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Wind Resource Assessment for EAGLE, ALASKA

Date last modified: 3/3/2006
Compiled by: Nick Szymoniak

SITE SUMMARY

ICAO Station ID:	PAEG
NCDC Data Set:	701975
Latitude (NAD27):	64.783
Longitude (NAD27):	-141.675
Magnetic Declination:	24° 34' E changing by 0° 23' W/year
Tower Type:	ASOS
Sensor Heights:	10 meters above ground level
Elevation:	268 meters
Monitor Start:	April 8, 1998
Monitor End:	Jan 14, 2006

This report summarizes wind resource data collected from the Automated Surface Observing System (ASOS) in Eagle, Alaska. The hourly data set from April 1998 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 Eagle.

The Eagle ASOS equipment and surrounding terrain are shown to the right. The City of Eagle and Eagle Village are located on the Taylor Highway, 6 miles west of the Alaska-Canadian border. Eagle is on the left bank of the Yukon River at the mouth of Mission Creek. The Yukon-Charley Rivers National Preserve is northwest of the area.

Image courtesy of Ed Doerr, NOAA

WIND RESOURCE SUMMARY

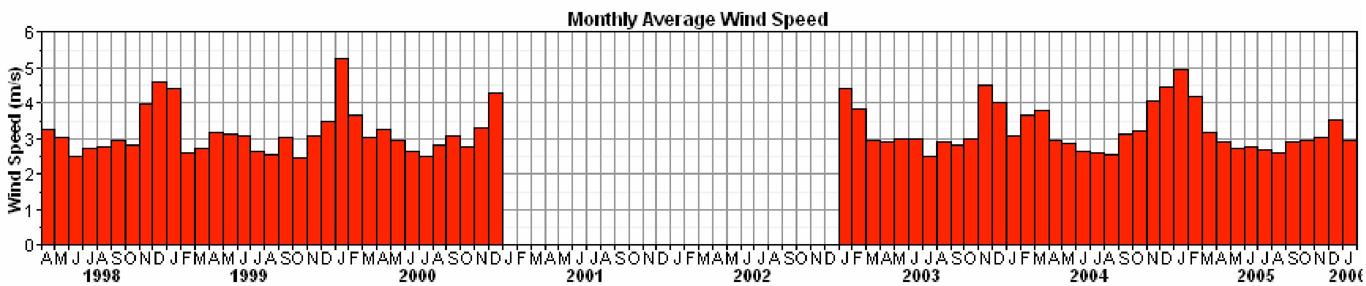
Annual Average Wind Speed (10m height):	3.3 m/s (7.4 mph)
Annual Average Wind Speed (30m height, estimated):	3.7 m/s (8.3 mph)
Average Wind Power Density (10m height):	40 W/m^2
Average Wind Power Density (30m height, estimated):	60 W/m^2
Wind Power Class (range = 1 to 7):	Class 1
Rating (Poor, Marginal, Fair, Good, Excellent, Outstanding):	Poor
Prevailing Wind Direction:	Southeast

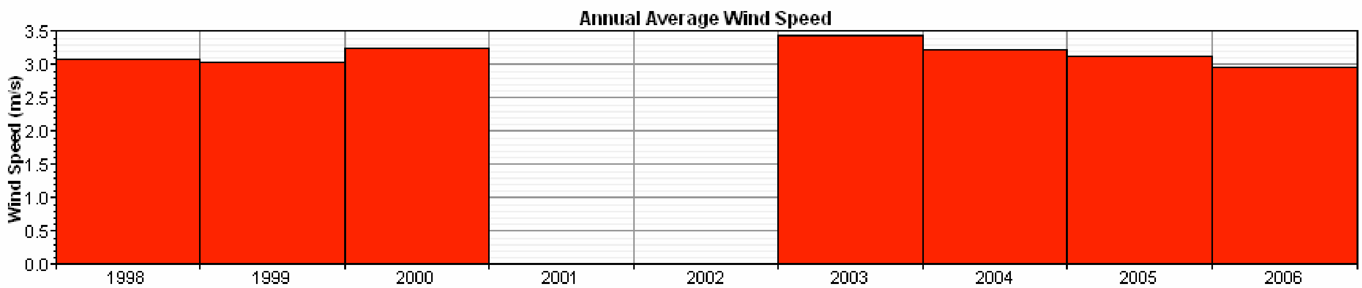
Image taken from:
http://www.alaska.faa.gov/fai/airports.htm

Based on data collected at the ASOS site, Eagle has a Class 1 wind resource, which is rated as “poor for wind power development.”

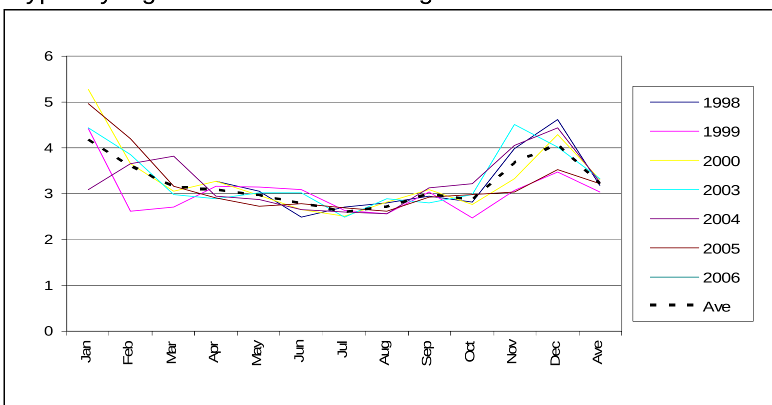
WIND DATA RESULTS FOR EAGLE ASOS SITE

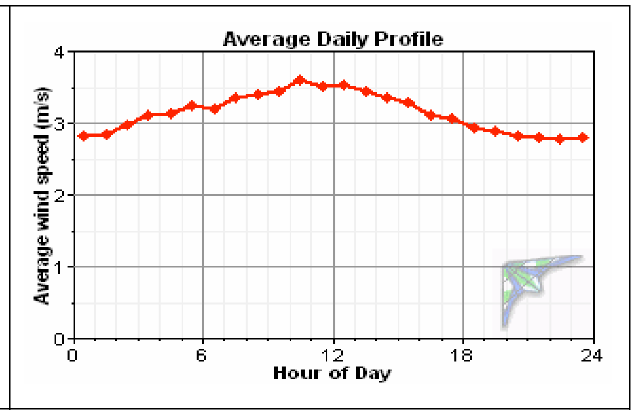
Wind speeds from April 1998 through January 2006 are summarized below. The average wind speed over the 6-year period is 3.3 m/s at a height of 10 meters above ground level. The annual wind speed rarely deviates more than 5% above or below this average. Data from 2001 and 2002 were not reported.





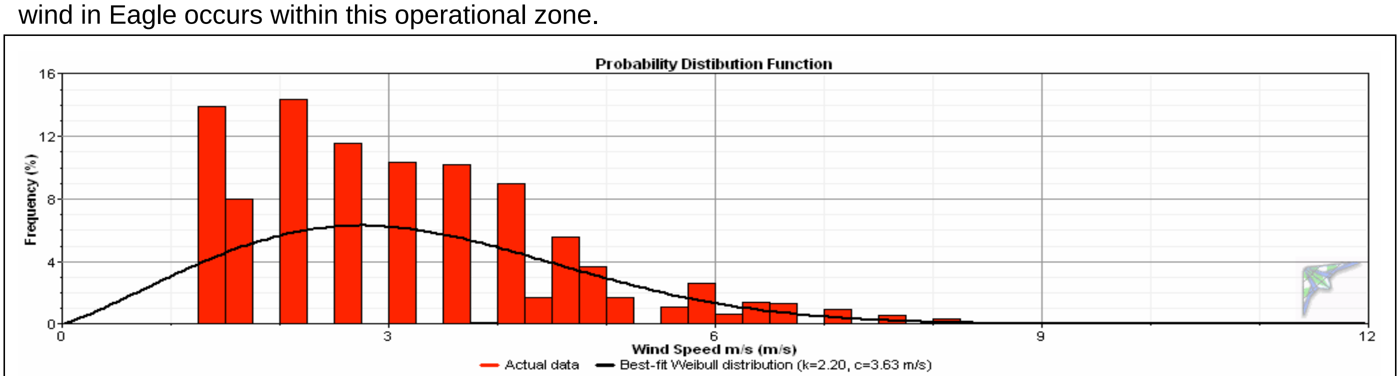
As shown, the highest wind month is typically January and the lowest wind month is typically July. Winds are typically highest in the late morning.





Average Monthly and Daily Wind Speeds from EAGLE ASOS, 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 31% of the wind in Eagle occurs within this operational zone.

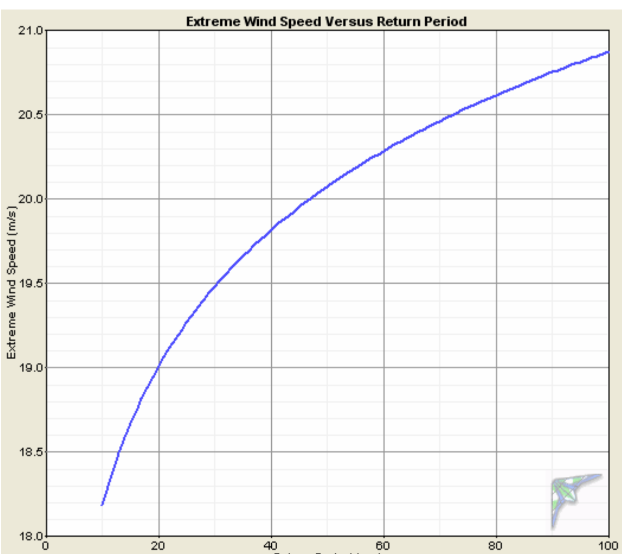


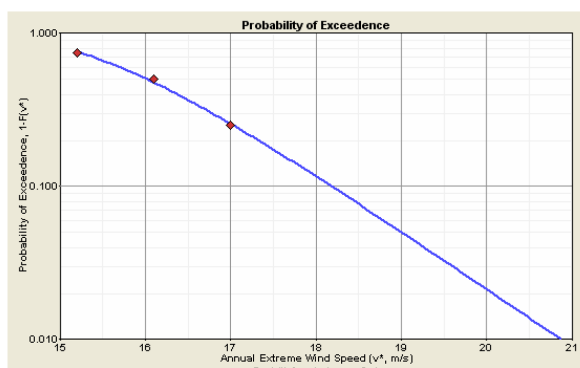
Average Wind Speeds at Eagle ASOS, 10-m Height (m/s)

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
0	4.4	3.3	2.9	2.8	2.7	2.3	2.5	2.3	2.4	2.3	3.6	3.8	[illegible]
1	4.4	3.5	3.3	2.9	3.0	2.4	2.6	2.3	2.3	2.6	3.4	3.7	3.0
2	4.7	3.7	3.2	2.8	3.0	2.6	2.7	2.6	2.7	2.7	3.4	3.5	3.1
3	4.7	3.6	3.0	3.2	3.1	2.7	2.7	2.5	2.8	3.1	3.7	4.1	3.3
4	4.4	3.6	3.1	3.1	3.1	2.8	2.6	2.8	3.0	2.9	3.6	4.2	3.3
5	4.4	3.8	3.3	3.1	3.1	2.7	2.4	2.9	3.1	2.6	3.9	4.1	3.3
6	4.3	3.7	3.5	3.2	3.2	2.8	2.7	3.2	3.0	3.1	4.2	4.5	3.4
7	4.6	3.7	3.4	3.3	3.2	3.1	2.6	3.3	3.1	2.9	4.1	4.4	3.5
8	5.1	4.0	3.5	3.0	3.1	3.1	2.9	3.2	3.5	3.0	4.6	4.8	3.6
9	5.2	3.6	3.5	3.0	3.1	2.9	3.0	3.2	3.6	3.0	4.4	4.6	3.6
10	5.0	3.6	3.8	3.2	3.0	3.0	3.1	2.9	3.7	3.1	4.4	4.0	3.6
11	4.7	3.9	3.5	3.3	2.9	3.0	2.9	2.8	3.7	3.1	4.4	4.1	3.5
12	4.5	4.0	3.6	3.3	2.9	3.1	2.9	2.9	3.5	3.1	4.0	4.0	3.5
13	4.4	4.1	3.5	3.3	3.0	3.2	2.9	2.8	3.3	3.1	4.0	4.2	3.5
14	4.2	4.4	3.2	3.5	3.3	3.0	2.8	2.7	3.3	3.0	4.0	4.4	3.5
15	4.6	4.8	2.8	3.4	3.2	3.3	2.9	2.8	3.2	3.2	4.0	4.2	3.5
16	4.6	4.6	2.5	3.1	3.2	3.2	2.6	2.6	3.5	3.0	4.1	4.5	3.5
17	4.1	4.0	3.1	3.0	3.4	3.0	2.6	2.6	3.0	2.6	3.6	4.3	3.3
18	4.2	3.5	3.2	3.3	3.0	2.6	2.5	2.6	3.2	2.7	3.3	4.4	3.2
19	4.1	3.7	2.9	2.7	2.8	2.4	2.2	2.5	2.8	2.8	3.4	4.0	3.0
20	4.1	3.1	2.8	2.9	2.6	2.5	2.4	2.5	2.7	2.9	3.1	3.6	2.9
21	4.4	3.3	2.7	3.1	2.6	2.4	2.2	2.3	2.4	2.9	3.5	3.1	2.9
22	3.7	2.9	2.9	2.6	2.3	2.5	2.1	2.3	2.2	2.7	3.2	3.2	2.7
23	4.1	3.0	2.9	2.8	2.4	2.5	2.2	2.3	2.2	2.6	3.3	3.6	2.8
Ave	4.4	3.7	3.2	3.1	3.0	2.8	2.6	2.7	3.0	2.9	3.8	4.1	3.3

EXTREME GUST ANALYSIS

Using the Windographer software program (www.mistaya.ca), a Gumbel distribution is fit to the 6 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 20.9 m/s.





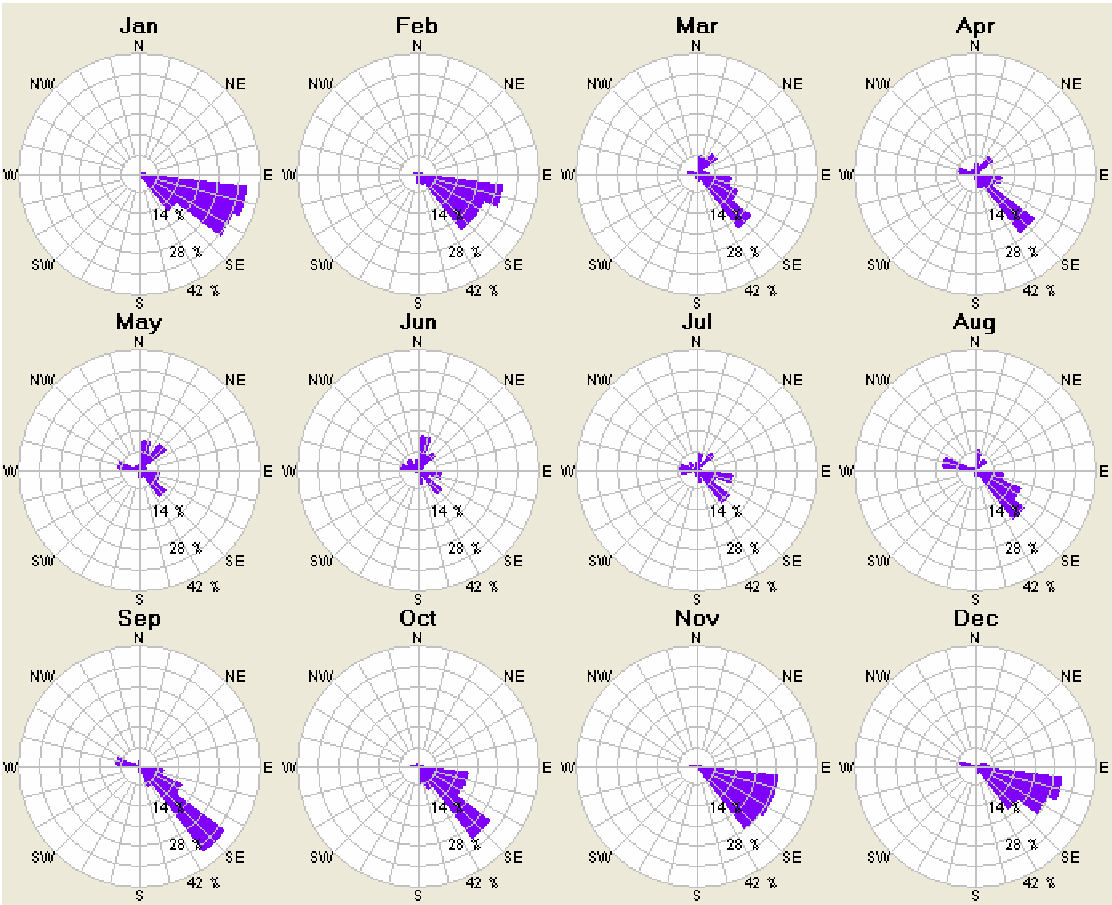
Return Period (yr)	Extreme Wind Speed (m/s)
20	19.0
25	19.3
50	20.1
100	20.9

Gumbel distribution parameters

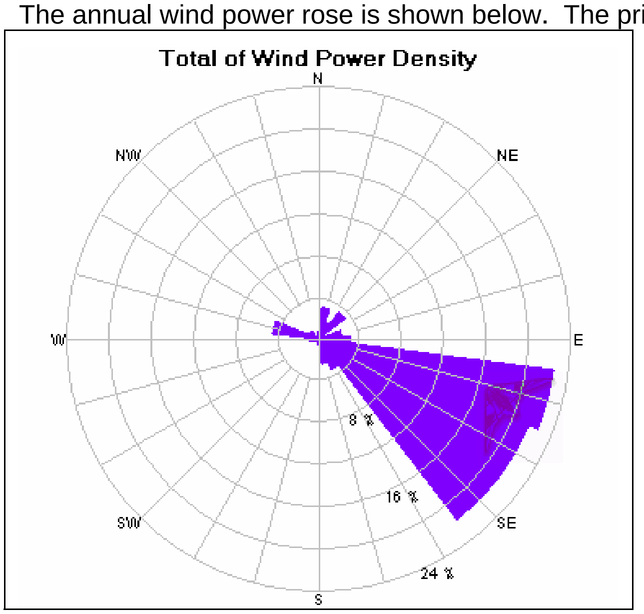
Scale:	1.14 m/s
Mode:	15.6 m/s
r^2	0.995

WIND DIRECTION

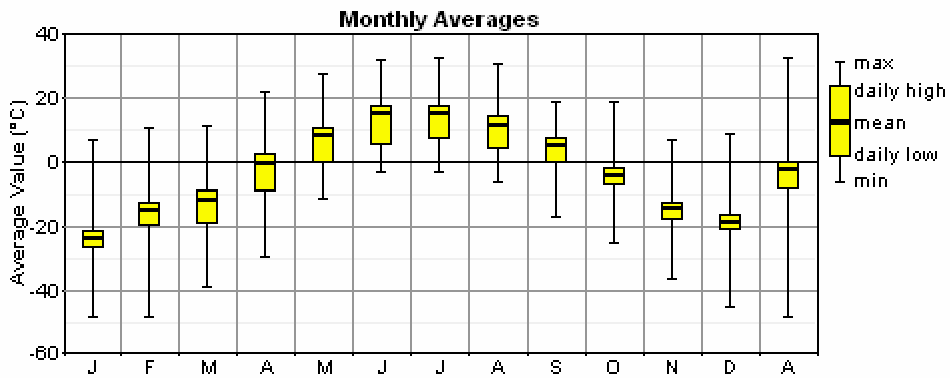
The monthly wind power roses, which show the percent of total power available in the wind from each direction, are shown below.



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



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 ASOS site are shown below. Over the 6 year period, the temperature dropped below -25°C during 9% of the time, or 800 hours per year.



Monthly Average Temperatures at Eagle ASOS, 1998-2006

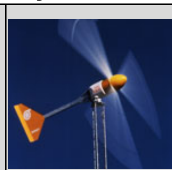
POTENTIAL POWER PRODUCTION FROM WIND TURBINES IN EAGLE
The power curves from various wind turbines were used to calculate potential energy production in Eagle. Although different wind turbines are available with different tower heights, to be consistent it is assumed that any wind turbine rated at 100 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 April 1998 through January 2006 at the ASOS weather station in Eagle, Alaska. The long-term annual average wind speed at the site is 3.3 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 40 W/m^2. Eagle has a Class 1 wind resource, which is rated “poor” for wind power development. The net capacity factor for wind turbines would range from 3% to 7%.

Based on this initial review, the community of Eagle appears to be a poor candidate for wind power. However, before abandoning 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. The information in this report is based on the site of the ASOS equipment. If the topography of the potential wind turbine location varies from the ASOS 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 ASOS 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	861	4,352	5,328	11,273	8,914	27,901	24,956	92,970
Feb	429	2,232	2,286	5,383	4,078	14,254	12,343	44,483
Mar	255	1,408	1,099	3,123	2,205	9,086	7,532	25,092
Apr	212	1,183	874	2,598	1,804	7,628	6,259	20,089
May	184	1,058	717	2,280	1,534	6,783	5,491	17,047
Jun	125	770	420	1,573	983	4,920	3,852	11,177
July	95	622	275	1,223	706	3,923	2,980	7,939
Aug	113	717	351	1,430	865	4,491	3,471	9,713
Sep	187	1,067	732	2,300	1,556	6,878	5,578	17,490
Oct	162	954	584	1,997	1,306	6,069	4,838	14,697
Nov	499	2,576	2,723	6,300	4,811	16,503	14,385	52,092
Dec	635	3,262	3,667	8,128	6,306	20,817	18,343	67,751
Annual	3,756	20,201	19,055	47,606	35,070	129,250	110,030	380,536
Annual Average Capacity Factor								
Gross CF	4%	8%	3%	5%	4%	6%	6%	7%
Net CF	4%	7%	3%	5%	4%	5%	5%	6%

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.