National Renewable Energy Laboratory

Small Wind Power For South Dakota



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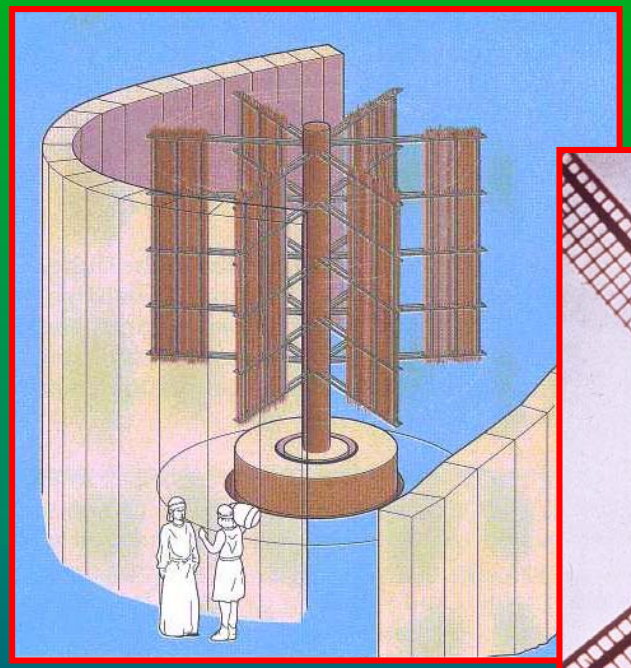
National Wind Technology Center

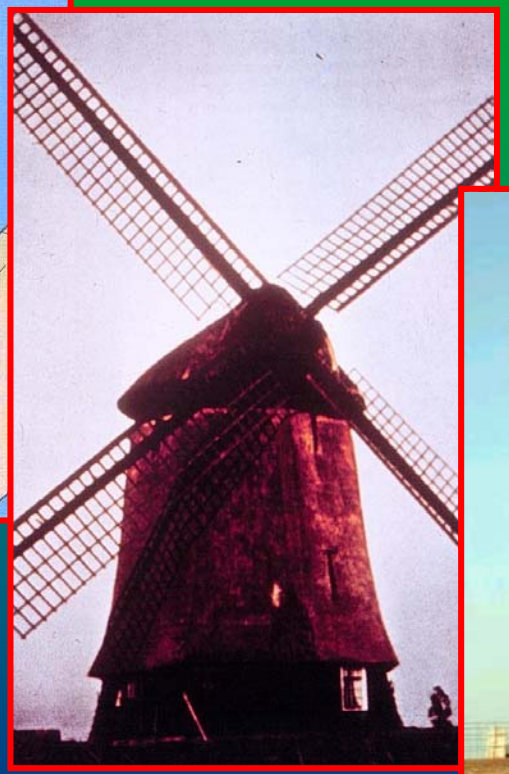
Operated for the U.S. Department of Energy by Midwest Research Institute • Battelle • Bechtel

Wind Power History

1400-1800 years ago,
in the Middle East

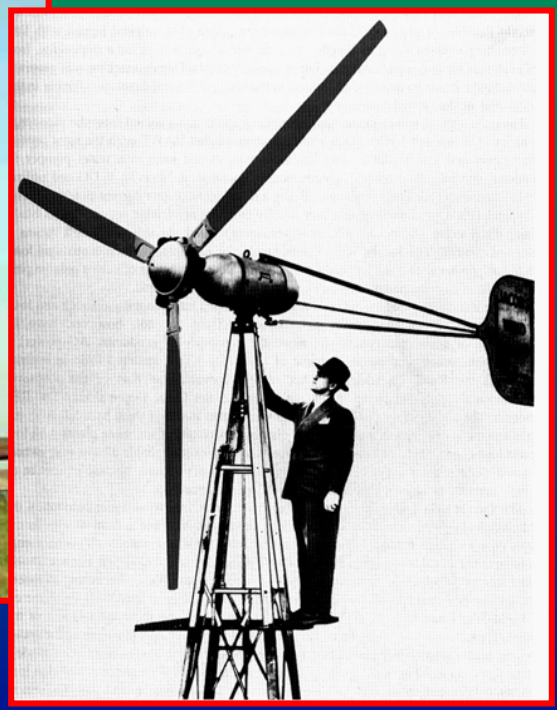


800-900 years ago,
in Europe



140 years ago,
water-pumping
wind mills

70 years ago,
electric power



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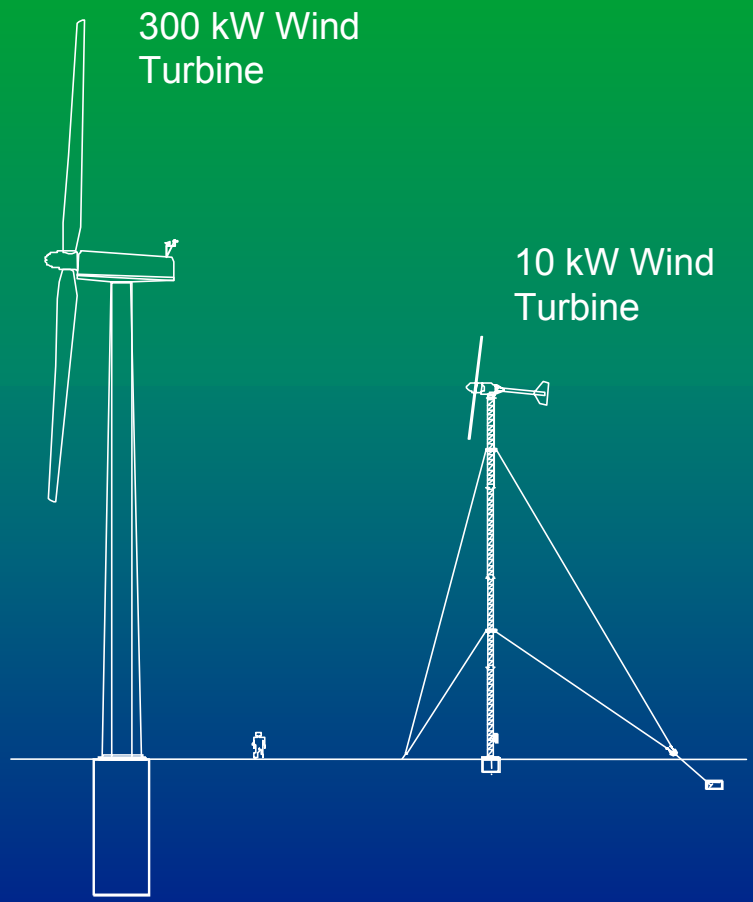
Small Wind Turbines are Different

- Large Turbines (600-1800 kW)
  - Installed in Windfarms, 10 - 100 MW
  - Provide Low Cost Power to the Grid
  - < $1,000/kW
  - Require 6 m/s (13 mph) Average Wind Speeds
- Small Turbines (0.3-50 kW)
  - Installed Off-Grid or at On-Grid Facilities
  - $2,000-6,000/kW
  - Designed for Reliability / Low Maintenance
  - Require 4 m/s (9 mph) Average



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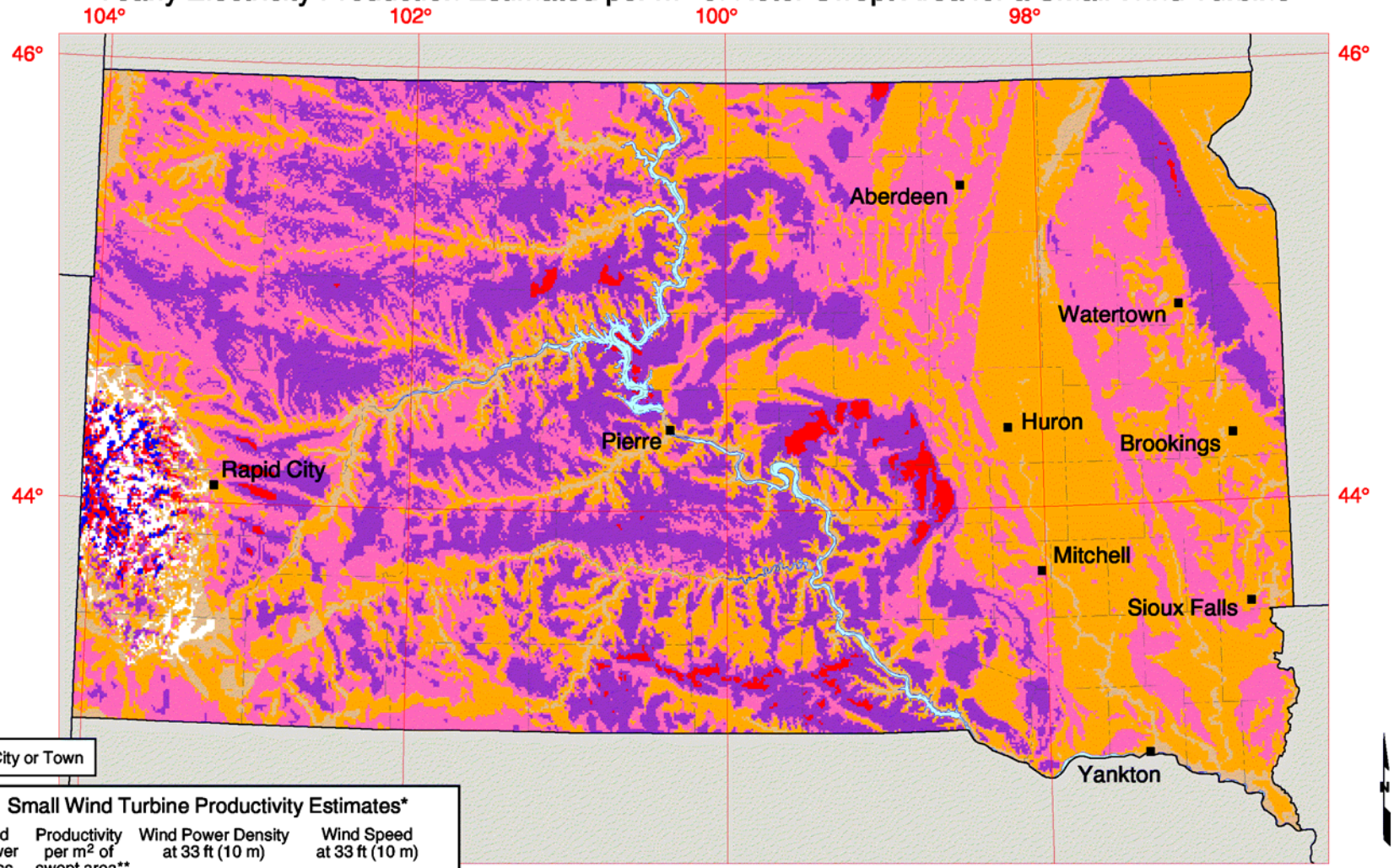
South Dakota - Wind Resource Map

Yearly Electricity Production Estimated per m^2 of Rotor Swept Area for a Small Wind Turbine



■ City or Town

Small Wind Turbine Productivity Estimates*

Wind Power Class	Productivity per m^2 of swept area** (kWh/year)	Wind Power Density at 33 ft (10 m) (W/m^2)	Wind Speed at 33 ft (10 m) (mph)	Wind Speed at 33 ft (10 m) (m/s)
1	< 350	<100	< 9.8	< 4.4
2	350 - 500	100 - 150	9.8 - 11.5	4.4 - 5.1
3	500 - 610	150 - 200	11.5 - 12.5	5.1 - 5.6
4	610 - 690	200 - 250	12.5 - 13.4	5.6 - 6.0
5	690 - 770	250 - 300	13.4 - 14.3	6.0 - 6.4
6	770 - 880	300 - 400	14.3 - 15.7	6.4 - 7.0
7	880 -1170	400 -1000	15.7 - 21.1	7.0 - 9.4

50 0 50 100 Kilometers

25 0 25 50 75 Miles

* Estimates are based on different models and sizes of wind turbines assuming a tower height of 80 ft (24 m).

** For systems of different sizes, multiply the estimated productivity by the total swept area of the turbine.

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Case Study:
On-Grid Farm with Wind System

- Southwestern Kansas
- Utility bill reduction
- Bergey Windpower Excel wind turbine
  10 kW, 23 ft rotor, 100 ft tower
- ~21,000 kWh/year generation,
  utility bill savings ~$2,800/year
- Installed in early 1980s, ~$20,000,
  received federal tax credit
- Maintenance costs $50/year
- One lightning strike, damage was
  covered by farm insurance

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On-Grid Home with Wind System

- Charlotte, VT, net metering for utility bill reduction
- Bergey Excel wind turbine, 23 ft rotor, 10 kW
- GridTek inverter 240 VAC single-phase
- 1.4 kW PV array
- Installed in 1999

Case Study:
On-Grid Small Business with Wind System

- R&M Mechanical Systems, Norman, OK
- Net-metering for utility bill reduction
- Bergey Windpower Excel wind turbine, 10 kW, 21 ft rotor, 80 ft tower
- ~15,000 kWh/year generation, utility bill savings are ~$1,300/year
- Installed in 1984, ~ $22,000
- Owner received an $8,000 tax credit and 5-year depreciation
- Maintenance and repair costs ~$75/year

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Net Metering of Renewable Energy

- Whenever a home power system is generating more electricity than is being consumed:
  - The excess power is sent back to the utility
  - The electric meter turns backward, which offsets consumption at another time
  - The homeowner is charged only for the “net” consumption/generation (monthly or annually)
- Net metering of wind energy is available:
  - to all rural customers in 23 states
  - to some residential customers in 9 other states

South Dakota Financial Incentives for Small Wind

- Property Tax Exemption
  - First 3 years after system installation
  - Residential: 100% of system assessed value
  - Commercial: 50% of system assessed value

Policy Options for Small Wind

- Investment Incentives (rebates, buy-downs)
- Investment Tax Credits
- Net Metering
- Sales Tax Reductions/Exemptions
- Property Tax Reductions
- Uniform Zoning Requirements
- Low Interest Loans
- Line Extension Policies
- Strategies for Supporting Wind Energy, A Review and Analysis of Policy Options, http://www.nationalwind.org/pubs/strategies/default.htm

Clean Power Estimator: *www.clean-power.com/nrelwind*

- Input your zip code
- Select a wind turbine (300 W to 50 kW) and a tower height
- Input economic factors: loan information, income tax status, annual electric utility bill
- The Estimator has data on: electric rates; tax rates; economic incentives for small wind turbines; local wind speeds; electric load profiles; and wind turbine performance
- The Estimator will give you cost and performance information

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Case Study:
On-Grid Home with Wind System

- Tehachapi, CA, net metering for utility bill reduction
- Bergey Excel wind turbine, 23 ft rotor, 10 kW
- Total installed cost was $34,122 in October 1999
- California Buy-Down Program, $16,871 cash rebate
- Estimated payback: 8 years

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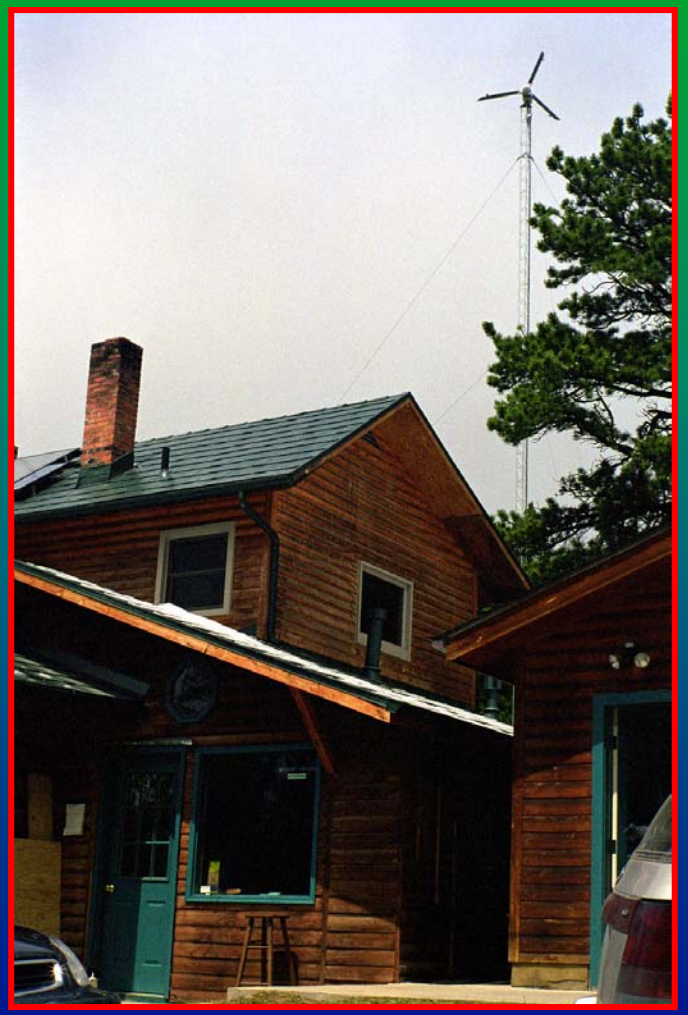
Is Wind Energy Practical For Me?

- Do you have a good wind resource?
- Do you have at least an acre of land in a rural area?
- Will your local zoning ordinances or neighborhood convenants allow wind turbines?
- Is your average electricity bill $150/month or more?
- Will the electric utility distribution lines have to be extended more than 1/2 mile to reach your property or home-site?
- Are you comfortable with long term investments?
- Do you need to pump water?

Questions?

Case Study:
Off-Grid Home with Wind/PV System

- West of Boulder, CO, at 9,000 ft
- Bergey 1500 wind turbine, 1.5 kW, 70 ft tower
- Solarex PV panels, 480 W
- 24 VDC battery, 375 Ah
- Onan generator, propane-fueled, 3 kW (at altitude)
- Trace inverter, 120 VAC, 1 phase
- Propane used for range, refrigeration, space heat, hot water (w/solar pre-heat)
- First wind turbine installed in 1978, fourth wind turbine now in service
- PV installed 1984 w/ tax credits
- System cost about $20,000



Costs for Line Extensions

Source: PG&E

Off-Grid Wind Water-Pumping

- Ranch near Wheeler, TX
- Water-pumping for 120 head of cattle
- Whisper 1000 wind turbine, 1 kW, 9 ft rotor, 30 ft tower

Questions?