Kodiak, Alaska Site 2 Wind Resource Report

Report written by: Douglas Vaught, P.E., V3 Energy LLC, Eagle River, AK
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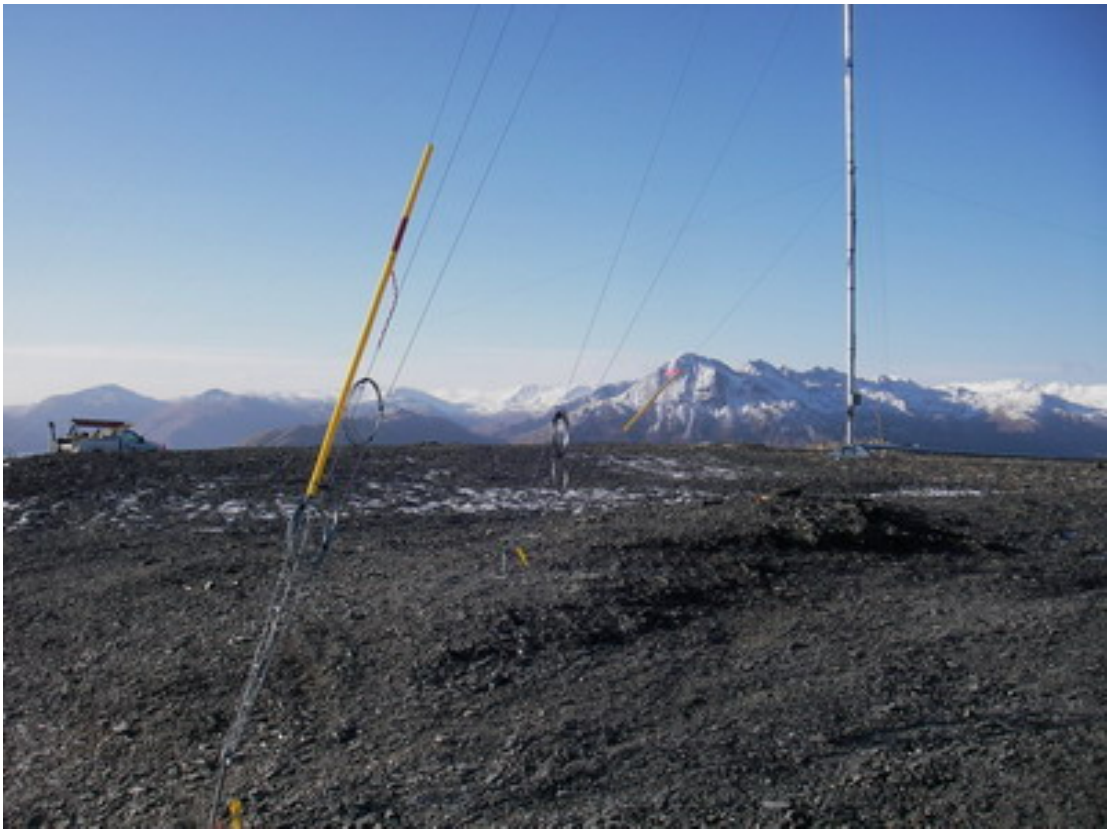


Photo by Doug Vaught, V3 Energy LLC

Summary Information

Pillar Mountain has superb potential for wind power development with a Class 7 rating, very low wind shear, seasonally directional winds, and low turbulence. A significant construction advantage of this site is that the underlying ground is mostly solid rock.

Meteorological Tower Data Synopsis

Wind power class (measured to date)	Class 7 – Superb
Average wind speed (30 meters)	8.25 m/s (measured)
Average wind speed (60 meters)	8.36 m/s (predicted)
Maximum wind speed (2 sec average)	52.0 m/s, 3/8/06 (30 m level)
Mean wind power density (50 meters)	943 W/m^2 (predicted)
Mean wind power density (30 meters)	917 W/m^2
Roughness Class	0.00 (description: smooth)
Power law exponent	0.023 (extremely low wind shear)
Turbulence Intensity (30 meters)	0.120
Data start date	November 4, 2005
Most recent data date	February 27, 2007

Community Profile

Current Population: 6,088 (2005 State Demographer est.)
Pronunciation/Other Names: (KOH-dee-ack); includes Shoonaq'
Incorporation Type: Home Rule City
Borough Located In: Kodiak Island Borough
School District: Kodiak Island Borough School District
Regional Native Corporation: Koniag, Incorporated

Location:

Kodiak is located near the north eastern tip of Kodiak Island in the Gulf of Alaska. Kodiak Island, "the emerald isle," is the largest island in Alaska, and is second only to Hawaii in the U.S. Kodiak National Wildlife Refuge encompasses nearly 1.9 million acres on Kodiak and Afognak Islands. It is 252 air miles south of Anchorage, a 45-minute flight, and is a 4-hour flight from Seattle. It lies at approximately 57.788890° North Latitude and -152.401900° West Longitude. (Sec. 32, T027S, R019W, Seward Meridian.) Kodiak is located in the Kodiak Recording District. The area encompasses 3.5 sq. miles of land and 1.4 sq. miles of water.

History:

The Island has been inhabited for the past 8,000 years. The first non-Native contacts were in 1763, by the Russian Stephen Glotov, and in 1792 by Alexander Baranov, a Russian fur trapper. Sea otter pelts were the primary incentive for Russian exploration, and a settlement was established at Chiniak Bay, the site of present-day Kodiak. At that time, there were over 6,500 Sugpiaqs (Koniags) in the area and the Island was called "Kikhtak." It later was known as "Kadiak," the Inuit word for island. Kodiak became the first capital of Russian Alaska, and Russian colonization had a devastating effect on the local Native population. By the time Alaska became a U.S. Territory in 1867, the Koniag region Eskimos had almost disappeared as a viable culture. Alutiiq (Russian-Aleut) is the present-day Native language. Sea otter fur harvesting was the major commercial enterprise, and eventually led to the near extinction of the species. However, in 1882 a fish cannery opened at the Karluk spit. This sparked the development of commercial fishing in the area. The "Town of Kodiak" was incorporated in 1940. During the Aleutian Campaign of World War II, the Navy and the Army built bases on the Island. Fort Abercrombie was constructed in 1939, and later became the first secret radar installation in Alaska. Development continued, and the 1960s brought growth in commercial fisheries and fish processing. The 1964 earthquake and subsequent tidal wave virtually leveled downtown Kodiak. The fishing fleet, processing plant, canneries, and 158 homes were destroyed - $30 million in damage. The infrastructure was rebuilt, and by 1968, Kodiak had become the largest fishing port in the U.S., in terms of dollar value. The Magnusson Act in 1976 extended

the U.S. jurisdiction of marine resources to 200 miles offshore, which reduced competition from the foreign fleet, and over time, allowed Kodiak to develop a groundfish processing industry.

Culture:

The local culture surrounds commercial and subsistence fishing activities. The Coast Guard comprises a significant portion of the community, and there is a large seasonal population. Kodiak is primarily non-Native, and the majority of the Native population are Alutiiq. Filipinos are a large subculture in Kodiak due to their work in the canneries. A Russian Orthodox Church seminary is based in Kodiak, one of two existing seminaries in the U.S. The Shoonaq' Tribe of Kodiak was federally recognized in January 2001. A branch of the University of Alaska Anchorage, Kodiak College is located in the City of Kodiak.

Economy:

The Kodiak economy is based on fishing, seafood processing, retail services and government. Adaptability and diversification in a variety of fisheries has enabled the Kodiak economy to develop and stabilize. 665 area residents hold commercial fishing permits, and numerous fish processing companies operate here year-round. The largest processors include Trident, Ocean Beauty, North Pacific, and Western Processors. The hospital and City also rank among the top employers. The largest U.S. Coast Guard station lies just south of the city. The Kodiak Launch Complex, a $38 million low-Earth orbit launch facility on 27 acres, was recently completed at Cape Narrow near Chiniak. The Kodiak Launch Complex, operated by the Alaska Aerospace Dev. Corp., is the only commercial launch range in the U.S. that is not co-located with a federal facility. The KLC launched its first payload in November 1998. In August 2003, Alaska Aerospace Dev. Corp. was awarded an $8 million contract to handle two or three Missile Defense Agency launches in 2003-2004. The Kodiak-launched missiles will be targets, not interceptors. With similar launches planned annually over the next five years, the contract could be worth up to $40 million. The Kodiak Chamber of Commerce provides economic development services to the area (www.kodiak.org).

Facilities:

Pillar Creek and Monashka Creek Reservoirs provide water, which is stored and distributed by pipe throughout the area. Piped sewage is processed in a treatment plant. All homes are fully plumbed. The piped system has been expanded to Miller Point and Spruce Cape, to replace individual wells and septic tanks in those areas. Refuse collection services are provided by the Borough. The landfill is located 6 miles north of the City, at Monashka Bay. Kodiak Electric Association, a cooperative utility, operates and purchases power from the Four Dam Pool-owned Terror Lake Hydroelectric Facility. It also operates a Coast Guard-owned plant, and owns three additional diesel-powered plants at Swampy Acres, Kodiak and Port Lions.

Transportation:

Kodiak is accessible by air and sea. The State-owned Kodiak Airport provides three asphalt runways. These runways measure: 7,562' long by 150' wide; 5,398' long by 150' wide; and, 5,011' long by 150' wide. Kodiak Municipal Airport offers a 2,475' long by 40' wide paved runway. Three scheduled airlines serve Kodiak with several daily flights, and a number of air taxi services provide flights to other communities on the Island. City-owned seaplane bases at Trident Basin and Lilly Lake serve floatplane traffic. The Alaska Marine Highway System operates a ferry service to and from Seward and Homer. Travel time to Homer by ferry is 12 hours. The Port of Kodiak includes two boat harbors with 600 boat slips and three commercial piers - the ferry dock, city dock and container terminal. Boat launch ramps and vessel haul-outs are also available. A $20 million breakwater on Near Island provides another 60 acres of mooring space at St. Herman Harbor. The replacement of the 32-year-old float system at the St. Paul Inner Harbor downtown was completed in 2000. Approximately 140 miles of state roads connect island communities on the east side of the island.

Climate:

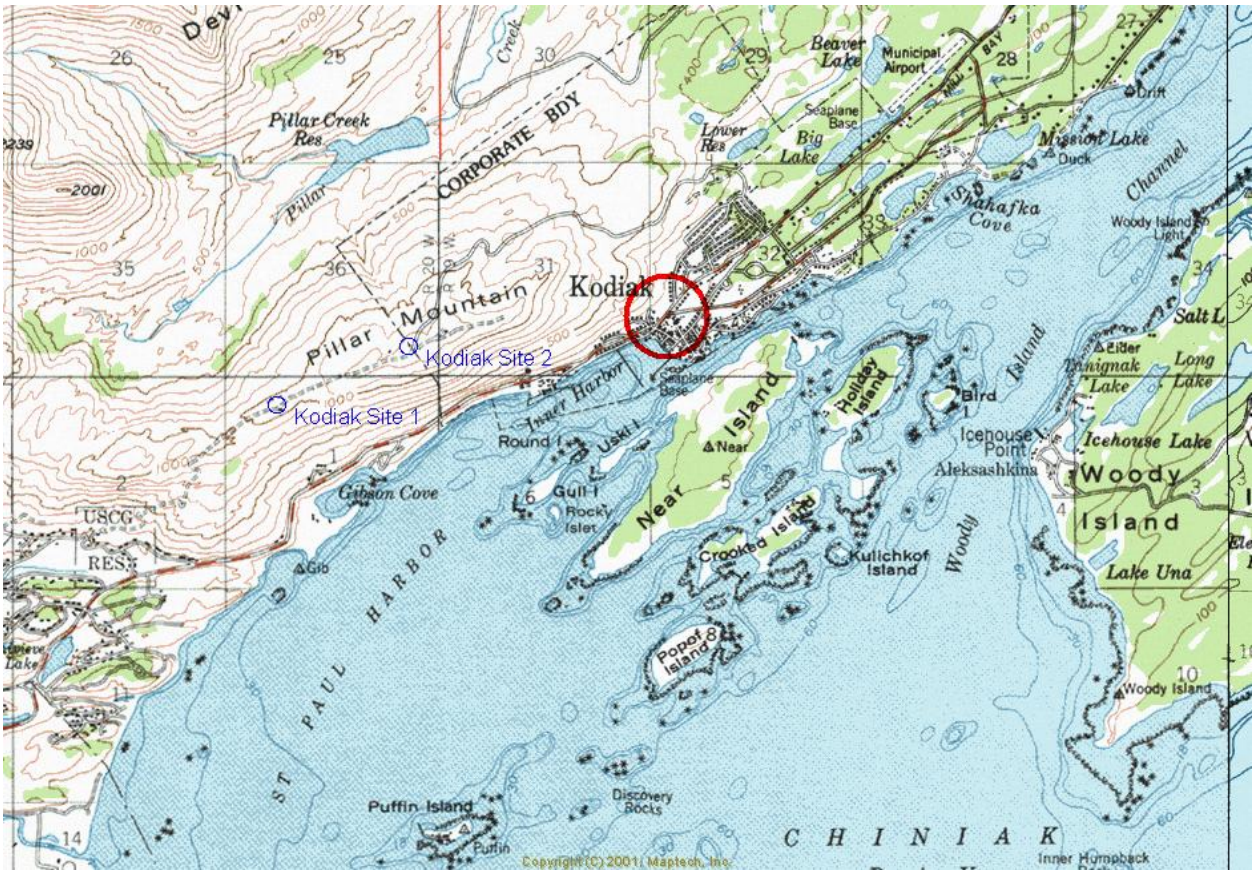
The climate of the Kodiak Islands has a strong marine influence. There is little or no freezing weather, moderate precipitation, occasional high winds, and frequent cloud cover and fog. Severe storms are

common from December through February. Annual rainfall is 67 inches, and snowfall averages 78 inches. January temperatures range from 14 to 46 F; July temperatures vary from 39 to 76 F.

(Above information from State of Alaska Department of Commerce, Community, and Economic Development website, www.dced.state.ak.us).

Site Information and Location

Site number	7357
Site Description	Kodiak, Alaska, Pillar Mountain ridgeline
Latitude/longitude	N 057° 47.257'; W 152° 26.394'
Site elevation	390 meters
Datalogger type	NRG Symphonie
Tower type	NRG 50 meter Tall Tower, replaced with NRG 30 meter Tall Tower



Met Tower Sensor Information

A 50 meter NRG Tall Tower was installed at Site 2 on November 4, 2005 with channels 1, 2, 3, and 4 instrumented with anemometers, channels 7 and 8 with wind vanes, and channel 12 with a temperature sensor. On March 30, this tower collapsed due to an accumulation of rime ice and accompanying high winds. A 30 meter replacement tower was installed on May 12 with channels 4 (30 meter level anemometer) and 12 (temperature) as common channels between the

two towers. New anemometer channels 5 and 6 and new wind vane channel 9 were added. Previously used channels 1, 2, 3, 7 and 8 in use on the 50 meter tower are not in use on the 30 meter tower.

Channel	Sensor type	Height	Multiplier	Offset	Orientation	Channel now active?
1	NRG #40 anemometer	50 m (A)	0.765	0.35	070° T	No
2	NRG IceFree III anemometer	50 m (B)	0.572	1.0	160° T	No
3	NRG #40 anemometer	40 m	0.765	0.35	070° T	No
4	NRG #40 anemometer	30 m (A)	0.765	0.35	West	Yes
5	NRG #40 anemometer	30 m (B)	0.765	0.35	East	Yes
6	NRG #40 anemometer	20 m	0.765	0.35	West	Yes
7	NRG IceFree III wind vane	50 m	0.351	255	ENE	No
8	NRG #200P wind vane	40 m	0.351	180	North	No
9	NRG #200P wind vane	30 m	0.351	000	South	Yes
12	NRG #110S Temp C	2 m	0.138	-86.383	N/A	yes

Data Quality Control Summary

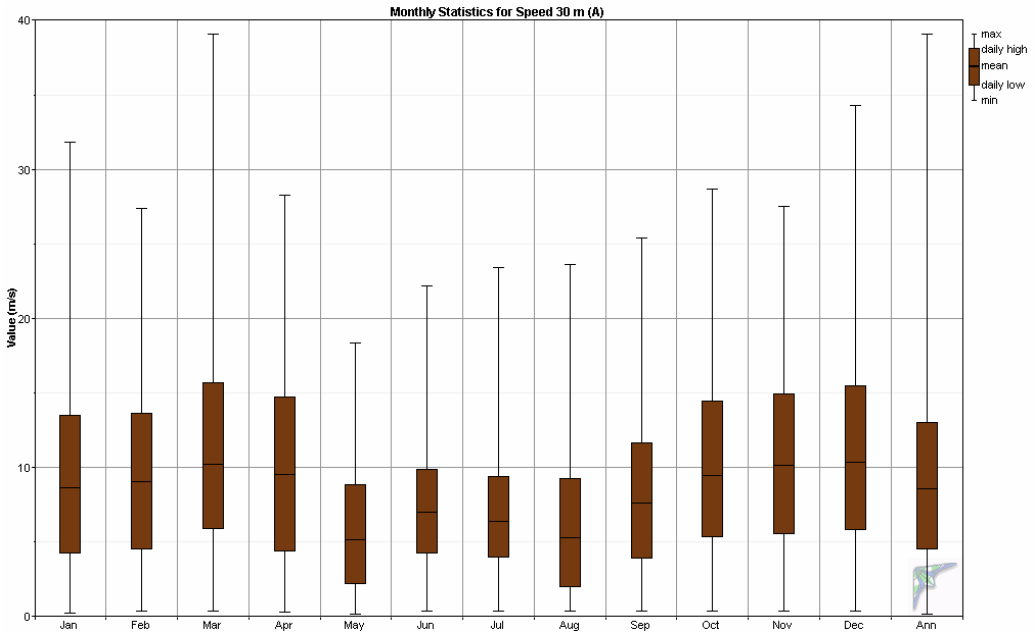
The only common channel, besides temperature, of the original 50 meter tower and the replacement 30 meter tower is Channel 4, the 30 meter (A) channel. Because of the complications and inherent data error risk of synthesizing a large amount of data, it was decided to restrict the data analysis to the original Channel 4 data from November 4, 2005 through tower collapse on March 30, 2006 and then all the operating channels of the replacement tower beginning on May 12, 2006. Once data was filtered to remove ice events, the data was synthesized to create complete data sets of the anemometer channels now in use, Channels 4, 5 and 6. For the wind vane channels, data was synthesized for all three wind vane channels, even though the 50 meter and 40 meter sensors (Channels 7 and 8) are no longer in use. For ease of review of data relevant to the hub height of a 1500 kW turbine, a 60 meter (virtual) anemometer was synthesized and added to the data set.

Measured Wind Speeds

The 30 meter (A) anemometer wind speed average for the reporting period is 8.25 m/s, the 30 meter (B) anemometer wind speed average is 8.22 m/s, and the 20 meter anemometer wind speed average is 8.14 m/s. The wind speed average for the 60-meter height synthesized anemometer level (a virtual anemometer) is 8.36 m/s. Because of the extremely low shear at this site, the 60 m average (virtual) wind speed is scarcely any greater than at 30 meters.

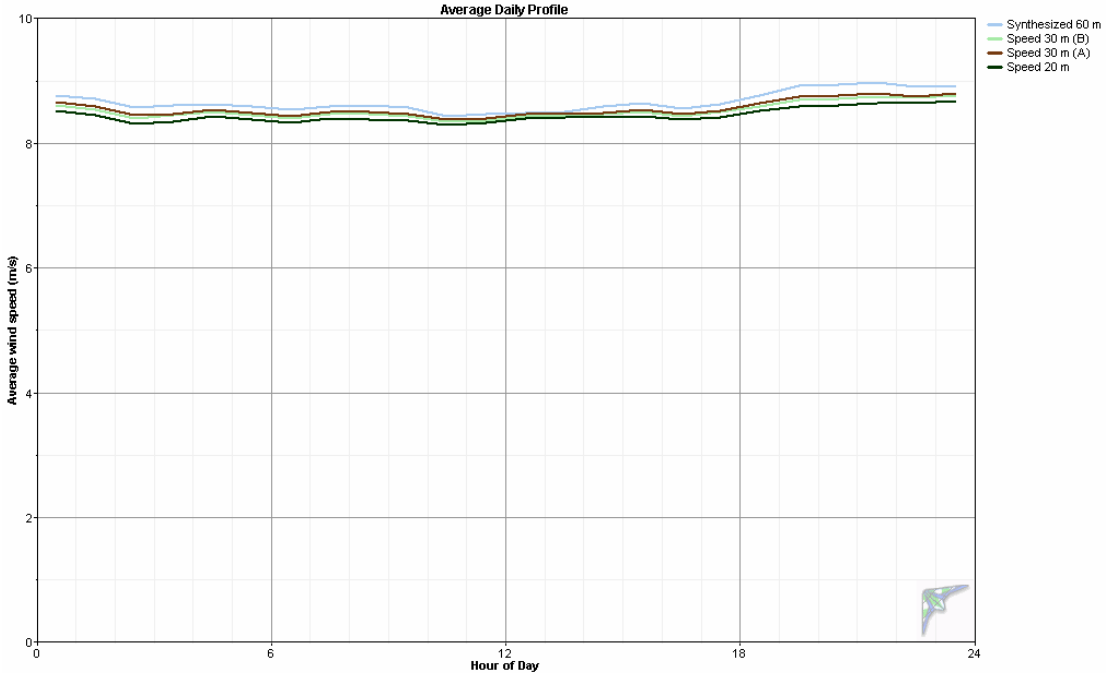
Wind Speed Summary

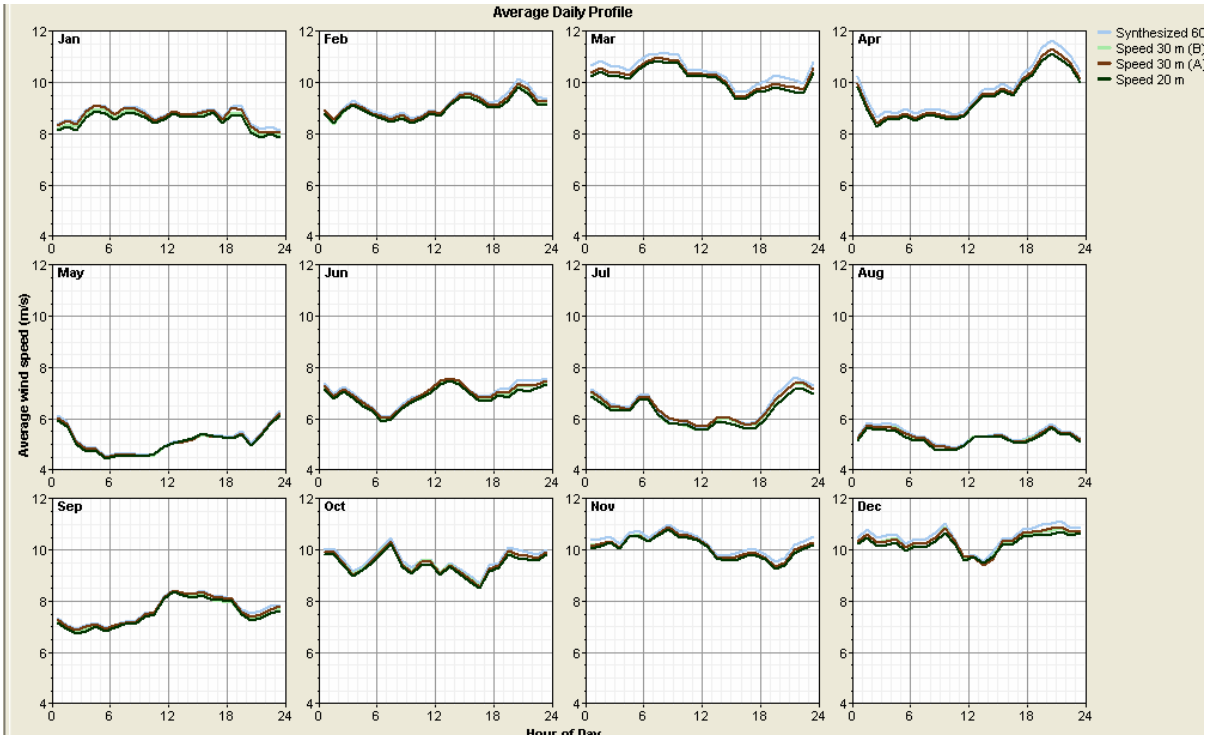
	60 m virtual speed		30 m (A) speed		30 m (B) speed		20 m speed	
Month	*Mean (m/s)*	*Max (m/s)*	Mean (m/s)	Max (m/s)	Mean (m/s)	Max (m/s)	Mean (m/s)	Max (m/s)
Jan	*8.74*	*32.4*	8.67	31.8	8.58	31.8	8.50	31.4
Feb	*9.16*	*28.2*	9.08	27.4	9.02	27.4	8.97	26.9
Mar	*10.47*	*39.9*	10.25	39.1	10.25	39.1	10.13	38.6
Apr	*9.73*	*28.9*	9.53	28.3	9.53	28.3	9.41	27.9
May	*5.19*	*18.8*	5.14	18.4	5.12	18.4	5.11	18.4
Jun	*7.05*	*23.0*	6.99	22.2	6.92	22.3	6.86	21.3
Jul	*6.48*	*24.5*	6.42	23.4	6.34	23.7	6.25	22.8
Aug	*5.38*	*24.2*	5.31	23.6	5.31	23.9	5.24	23.5
Sep	*7.65*	*26.3*	7.61	25.4	7.53	25.5	7.50	24.7
Oct	*9.63*	*28.7*	9.50	28.7	9.52	28.7	9.41	28.9
Nov	*10.28*	*27.6*	10.14	27.4	10.14	27.6	10.07	27.6
Dec	*10.53*	*33.9*	10.37	34.3	10.35	33.9	10.26	35.1
Annual	***8.36***	*39.9*	**8.25**	39.1	**8.22**	39.1	**8.14**	38.6



Daily wind profile

The daily wind profile indicates that the lowest wind speeds of the day occur in the morning hours of 2 to 11 a.m. and the highest wind speeds of the day occur during the evening hours of 9 to 12 p.m. The daily variation of wind speed is quite minimal on an annual basis, but as shown, more pronounced on a monthly basis.





Time Series of Wind Speed Monthly Averages

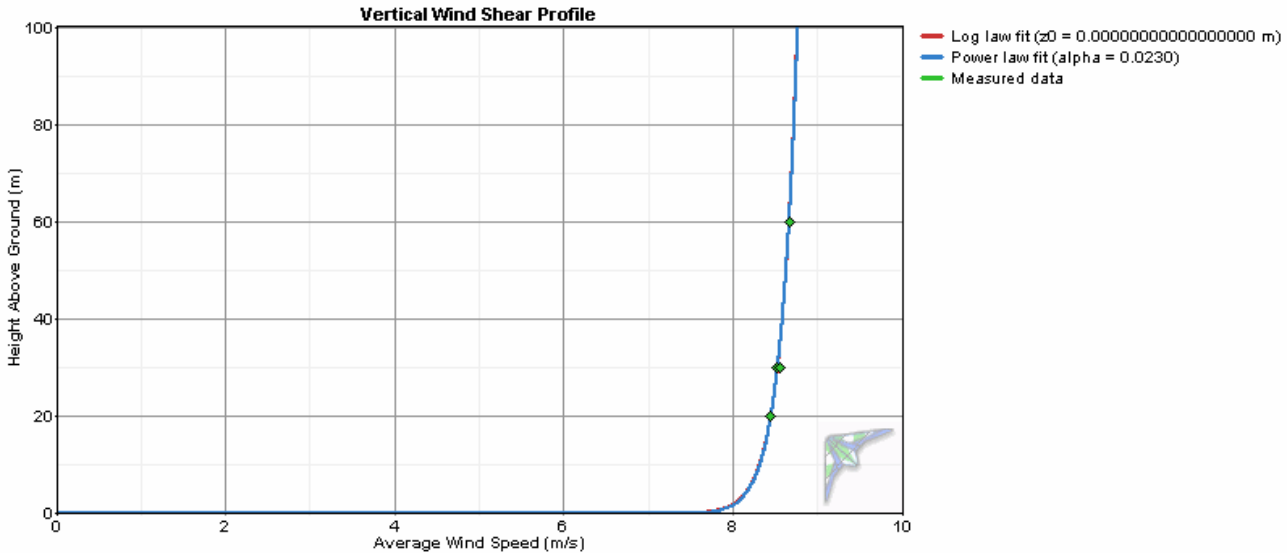
As expected, the highest winds occurred during the fall through spring months with relatively light winds during the summer months of May through August. The unusually low winds measured in January 2006 were due to a persistent high pressure system over Alaska that month that resulted in relatively calm winds and extremely cold temperatures Statewide. Note that measured winds during winter 2006/2007 are notably higher than during winter 2005/2006.

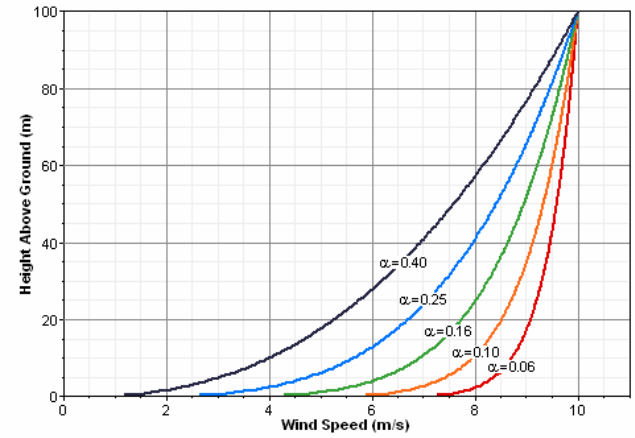
Excess wind speed

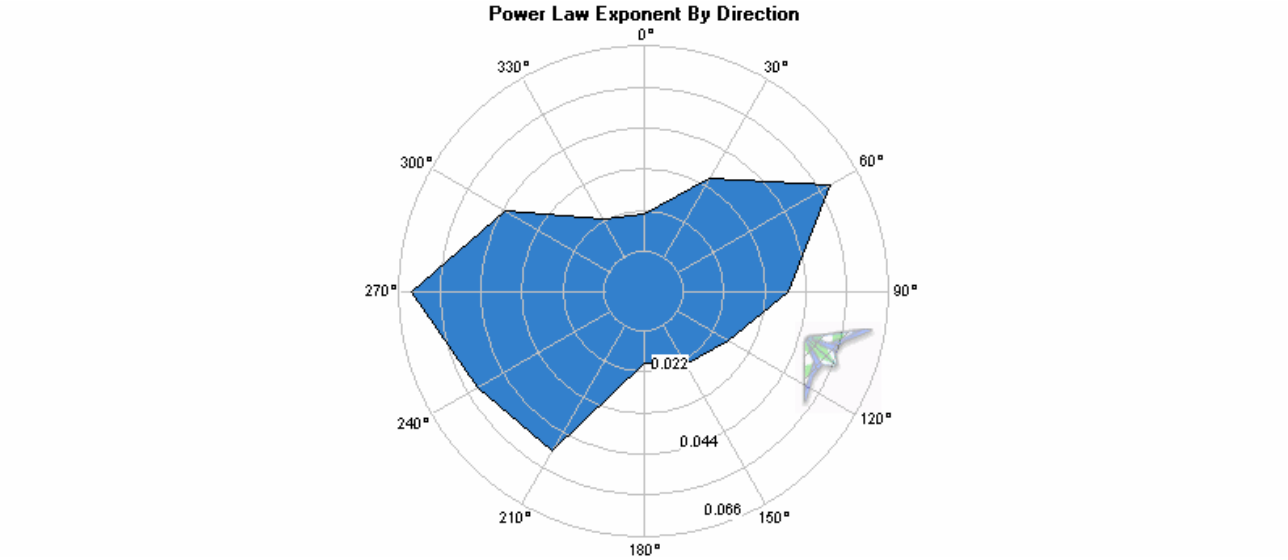
Most wind turbines have a cut-out speed of 25 m/s, or more precisely, cut-out when the 10 minute average wind speed exceeds 25 m/s. Given the powerful wind resources on Pillar Mountain, one could expect occasional high wind speed shut downs of turbines. During a 455 day period (November 4, 2005 to February 2, 2007), there were 596 ten minute periods or 99.3 hours where predicted wind speeds at 60 meters elevation (using the *virtual* anemometer) exceeded 25 m/s. This represents 0.91 percent of the time. Note however that turbines will not immediately restart once ten minute average wind speeds dip below 25 m/s and hence the lost production time due to high winds would be higher than the calculated 0.91 percent. This should be discussed with turbine manufacturers.

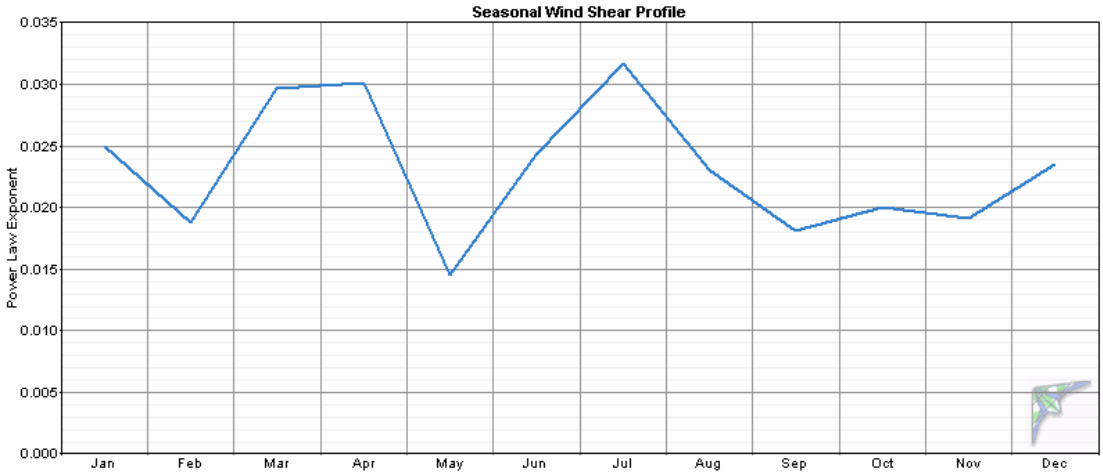
Wind Shear Profile

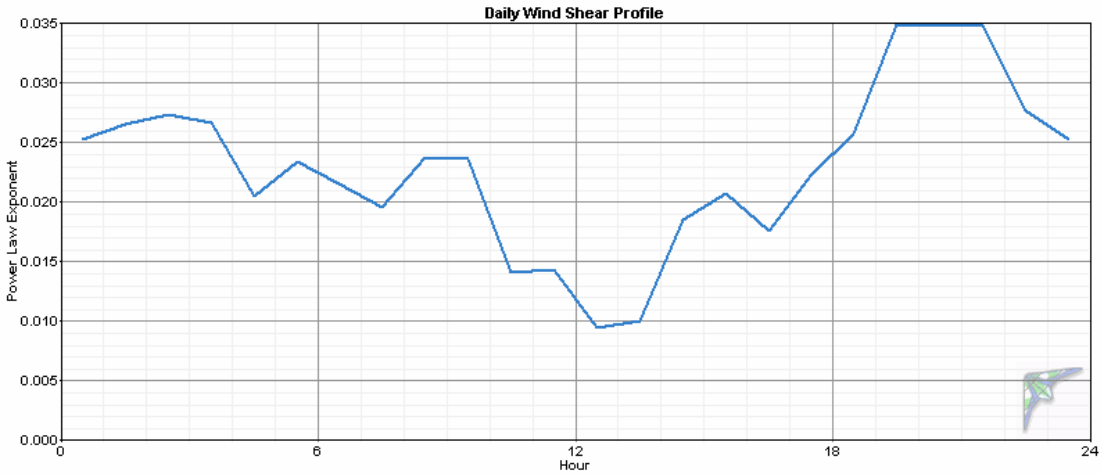
The average power law exponent was calculated at 0.023, indicating *extraordinarily low* wind shear at Site 2. The practical application of this information is that a low turbine tower height is advisable as there is very little marginal gain in average wind speed with height. Other graphs show the variability of wind shear by direction and seasonal and daily variability. This variability is not particularly significant at this site given the very low average shear value.





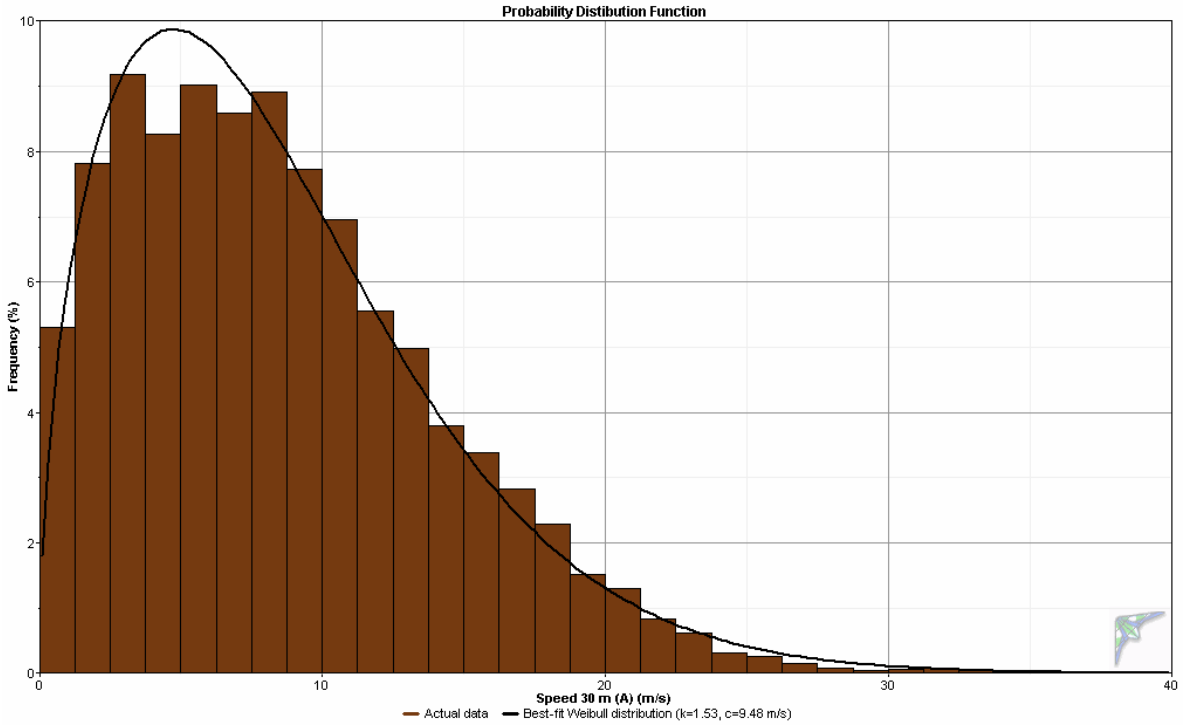

Power Law Exponent By Direction
0°
30°
60°
90°
120°
150°
180°
210°
240°
270°
300°
330°
0.022
0.044
0.066

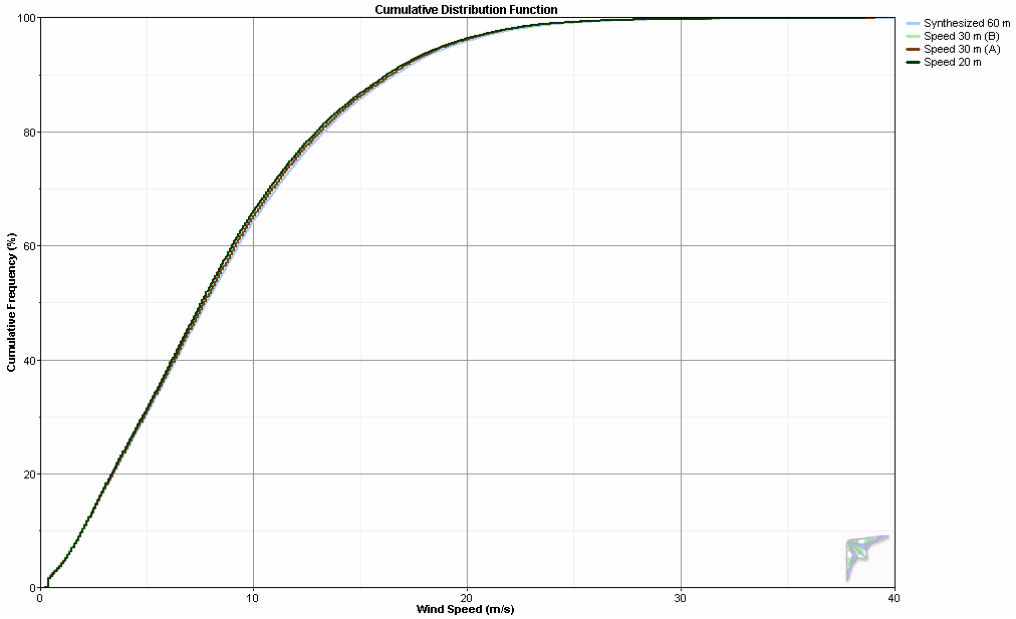

Seasonal Wind Shear Profile
Power Law Exponent
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec


Daily Wind Shear Profile
Power Law Exponent
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
0
6
12
18
24
Hour

Probability Distribution Function

The probability distribution function provides a visual indication of measured wind speeds in one meter per second "bins". Note that most wind turbines do not begin to generate power until the wind speed at hub height reaches 3.5 to 4 m/s, also known as the "cut-in" wind speed. The black line in the graph is a best fit Weibull distribution. At the 30 meter level, Weibull parameters are k = 1.53 (indicates a broad distribution of wind speeds) and c = 9.48 m/s (scale factor for the Weibull distribution) for the measurement period of 11/4/2005 to 2/27/2007.

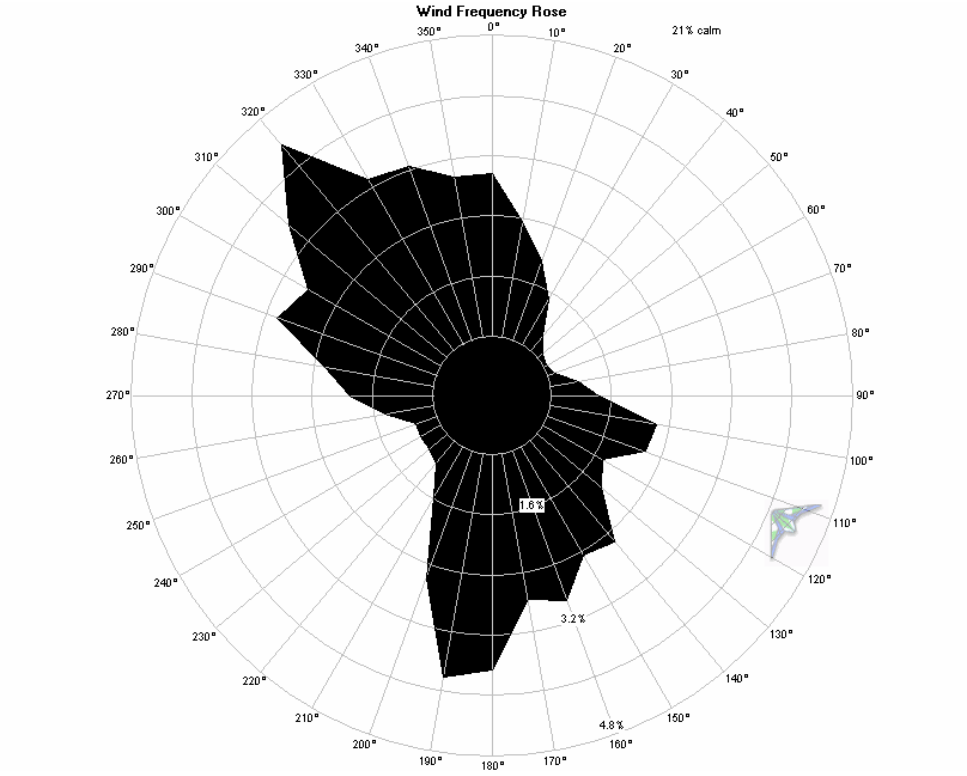




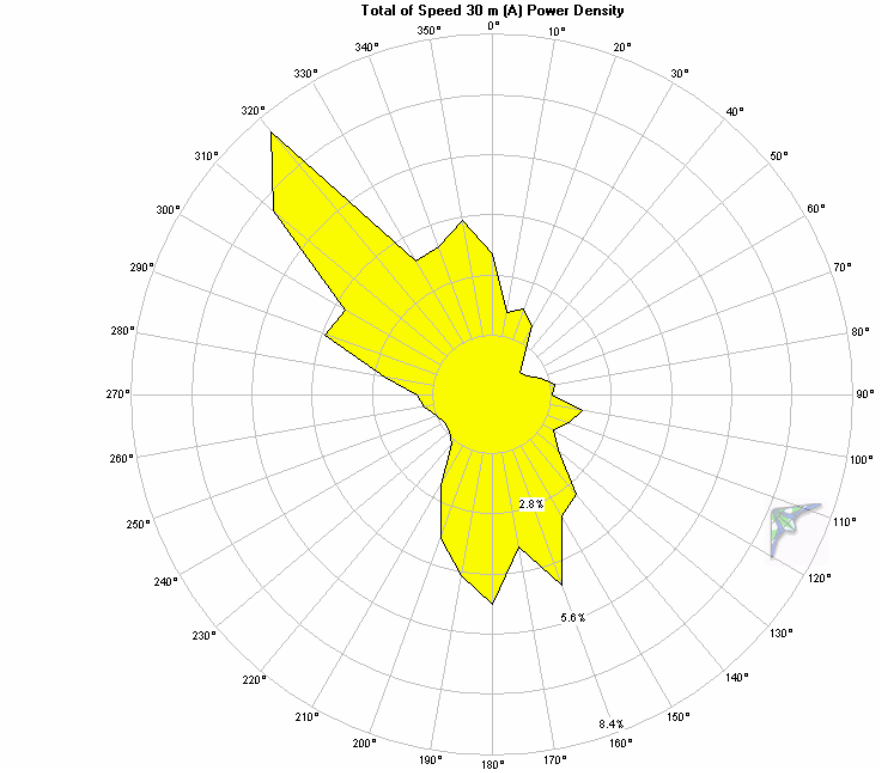
Wind Roses

Kodiak Site 2 winds are strongly directional; the 30 meter wind frequency rose (green) indicates predominately northwest winds with a lesser component of south-southeast winds. This data observation is even stronger when one considers the power density rose (yellow). The practical application of this information is that several turbines can potentially be spaced closely together perpendicular to the prevailing NW and SSE winds. The frequency of calm winds, shown in the upper right quadrant of the frequency roses, is defined as the percent of time that winds exceed a selected threshold value, in this case 3.5 m/s.

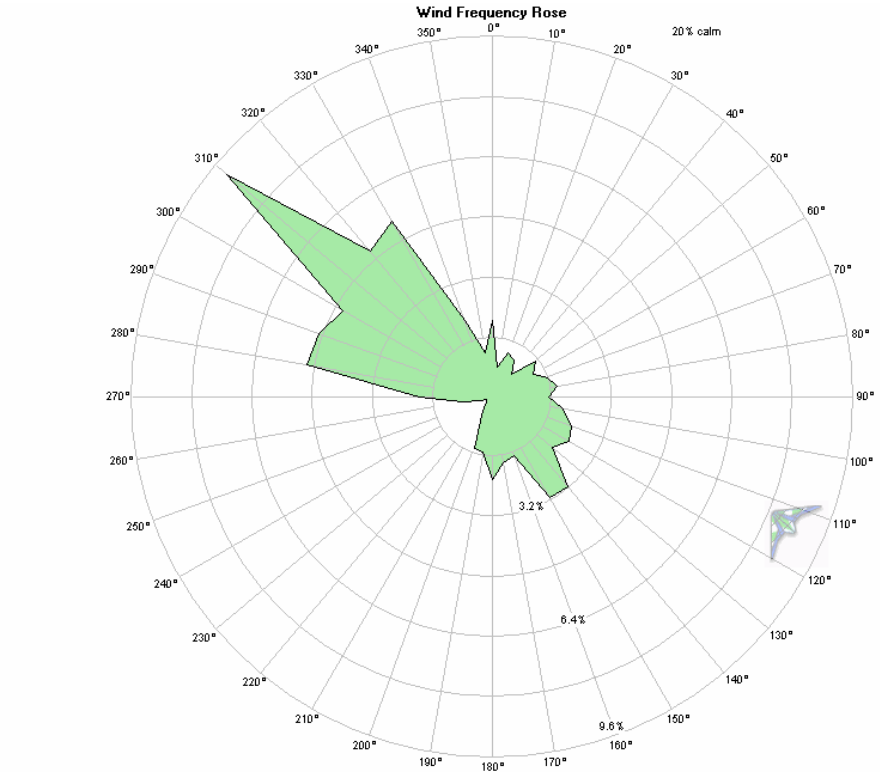
Wind frequency rose – 30 meters



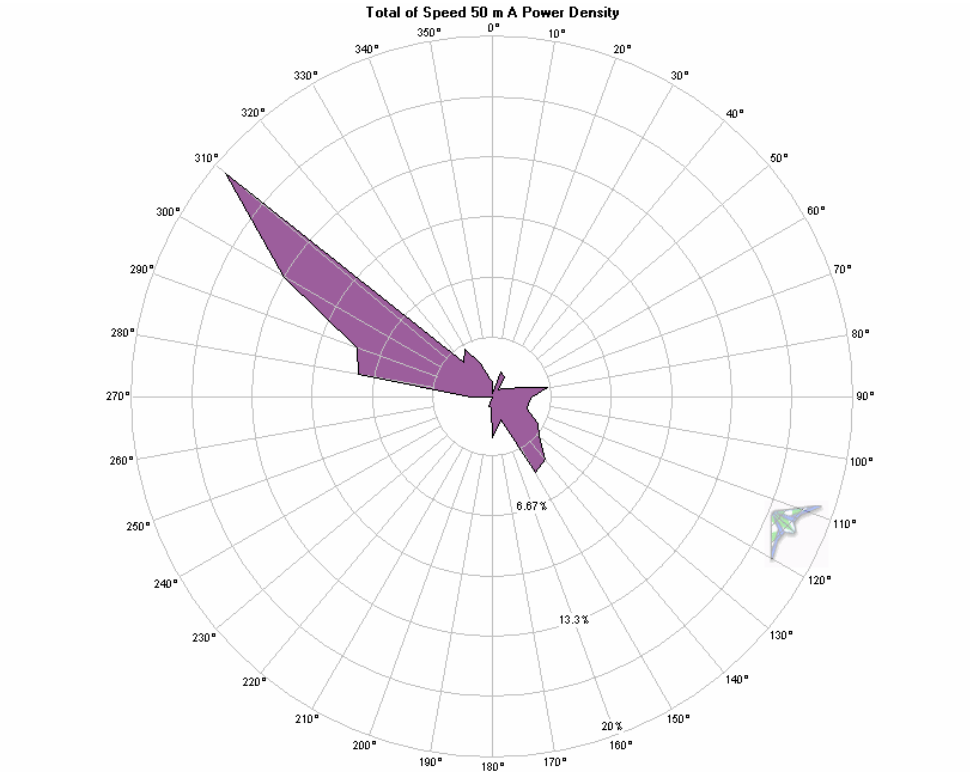
Power density rose – 30 meters



Wind frequency rose – 50 meters (11/04/05 through 3/30/06)

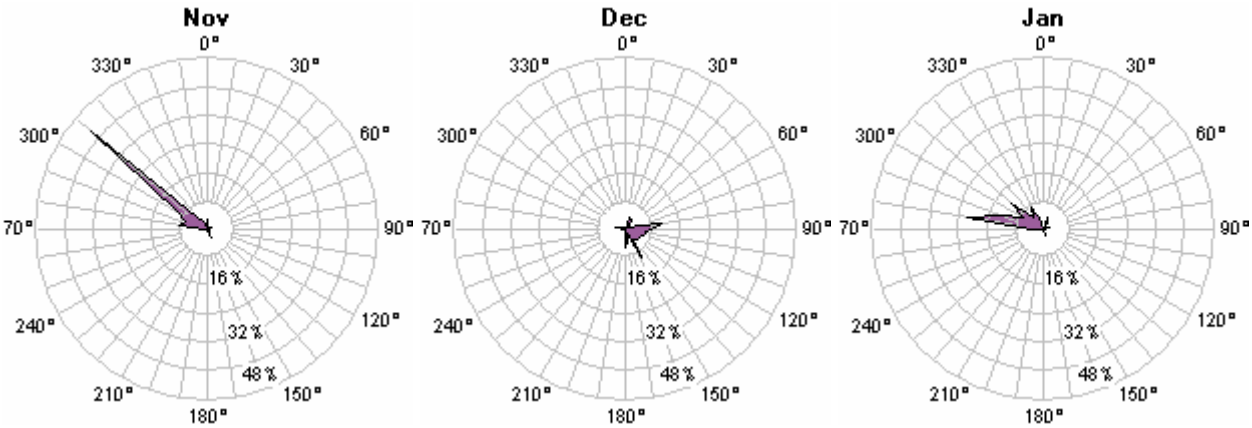


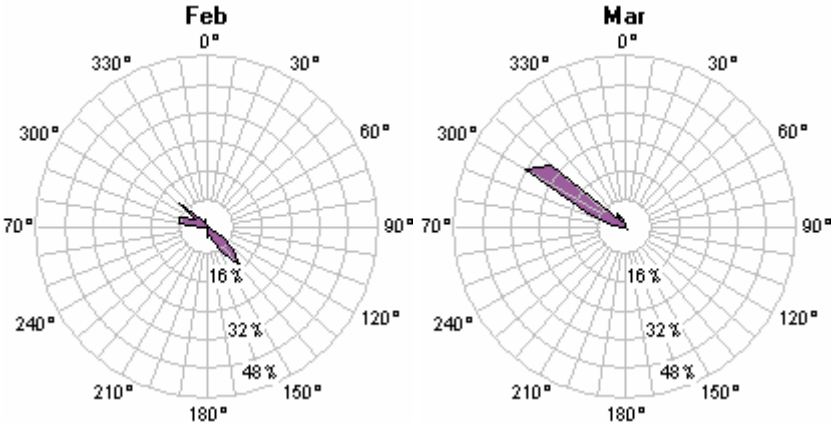
Power density rose – 50 meters *(11/04/05 through 3/30/06)*



*Wind Power Density Rose by Month (**50** meters)*

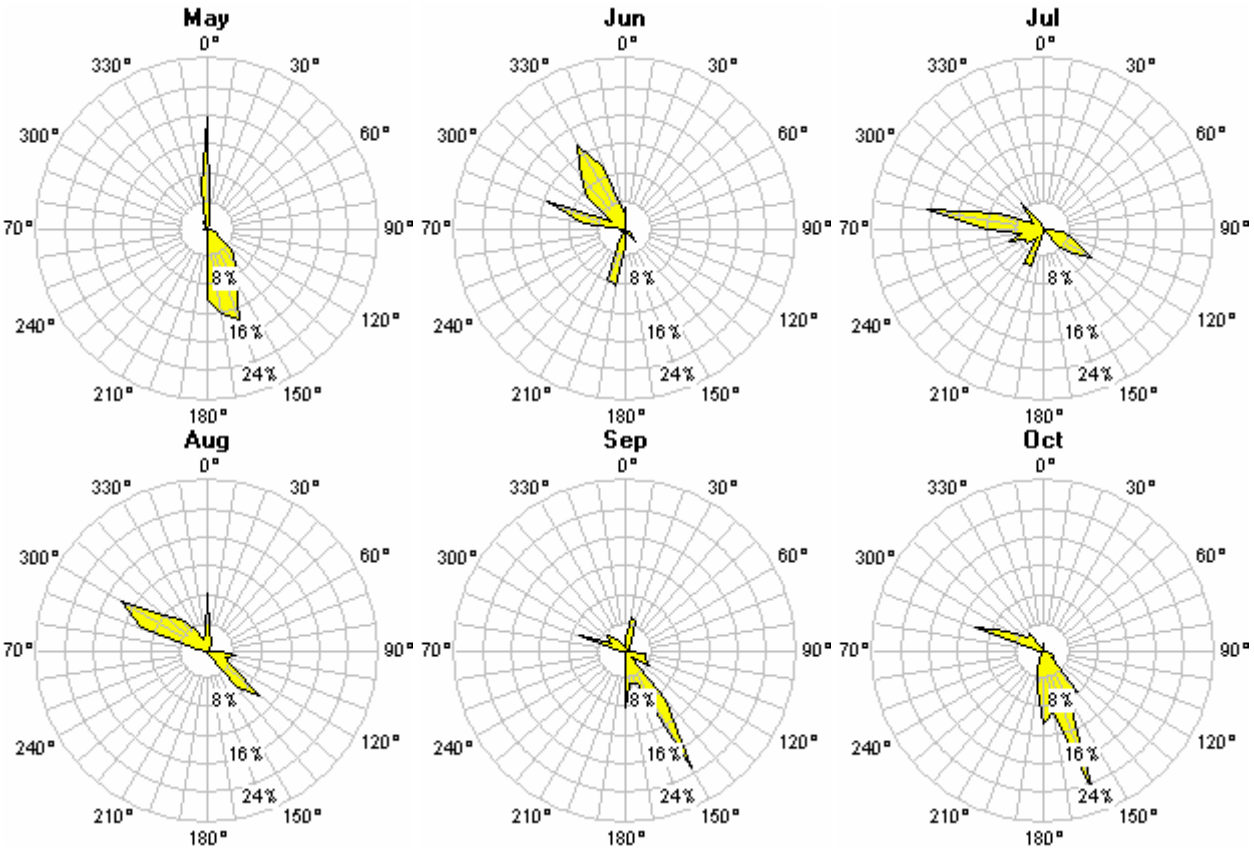
Note: only actual measured data months in 2005 and 2006 are shown (November 4, 2005 through March 30, 2006). Scale of graphs is common.





*Wind Power Density Rose by Month (**30** meters)*

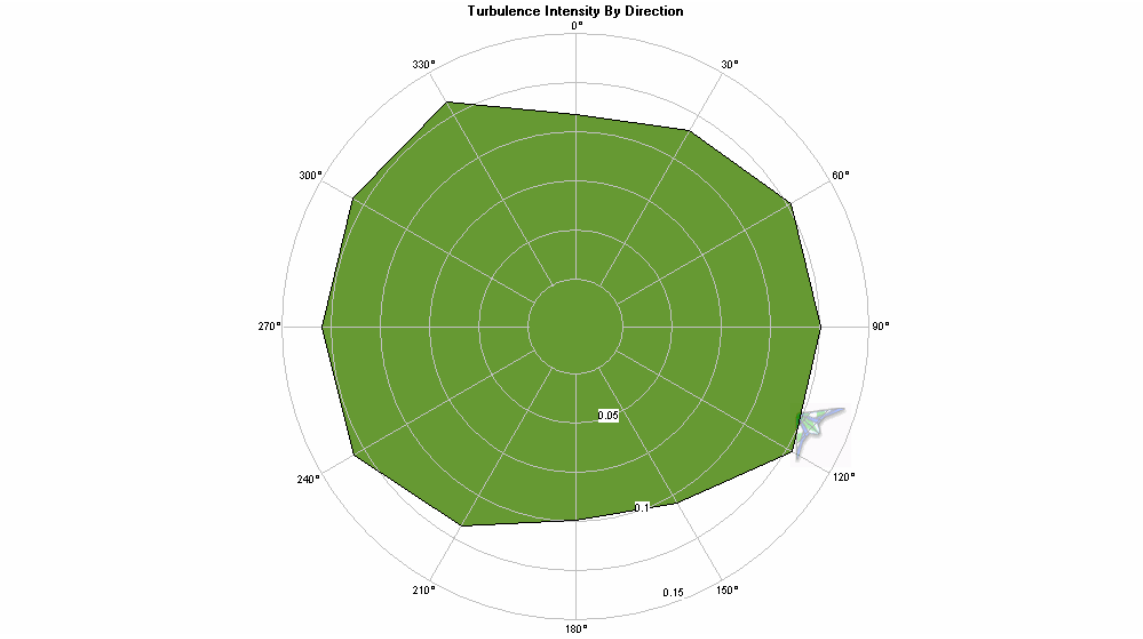
Note: only actual measured data months in 2006 without a synthesis overlap are shown (May 12 through October 31, 2006. Scale of graphs is common.



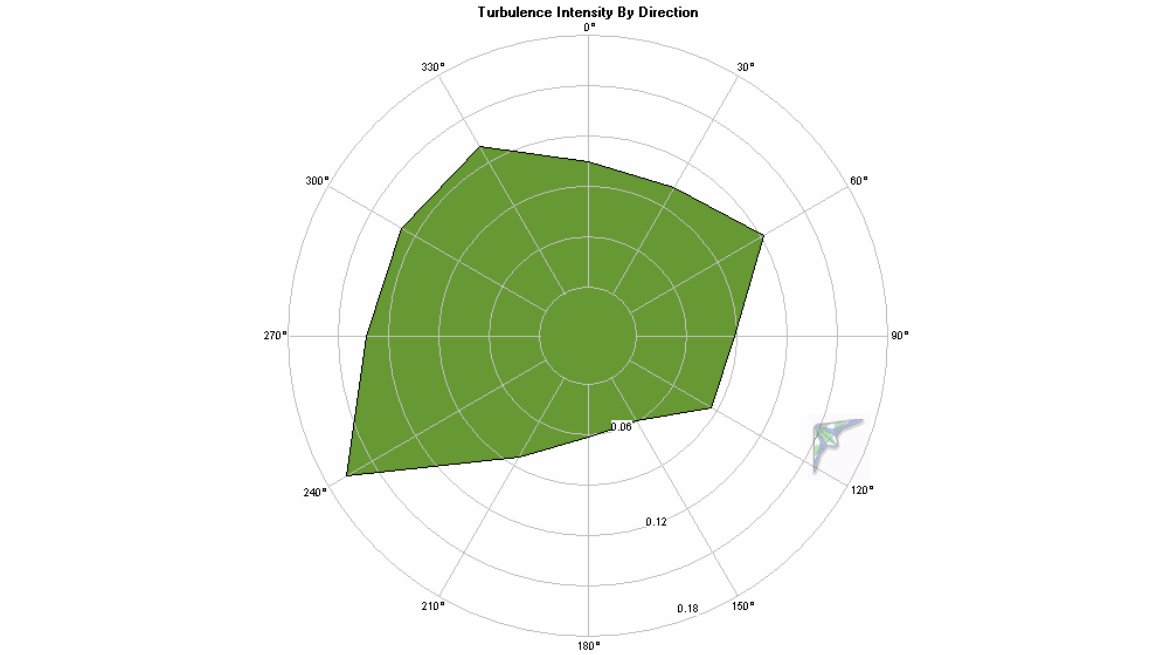
Turbulence Intensity

The Kodiak Site 2 turbulence intensity remains extremely favorable with a mean of 0.109 at 50 meters (five months data) and a mean of 0.120 (A channel) and 0.110 (B channel) at 30 meters. Turbulence intensity is calculated for each time step as the standard deviation of the wind speed divided by the mean of the wind speed.

30 meter vane – 30 meter (A) Turbulence Intensity (Mean = 0.120)



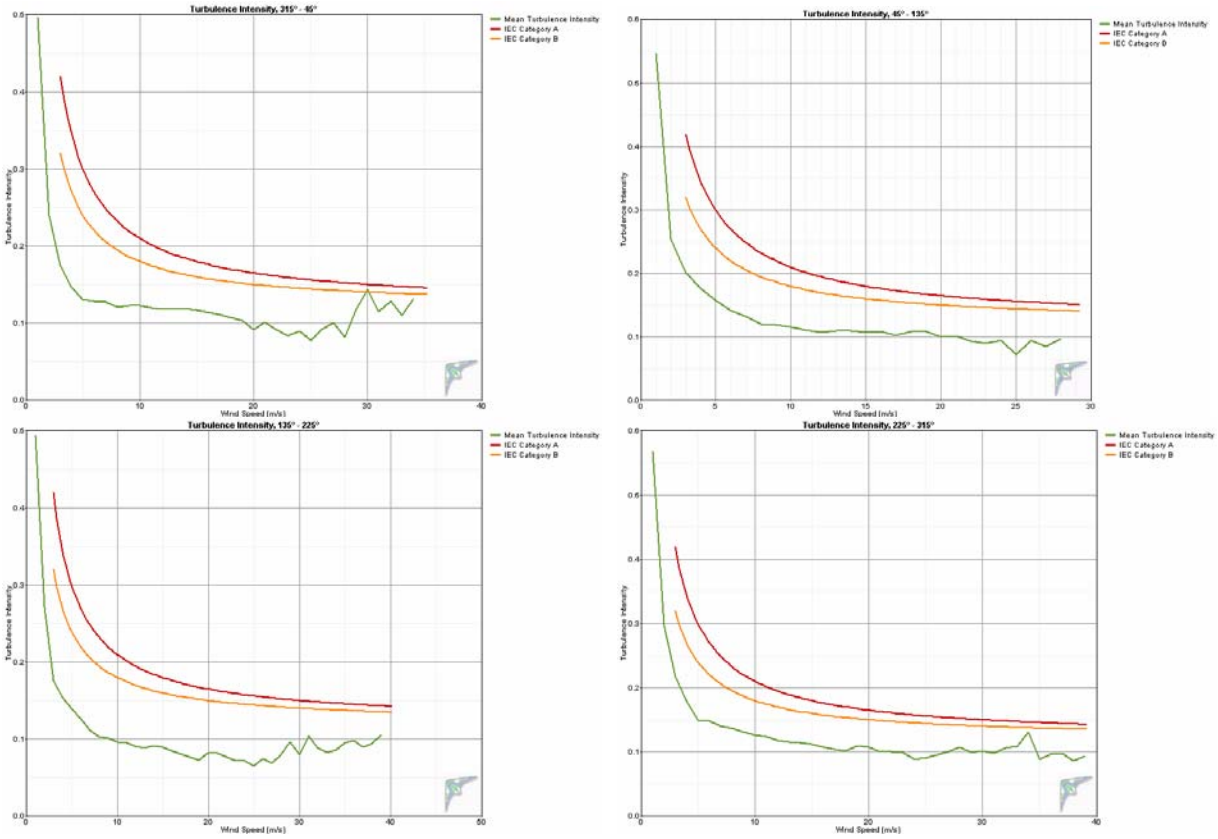
50 meter vane – 50 meter (A) Turbulence Intensity (Mean = 1.109), 11/4/05 through 3/30/06



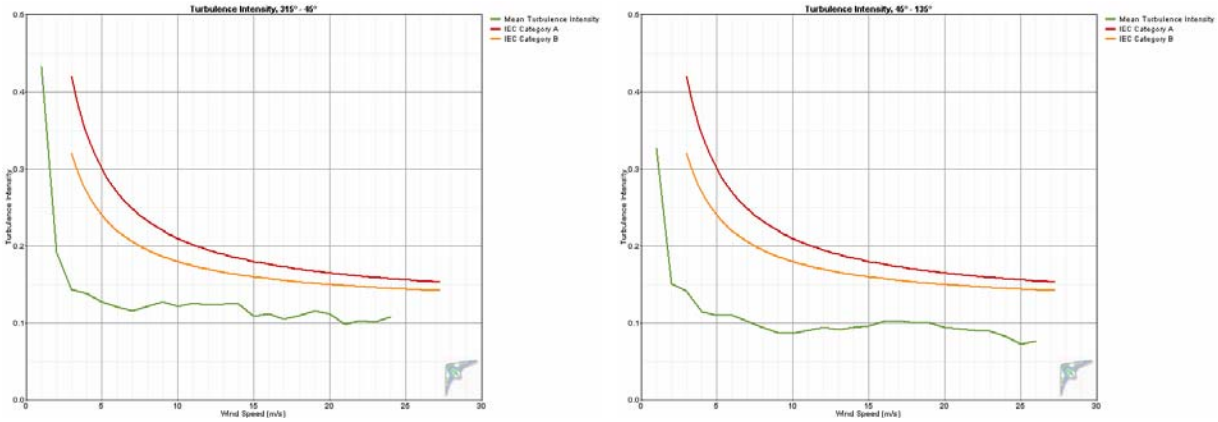
International Energy Agency turbulence standard comparisons

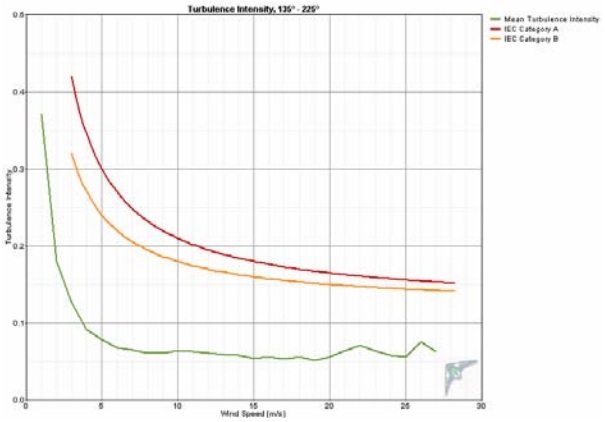
As indicated, turbulence is within International Energy Agency (IEA) Category A and B standards for all wind directions and at all measured wind speeds.

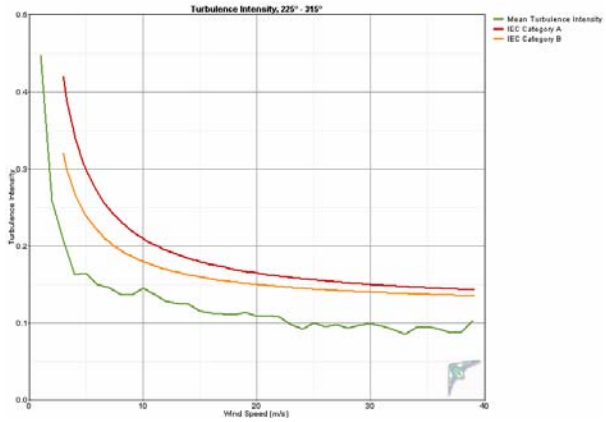
30 meter vane – 30 meter (A) speed



50 meter vane – 50 meter (A) speed







Turbulence Tables

Turbulence Table 50 m A speed - 50 m vane (11/04/05 to 3/30/06), threshold 4 m/s

Bin Midpoint (m/s)	Bin Endpoints Lower (m/s)	Upper (m/s)	Records In Bin	Standard Deviation of Wind Speed (m/s)	Mean Turbulence Intensity	Standard Deviation of Turbulence Intensity	Characteristic Turbulence Intensity
1	0.5	1.5	746	0.371	0.400	0.207	0.607
2	1.5	2.5	1089	0.396	0.203	0.136	0.339
3	2.5	3.5	1168	0.474	0.160	0.102	0.262
4	3.5	4.5	1290	0.522	0.132	0.079	0.211
5	4.5	5.5	1421	0.624	0.126	0.076	0.202
6	5.5	6.5	1478	0.695	0.117	0.063	0.180
7	6.5	7.5	1536	0.780	0.112	0.060	0.172
8	7.5	8.5	1456	0.865	0.109	0.059	0.167
9	8.5	9.5	1480	0.966	0.108	0.055	0.163
10	9.5	10.5	1356	1.103	0.111	0.052	0.163
11	10.5	11.5	1129	1.193	0.109	0.048	0.157
12	11.5	12.5	991	1.280	0.107	0.046	0.153
13	12.5	13.5	862	1.359	0.105	0.043	0.148
14	13.5	14.5	739	1.466	0.105	0.045	0.150
15	14.5	15.5	687	1.486	0.099	0.044	0.143
16	15.5	16.5	667	1.569	0.098	0.043	0.141
17	16.5	17.5	597	1.656	0.098	0.038	0.135
18	17.5	18.5	433	1.724	0.096	0.038	0.134
19	18.5	19.5	343	1.850	0.098	0.036	0.134
20	19.5	20.5	279	1.831	0.092	0.033	0.125
21	20.5	21.5	205	2.000	0.095	0.031	0.126
22	21.5	22.5	166	2.044	0.093	0.032	0.125
23	22.5	23.5	147	2.016	0.088	0.023	0.111
24	23.5	24.5	99	2.038	0.085	0.021	0.106
25	24.5	25.5	41	2.239	0.090	0.024	0.114
26	25.5	26.5	41	2.390	0.092	0.020	0.112
27	26.5	27.5	33	2.561	0.095	0.028	0.123
28	27.5	28.5	17	2.600	0.093	0.019	0.112
29	28.5	29.5	18	2.822	0.098	0.021	0.119
30	29.5	30.5	18	2.961	0.099	0.021	0.120

31	30.5	31.5	31	2.974	0.096	0.019	0.115
32	31.5	32.5	41	2.932	0.092	0.024	0.116
33	32.5	33.5	21	2.805	0.085	0.021	0.106
34	33.5	34.5	12	3.192	0.094	0.022	0.116
35	34.5	35.5	12	3.325	0.095	0.014	0.109
36	35.5	36.5	8	3.325	0.092	0.010	0.102
37	36.5	37.5	5	3.240	0.087	0.012	0.100
38	37.5	38.5	2	3.350	0.088	0.004	0.093
39	38.5	39.5	1	4.000	0.104	0.000	0.104

Turbulence Table 50 m B speed - 50 m vane (11/04/05 to 3/30/06), threshold 4 m/s

Bin Midpoint (m/s)	Bin Endpoints Lower (m/s)	Upper (m/s)	Records In Bin	Standard Deviation of Wind Speed (m/s)	Mean Turbulence Intensity	Standard Deviation of Turbulence Intensity	Characteristic Turbulence Intensity
1	0.5	1.5	917	0.100	0.081	0.113	0.194
2	1.5	2.5	1090	0.353	0.181	0.104	0.285
3	2.5	3.5	1094	0.423	0.144	0.098	0.242
4	3.5	4.5	1296	0.487	0.124	0.083	0.206
5	4.5	5.5	1397	0.604	0.121	0.072	0.193
6	5.5	6.5	1637	0.687	0.116	0.064	0.180
7	6.5	7.5	1562	0.774	0.112	0.062	0.173
8	7.5	8.5	1558	0.867	0.109	0.060	0.169
9	8.5	9.5	1517	0.927	0.104	0.060	0.164
10	9.5	10.5	1347	1.049	0.106	0.056	0.162
11	10.5	11.5	1099	1.161	0.106	0.054	0.160
12	11.5	12.5	968	1.215	0.102	0.052	0.154
13	12.5	13.5	816	1.281	0.099	0.050	0.149
14	13.5	14.5	732	1.405	0.101	0.045	0.146
15	14.5	15.5	697	1.514	0.101	0.044	0.145
16	15.5	16.5	657	1.565	0.098	0.040	0.138
17	16.5	17.5	629	1.647	0.097	0.037	0.135
18	17.5	18.5	458	1.712	0.095	0.038	0.134
19	18.5	19.5	309	1.771	0.094	0.039	0.133
20	19.5	20.5	274	1.719	0.086	0.036	0.123
21	20.5	21.5	205	1.902	0.091	0.031	0.122
22	21.5	22.5	173	1.917	0.087	0.032	0.119
23	22.5	23.5	143	2.072	0.090	0.043	0.134
24	23.5	24.5	96	2.003	0.084	0.022	0.105
25	24.5	25.5	65	2.192	0.088	0.023	0.111
26	25.5	26.5	39	2.210	0.085	0.021	0.106
27	26.5	27.5	31	2.665	0.099	0.026	0.125
28	27.5	28.5	16	2.631	0.094	0.021	0.115
29	28.5	29.5	21	3.043	0.105	0.023	0.128
30	29.5	30.5	13	2.831	0.095	0.026	0.120
31	30.5	31.5	11	3.555	0.115	0.023	0.139
32	31.5	32.5	27	3.511	0.110	0.033	0.142
33	32.5	33.5	26	3.585	0.109	0.027	0.136
34	33.5	34.5	29	4.190	0.123	0.031	0.154
35	34.5	35.5	12	4.233	0.121	0.031	0.152

36	35.5	36.5	13	4.200	0.117	0.029	0.146
37	36.5	37.5	5	4.680	0.127	0.015	0.142
38	37.5	38.5	7	5.329	0.141	0.021	0.163
39	38.5	39.5	6	4.700	0.121	0.013	0.134
40	39.5	40.5	5	5.420	0.136	0.004	0.140
41	40.5	41.5	5	5.540	0.136	0.006	0.141
42	41.5	42.5	4	5.175	0.123	0.015	0.138
43	42.5	43.5	2	5.300	0.123	0.003	0.126
44	43.5	44.5	1	6.200	0.140	0.000	0.140
45	44.5	45.5	0	6.200	0.140	0.000	0.140

Turbulence Table 40 m speed - 40 m vane (11/04/05 to 3/30/06), threshold 4 m/s

Bin Midpoint (m/s)	Bin Endpoints Lower (m/s)	Upper (m/s)	Records In Bin	Standard Deviation of Wind Speed (m/s)	Mean Turbulence Intensity	Standard Deviation of Turbulence Intensity	Characteristic Turbulence Intensity
1	0.5	1.5	825	0.383	0.413	0.215	0.628
2	1.5	2.5	1014	0.426	0.221	0.148	0.369
3	2.5	3.5	1179	0.485	0.163	0.107	0.270
4	3.5	4.5	1303	0.541	0.137	0.081	0.218
5	4.5	5.5	1418	0.641	0.129	0.073	0.202
6	5.5	6.5	1464	0.721	0.121	0.063	0.184
7	6.5	7.5	1493	0.802	0.115	0.061	0.176
8	7.5	8.5	1463	0.885	0.111	0.057	0.168
9	8.5	9.5	1525	0.992	0.111	0.054	0.164
10	9.5	10.5	1283	1.142	0.115	0.050	0.165
11	10.5	11.5	1164	1.234	0.113	0.047	0.160
12	11.5	12.5	1021	1.295	0.108	0.045	0.154
13	12.5	13.5	833	1.425	0.110	0.044	0.154
14	13.5	14.5	738	1.517	0.109	0.044	0.152
15	14.5	15.5	707	1.574	0.105	0.042	0.147
16	15.5	16.5	653	1.586	0.100	0.041	0.140
17	16.5	17.5	563	1.690	0.100	0.039	0.139
18	17.5	18.5	400	1.768	0.099	0.037	0.135
19	18.5	19.5	312	1.873	0.099	0.035	0.134
20	19.5	20.5	271	1.849	0.093	0.033	0.126
21	20.5	21.5	201	2.083	0.100	0.042	0.142
22	21.5	22.5	175	2.044	0.093	0.029	0.122
23	22.5	23.5	145	2.034	0.089	0.025	0.113
24	23.5	24.5	81	2.048	0.086	0.026	0.112
25	24.5	25.5	38	2.276	0.091	0.018	0.109
26	25.5	26.5	42	2.579	0.100	0.026	0.126
27	26.5	27.5	30	2.463	0.091	0.026	0.118
28	27.5	28.5	17	2.829	0.102	0.016	0.117
29	28.5	29.5	20	2.970	0.103	0.023	0.126
30	29.5	30.5	16	2.919	0.097	0.017	0.114
31	30.5	31.5	34	3.035	0.098	0.021	0.119
32	31.5	32.5	40	3.007	0.094	0.023	0.117
33	32.5	33.5	19	2.958	0.090	0.022	0.112
34	33.5	34.5	12	3.275	0.097	0.025	0.122

35	34.5	35.5	11	3.264	0.093	0.011	0.104
36	35.5	36.5	8	3.425	0.095	0.008	0.104
37	36.5	37.5	5	3.220	0.087	0.010	0.097
38	37.5	38.5	2	3.750	0.098	0.009	0.107
39	38.5	39.5	0	3.750	0.098	0.009	0.107

Turbulence Table 30 m A speed - 30 m vane (11/04/05 to 2/27/07), threshold 3.5 m/s

Bin Midpoint (m/s)	Bin Endpoints Lower (m/s)	Bin Endpoints Upper (m/s)	Records In Bin	Standard Deviation of Wind Speed (m/s)	Mean Turbulence Intensity	Standard Deviation of Turbulence Intensity	Characteristic Turbulence Intensity
1	0.5	1.5	3182	0.482	0.521	0.331	0.852
2	1.5	2.5	4598	0.511	0.264	0.164	0.428
3	2.5	3.5	4973	0.556	0.190	0.125	0.315
4	3.5	4.5	4729	0.644	0.163	0.104	0.267
5	4.5	5.5	4751	0.708	0.143	0.079	0.222
6	5.5	6.5	4871	0.806	0.135	0.071	0.206
7	6.5	7.5	4916	0.879	0.126	0.062	0.188
8	7.5	8.5	4839	0.946	0.119	0.057	0.176
9	8.5	9.5	4628	1.052	0.117	0.053	0.171
10	9.5	10.5	3959	1.139	0.115	0.050	0.165
11	10.5	11.5	3570	1.224	0.112	0.049	0.161
12	11.5	12.5	3153	1.286	0.108	0.046	0.154
13	12.5	13.5	2711	1.395	0.108	0.045	0.153
14	13.5	14.5	2320	1.504	0.108	0.047	0.155
15	14.5	15.5	1994	1.581	0.106	0.046	0.152
16	15.5	16.5	1745	1.634	0.102	0.046	0.149
17	16.5	17.5	1599	1.677	0.099	0.045	0.144
18	17.5	18.5	1258	1.748	0.097	0.043	0.141
19	18.5	19.5	984	1.842	0.097	0.042	0.139
20	19.5	20.5	764	1.876	0.094	0.039	0.133
21	20.5	21.5	639	1.975	0.094	0.042	0.136
22	21.5	22.5	459	1.929	0.088	0.038	0.126
23	22.5	23.5	344	1.961	0.086	0.034	0.120
24	23.5	24.5	223	2.045	0.086	0.038	0.124
25	24.5	25.5	148	1.914	0.077	0.036	0.113
26	25.5	26.5	130	2.243	0.087	0.041	0.127
27	26.5	27.5	80	2.333	0.087	0.040	0.127
28	27.5	28.5	46	2.453	0.088	0.038	0.126
29	28.5	29.5	36	3.006	0.104	0.034	0.138
30	29.5	30.5	22	3.316	0.111	0.035	0.146
31	30.5	31.5	35	3.180	0.103	0.019	0.121
32	31.5	32.5	46	3.363	0.105	0.023	0.128
33	32.5	33.5	24	3.325	0.101	0.023	0.124
34	33.5	34.5	15	3.507	0.103	0.026	0.130
35	34.5	35.5	12	3.275	0.094	0.014	0.108
36	35.5	36.5	12	3.533	0.098	0.010	0.108
37	36.5	37.5	5	3.360	0.091	0.005	0.096
38	37.5	38.5	4	3.500	0.092	0.010	0.102
39	38.5	39.5	2	3.850	0.099	0.009	0.107

40	39.5	40.5	0	3.850	0.099	0.009	0.107

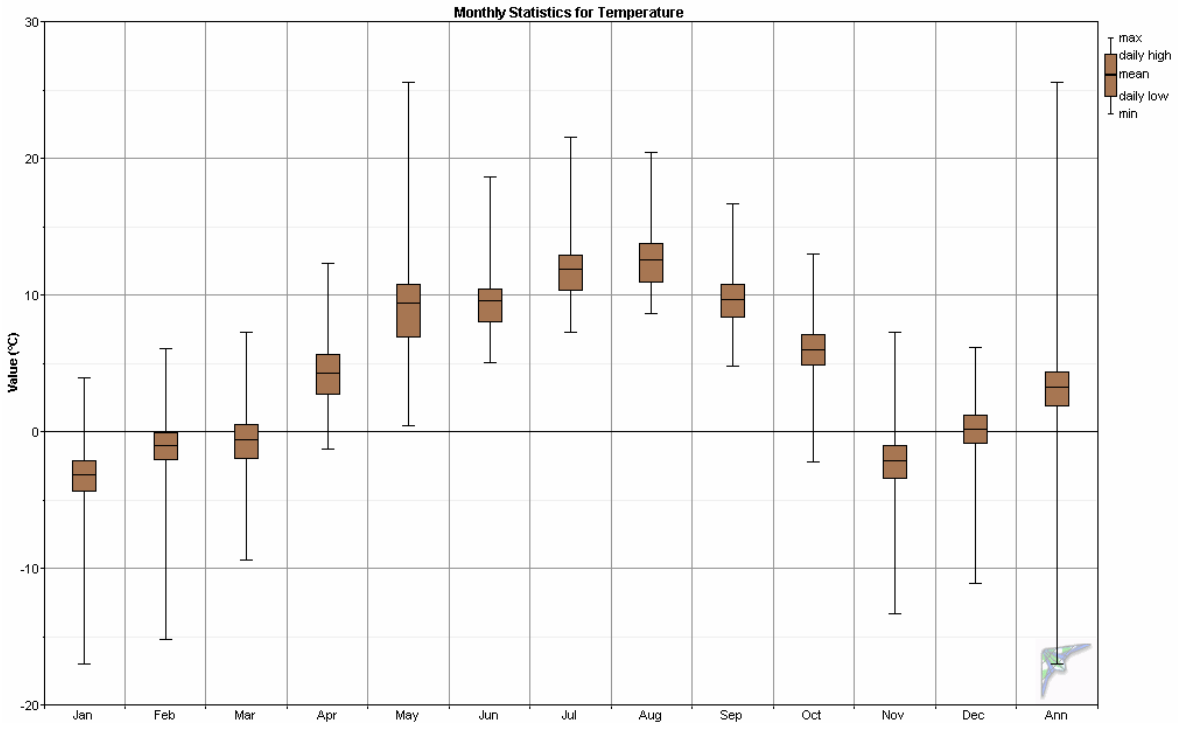
Turbulence Table 30 m B speed - 30 m vane (11/04/05 to 2/27/07), threshold 3.5 m/s

Bin Midpoint (m/s)	Bin Endpoints Lower (m/s)	Upper (m/s)	Records In Bin	Standard Deviation of Wind Speed (m/s)	Mean Turbulence Intensity	Standard Deviation of Turbulence Intensity	Characteristic Turbulence Intensity
1	0.5	1.5	3335	0.549	0.592	0.436	1.029
2	1.5	2.5	4600	0.579	0.300	0.194	0.494
3	2.5	3.5	4878	0.603	0.205	0.129	0.334
4	3.5	4.5	4706	0.661	0.167	0.103	0.270
5	4.5	5.5	4794	0.719	0.145	0.081	0.226
6	5.5	6.5	4918	0.790	0.132	0.069	0.201
7	6.5	7.5	5035	0.850	0.122	0.061	0.183
8	7.5	8.5	4750	0.908	0.114	0.056	0.170
9	8.5	9.5	4608	0.965	0.108	0.053	0.161
10	9.5	10.5	3880	1.009	0.101	0.052	0.153
11	10.5	11.5	3570	1.055	0.096	0.050	0.147
12	11.5	12.5	3148	1.123	0.094	0.049	0.143
13	12.5	13.5	2787	1.182	0.091	0.048	0.139
14	13.5	14.5	2313	1.258	0.090	0.049	0.140
15	14.5	15.5	1948	1.250	0.084	0.050	0.134
16	15.5	16.5	1748	1.269	0.080	0.050	0.129
17	16.5	17.5	1560	1.301	0.077	0.047	0.124
18	17.5	18.5	1204	1.344	0.075	0.048	0.123
19	18.5	19.5	975	1.410	0.074	0.046	0.120
20	19.5	20.5	733	1.436	0.072	0.046	0.118
21	20.5	21.5	621	1.419	0.068	0.045	0.113
22	21.5	22.5	454	1.443	0.066	0.045	0.111
23	22.5	23.5	335	1.301	0.057	0.042	0.099
24	23.5	24.5	226	1.433	0.060	0.045	0.104
25	24.5	25.5	156	1.606	0.064	0.044	0.108
26	25.5	26.5	131	1.596	0.062	0.045	0.107
27	26.5	27.5	82	1.446	0.054	0.045	0.099
28	27.5	28.5	49	1.457	0.052	0.045	0.098
29	28.5	29.5	39	1.649	0.057	0.054	0.110
30	29.5	30.5	19	1.366	0.045	0.050	0.095
31	30.5	31.5	40	1.417	0.046	0.046	0.091
32	31.5	32.5	43	1.278	0.040	0.040	0.080
33	32.5	33.5	24	0.937	0.028	0.024	0.052
34	33.5	34.5	15	0.848	0.025	0.032	0.057
35	34.5	35.5	12	0.721	0.021	0.012	0.033
36	35.5	36.5	12	0.865	0.024	0.015	0.039
37	36.5	37.5	5	1.185	0.032	0.008	0.040
38	37.5	38.5	4	0.557	0.015	0.007	0.022
39	38.5	39.5	2	0.686	0.018	0.006	0.023
40	39.5	40.5	0	0.686	0.018	0.006	0.023

Air Temperature and Density

Over the reporting period, Kodiak Site 2 had an average temperature of 4.8° C. The minimum recorded temperature during the measurement period was -17.0° C and the maximum temperature was 25.6° C, indicating a cool temperate operating environment for wind turbine operations. Consequent to Kodiak's cool temperatures, but counterbalanced by Site 2's elevation of 390 meters, the average air density of 1.214 kg/m^3 is approximately three percent higher than the standard air density of 1.1798 kg/m^3 (at 12.5° C and 96.7 kPa) at this elevation. Density variance from standard is accounted for in turbine performance predictions.

	Temperature				Air Density		
Month	Mean (°C)	Min (°C)	Max (°C)	Std. Dev. (°C)	Mean (kg/m³)	Min (kg/m³)	Max (kg/m³)
Jan	-3.1	-17.0	4.0	5.494	1.249	1.216	1.316
Feb	-1.0	-15.2	6.1	4.052	1.239	1.207	1.307
Mar	-0.5	-9.4	7.3	2.595	1.236	1.202	1.278
Apr	4.3	-1.3	12.4	2.461	1.215	1.180	1.240
May	9.5	0.5	25.6	5.265	1.193	1.128	1.232
Jun	9.6	5.1	18.7	2.792	1.192	1.155	1.211
Jul	11.9	7.3	21.6	2.947	1.182	1.143	1.202
Aug	12.6	8.7	20.5	2.373	1.180	1.148	1.196
Sep	9.7	4.8	16.7	1.866	1.192	1.163	1.213
Oct	6.0	-2.2	13.0	2.956	1.207	1.178	1.244
Nov	-2.1	-13.3	7.3	4.021	1.244	1.202	1.297
Dec	0.3	-11.1	6.2	3.835	1.233	1.206	1.286
All data	**4.8**	-17.0	25.6	6.764	**1.214**	1.128	1.316



Air Density DMap

The DMap is a visual indication of the daily and seasonal variations of air density (and hence temperature). Air densities higher than standard will yield higher turbine power than predicted by turbine power curves (which are calibrated for a sea level temperature of 15° C, air pressure of 101.3 kPa, and air density of 1.225 kg/m^3, while densities lower than standard will yield lower turbine power than predicted by the power curves.