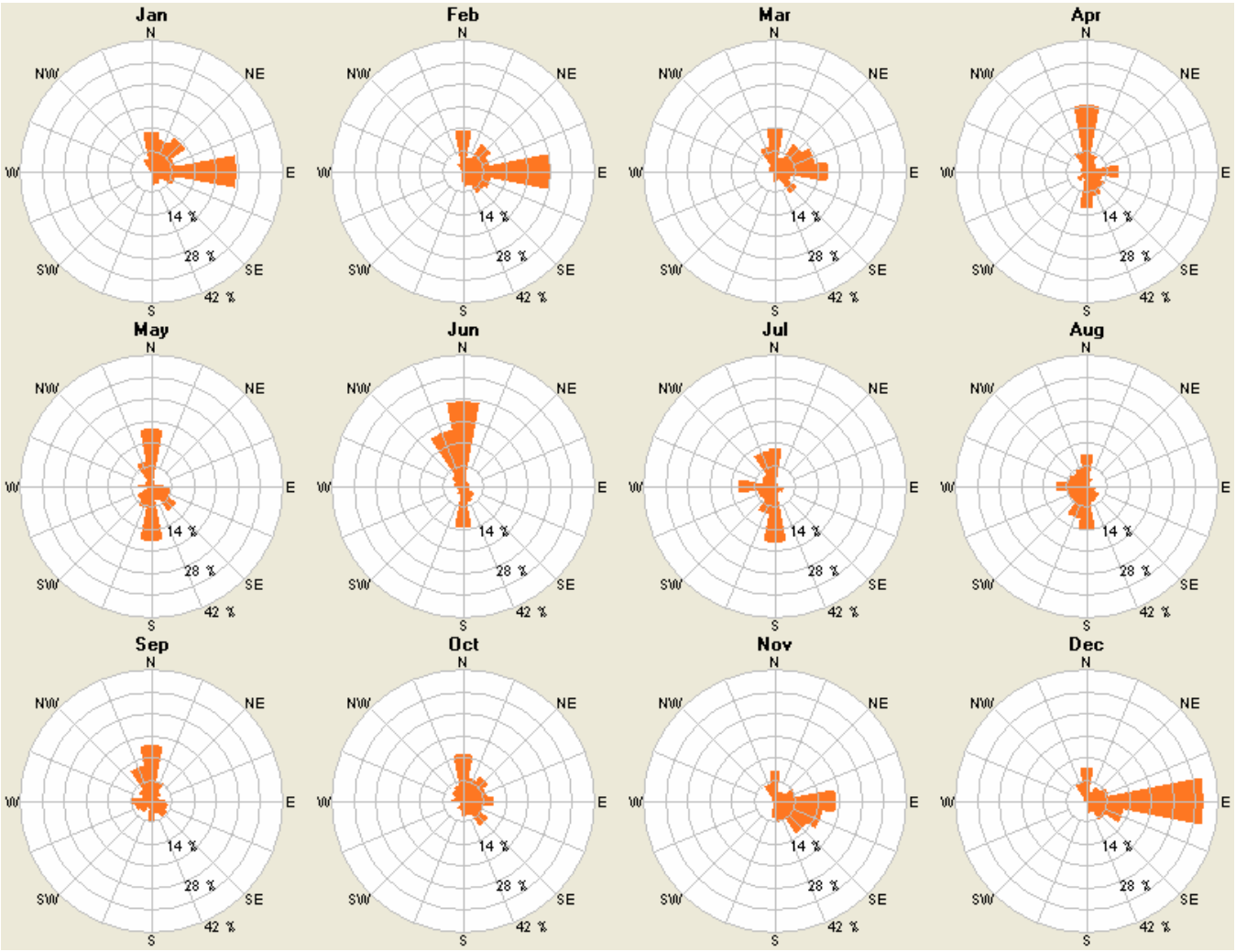
Gumbel distribution parameters

Scale:	4.63 m/s
Mode:	20.8 m/s
r^2	0.961

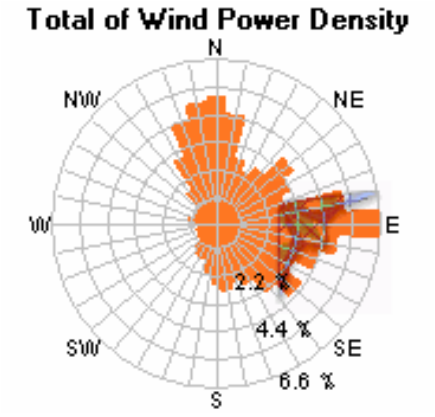
Return Period (yr)	Extreme Wind Speed (m/s)
20	34.6
25	35.6
50	38.9
100	42.1

WIND DIRECTION

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

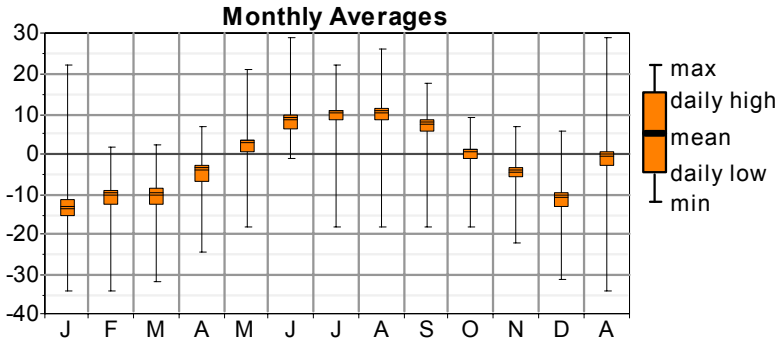


The annual wind power rose is shown below. Primary wind directions are the North and East.



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 10 year period, the temperature dropped below -25°C during 1% of the time, or 101 hours per year.



Monthly Average Temperatures at Hooper Bay AWOS, 1995-2004

POTENTIAL POWER PRODUCTION FROM WIND TURBINES IN HOOPER BAY

The power curves from various wind turbines were used to calculate potential energy production in Hooper Bay. 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 December 2004 at the AWOS weather station in Hooper Bay, Alaska. The long-term annual average wind speed at the site is 6.7 m/s at a height of 10 meters above ground level. Taking the local air density into account, the average wind power density for the site is 340 W/m^2. Hooper Bay has a Class 6 wind resource, which is rated “outstanding” for wind power development. The net capacity factor for wind turbines would range from 26% to 40%.

Based on this initial review, the community of Hooper Bay appears to be a good candidate for wind power. However, before investing 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. 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	2,630	11,977	19,565	38,312	31,435	85,458	78,218	265,645
Feb	2,564	11,822	19,936	38,649	31,656	85,986	78,126	261,728
Mar	2,478	11,283	18,095	35,584	29,252	79,474	72,942	249,975
Apr	2,175	9,869	15,384	30,467	25,066	68,096	62,681	217,796
May	1,751	8,152	11,998	23,971	19,650	55,157	50,606	180,793
Jun	1,524	7,194	10,310	20,714	16,896	48,152	44,059	158,824
July	1,348	6,551	9,103	18,351	14,906	43,558	39,582	144,250
Aug	1,948	9,005	13,597	26,994	22,188	60,536	56,406	199,305
Sep	1,836	8,507	12,747	25,382	20,823	57,630	53,213	188,415
Oct	1,943	8,995	13,575	26,957	22,139	61,028	56,552	199,788
Nov	2,570	11,685	19,225	37,609	30,888	83,254	76,413	258,257
Dec	2,616	11,936	19,479	38,128	31,309	84,633	77,820	264,290
Annual	25,384	116,976	183,013	361,114	296,209	812,959	746,617	2,589,063
Annual Average Capacity Factor								
Gross CF	29%	45%	32%	41%	34%	37%	38%	45%
Net CF	26%	40%	29%	37%	31%	33%	34%	40%

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.