Systems Performance Analyses of Alaska Wind-Diesel Projects

Wind turbines in Kotzebue, Alaska. Ian Baring-Gould/PIX16098.

Kotzebue, Alaska

Located above the Arctic Circle on a spit of land facing the Kotzebue Sound, the coastal community of Kotzebue has approximately 3,000 residents and serves as a regional hub for northwest Alaska.

The Kotzebue Electric Association (KEA) supplies power to the community, which has an average load of approximately 2.5 MW and a minimum load of 700 kW. Loads are greatest during the winter months because of heating and lighting needs. A critical load is the heating of the town's water supply. The diesel plant has an installed capacity of 11 MW, and KEA runs two generators continuously during the winter with the rest as backup. On average, KEA consumes 1.4 million gallons of diesel fuel with an average efficiency of 14 kWh per gallon[1].

Installation of the Kotzebue wind turbines began in 1997 as a demonstration project showing how wind energy could be added to the energy mix of rural electric cooperatives. The wind farm is located on the tundra 4 miles south of Kotzebue and half a mile from the coast.

Kotzebue is the largest Eskimo village north of the Arctic Circle. In the Inupiat Eskimo language, the town's name means "place almost an island." Larry Flowers/PIX04684.

The first turbines to be installed were three Atlantic Orient Corporation (AOC) 15/50, 50-kW wind turbines on lattice towers on a location south of the main town and airstrip. Since that time, the wind farm has grown to an installed capacity of 915 kW comprised of 17 turbines: 15 AOC 15/50 or Entegrity EW50 (50 kW); one remanufactured Vestas V17 (65 kW); and one Northern Power Systems Northwind 100/19 (100 kW) wind turbine.

One gallon of diesel fuel is saved for each 14 kilowatt-hours produced by the wind farm. Although the annual average wind speed measured at the site is modest (about 5.5 m/s based on data collected at the site between 1998 and 2004), the wind turbines generated about 667,580 kWh last year, saving an estimated 45,500 gallons of diesel fuel[2] (although this is believed to be under-reported). Specific penetration values were not obtained from this plant, but currently only turbine curtailment is used to control at times of high wind output. Data collected by the U.S. Department of Energy (DOE) and the Electrical Power Research Institute through 2004 showed a relatively high system availability of 92%, including wind farm down time due to power transmission outages. Although more current assessments have not been published, these availability numbers have remained consistent on an annual basis[3].

The Kotzebue project systems performance analysis clearly demonstrates the ability for turbines to operate in remote communities with high availability, primarily due to the KEA's strong technical capabilities and dedication. Grants covered almost all turbine expenses, so the economic benefits of the project were immediately tangible and have helped to stabilize the cost of energy to the community.

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[1] http://solar.nmsu.edu/publications/wind_hybrid_nrel.pdf

[2] http://www.aidea.org/aea/PDF%20files/2007PCEStatisticsFY06.pdf

[3] http://www.nrel.gov/docs/fy00osti/28620.pdf

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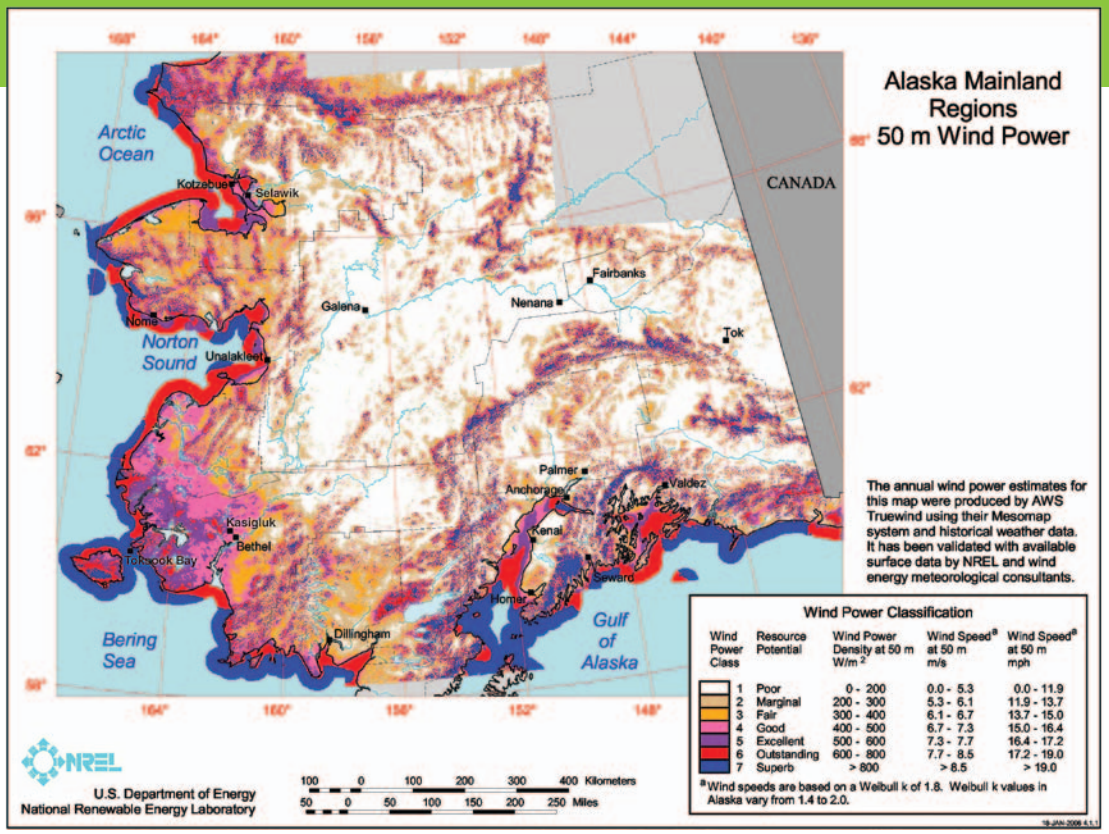

Turbines at time of data assessment on 9/12/08: Ten 50-kW AOC 15/50 and Entegrity Wind Systems EW50; one 100-kW Northern Power Systems Northwind 100/19 A

Current turbines: Fifteen 50-kW AOC 15/50 and Entegrity Wind Systems EW50; one 100-kW Northern Power Systems Northwind 100/19 A; one remanufactured Vestas V-17

Capacity: 0.925 MW

Developer/owner: Kotzebue Electric Association

Date online: Initial three turbines in 1997 with expansion since

Rated power (at time of data assessment): 10*50 kW per turbine; 1*100kW; plant rating 600 kW[4]

Rated power (current): 15*50 kW per turbine; 1*100 kW; 1*75 kW; plant rating 915 kW[24]

Data collection dates: 1/02 – 6/04; 4/07 – 10/8/07

Energy Flow (Based on Monthly Summations)	
Wind turbine output	110.5 kW*
Average wind speed	5.56 m/s @ 26.5 m on site; Alaska Energy Authority estimate 5.5 m/s @ 8 m at airport

*1/02 – 6/04

Performance Characteristics Based on Energy Flow (Based on Monthly Summations)	
Average net capacity factor	11.6%*
Optimal net capacity factor based on Alaska Energy Authority wind data	Hybrid2: 28.7%
Estimated fuel savings	322,345 gal**
Wind system availability	92.8%* (includes line outages)

*1/02 – 6/04
**1/02 – 6/04 using FY06 Statistical Report of the Power Cost Equalization Program efficiency (available at www.akenergyauthority.org/PDF%20files/2007PCEStatisticsFY06.pdf)

Other Data	
Diesel fuel price	$1.96/gal*
Residential electrical rate	$0.3205/kWh*
Diesel efficiency (kWh from diesel/gal)	14.67 kWh/gal*

* FY06 Statistical Report of the Power Cost Equalization Program (available at www.akenergyauthority.org/PDF%20files/2007PCEStatisticsFY06.pdf)

[4] Note: The Entegrity EW50 and AOC 15/50 are known to be underrated. Different organizations have assigned various ratings for this turbine. A rating of 66 kW, which was the value assigned by the NREL Turbine Verification Program for turbines operating in Kotzebue, was used in all performance calculations. This results in a plant-installed capacity of 760 kW at the time of the assessment and 1,165 kW currently.

In the previous tables, **capacity factor** is the ratio of actual average power produced to the rated power of the wind plant over a defined time period and provides an indication of the wind resource and system efficiencies (capacity factors above 15% for distributed wind systems would be considered good, although the acceptable capacity factor for a specific community will depend on project and alternative fuel costs). **Wind system availability** refers to the percentage of time that the wind turbine is available to produce power. Availability above 90% for new projects in remote communities would be considered acceptable; availability above 95% is desirable.

For more information on Alaska wind-diesel projects, please contact:

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