ALASKA ENERGY AUTHORITY

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Wind Resource Assessment for CHEFORNAK, ALASKA

Date last modified: 3/15/2006
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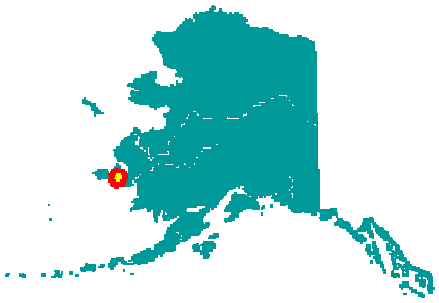
SITE SUMMARY



Latitude (NAD27):	approx. 60.16˚ N
Longitude (NAD27):	approx. 164.266˚ W
Magnetic Declination:	13˚ 27' East
Elevation:	12 meters (40 ft)
Wind Data Source:	Synthesized based on surrounding stations

Chefornak is located at the junction of the Keguk and Kinia Rivers in the Yukon-Kuskokwim Delta, about 100 miles southwest of Bethel and 500 miles southwest of Anchorage. Chefornak is located in a marine climate. (source: Department of Community and Economic Development)

(Photo source: Department of Community and Economic Development)

WIND RESOURCE SUMMARY

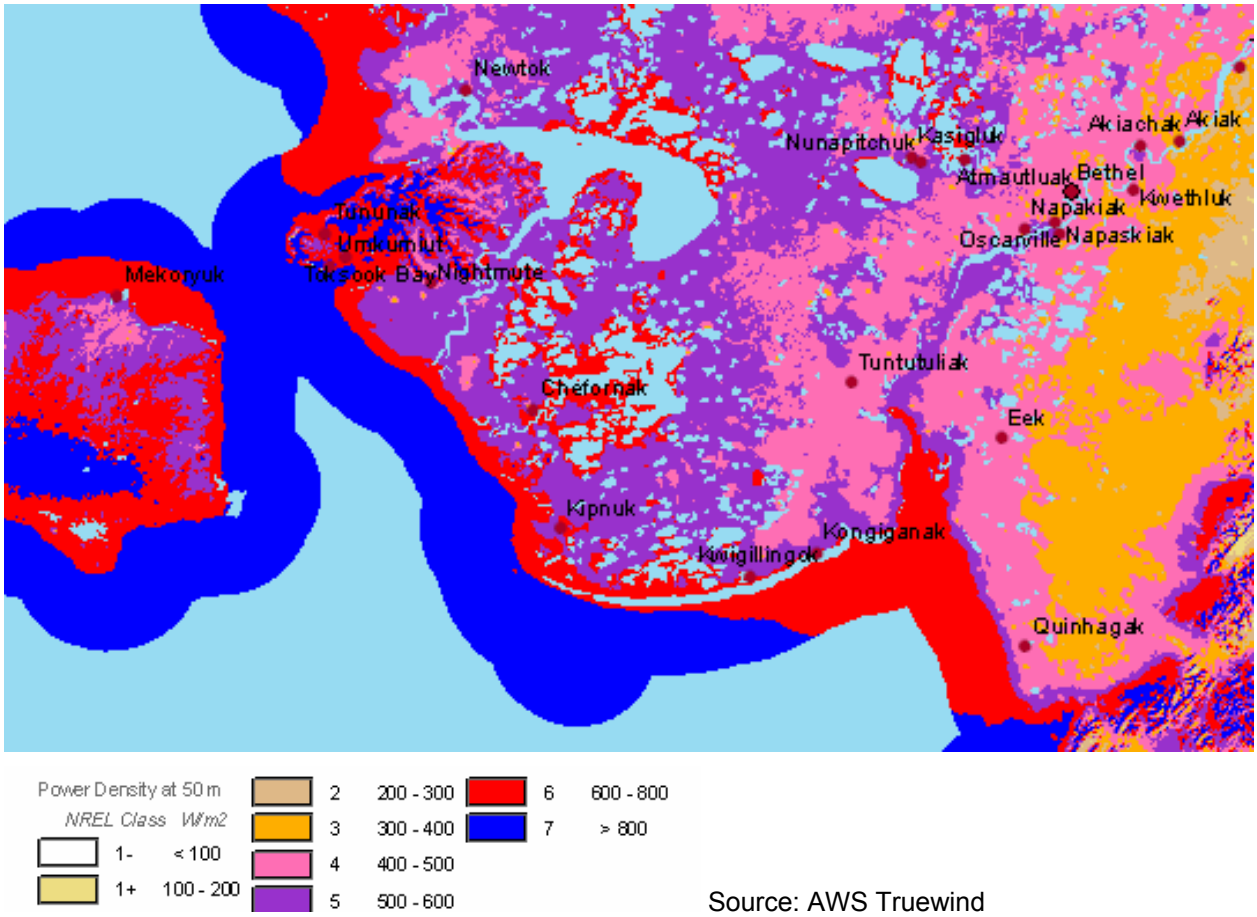
Annual Average Wind Speed (30m height, estimated):	7.3 m/s (16.3 mph)
Annual Average Wind Speed (50m height, estimated):	8.4 m/s (18.8 mph)
Average Wind Power Density (30m height, estimated):	500 W/m^2
Average Wind Power Density (50m height, estimated):	800 W/m^2
Wind Power Class (range = 1 to 7):	Class 6
Rating (Poor, Marginal, Fair, Good, Excellent, Outstanding):	Outstanding

The wind resource in Chefornak was estimated based on data collected from 30-meter tall meteorological towers in the surrounding communities of Nightmute, Toksook Bay, Kongiganak, and Bethel. The Automated Surface Observation System (ASOS) in Mekoryuk was used as a long-term reference station. The purpose of this effort is to provide a high quality wind resource data set that can be used to evaluate the feasibility of utilizing utility-scale wind energy in the community.

Source: Federal Aviation Administration

INTRODUCTION

On initial review, the community of Chefornak appears to be a good candidate for wind power. The wind resource map below shows that Chefornak is located within a wind regime of Class 5 to 6. In most cases, wind power classes of 4 and above are believed to be viable for generation of electricity by wind turbines.



Source: AWS Truewind

Figure 1. Wind Resource Map of Alaska

In June of 2004, the Alaska Energy Authority supported the installation of 30-meter tall meteorological towers in Nightmute and Toksook Bay. A met tower was also installed in Kongiganak in October 2004 and in Bethel in December 2004. An Automated Surface Observation System (ASOS) is located in Mekoryuk and provides long-term wind resource data for the region. In this report a wind resource data set for Chefornak was synthesized based on data collected from these other wind monitoring stations in the area. The purpose of this effort is to provide a high quality wind resource data set that can be used to evaluate the feasibility of utilizing utility-scale wind energy in the community.

This report summarizes the data processing procedures that were performed with the met tower data in order to create an annual dataset of "typical" wind speeds in Chefornak. This data set is then used to calculate potential power production from wind turbines in the community. The raw data sets from the various wind monitoring stations are available on the Alaska Energy Authority website (www.akenergyauthority.org) so one could perform their own calculations. The synthesized data set for Chefornak is also available on the website.

WIND DATA

The table below summarizes the wind data from the various monitoring sites. These parameters were used to create a data set for Chefornak using the software program Windographer (www.mistaya.ca). It is presumed that the wind resource in Chefornak will most closely match that of Nightmute and Kongiganak.

	Nightmute 30m measured	Toksook Bay 30m measured	Bethel 30m measured	Kongiganak 30m measured	Mekoryuk 10m measured	Chefornak 30m estimated
Weibull k	1.641	1.753	1.899	1.911	1.78	1.8
Weibull c	7.99	7.88	7.72	8.18	6.87	8.0
Hour of peak wind	18	18	18	17	16	18
Autocorrelation coefficient	0.92	0.90	0.93	0.93	0.90	0.92
Diurnal pattern strength	0.04	0.06	0.06	0.03	0.09	0.05
Wind power class	6	6	4	6	6	6
Wind power density	557	486	426	496	318	500
Wind Shear	0.14	0.14	0.19	0.24	N/A	0.10
Turbulence Intensity	0.12	0.11	0.09	0.08	N/A	0.1
Mean wind speed (m/s)						
Jan	11.4	8.0	10.0	8.3	6.9	9.3
Feb	8.8	8.0	7.5	8.5	7.0	8.1
Mar	9.0	7.6	7.7	8.4	6.6	8.2
Apr	7.5	7.0	6.4	7.6	6.0	7.1
May	6.3	6.1	5.4	6.2	5.3	5.9
Jun	6.0	6.2	5.5	5.9	5.3	5.6
Jul	4.9	5.3	5.2	5.3	4.6	4.8
Aug	6.0	6.8	6.0	6.7	5.9	6.0
Sep	6.6	6.7	6.7	7.5	6.0	6.6
Oct	7.0	7.7	7.7	7.8	6.7	6.9
Nov	8.0	8.8	8.8	9.2	7.7	8.1
Dec	9.2	8.6	8.2	8.6	7.6	8.3
Annual	7.2	7.0	6.9	7.3	6.1	7.1

The monthly average wind speeds from all sites are compared in the graph below. As shown, the region experiences a strong seasonal wind profile, with stronger winds in the winter months than the summer months.

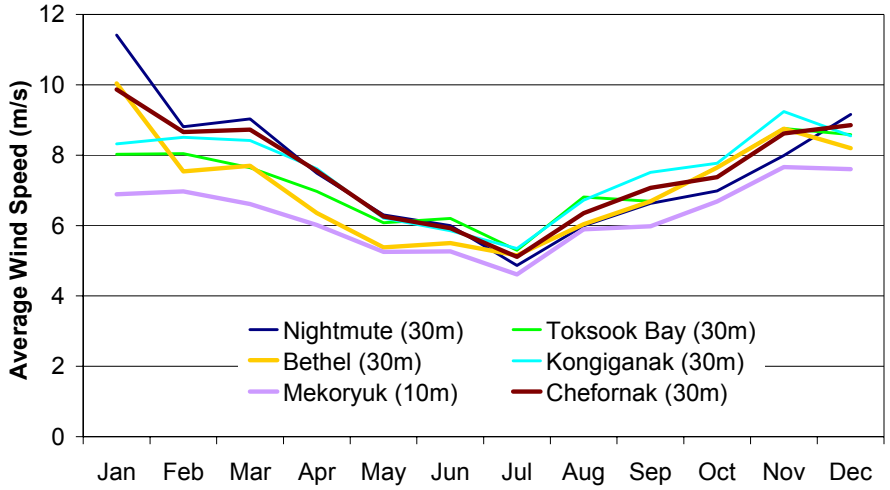
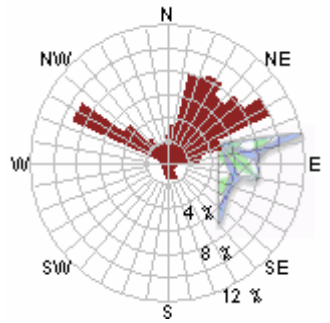
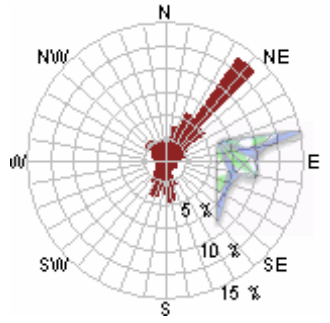
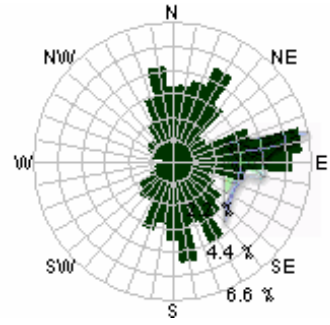
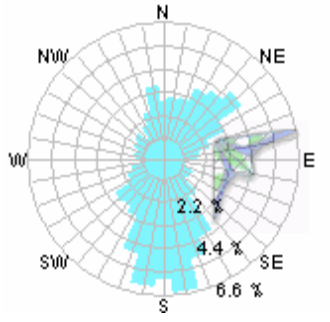
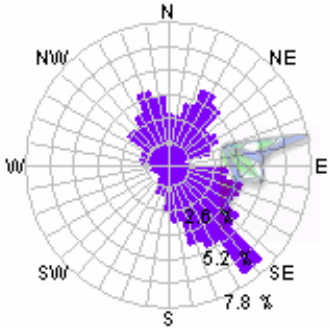


Figure 2. Comparison of Wind Speed Measurements

WIND DIRECTION

The charts below show the wind power roses (percent of power available in the wind from each direction) for the wind monitoring sites surrounding Chefornak.

Table 1. Comparison of Wind Power Roses

 **NIGHTMUTE**	 **BETHEL**	 **TOKSOOK BAY**
 **KONGIGANAK**	 **MEKORYUK**	

POTENTIAL POWER PRODUCTION FROM WIND TURBINES

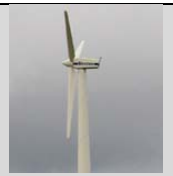
Various wind turbines were used to calculate the potential energy production from wind turbines in Chefornak. Although different wind turbines are offered with different tower heights, to be consistent it is assumed that any wind turbine rated at 100 kW or less would be mounted on a 30-meter tall tower, while anything larger would be mounted on a 50-meter tower. The wind resource was adjusted to these heights based on a wind shear of 0.10. The data was also adjusted to account for local air density.

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, yaw losses, array losses, and extreme weather conditions can further reduce turbine output. The gross capacity factor is multiplied by 0.90 to account for these factors, resulting in the net capacity factor listed.

CONCLUSION

Data from meteorological stations in the surrounding communities of Nightmute, Toksook Bay, Kongiganak, Mekoryuk, and Bethel were compared, and the general trends were used to synthesize a wind speed data set for Chefornak. This information was used to make predictions as to the potential energy production from wind turbines in Chefornak. It is estimated that the long-term annual average wind speed in Chefornak is 7.1 m/s at a height of 30 meters above ground level and the average wind power density for the site is 500 W/m^2. This information means that Chefornak has a Class 6 wind resource, which is rated “outstanding” for wind power development. However, the wind resource can be highly variable between sites. Although the topography of the area is not complex, the actual wind resource at the potential wind turbine location in Chefornak may vary from that presented in this report due to the great distance between the wind monitoring sites used in the analysis.

Table 2. 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	2,738	13,042	22,716	43,409	35,371	106,940	97,102	314,559
Feb	2,192	10,242	16,944	32,914	26,909	85,052	77,127	255,542
Mar	2,458	11,488	19,072	37,012	30,253	95,512	86,443	286,010
Apr	1,968	9,076	14,210	28,100	22,979	76,008	69,346	234,877
May	1,389	6,603	9,456	19,033	15,498	55,406	50,750	178,326
Jun	1,170	5,640	7,860	15,935	12,915	47,341	43,291	153,633
July	787	3,995	5,030	10,545	8,361	34,609	31,317	113,683
Aug	1,412	6,675	9,605	19,343	15,767	56,183	51,489	180,381
Sep	1,677	7,780	11,690	23,347	19,103	65,260	59,623	205,370
Oct	1,895	8,711	13,392	26,614	21,797	73,297	66,887	228,372
Nov	2,342	10,886	17,995	35,014	28,621	90,149	81,813	271,367
Dec	2,489	11,625	19,435	37,656	30,748	96,848	87,681	288,848
Annual	22,516	105,764	167,408	328,919	268,321	882,604	802,869	2,710,965
Annual Average Capacity Factor								
Gross CF	26%	40%	29%	38%	31%	40%	41%	47%
Net CF	23%	36%	26%	34%	28%	36%	37%	42%

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 wind resource measured at the met tower site, adjusted for long-term trends and local air density.