



Wind Energy Applications



Larry Flowers Montana Farm Bill February 2004





Sizes and Applications



Small (≤10 kW)

- Homes
- Farms
- Remote Application



Intermediate (10-250 kW)

- Village Power
- Hybrid Systems
- Distributed Power



Large (660 kW - 2+MW)

- Central Station Wind Farms
- Distributed Power
- Community Wind

Large and Small Wind Turbines are Different

Large Turbines (500-1500 kW)

- Installed in "Windfarm" Arrays Totaling 1 - 100 MW
- \$1,000/kW; Designed for Low Cost of Energy
- Requires 6 m/s (13 mph) Average Sites

• Small Turbines (0.3-100 kW)

- Installed in "Rural Residential" On-Grid and Off-Grid Applications
- \$2,500-5,000/kW; Designed for Reliability / Low Maintenance
- Requires 4 m/s (9 mph) Average Sites



Growth of Wind Energy Capacity Worldwide



Sources: BTM Consult Aps, March 2001 Windpower Monthly, January 2003









- Declining Wind Costs
- Fuel Price Uncertainty
- Federal and State Policies
- Economic Development
- Green Power
- Energy Security







Wind Cost of Energy







Wind Economics – Determining Factors



- Wind Resource
- Financing and Ownership Structure
- Taxes and Policy Incentives
- Plant Size: equipment, installation and O&M economies of scale
- Turbine size, model, and tower height
- Green field or site expansion
- What is included: land, transmission, ancillary services





















THE "DASH TO GAS"







Economic Development Impacts

- Land Lease Payments: 2-3% of gross revenue \$2500-4000/MW/year
- Local property tax revenue: 100 MW brings in on the order of \$500,000 1 million/yr
- 1-2 jobs/MW during construction
- 2-5 permanent O&M jobs per 50-100 MW
- Local construction and service industry: concrete, towers usually done locally
- Investment as equity owners: production tax credit, accelerated depreciation





Wind Power Provides Rural Economic Benefits



- 240 MW of wind in Iowa
 - \$640,000/yr in lease payments to farmers (\$2,000/turbine/yr)
 - \$2 million/yr in property taxes
 - \$5.5 mil/yr in O&M income
 - 40 long-term O&M jobs
 - 200 short-term construction jobs
 - Doesn't include multiplier effect
- 107 MW wind project in MN
 - \$500,000/yr in lease payments to farmers
 - \$611,000 in property taxes in 2000
 = 13% of total county taxes
 - 31 long-term local jobs and \$909,000 in income from O&M (includes multiplier effect)





Wind Power Provides Rural Economic Benefits



- 40 MW of wind in South Dakota = \$400,000 - \$450,000/yr for Hyde County, including:
 - More than \$100,000/yr in annual lease payments to farmers (\$3,000 \$4,000/turbine/yr)
 - \$250,000/yr in property taxes (25% of Highmore's education budget)
 - 75 -100 construction jobs for 6 months
 - 5 permanent O&M jobs
 - Sales taxes up more than 40%
 - Doesn't include multiplier effect





- Permitting and Siting (visual, noise, avian, land use)
- Transmission: capacity allocation, RTO formation, new line builds/planning
- Power Variability: impact on utility operations
- Evolving competitive markets
- Green power markets
- Policy environment PTC, RPS, state tax provisions



The Wind Project Development Process





Uses of Small Wind Turbines in Rural America

ALLEN 4 50%



- Ranch near Wheeler, Texas
- Water-pumping for 120 head of cattle
- Whisper H80 wind turbine, 1 kW, 9-ft rotor, 30-ft tower





Case Study:



AOC 15/50 powers school in Clarion, IA



 This AOC 15/50 wind turbine on a farm in Clarion, Iowa save the Clarion-Goldfield Community School about \$9,000 per year on electrical purchase and provides a part of the school's science curriculum.





Case Study: On-Grid Farm

- Southwestern Kansas
- Utility bill reduction
- Bergey Windpower Excel turbine, 10 kW, 23-ft rotor, 100-ft tower
- Electricity production ~21,000 kWh/year
- Utility bill savings ~\$2,800/year
- Installed in early 1983, ~\$20,000
- Received federal tax credit
- Maintenance costs, \$50/year
- One lightning strike, one blade was replaced



Net Metering of Renewable Energy

Energy consumed Load immediately retail rate

> Excess energy used to **offset** consumption at another time **retail rate**

_oad Net excess energy (determined monthly or annually): retail rate, avoided cost, or given to the utility









•Capacity: .1 MW, completed in 2000

- •Turbine Manufacturer: Atlantic Orient Corporation
- •Developer: Kotzebue Electric Association



Saint Paul Island, Alaska





•Turbine Size: 225 kW

> •Turbine Manufacturer: Vestas

•Developer/owner: Northern Power Systems

•Capacity: .225 MW



Rosebud, SD





- •Turbine Size: 750 KW
- •Turbine Manufacturer: NEG Micon
- •Turbine Owner: Rosebud Sioux Indian Reservation (Commissioned March 2003)
- •PPA: Basin Electric
- •Green Tags: Native Energy, US Air Force



Spirit Lake





Photo courtesy of AWEA

•Turbine Manufacturer: NEG Micon

•Size: 750 kw

•Owner: Spirit Lake Community Schools

•Operational: October 2001









Moorhead, Minnesota





•Turbine Size: 750 kW

- •Turbine Manufacturer: NEG Micon
- •Developer: Moorhead Public Service

•Capacity: .75 MW







- •Turbine Size: 750 kW
- •Capacity: 2.25 MW
- •Turbine Manufacturer: Zond Corporation
- •Turbine Owner: Consortium/Cedar Falls is lead with 2/3 ownership



"In my 44 years in the municipal utility business, no utility project has ever generated more customer support and interest than our wind turbine project."

Nick Scholer, former manager of Algona Municipal Utilities, Algona, Iowa





Ponnequin, Colorado



- Turbine Manufacturer: Vestas, NEG Micon
- Developer/owner: DisGen/Xcel Energy

- •Turbine Size: 660-750 kW
- •Capacity: 31.5 MW
- •Commissioned: 1999



Highmore, SD





Turbine Manufacturer: GE Wind
Developer/Owner: FPL Energy
Size: 1.5 MW

•Capacity: 40 MW









- •Turbine Size: 1.5MW
- Manufacturer: GE Wind
- Developer/Owner: GE Wind/Shell, PPM
- •Capacity: 162 MW
- •Commissioned: 2003









- Turbine Size: 660 kW
- •Turbine Manufacturer: Vestas
- •Developer/Owner: FPL Energy
- •Capacity: 262 MW







Montana's Wind Resources

- The new wind map shows many areas of good wind resource
- Northwestern plains and foothills
 - Many areas of class 4-6
 - Highest near eastern slopes of the Rocky Mountains
 - Winter maximum
- Central and eastern plains
 - Many areas of class 4, some class 5 & 6
 - Best on elevated terrain features such as ridges, hilltops, and plateaus
 - Winter and spring maximum
- Mountain wind corridors
 - Windy corridors at relatively low elevation class 4-6
 - Examples Livingston, Whitehall, Norris Hill, Judith Gap
 - Winter maximum
- Mountain ridge crests
 - High ridges and summits with class 4-7
 - Winter maximum



- Wind resource class 4 and above (good-to-excellent wind for utility scale applications)
- Montana's windy land area
 - 67,210 square kilometers or 16,607,980 acres
 - 18% of state's total area (376,564 square kilometers)
 - Total windy land is slightly larger than state of West Virginia
- Montana's wind potential
 - 336,050 MW of potential installed nameplate capacity
 - Assumes 5 MW per square kilometer or 1 MW per 50 acres of windy land
- Indian Reservations
 - Windy land 7,121 square kilometers or 1,759,630 acres
 - Wind potential 36,505 MW
- Excluded areas:
 - Environmentally sensitive lands (parks, wilderness, wildlife refuges, etc)
 - Urban areas
 Steep slopes > 20%
 Water bodies

Lewiston Montana Area Wind Power Resource Estimates 60 Kilometers Transmission Line* Indian 40 Miles Voltage (kV) Reservation - - 100 Flatwood — 100-101 Discifeet Rocky Boy's — 230 Fort Kelknap Fort Pack = 500 The wind power resource estimates were produced by TrueWind Solutions using their Mexomap system and historical weather data. This map has been velidated with Composite of IRDI, Montana Dept. of Environmental Quality N. Cheyonne Crow and WAPA date available surface data by the National Renewable Energy Laboratory and wind energy meteorological consultants. Wind Power Classification Wind Power Wind Respurce Wind Speed[®] Wind Speed⁴ Power Potential Density at 50 m at 50 m at 50 m Class Wini in/is righ 5.6 - 6.4 6.4 - 7.0 7.0 - 7.5 7.5 - 8.0 12.5 - 14.3 14.3 - 16.7 15.7 - 16.8 Marginal Fair Good 200 - 300 300 - 400 U.S. Department of Energy National Renewable Energy Laboratory 400 - 500 Expellent 500 - 500 16.8-17.9 Outstand ng 600-800 8.0 - 8.8 17.9-19.7 Superb > 800 > 8.0 > 19.7 ⁸Wind speeds are approximate and based on a Weibuli k value of 2.0. 12-MAR-2002 2.3.1













Montana Annual Wind Power Pattern by Region







Annual Power Pattern - Eastern Plains







Annual Power Pattern - Northwestern Plains





Wind Energy Finance



http://analysis.nrel.gov/windfinance/login.asp

Inputs

- General Assumptions (e.g. Project size, Inflation rate)
- Capital Costs
- Operating Costs
- Financing Assumptions
- Tax Assumptions
- Constraining Assumptions (e.g. Minimum IRR, Minimum Debt Service Coverage Ratio)

Outputs

- Internal Rate of Return
- Debt Service Coverage Ratio
- Net Present Value
- Cash Flows

Features

- Extensive help file explains each entry
- Easily handles a variety of tax parameters
- Exportable summaries and cash flows





Carpe Ventem www.windpoweringamerica.gov



2003 Federal Farm Bill Awardees



\$187,134 for 9 small wind projects

Small Wind Awards										
	Grant		Project							
State	Request		Size	Ownership	Application					
<u>IA</u>	\$	10,000	10kW	Small Bus	Net Metering (grain drying)					
ID	\$	10,000	20kW	Ag Producer	Net Metering					
MN	\$	17,175	39kW	Ag Producer	Net Metering					
MN	\$	17,110	35kW	Ag Producer	Net Metering					
MN	\$	16,850	35kW	Small Bus	Net Metering					
MN	\$	16,850	35kW	Small Bus	Net Metering					
NE	\$	10,000	10kW	Small Bus	Net Metering					
					reduce annual energy purchases,					
					reduce operating costs, &					
<u>NY</u>	\$	78,819	100kW	Ag Producer	generate additional revenue					
WA/MT	\$	77,449	90kW	Small Bus	Net Metering					
WA	\$	11,700	20kW	Small Bus	Net Metering					





Large Wind Awards										
	Grant	Project			# of					
State	Request	Size	Ownership	Application	Projects					
MN	\$192,900	1.25MW	Coop (small business)	Wholesale Power Production	5					
ID	\$500,000	1.5MW	Ag Producer	Wholesale Power Production	1					
MN	\$500,000	1.5MW	Rural Electric Coop	Wholesale Power Production	2					
IL	\$438,544	1.65MW	Rural Electric Coop (small bus)	distributed to coop members	1					
MN	\$200,000	1.65MW	Coop (small business)	Wholesale Power Production	1					
MN	\$178,201	1.65MW	Coop (small business)	Wholesale Power Production	7					
MN	\$500,000	1.9MW	Ag Producer	Wholesale Power Production	1					
MA	\$470,000	3MW	Coop (small business)	Wholesale Power Production	1					
IA	\$402,500	5.6MW	Small Bus	Wholesale Power Production	1					
ТΧ	\$500,000	9.9MW	Small Bus	Wholesale Power Production	1					
IL	\$300,000	22.5MW	Small Bus	Wholesale Power Production	1					
VA	\$500,000	49.5MW	Small Bus	Wholesale Power Production	1					
IA	\$99,999	111MW	Small Bus	Wholesale Power Production	1					









- Fourth generation MT farmer
- 1200 acre cattle ranch and wheat farm
- Offset all electricity used on home and farm operations
- 100 foot tower
- Turbine installed September 2003
- Class 3 winds 12 mph annual average

Alger's Estimated Cost and Production

- Installed Turbine System \$36,850
 - Lower than typical
 - Turbine system costs only, no dealer payment
 - Site preparation done by J. Algers
- USDA RESG (25% grant) \$7,696
- Montana NCAT USB Funds \$12,500
- Estimated electricity used 14,200 kWh/yr
- Estimate electricity produced 18,000 kWh/yr (based on Class 3 wind site)





- Evaluate the costs of the turbine and the productivity based on average annual wind speed see if it meets your electric load
- Zoning/Permitting get special use permit from local county zoning board (should consult with neighbors)
- Seek approval for interconnection from local utility
- Prepare the site identify location for turbine tower and guys (micrositing), work with turbine manufacturer to build foundations, location of inverter and electrical connection, trenching for conduit
- Make arrangement for turbine purchase/delivery
- Erect turbine yourself or hire an installer
- Connect to electrical grid licensed electrician
- Get final approval from utility for installation of turbine & electrical meter



Doug Nelson Bison Ranch – East Glacier, MT









- Nelson's 700 acre ranch
- Class 4 wind resource 13 mph annual average wind speed
- 60' tower
- estimate 20,000 kWh/yr
- use electricity to power Nelson's shop, extensive electric fences, and partially offset electricity for home and ranch operations





- Things that may or may not be required
 - Turbine application (AC, DC, water pumping)
 - Wind resource w/ some reference
 - Estimated kWh productivity
 - Site plan showing turbine installation, wire runs, location of controller/battery, equipment
 - Electrical schematic
 - Grid Interconnect agreement
 - County zoning/permitting
 - Copy of SWT warranty
 - Operation and Maintenance guidelines