



National Renewable Energy Laboratory



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable



TECHNOLOGY, PERFORMANCE, AND MARKET OF WIND-DIESEL APPLICATIONS FOR REMOTE AND ISLAND COMMUNITIES

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The market for wind-diesel power systems in Alaska and other areas has proven that the integration of wind turbines with conventional isolated generation is a commercial reality. During the past few years, the use of wind energy to reduce diesel fuel consumption has increased, providing economic, environmental, social, and security benefits to communities' energy supply.



NW100 turbines over bulk fuel tanks in Kasigluk, Alaska.



MEDAAE59, 800-kW turbines in San Cristobal, Galapagos.

Markets

Rapidly expanding market for wind-diesel technologies:

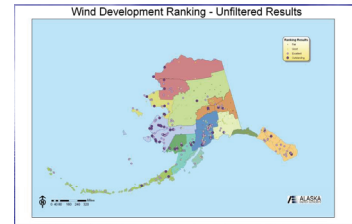
- 11 projects operating or under construction in Alaska; an additional 14 projects are funded
- Operating projects in almost every region of the world
- Expanded interest in Canada, Caribbean and Pacific Islands, and Antarctica.

Alaska

- 116 communities have a strong wind potential
- New State Energy Plan released in January 2009 shows strong wind potential in many communities (<http://www.aidea.org/aea/>)
- Rural communities have a potential of 90 MW to 240 MW of installed capacity
- \$100 M USD renewable energy fund helps to fund remote wind projects.

Canada

- 40-190 MW potential in large communities and mines with loads above 10 MW, with a potential to save between loads 25 mil – 120 mil l of diesel savings/yr.
- 30-130 MW potential MW in smaller communities with loads less then 10 MW, with a potential to save between loads 16 mil – 77 mil l of diesel savings/yr.



Communities where wind could play a significant role in reducing power costs.

Project Examples



Kotzebue Alaska

- Large coastal hub community in Northwestern Alaska with a population of ~3,100
- 2-MW peak load with 700-kW minimum load and 915-kW of installed wind
- Average penetration of ~5% with wind generating 1,064,242 kWh in 2007
- Diesel fuel saving of more than 71,500 gal (270,600 l) in 2007
- Good turbine availability (92.8% 1/02 to 6/04) due to strong technical support.



Kotzebue, Alaska Wind Farm consisting of 15 AOC 15/50 or Entegriy EW50 (50 kW); one Vestas V17 (65 kW); and one Northern Power Systems Northwind 100/19 (100-kW).



Toksook Bay, Alaska

Power system that supplies the ~800 people of the communities of Toksook Bay and Nightmute in coastal Southwest Alaska

- Average load just under 370 kW (both Toksook and Nightmute)
- Three NW100-kW turbines and resistive community heating loads
- Installed in the fall and winter of 2006
- 24.2% average wind penetration with much higher instantaneous penetration
- Almost 700 MWh generated by wind last year, saving almost 46,000 gal (174,239 l) of fuel
- First-year turbine availability of 92.4% - currently under warrantee
- Average net capacity factor of 26.0% from August 2007 to July 2008.



Three Northern Power Systems Northwind 100/19 (100-kW) on special permafrost foundations.

Other Documented Wind-Diesel Power Systems

Medium Penetration

- San Clemente Island, USA
- Kasigluk, USA
- Denham, Australia
- Flores Island, Azores, Portugal
- San Cristobal, Galapagos, Ecuador.

High Penetration

- Wales, USA
- St. Paul, USA
- Coral Bay, Australia
- Utsira, Norway
- Mawson Station, Antarctica (Australia).

Technology Advances

Advances that Can Improve the Application of Remote Systems

- Advanced Power Control
- Secondary dispatchable loads
 - Electric or hybrid electric vehicles
 - Electric heating through thermal loads
 - Water desalination
- Medium-scale turbines for remote applications
- Advances in software models
 - Expanded modeling capabilities in resource assessment, performance, control, and electrical response have improved the ability to understand wind-diesel systems
- New ownership models including power purchase agreements
- Advances in diesel technology, low load, and fuel injected.



Electric Utility ATV at Summit Station, Greenland.

Entegriy EW50 (50 kW) on tubular tower.



Industry Challenges

Technical

- Lack of dispatchable load and controllers to allow higher-penetration systems
- Lack of guidelines and standards
- Lack of an established technology track record
- High and undocumented installation and operation expenses

Institutional

- Poor understanding of the technology by decision makers
- Lack of trained personnel and the ability to keep trained personnel in communities
- Vested interests in maintaining the existing infrastructure and systems
- Environmental, siting, or other development concerns.

Policy

- High capital cost and general discounting of sustainability
- Perceived risk and associated higher financial costs
- Subsidized diesel fuel markets
- Lack of consideration of environmental impacts of diesel power generation
- Lack of funding to support the development of diesel alternative systems
- Complicated and multi-jurisdictional permitting processes
- Lack of regional implementation approaches.