

NREL Antarctica Activities

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Historical Activities

- FEMP Involvement
 - Remote Power Systems
 - Energy Efficiency
 - Retrofit of McMurdo and South Pole Stations
- Cooperation in the Development and Testing of the NW100 with NSF
 - 100 kW wind turbine designed for arctic
 - Testing at the NWTTC & in Northern Alaska



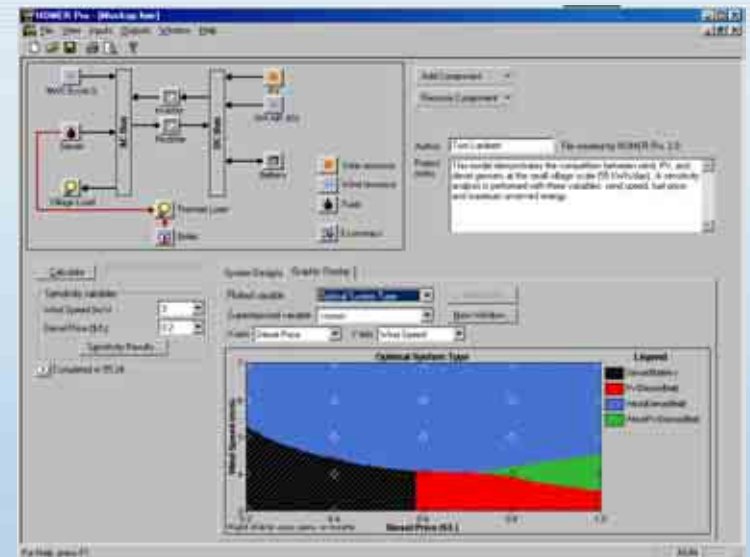
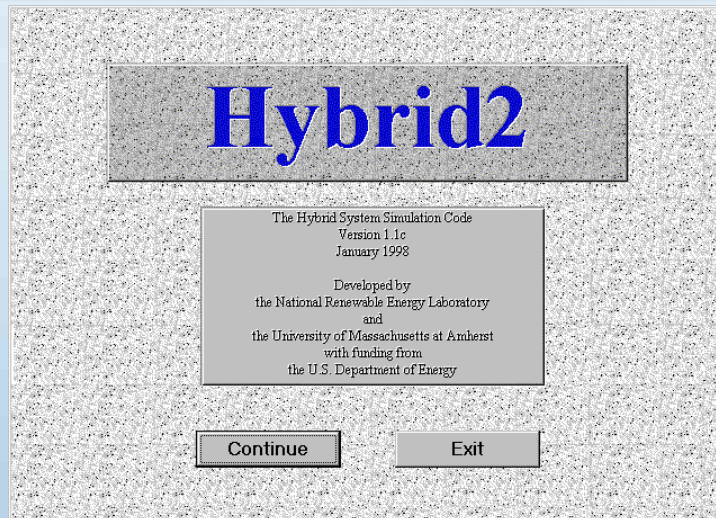
Retrofit Current Power Plants

- Problems:
 - Dependence on diesel fuel
 - Pollution
 - Fuel storage
 - Potential problems with fuel delivery and Ice limitations
 - Cost of diesel fuel (South Pole)

- Install wind energy to reduce the dependence on diesel fuel
 - Reduce the need to expand storage facilities
 - Allow the diesels to run longer using the same fuel storage levels
 - Save \$\$\$

NREL Analysis Process

- Collect site and plant data
- Collect wind Speed and load data
- Determine system constraints
- Complete initial analysis
- Determine next steps





McMurdo Station - Current

- Year round station with a load ranging from 1600 kW (June) to 2000 kW (Dec)
- Large contractor operated diesel power station
 - 1,300,000 gal/year of diesel
 - Combined heat and power
 - \$1.30 / Gal
 - 6 diesels all around 800 kW



McMurdo - Data Gathering

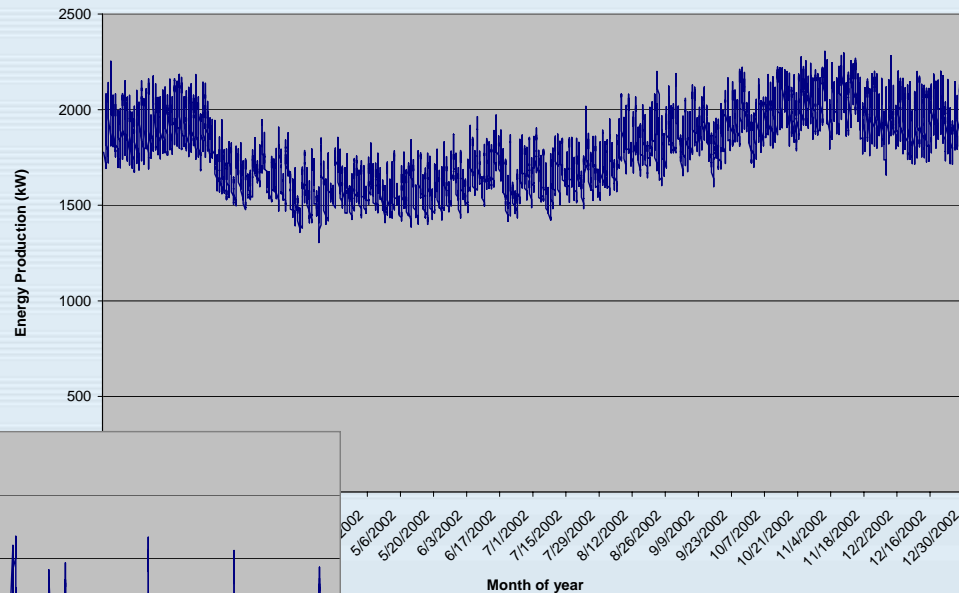
- Installed anemometers at
 - Arrival Heights
 - Snow Dump
 - Crater Hill

Crater Hill				Arrival Heights				Snow Dump			
Date	Average	Gust	Dirac	Date	Average	Gust	Dirac	Date	Average	Gust	Dirac
	MPH	MPH			MPH	MPH			MPH	MPH	
1/25/03				1/24/03				1/29/03			
20-Feb	14.9	56	146	18-Feb	16.7	108	200	3-Feb	No Data		
19-Mar	16	71	174	20-Mar	17.04	71	204	18-Feb	11.1	40	219
19-Apr	14.9	90	158	19-Apr	15.9	84	180	19-Mar	11.2	55	225
20-May	23.88	98	146	19-May	Missing			19-Apr	11.3	63	221
19-Jun	20.05	99	174	20-Jun	Bad data			20-May	15.85	72	226
5-Jul	19.95	69	148	25-Jul	Bad data			19-Jun	13.28	85	229
24-Jul	Bad data			22-Aug	17.44	108	200	12-Jul	12.5	50	228
22-Aug	Bad data			24-Sep	17.81	95	159	Sensor	Removed		
Oct-03	Bad data										
	Max wind	99.0mph		Max wind	108.0mph			Max wind	85.0mph		
	speed	44.3m/s		speed	48.3m/s			speed	38.0m/s		

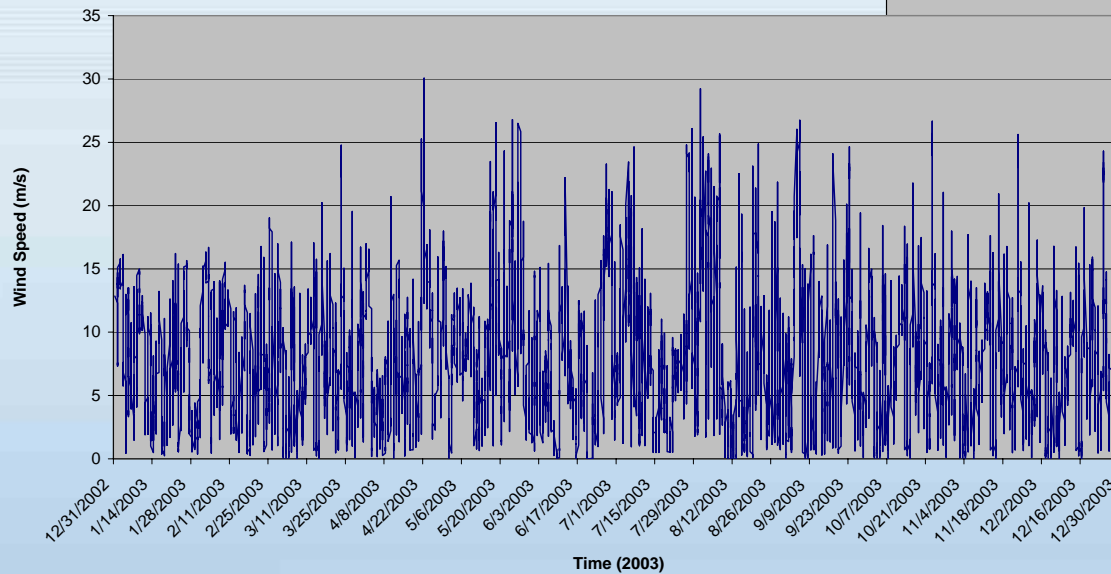


McMurdo - Wind and Load Data

Load Data for McMurdo Station



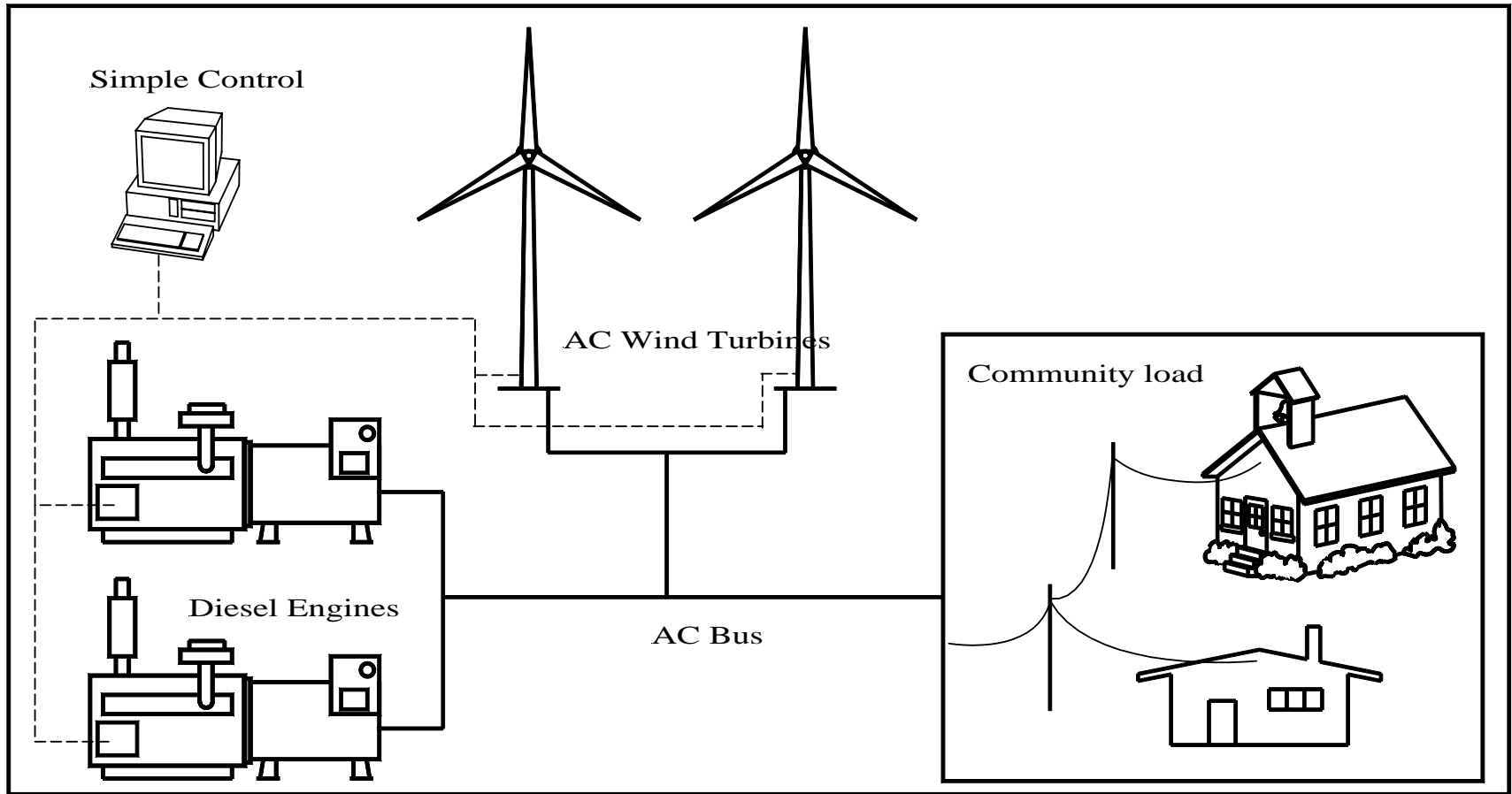
Data based Wind speed for McMurdo







McMurdo Station - Concept





McMurdo - Results

- Due to limited space, about 1250 kW of wind could be installed.
- Turbines would be in the 250k range
- Wind produces ~32% of power
- Capital cost of \$2.3 million
- Simple payback in about 4 years
- Saves ~30% of fuel or 342,700 gal/yr
- Energy efficiency measures?



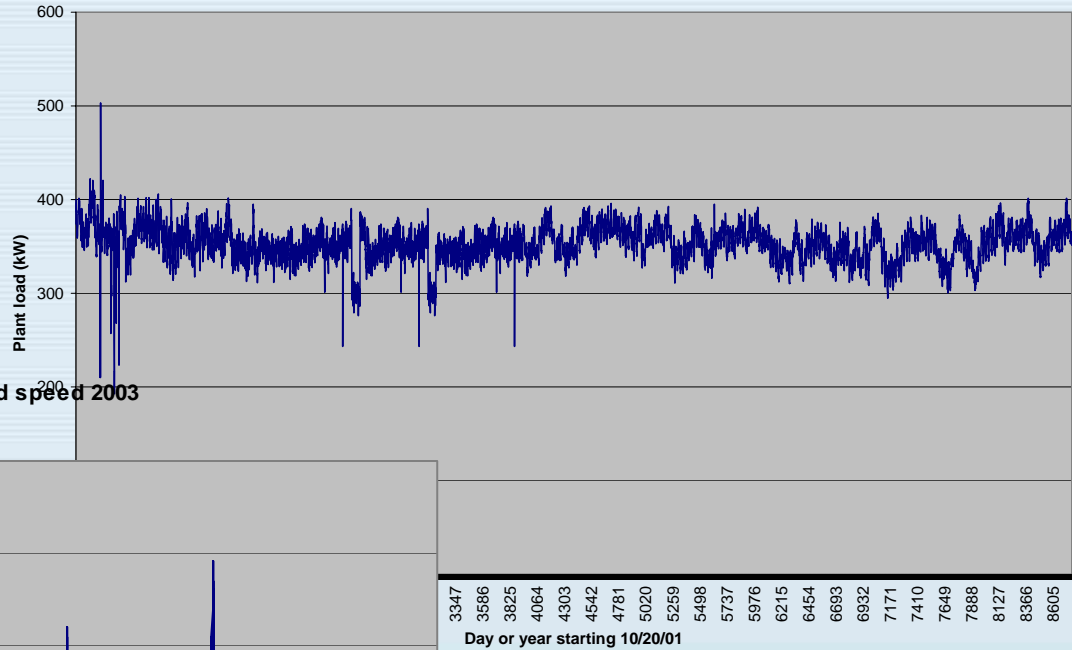
South Pole Station - Current

- Year round station with an estimated constant load of 500 kW (new station)
- Diesel power station
 - 341,000 gal/year of diesel
 - Combined heat and power
 - Diesel cost between \$12.00 (\$3.17/l) and \$15.70 (\$3.78/l)
 - 3x750 kW diesels and one 250 kW peak

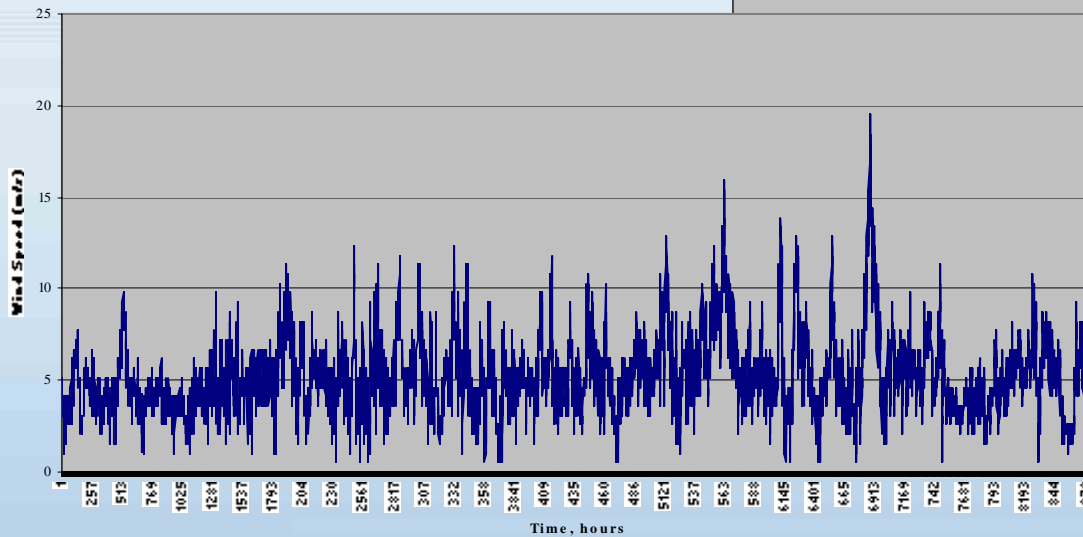


South Pole Station - Data

South Pole Station Power consumption

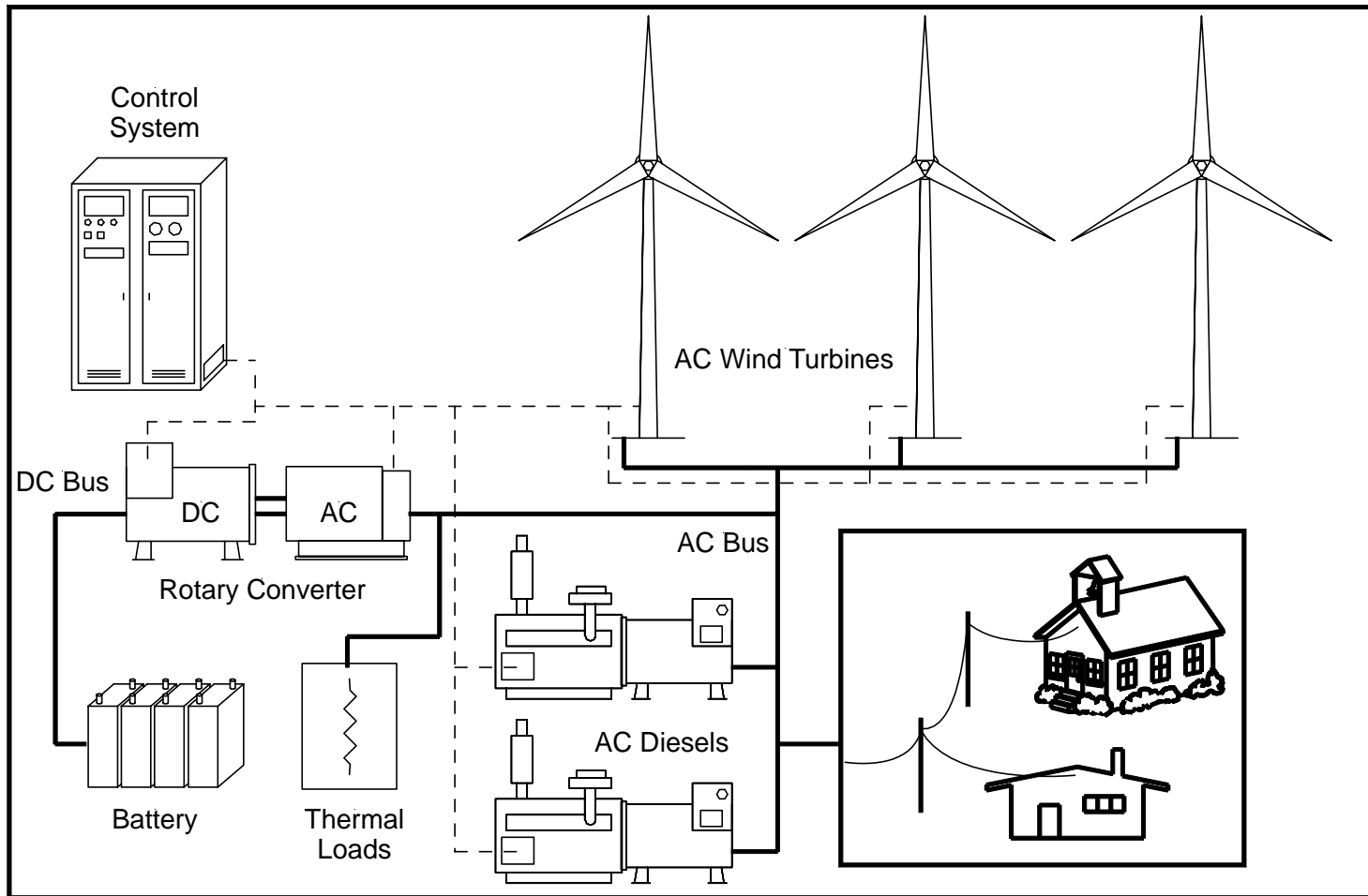


South Pole Station, Analysis wind speed 2003





South Pole Station - Concept





South Pole Station - Results

- Still in process....
 - Current cost of energy is ~\$1.90/kWh
- Low Penetration system (Diesels always on) - for each turbine installed
 - Turbine costs ~\$350,000 (3500 kW)
 - Cost of energy \$0.12 / kWh
 - Simple payback of 1 year
 - Saves ~4% of fuel or 21,400 l/year
- High Penetration System
 - Wind speed might be too low



South Pole - The Issues

- No Turbine that will work, primarily due to the temperature
 - NW100 the only real option - not yet...
- Unclear wind speed at heights above the ground
- Foundations for large wind turbines untested
- Technology acceptance



The Price of Clean - the White system

- Complete Wind Powered System

- 3.0 MW wind farm (30 x100 kW)
- 750 kW Fuel Cell
- 750 kW Electrolizer
- Limited “Future” H2 Storage
- Diesels stay as a backup

- And the price tag

Assuming real but reasonable prices

\$ 20 Million and 300 tons of transport

- Currently spending about ~ \$4.7 M/year on fuel and a ~ 1000 tons/year transport
- The White System would cost about ~\$1 M/year for additional O&M and ~10 tons/year.
- Simple payback: 4.9 years
- Transport payback: 0.3 years