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Wind Resource Assessment for KING SALMON, ALASKA

Date last modified: 4/14/2006
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SITE SUMMARY

ICAO Station ID:	PAKN
NCDC Data Set:	703260
Latitude (NAD27):	58.683
Longitude (NAD27):	-156.65
Magnetic Declination:	16° 44' E changing by 0° 12' W/year
Tower Type:	ASOS
Sensor Heights:	10m
Elevation:	17.4m
Monitor Start:	Jan 1, 2000
Monitor End:	Jan 14, 2006

This report summarizes wind resource data collected from the Automated Surface Observing System (ASOS) in King Salmon, Alaska. The hourly data set from January 2000 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 Saint Paul.

The King Salmon ASOS equipment and surrounding terrain are shown to the right. King Cove is located on the south side of the Alaska Peninsula, on a sand spit fronting Deer Passage and Deer Island.

Image courtesy of Ed Doerr, NOAA

WIND RESOURCE SUMMARY

Annual Average Wind Speed (10m height):	4.4 m/s (9.9 mph)
Annual Average Wind Speed (30m height, estimated):	5.0 m/s (11.1 mph)
Average Wind Power Density (10m height):	110 W/m^2
Average Wind Power Density (30m height, estimated):	150 W/m^2
Wind Power Class (range = 1 to 7):	Class 2
Rating (Poor, Marginal, Fair, Good, Excellent, Outstanding):	Marginal
Prevailing Wind Direction:	South, West

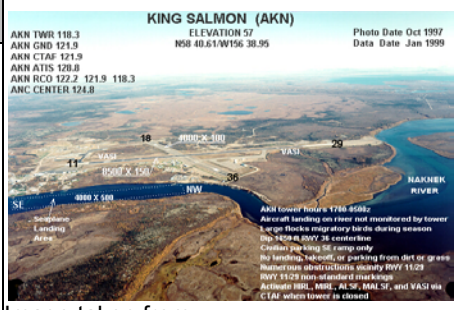
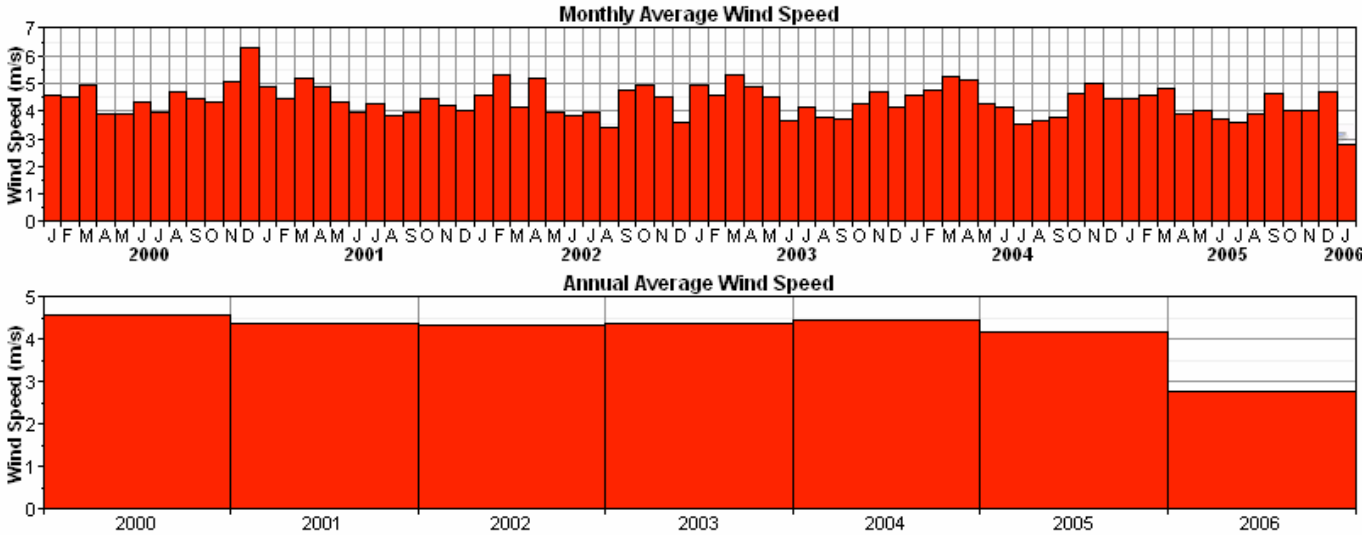


Image taken from:
http://www.alaska.faa.gov/fai/airports.htm

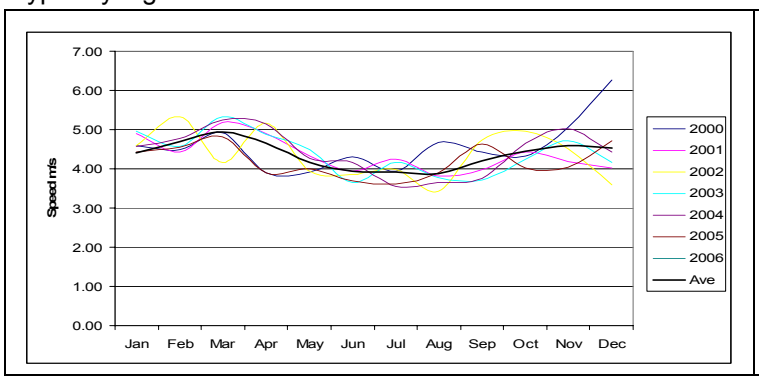
Based on data collected at the ASOS site, King Salmon has a Class 2 wind resource, which is rated as “marginal for wind power development.”

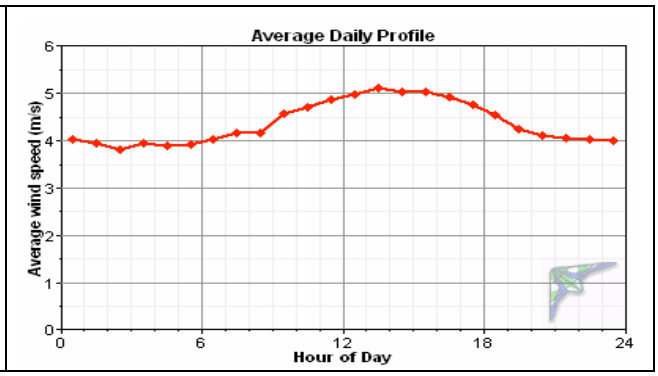
WIND DATA RESULTS FOR KING SALMON ASOS SITE

Wind speeds from January 2000 through January 2006 are summarized below. The average wind speed over the 6-year period is 4.4 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.



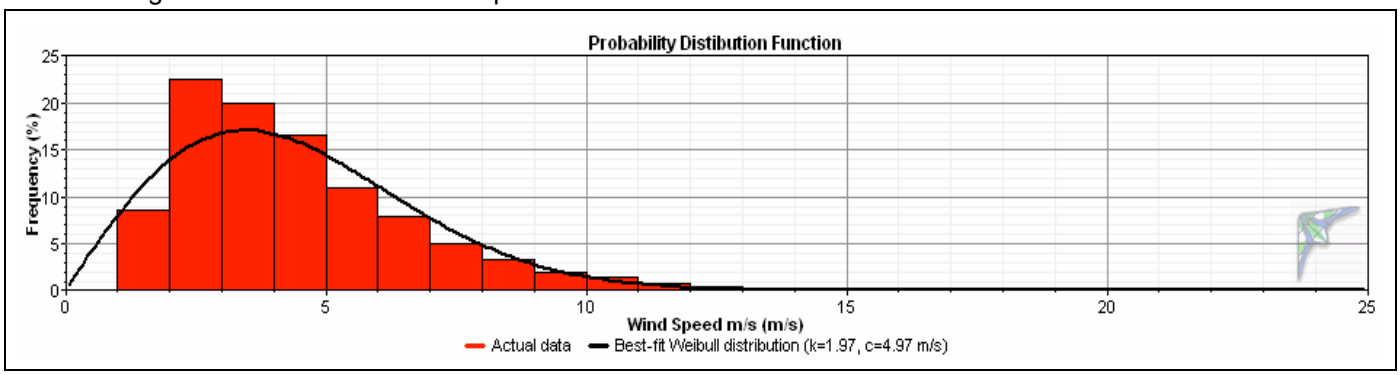
As shown, the highest wind month is typically March and the lowest wind month is typically August. Winds are typically highest in the afternoon.





Average Monthly and Daily Wind Speeds from King Salmon 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 49% of the wind in King Salmon occurs within this operational zone.

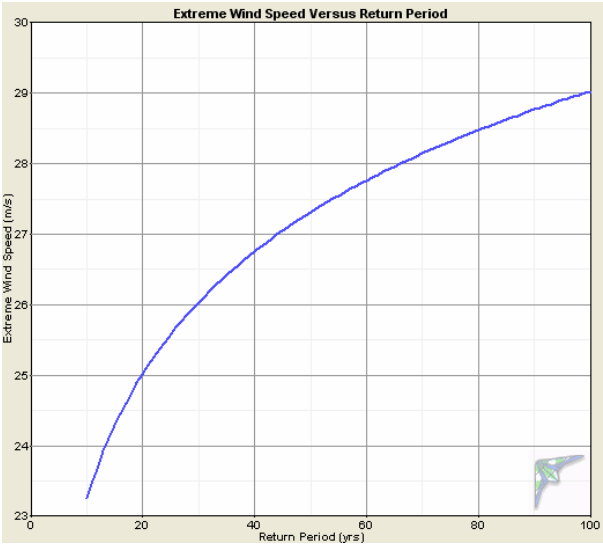


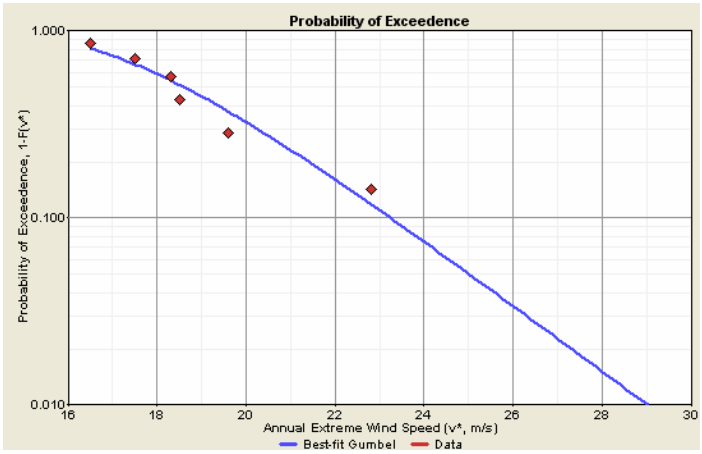
Average Wind Speeds at King Salmon ASOS, 10-m Height (m/s)

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
0	4.0	4.2	4.6	4.3	3.2	3.0	3.5	3.6	3.6	3.9	3.9	4.1	3.8
1	4.0	4.6	4.9	4.2	3.4	2.9	3.5	3.6	3.2	3.8	4.1	3.7	3.8
2	3.9	4.5	4.4	4.2	3.6	3.2	3.2	3.3	3.8	3.6	4.1	3.7	3.8
3	3.8	4.5	4.1	3.7	3.6	3.3	3.3	3.3	3.8	3.5	4.3	3.9	3.8
4	3.9	4.5	4.2	3.9	3.4	3.3	3.4	3.5	3.8	3.7	4.3	4.2	3.8
5	4.1	4.4	4.2	4.1	3.8	3.8	3.6	3.5	3.8	3.8	4.3	4.1	4.0
6	4.3	4.5	4.7	4.2	3.8	4.0	4.0	3.7	4.2	3.8	4.4	4.0	4.1
7	4.2	4.6	4.6	4.1	4.1	4.2	4.2	3.5	4.2	3.7	4.6	4.3	4.2
8	4.0	4.6	4.8	4.5	4.3	4.3	4.3	3.7	4.6	4.1	4.5	4.6	4.4
9	4.2	4.5	5.1	4.7	4.3	4.4	4.3	3.8	4.6	4.3	4.6	4.7	4.5
10	4.7	4.5	4.8	4.8	4.5	4.1	4.3	3.8	4.5	4.4	5.2	4.8	4.5
11	5.0	4.8	5.1	4.8	4.6	4.3	4.1	3.9	4.7	4.5	5.3	5.0	4.7
12	5.4	5.1	5.1	5.0	4.8	4.3	4.2	4.2	4.6	4.8	5.0	5.2	4.8
13	5.3	5.0	5.6	5.7	4.6	4.3	4.2	4.4	4.6	5.2	5.1	5.7	5.0
14	5.3	4.5	5.8	5.6	4.7	4.3	4.2	4.4	4.8	5.3	4.9	6.0	5.0
15	5.1	4.8	5.6	5.5	4.9	4.2	4.7	4.5	4.5	5.2	5.3	5.6	5.0
16	5.4	5.0	5.6	5.1	4.9	4.2	4.3	4.6	4.3	5.1	5.3	5.5	4.9
17	5.5	5.4	5.8	5.3	4.5	4.3	4.2	4.6	4.7	5.3	5.3	4.8	5.0
18	5.0	5.1	5.4	5.0	4.8	4.4	4.1	4.6	4.6	5.2	4.9	4.9	4.8
19	5.0	5.0	5.3	5.1	4.7	4.1	4.0	3.9	4.4	5.4	4.4	4.5	4.7
20	4.6	4.7	4.8	4.6	4.1	4.1	3.8	3.9	4.1	5.1	4.2	4.0	4.3
21	4.4	4.8	4.9	4.5	3.9	3.8	3.6	4.0	4.0	4.4	4.2	4.0	4.2
22	4.2	4.5	4.8	4.5	3.7	4.0	3.7	3.7	4.0	4.3	4.2	4.1	4.1
23	4.2	4.4	4.5	4.4	3.5	3.6	3.5	3.4	3.8	4.3	4.1	4.2	4.0
Ave	4.6	4.7	4.9	4.7	4.2	3.9	3.9	3.9	4.2	4.4	4.6	4.6	4.4

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 29.0 m/s.





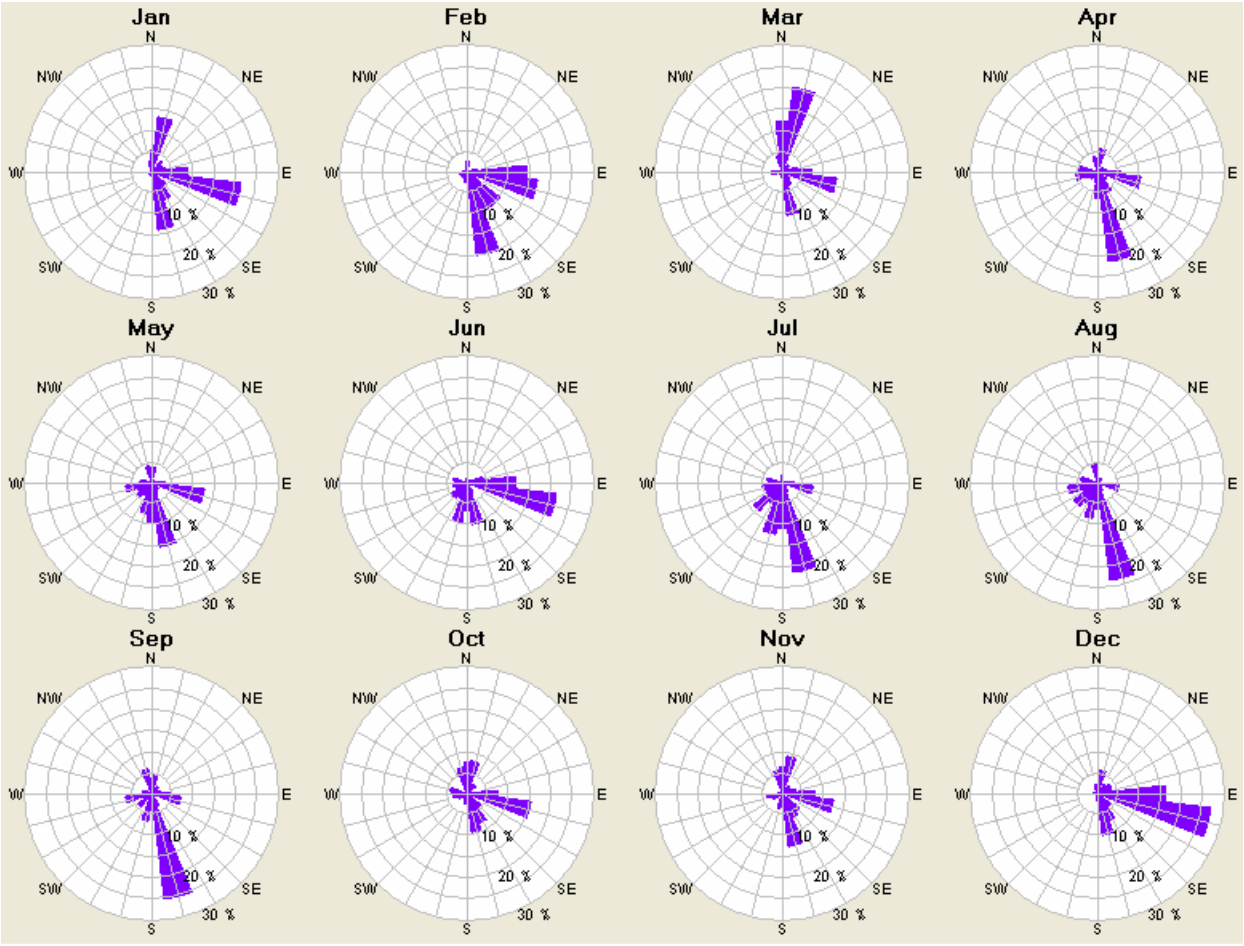
Return Period (yr)	Extreme Wind Speed (m/s)
20	25.0
25	25.6
50	27.3
100	29.0

Gumbel distribution parameters

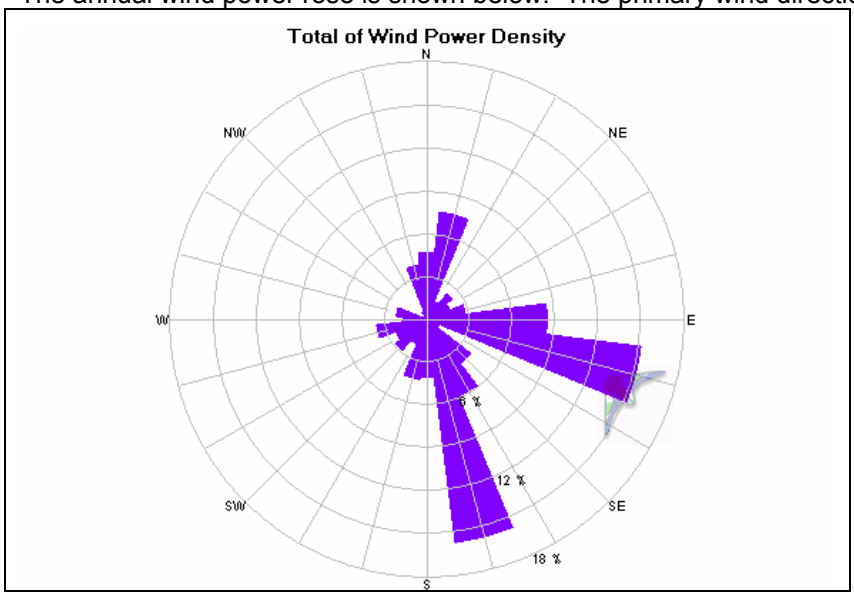
Scale:	2.46 m/s
Mode:	17.7 m/s
r^2	0.937

WIND DIRECTION

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

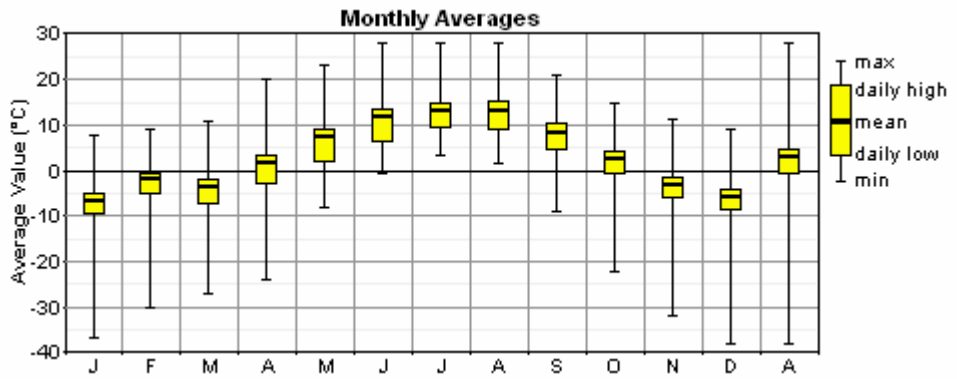


The annual wind power rose is shown below. The primary wind directions are the South and West.



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 less than 1% of the time.



Monthly Average Temperatures at King Salmon ASOS, 2000-2006

POTENTIAL POWER PRODUCTION FROM WIND TURBINES IN KING SALMON

The power curves from various wind turbines were used to calculate potential energy production in King Salmon. 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 2000 through January 2006 at the ASOS weather station in King Salmon, Alaska. The long-term annual average wind speed at the site is 4.4 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 110 W/m^2. King Salmon has a Class 2 wind resource, which is rated “marginal” for wind power development. The net capacity factor for wind turbines would range from 10% to 17%.

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	963	4,810	6,321	13,010	10,422	31,636	28,426	104,001
Feb	959	4,674	6,226	12,825	10,305	30,510	27,676	100,911
Mar	1,198	5,802	7,975	16,211	13,118	38,364	34,848	126,392
Apr	961	4,783	6,321	12,985	10,414	31,516	28,337	103,592
May	712	3,643	4,416	9,425	7,425	23,736	21,118	77,667
Jun	580	2,985	3,442	7,548	5,866	19,136	16,914	62,027
July	580	3,016	3,466	7,612	5,887	19,423	17,115	62,657
Aug	566	2,937	3,349	7,390	5,704	18,828	16,546	60,534
Sep	721	3,651	4,470	9,500	7,497	23,584	21,058	77,467
Oct	869	4,385	5,609	11,676	9,279	28,741	25,735	94,379
Nov	941	4,705	6,204	12,741	10,213	31,084	27,893	102,090
Dec	961	4,819	6,330	13,019	10,430	31,707	28,461	104,219
Annual	10,010	50,210	64,129	133,939	106,558	328,263	294,126	1,075,933
Annual Average Capacity Factor								
Gross CF	11%	19%	11%	15%	12%	15%	15%	19%
Net CF	10%	17%	10%	14%	11%	14%	13%	17%

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.