



Wind Energy Applications

Régie de l'énergie
 DOSSIER: R-3648-2007 Phx 2 2
 DÉPOSÉE EN AUDIENCE
 Date 19 juin 2008
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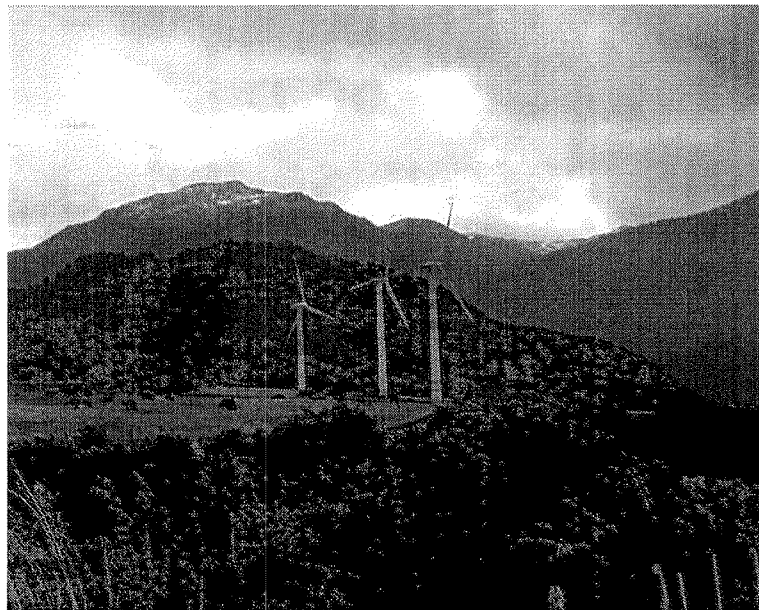
SÉ/AQLPA

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EXTRAITS

Déposé au dossier
 R-3648-2007 Phx 2
 Le 19 juin 2008
 C-9-32
 SE-AQLPA 3 Doc. 6



January 30, 2004

Anchorage, AK



Wind-Diesel Power Systems

- **Larger systems with demands over ~ 100 kW peak load us to many MW**
- **Based on an AC bus configurations**
- **Batteries, if used, store power to cover short lulls in wind power**
- **Both small and large renewable penetration designs available**
- **Large potential mature with fewer examples**
- **Provide AC power**



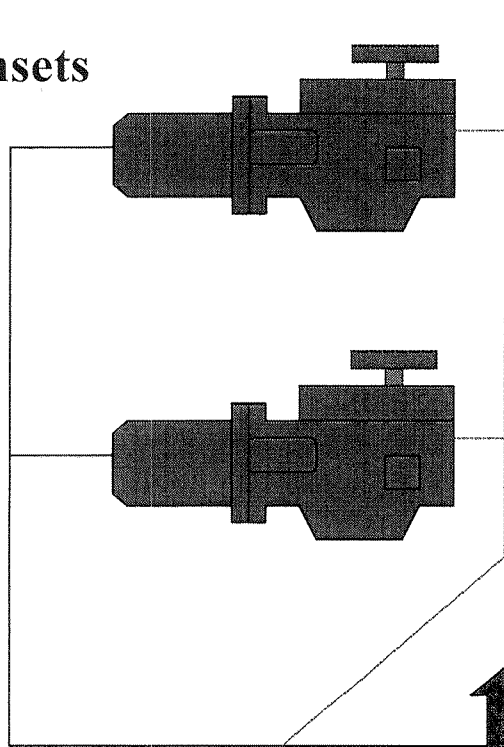
Wind-Diesel Systems Configurations

| | Low | Medium | High |
|---------------------------|----------------------------|--|---------------------------------------|
| Peak Instantaneous | <50% | 50 – 100% | 100 – 400% |
| Annual Average | <20 | 20 – 50% | 50 – 150 % |
| Commercial status | Fully utilized | Well proven Fully commercial Multiple use | System prototype Operating |
| Examples | Denmark, Greece | San Clemente, CA Kotzebue, Ak Coyaique, Chile | St. Paul Wales Ak |

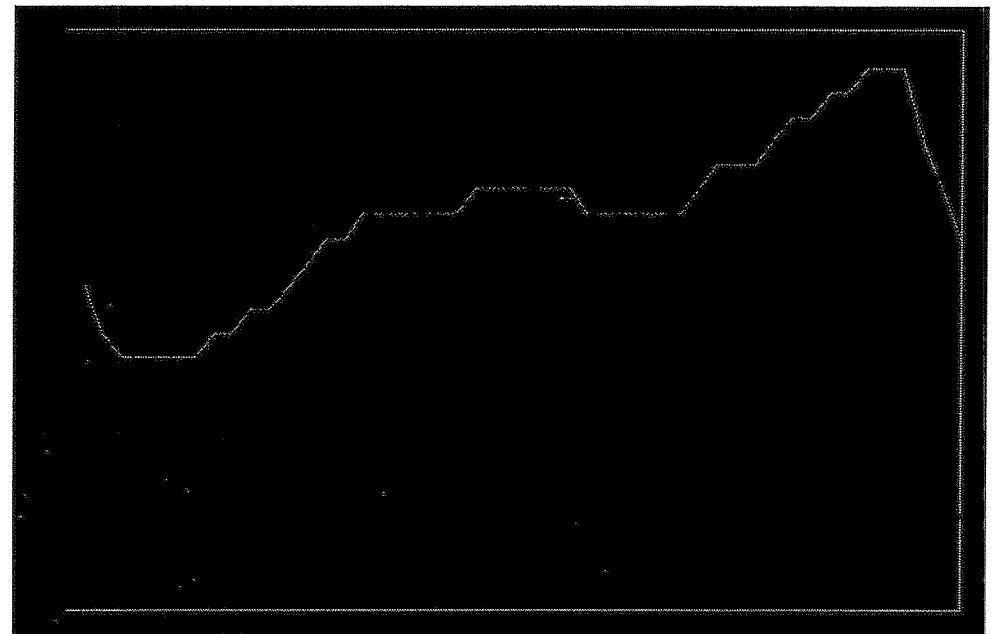
Diesel Only Power System

System Controller

Diesel Gensets



Power



Time

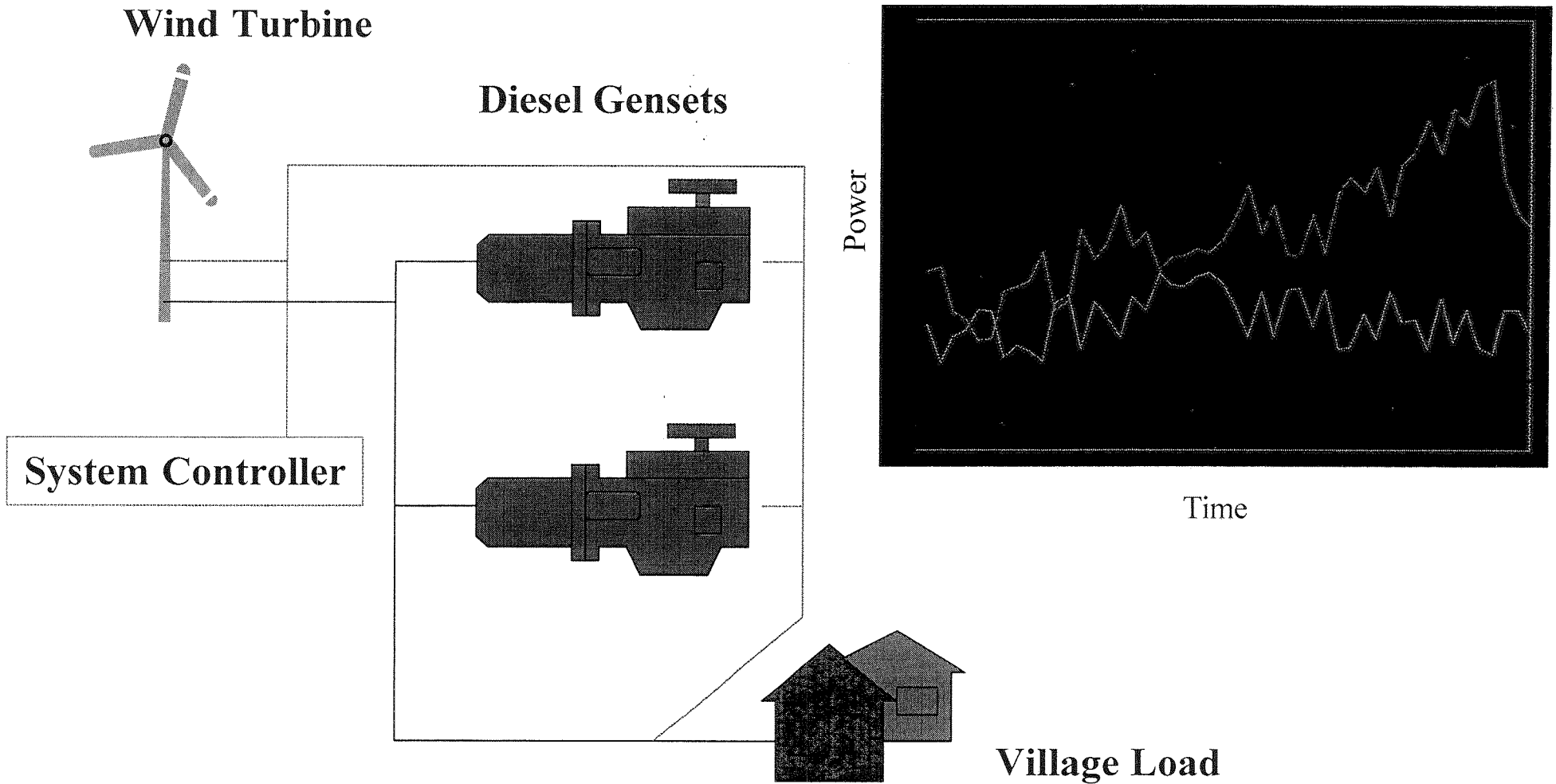
Village Load



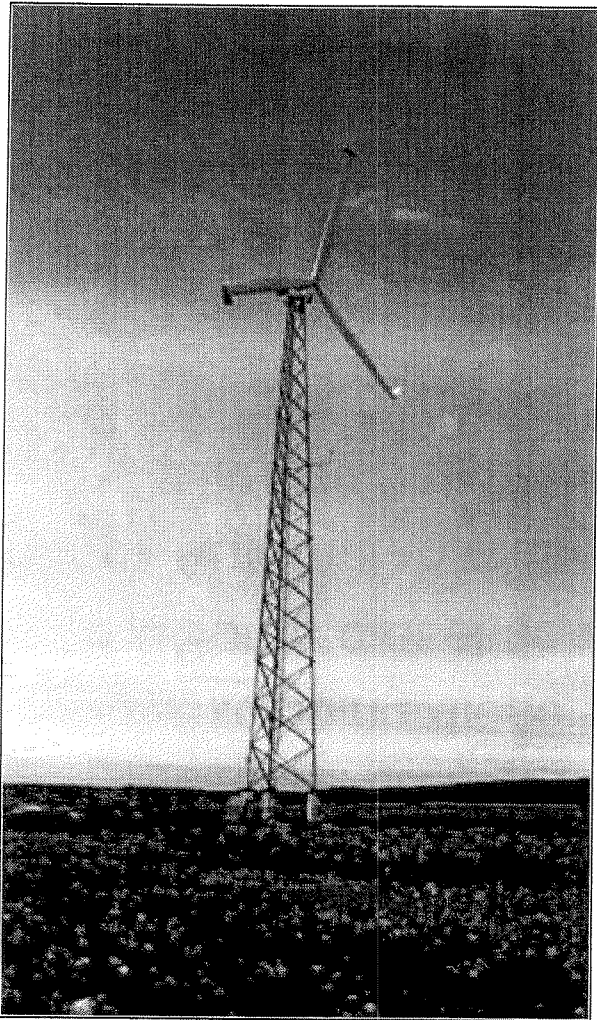
Low Penetration



- Capital cost of between \$1,000-1,500/ per kW of wind capacity, excluding diesel units and plant BOS
- Easy integration with existing diesel system, little or no diesel modifications required
- Very little plant modifications necessary
- little or no equipment other than wind turbine(s) required
- Modest fuel savings of up to ~20% possible.
- System support requirements:
 - Wind turbine maintenance.

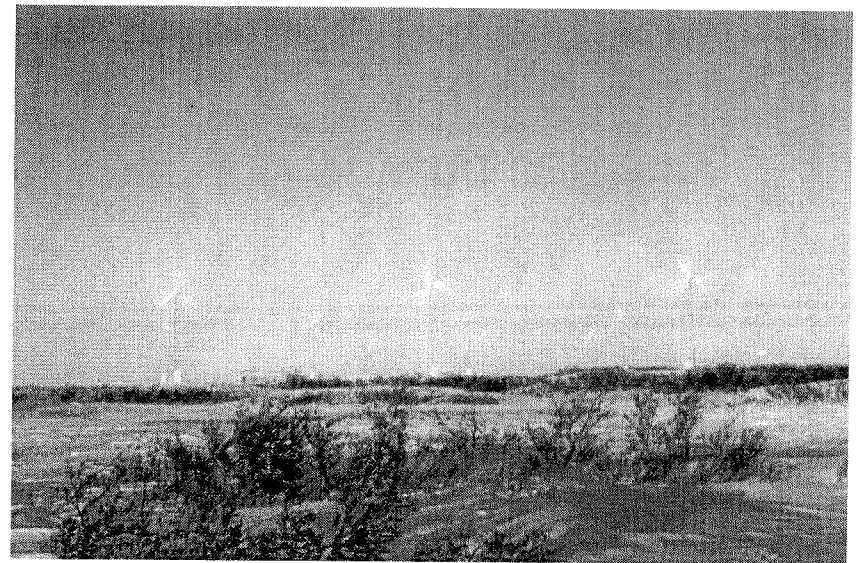


Kotzebue, Alaska



- Application: Village power system
- 11 MW diesel power plant
- Operating with 10 turbines since 1999
- 2MW average load, min load 700kW. Peak wind penetration level ~ 35%
- Local utility plans expansion to 2-3 MW

of wind
turbine
capacity





Medium Penetration



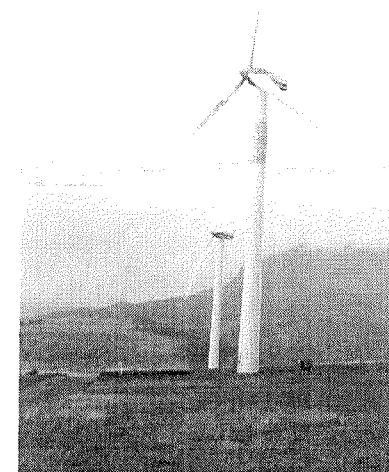
- Capital cost of between \$1,500-2,500 per kW of wind capacity, excluding diesel units and plant BOS.
- Some diesel controls modifications necessary
- Automated diesel operation desirable
- Usually must install/integrate secondary loads to regulate minimum diesel loading.
- Requires relatively simple supervisory control
- Rudimentary control of wind turbine output recommend
- Greater fuel savings possible, up to ~40%



Alto-Baguales Wind, Hydro, Diesel Power System, Coyhaique, Chile



- Edelayesen (SAESA / PSEG)
- 18,703 people, 13.75 MW peak
- 16.9 MW Dsl, 4.6 MW hydro & 2 MW wind
- Wind cost: \$0.058 - \$0.060/kWh
- Diesel cost: \$0.0563/kWh
- Daily penetration 22%, Cap factor <50%
- Expected annual savings of 600,000 G of diesel fuel and 13 million pounds of CO₂
- Installed 2001, commissioned 2002



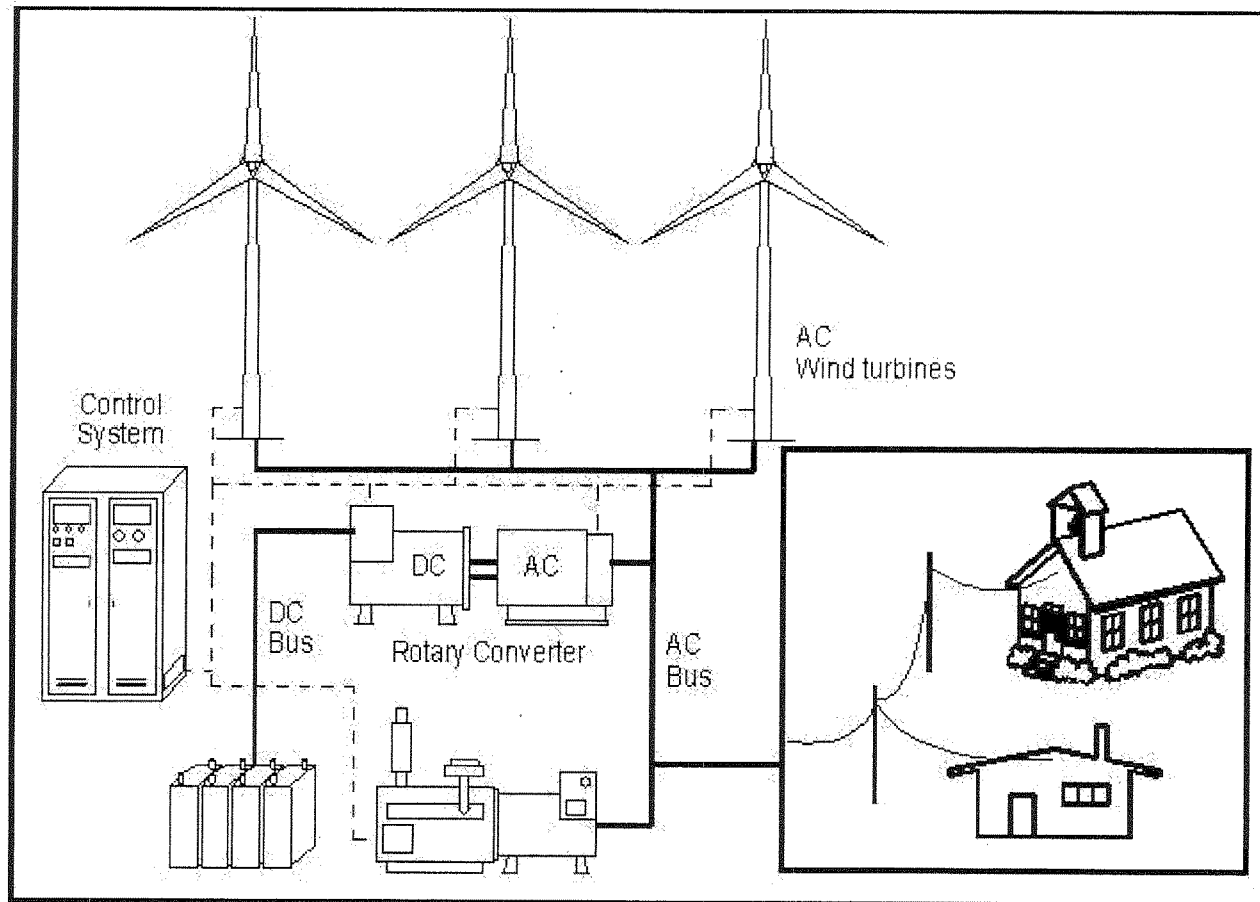


High Penetration

DIFFÉRENCE TRAJEURE AVEC TROYENNE PENETRATION

- Capital cost between \$2,500-4,000 per kW of wind capacity, excluding diesel units and plant BOS
- Significant diesel controls modifications may be necessary and new diesel control panels highly recommended
- Must install integrated secondary loads
- Requires sophisticated supervisory control system
- Some control of wind turbine output recommend
- Highest fuel savings possible, up to ~70%
- Additional support requirements:
 - Wind turbine maintenance
 - Secondary load maintenance
 - Active assessment to insure system maintains adequate control of system power quality.

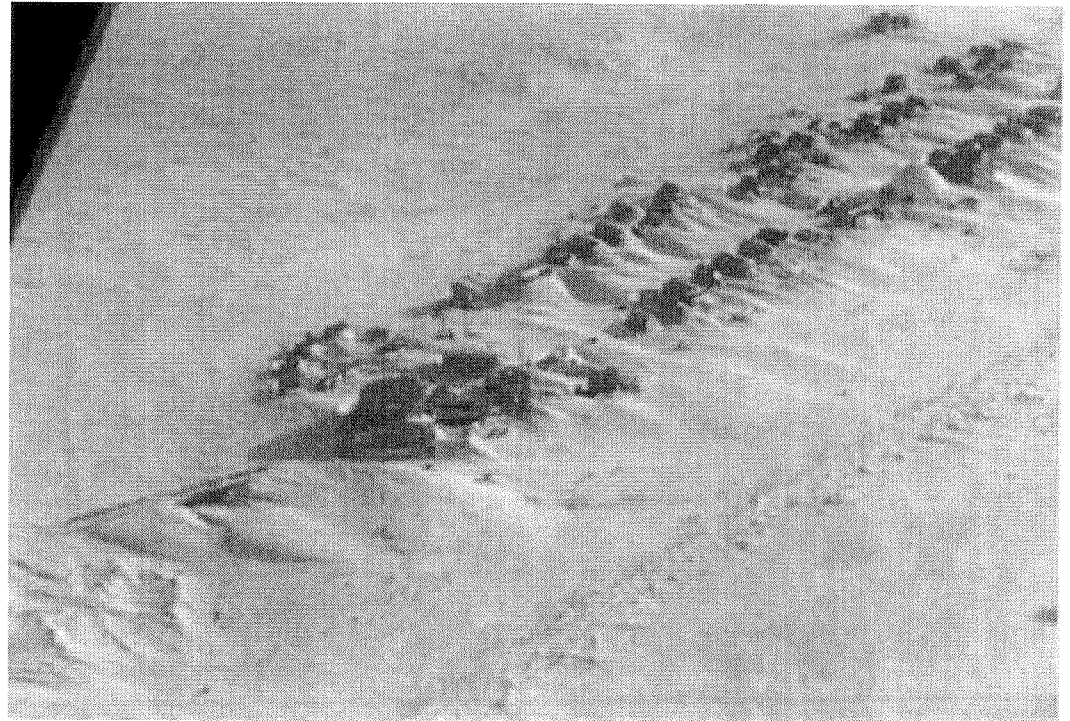
High Penetration with diesel with storage



Wales Alaska Wind Diesel System

High penetration system

- **80kW average load with 130kW of wind power**
- **Short term battery storage**
- **Resistive loads used for heating and hot water**





Wales Alaska High Penetration Wind-Diesel Power System with Storage



Rural community

- 160 persons
- ~70 kW avg load

Power System

- Modifications of existing diesel plant
- Two AOC 65 kW
- External heating loads
- 130 Ah NiCad battery
- Rotary converter

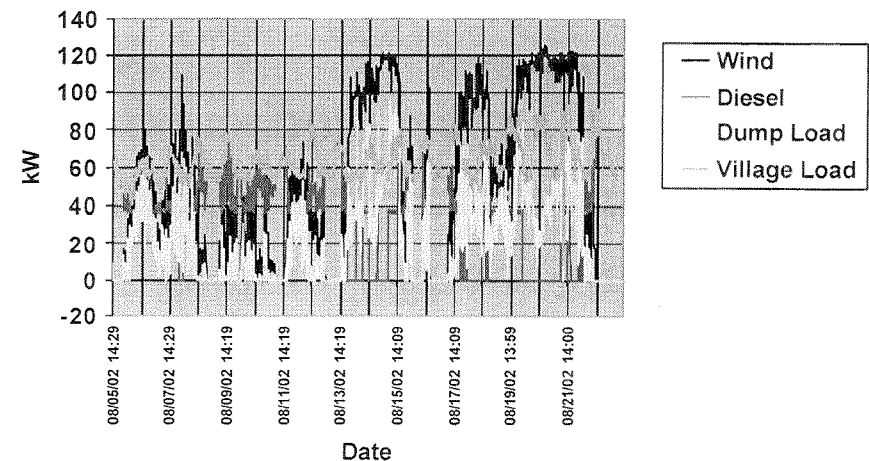


Commissioned in March 02

Expected system impact

- Projected average wind penetration ~70%
 - Fuel savings ~45%
 - ~25% expected reduction in diesel op
- NREL, KEA and AVEC

Wales System 10-minute Power Averages
August 5-23, 2002





St. Paul High Penetration Wind-Diesel Power System Without Storage

Provide electrical and thermal loads to the industrial/airport facility

- Owned and financed by the TDX corporation
- 225-kW Vestas and two 150-kW Volvo diesels
- Synchronous condenser
- 6000-gal. hot water tank and distribution
- Peak plant output 160 kW, current load ~85 kW
- Average penetration ~100%, peak >400%
- COE ~\$.21/kWh (current diesel grid \$.34/kWh)

