Small Wind Systems for Village Power: An Update

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Modern Small Wind Turbines: High Tech, High Reliability, Low Maintenance

- 50 W - 50 kW Capacity
- Aerospace Technology
- Mechanically Simple: 3 Moving Parts
- No Regular Maintenance Required
- Low Costs: $1 - 3 / Watt
- Proven: ~200,000 Installed, Over a Billion Operational Hours

10 kW Unit (Bergey)
Modern Small Wind Turbines: A Least-Cost Option for Small Power

"With reasonable assumptions concerning discount rates, capacity factors, and fuel costs, micro-hydro and wind turbines can have the lowest life cycle costs in locations where the resource is sufficient."

Fueling Development: Energy Technologies for Developing Countries, April, 1992
U.S. Office of Technology Assessment
Existing Wind Maps
The Curse of Meteorological Data

- Sheltered Wind Sensors
  - Below Trees, Buildings, Etc.
  - Roof Mounted
- Worn Bearings, No Calibrations, Etc.
- “Disappearing Wind”
- Power \( \sim (\text{Velocity})^3 \); So 20% Error in Wind Speeds Means ~50% Error in Available Energy

Most National Wind Maps Radically Under-Estimate Available Wind Energy Resources!

Case of “Disappearing Wind”
Kupang, Indonesia
Finding the True Wind Resource

- NREL Wind Mapping with Additional Data Sources: Satellite, Ex-Military Data, Etc.
- Low Cost Wind Loggers Specifically Designed for Small Wind Applications
Small Wind Applications

Wind Home Systems

Wind Turbine

Tower

Wind Charge Controller

DC Source Center

PV Array (Optional)

PV Charge Controller

DC to AC Inverter

Battery Bank

DC Loads

120/240 VAC Loads

System Controls Not Shown

Engine Generator (Optional)

Hybrid Power Systems

Wind Turbine

Tower

Wind Charge Controller

DC Source Center

PV Array (Optional)

PV Charge Controller

DC to AC Inverter

Battery Bank

DC Loads

120/240 VAC Loads

System Controls Not Shown

Engine Generator (Optional)

Wind-Electric Systems

Wind Turbine

Tower

Pump & System Controller

Jack Pump

Centrifugal Pump

Submersible Pump
Industry Trends

- Remote Power Markets are Expanding, Companies are Growing Nicely
- Small Wind/PV Hybrids & Wind Home Systems Entering Mainstream of Rural Electrification
- Package Standardization: Lower Costs & Easier Operational Support
- Growing Evidence of Significant Battery Life Extension Due to Charging from Wind
China Rural Electrification
World’s Largest Market for Small Wind

- 140,000 Existing Systems
- Wind/PV Hybrid Home Systems
  … SETC / World Bank Project: 30,000 New Hybrid Systems
- SDPC “Brightness Engineering” Village Power Program … ~ 35,000 5-10 kW Wind/Diesel Systems
- Foreign Cooperation to Improve Technology … Hua De (donor-aid) & Xiangtan Bergey Windpower Ltd (private sector JV)
Chile Region X Electrification
Wind/Diesel Favored Over Diesel-Only

◆ Collaboration Between CNE, Regional Governments, NREL, and NRECA
◆ 1997: Region IX Pilot Projects
◆ 1998: Region X Pilot Projects
◆ 1999: Regional Implementation: Isla de Chiloe
  ~ Thirty 3-40 kW Wind/Diesel Systems

Villa Las Araucarias, Region IX
Advanced Small Wind Turbines
Technology on the Move

- US-DOE Advanced Small Wind Turbine Program ... 8, 16, & 40 kW
- Injection-Molded & Pultruded Blades
- Special Low Wind Rotors
- 10 Year Preventive Maintenance Interval; 50 Year Operating Life
- Very Tall Towers, up to 82 meters (270 ft)
- Many Other Private Sector R&D Programs
PV / SHS is Not a Silver Bullet for Rural Electrification … Consumers Often Want More Than ~ 200 Wh/Day, Direct Current

Consumers are Technology Neutral

Small Wind Turbines have Attractive Cost Reduction and Technology Transfer Potential

Goal of Bilateral and Multilateral Finance and Market Stimulation Programs Should be Best Service at Least Cost

Industry Seeks New Public-Private Partnerships to Provide Market Transformation Opportunities in Village Power