4

SITE-BY-SITE WIND ANALYSES

Wind data have been gathered at numerous sites in Montana through the years. Many of these sites were analyzed for the *Montana Wind Energy Atlas,* and the results for fifty-six of the sites are presented here. Other sites identified during this study are discussed briefly in Appendix C.

The site-by-site analyses are presented alphabetically by county and site name. This order is reflected in Table IV-1, which shows annual average wind speed (in miles per hour [mph] and meters per second [m/s]) and wind power (in watts per square meter [watts/m^2]) at anemometer height for each

Table IV-1
Sites Analyzed for the Montana Wind Energy Atlas
Annual Average Wind Speed and Wind Power

County	Site	Wind Speed (mph)	Wind Speed (m/s)	Wind Power (watts/m^2)
Beaverhead	Dillon FAA Airport*	9.2	4.1	80.0
Big Horn	Decker Coal #8	9.4	4.2	106.0
	Spring Creek #1	7.3	3.2	56.7
	Westmoreland Absaloka #2	6.3	2.8	25.8
Blaine	Hays	12.0	5.3	194.6
Broadwater	Three Forks	8.6	3.8	72.5
Cascade	Great Falls Malmstrom Air Force Base*	8.7	3.9	106.0
	GREAT FALLS NWS AIRPORT*	11.9	5.3	183.0
	Salem	10.2	4.6	139.7
Chouteau	Highwood Bench	10.5	4.7	122.6
Custer	Miles City FAA Airport*	10.5	4.7	116.0
Daniels	Scobey Border*	7.2	3.2	85.3
	SCOBEY HANRAHAN	11.6	5.2	178.3
Dawson	GLENDIVE MICROWAVE*	12.2	5.4	168.5

Table IV-1
Sites Analyzed for the Montana Wind Energy Atlas (cont'd.)
Annual Average Wind Speed and Wind Power

County	Site	Wind Speed (mph)	Wind Speed (m/s)	Wind Power (watts/m²)
Deer Lodge	ANACONDA C-HILL	13.3	6.0	279.8
	Anaconda Highway Junction	8.0	3.6	62.8
	Anaconda Mill Creek	9.5	4.2	95.2
	ANACONDA WEATHER HILL	17.0	7.6	517.4
Fergus	Lewistown FAA Airport*	10.1	4.5	109.0
Flathead	Big Prairie	3.4	1.5	8.4
	Columbia Falls Water Supply	6.4	2.9	48.3
	Kalispell NWS Airport*	6.9	3.1	53.0
Gallatin	Bozeman FAA Airport*	7.8	3.5	71.0
Glacier	Blackfoot*	16.4	7.3	432.3
	CUT BANK	12.8	5.7	217.1
	CUT BANK FAA AIRPORT*	12.5	5.6	228.0
Granite	Drummond FAA Airport*	7.2	3.2	52.0
Hill	Havre NWS Airport*	10.7	4.8	135.0
Jefferson	Microwave Tower*	10.8	4.8	237.6
	WHITEHALL FAA AIRPORT*	13.2	5.9	325.0
Lake	Ronan Ninepipes	4.5	2.0	17.0
Lewis & Clark	Helena NWS Airport*	7.8	3.5	69.0
	Sieben 1*	16.7	7.4	404.3
Liberty	Whitlash	13.6	6.1	259.6
Madison	Norris Hill	17.0	7.6	414.3
Mineral	Superior NWS Airport*	5.1	2.3	16.0
Missoula	Missoula Hoerner-Waldorf #1	5.1	2.3	30.5
	Missoula NWS Airport*	6.3	2.8	43.0
	Missoula University of Montana	6.3	2.8	48.8
Park	LIVINGSTON CANDIDATE WIND TURBINE SITE*	15.6	7.0	494.4
	LIVINGSTON FAA AIRPORT*	15.7	7.0	510.0
Pondera	Heart Butte*	18.0	8.0	649.7
Powder River	Broadus Randall Ranch*	10.1	4.5	118.9
Rosebud	COLSTRIP BN*	12.9	5.8	453.6
	Western Energy #12	7.3	3.3	48.4

Table IV-1
Sites Analyzed for the Montana Wind Energy Atlas (cont'd.)
Annual Average Wind Speed and Wind Power

County	Site	Wind Speed (mph)	Wind Speed (m/s)	Wind Power ($watts/m^2$)
Silver Bow	Butte FAA Airport*	8.1	3.6	90.0
	Butte Hebgen Park	3.7	1.7	8.9
Teton	Choteau	10.1	4.5	116.0
Valley	Fort Peck*	10.6	4.7	219.9
	Glasgow Air Force Base*	9.6	4.3	109.0
	GLASGOW NWS AIRPORT*	11.0	4.9	139.0
Wheatland	JUDITH GAP	13.0	5.8	239.2
Yellowstone	BILLINGS NWS AIRPORT*	11.4	5.1	130.0
	Custer FAA Airport*	8.7	3.9	79.0
	Laurel New Farm	7.8	3.5	63.6
	Shawnee Park*	5.9	2.6	28.2

NOTE: Capitalized site names indicate high-potential sites.
* Asterisk indicates those sites at which the anemometer height was other than 10 meters. Data on wind speed and power are as recorded at the anemometer height.

Table IV-2
Sites Analyzed for the Montana Wind Energy Atlas
Wind Energy Potential Ranking by Wind Speed

Site Name	Anemometer Height (m)	Annual Average Wind Speed (mph)
HEART BUTTE, Pondera County	11.0	18.0
ANACONDA WEATHER HILL, Deer Lodge County	10.0	17.0
NORRIS HILL, Madison County	10.0	17.0
SIEBEN 1, Lewis and Clark County	11.0	16.7
BLACKFOOT, Glacier County	9.0	16.4
LIVINGSTON FAA AIRPORT, Park County	17.4	15.7
LIVINGSTON CANDIDATE WIND TURBINE SITE, Park County	9.1	15.6
WHITLASH, Liberty County	10.0	13.6
ANACONDA C-HILL, Deer Lodge County	10.0	13.3
WHITEHALL FAA AIRPORT, Jefferson County	9.1	13.2
JUDITH GAP, Wheatland County	7.0	13.0
COLSTRIP BN, Rosebud County	4.0	12.9
CUT BANK, Glacier County	10.0	12.8
CUT BANK FAA AIRPORT, Glacier County	6.1	12.5

Table IV-2
Sites Analyzed for the Montana Wind Energy Atlas (cont'd.)
Wind Energy Potential Ranking by Wind Speed

Site Name	Anemometer Height (m)	Annual Average Wind Speed (mph)
GLENDIVE MICROWAVE, Dawson County	4.0	12.2
HAYS, Blaine County	10.0	12.0
GREAT FALLS NWS AIRPORT, Cascade County	6.7	11.9
SCOBEY HANRAHAN, Daniels County	10.0	11.6
BILLINGS NWS AIRPORT, Yellowstone County	7.6	11.4
GLASGOW NWS AIRPORT, Valley County	6.1	11.0
Microwave Tower, Jefferson County	4.0	10.8
Havre NWS Airport, Hill County	6.1	10.7
Fort Peck, Valley County	4.0	10.6
Highwood Bench, Chouteau County	10.0	10.5
Miles City FAA Airport, Custer County	12.2	10.5
Salem, Cascade County	10.0	10.2
Choteau, Teton County	10.0	10.1
Lewistown FAA Airport, Fergus County	6.1	10.1
Broadus Randall Ranch, Powder River County	4.0	10.1
Glasgow Air Force Base, Valley County	4.0	9.6
Anaconda Mill Creek, Deer Lodge County	10.0	9.5
Decker Coal #8, Big Horn County	10.0	9.4
Dillon FAA Airport, Beaverhead County	6.1	9.2
Great Falls Malmstrom Air Force Base, Cascade County	4.6	8.7
Custer FAA Airport, Yellowstone County	10.1	8.7
Three Forks, Broadwater County	10.0	8.6
Butte FAA Airport, Silver Bow County	18.0	8.1
Anaconda Highway Junction, Deer Lodge County	10.0	8.0
Bozeman FAA Airport, Gallatin County	13.1	7.8
Helena NWS Airport, Lewis & Clark County	6.1	7.8
Laurel New Farm, Yellowstone County	10.0	7.8
Spring Creek #1, Big Horn County	10.0	7.3
Western Energy #12, Rosebud County	10.0	7.3
Drummond FAA Airport, Granite County	8.5	7.2

Table IV-2
Sites Analyzed for the Montana Wind Energy Atlas (cont'd.)
Wind Energy Potential Ranking by Wind Speed

Site Name	Anemometer Height (m)	Annual Average Wind Speed (mph)
Scobey Border, Daniels County	4.0	7.2
Kalispell NWS Airport, Flathead County	6.1	6.9
Columbia Falls Water Supply, Flathead County	10.0	6.4
Missoula NWS Airport, Missoula County	6.1	6.3
Missoula University of Montana, Missoula County	10.0	6.3
Westmoreland Absaloka #2, Big Horn County	10.0	6.3
Shawnee Park, Yellowstone County	4.0	5.9
Missoula Hoerner-Waldorf #1, Missoula County	10.0	5.1
Superior NWS Airport, Mineral County	17.7	5.1
Ronan Ninepipes, Lake County	10.0	4.5
Butte Hebgen Park, Silver Bow County	10.0	3.7
Big Prairie, Flathead County	10.0	3.4

NOTE: Capitalized site names indicate high-potential sites.
The rankings would have been different had all anemometers been at a standard height.

site analyzed. Table IV-2 ranks the sites according to their wind energy potential. Caution should be exercised in comparing the average speeds at sites with anemometers of different heights. (Readers wishing to determine the wind speed at a standard height of 10 meters may use the power law, discussed in Chapter V.)

Each site analysis includes a discussion of the time period of data collection, the method of data collection, and the quality of the data. Suspect data have been noted or deleted where possible; however, the quality of the data by and large reflects the quality assurance programs of the agencies that did the original data collection. Data summaries of monthly and annual average wind speed and wind power are provided. Monthly and annual wind speed distributions, showing the percentage of time the wind speed was within a given range, also are presented.

Sites where the average annual wind speed is equal to or greater than 11 miles per hour (4.9 meters per second) are considered "high potential" for purposes of this *Atlas*. For those sites with high wind energy potential, the following data summaries also are provided:

- Diurnal wind speed frequency distributions by season;
- Directional frequency and average wind speed (including wind rose graphics).

In addition, detailed descriptions of site characteristics are presented for the high-potential sites. These descriptions generally include information on current use of the site, availability of space for further development, ease of access, and distance from transmission lines, sensitive communications facilities, and aircraft corridors.

A table showing monthly and annual Weibull distribution coefficients (scale factor "c" and shape factor "k") also is presented for each of the high-potential sites. The two-parameter Weibull distribution has been found to be a reliable mathematical approximation of actual wind speed distributions for many locations and is widely used for wind modeling purposes. (The Weibull distribution is discussed in Appendix B.)