Kotzebue Wind Project Expansion / Integration

Rural Energy Conference
Fairbanks, Alaska

Brad Reeve
General Manager
Kotzebue Electric Association Inc.

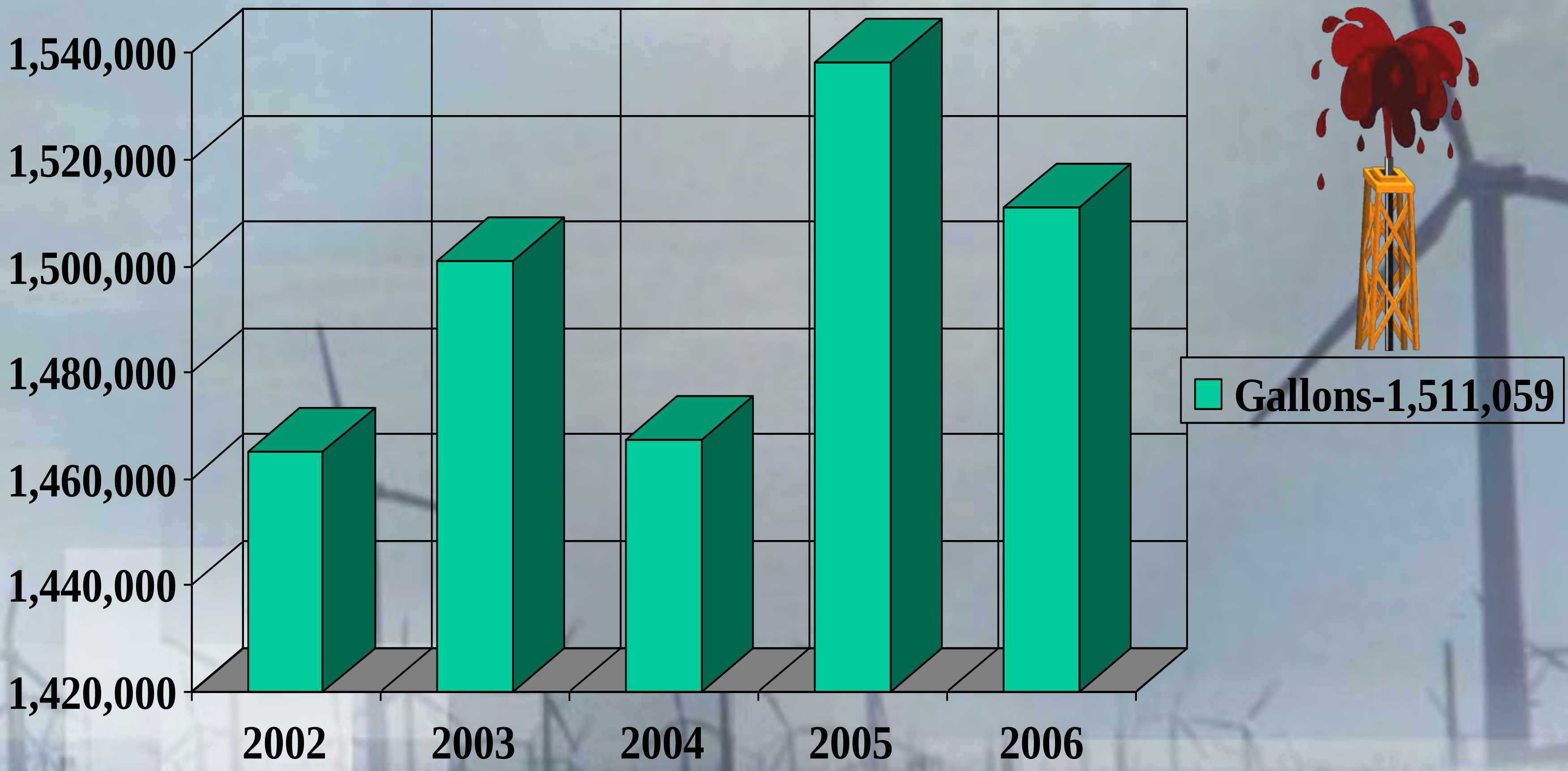
Kotzebue Electric Association

- 1991- began looking seriously at wind
- 1992 - installed met tower
- 1994 – K E A invested $250 K to develop wind
- Difficulty finding wind equipment
- 1995 -Ordered turbines
- 1997 installed first

Wind Integration

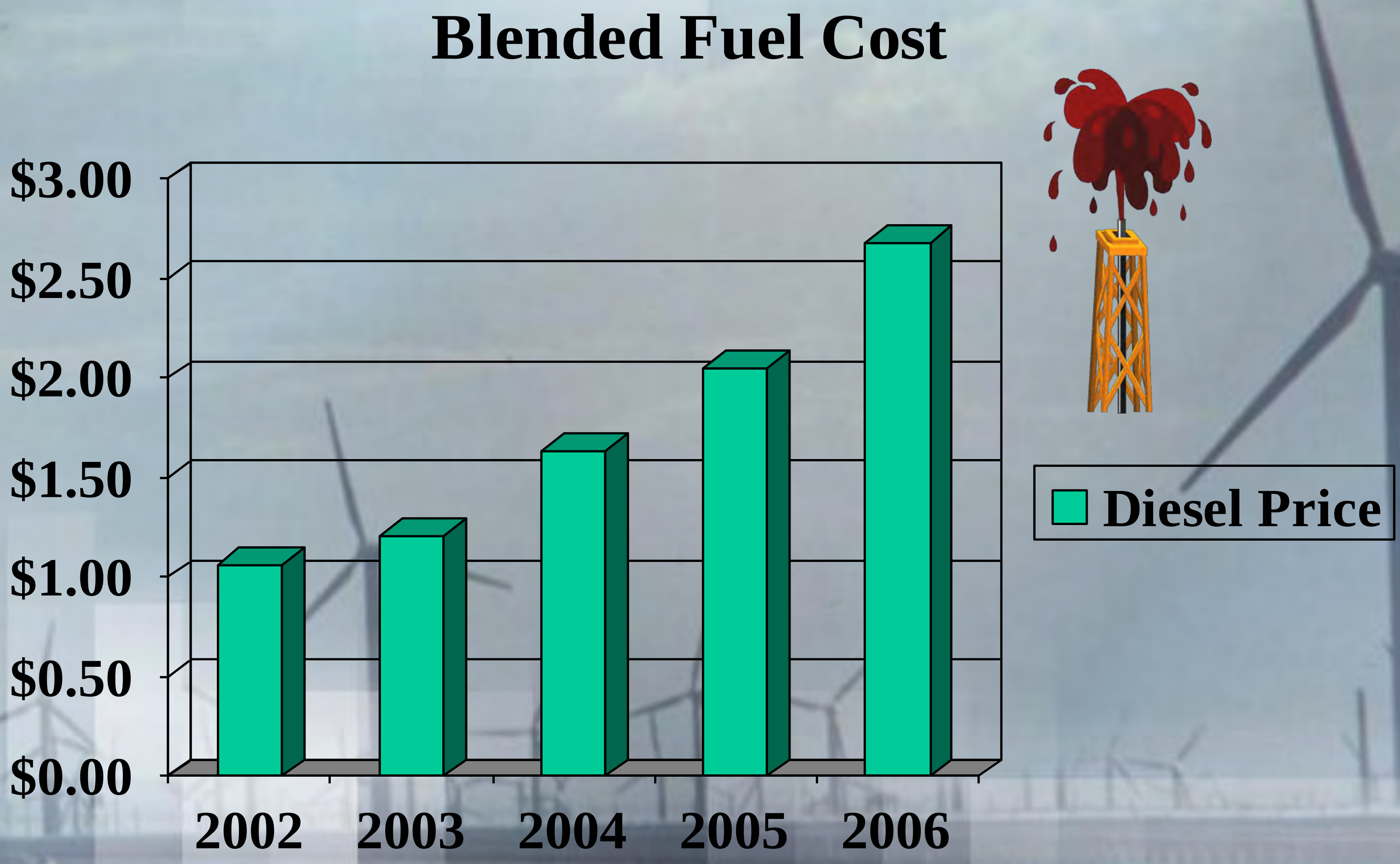
- Kotzebue like most Rural Communities is faced with overwhelming fuel cost increases
- Diesel requirements are increasing to deal with additional infrastructure i.e. school additions, water and sewer system upgrades
- Wind can help answer part of the question, but can create system stability issues that must be dealt with
- The higher the penetration the higher the system capitol cost

Annual Fuel use in Gallons

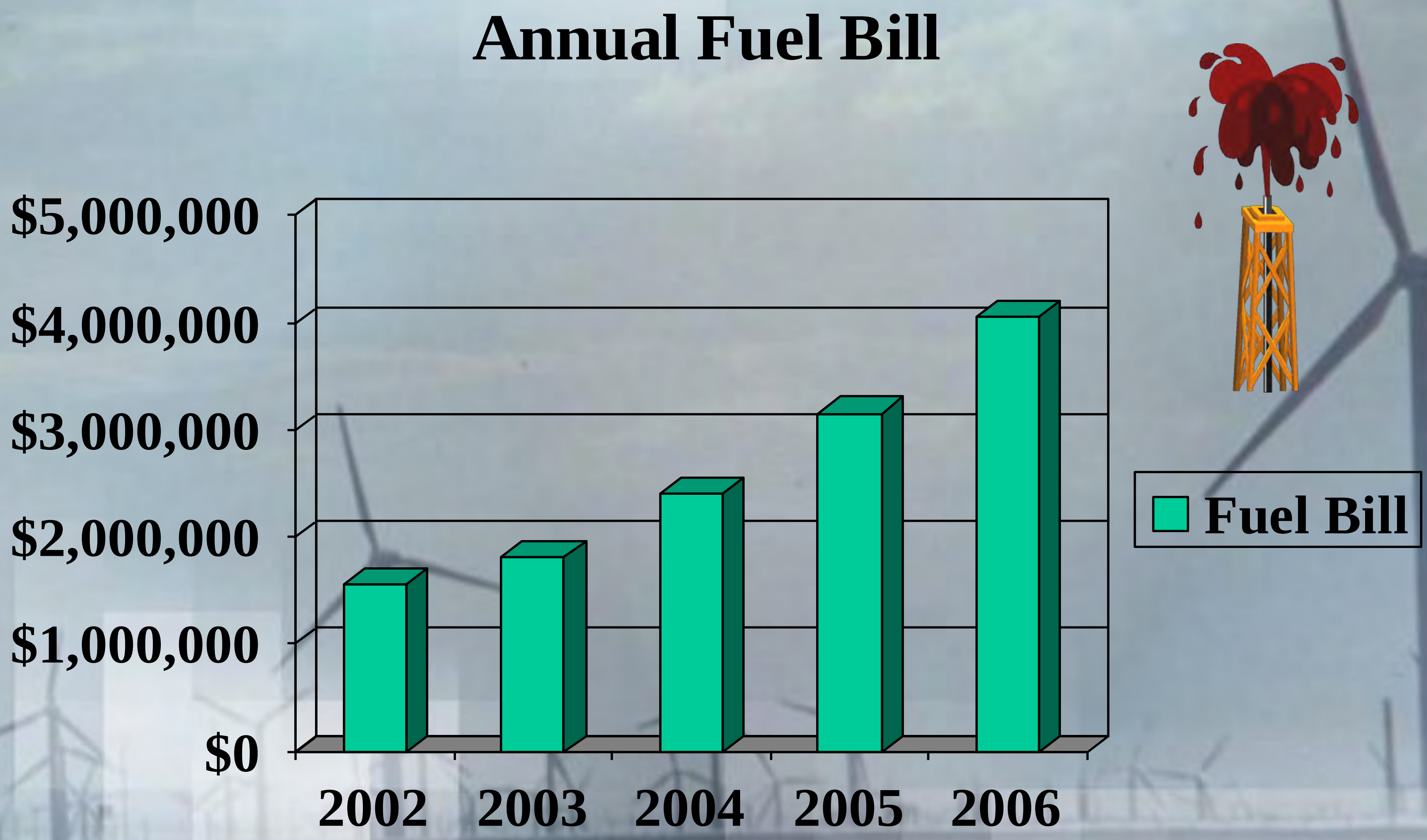


Rising Fuel Cost

Fuel Price Trend



Fuel Price Trend



Fuel Cost

- **World consumption of energy is on the rise, surpluses that previously existed are no longer available**
- **US refineries are not keeping up with demand**
- **Joint fuel buying helps - Western Alaska Fuel Group – K E A, Nome Naknek, Dillingham, Unalakleet, B uckland combine the buying power of 7.5 m il l I o n g a l l o n s**

What Role Does Wind Play for KEA

- Reduces the amount and cost of fuel
- Provides jobs instead of buying fuel
- Reduces emissions from power plant
- It is the best local energy resource
- It diversifies our energy resources

Construction

Construction Issues

- F oundation design is critical
- Different parts of the state will need different foundations
- S afety & training programs are critical
- Cranes are expensive
- K E A has designed a tilt up tower system for smaller communities
- All K E A wind turbine construction is done in the winter

Wales Alaska - Entegrity 15/50

Arctic Foundations

Arctic Foundations

Why in the Winter?

- **Primarily to protect the tundra**
- **Construction is done in the winter when the ground is frozen in order to move heavy equipment onsite**
- **Working on frozen tundra does not damage the vegetative layer**

Wind Equipment

Entegrity 15/50

15 – Entegrity 15/50 turbines
- 3 installed July 1997
- 7 installed May 1999
- 2 installed April 2005
- 2 installed April 2006
- 1 installed in 2007
- Rated Capacity - 66 kW

Northwind 100

Northwind 100 installed April 2002

Rated Capacity 100 kW

Vestas E-15

Vestas E-15

installed April 2006

Rated Capacity 65 kW

Vestas V-15 Turbine

Kotzebue Wind System

15 – Entegrity Wind Sys.15/50 turbines - 66 kW rating

- **3 installed April 1997**
- **7 installed May 1999**
- **2 installed April 2005**
- **2 installed April 2006**
- **1 installed April 2007**

1 – Northwind 100 turbine - 100 kW rating

- **installed April 2002**

1 – Vestas V-15 turbine - 65 kW rating

- **installed May 2006**
- **17 TOTAL**

Wind Capacity – 1155 kW

What’s the Big Deal With Wind? How is Wind Different?

- **Utilities normally schedule firm generation to meet a variable load**
- **Now utilities need to integrate variable generation with a variable load**
- **More need to understand load characteristics with and without wind**
- **Need to realize that wind behaves more like load than generation (origin of the concept of “negative load”)**

Changing Perceptions

- **Wind plants are different from conventional power plants**
- **Wind plant technology is constantly evolving towards better performance**
- **Question has changed from "Can wind plants be integrated into utility systems?" to "How much does it cost to integrate wind plants?"**

Impacts of Wind Generation on Distribution Systems

- **Distributed wind generation falls outside the body of conventional distribution system engineering practice**
- **“Rules of thumb” and associated analytical tools for distribution system planning, design, and operation with radial distribution feeders may no longer be valid for feeders interconnected to wind generators**
- **Additional steps must be taken to safeguard system performance, reliability, and safety**
- **Each distributed wind installation must be evaluated to determine specific impacts**

Penetration Issues

- KEA reached a level of penetration that required new operating procedures and equipment
- Heavy wind penetration drives up the cost and increases system stability issues
- KEA has installed a new SCADA system that will move us into higher penetration levels

Wind Diesel Integration

E ngineering study identified 3 different system alternatives

- P LC B ased S ystems
- Proprietary H ybrid PLC S ystem
- Industrial PC Based
- No one system met all of KEA’s requirements
- Some systems were proprietary, no rights to work on control software
- We chose a G E P L C product and supplier E lectric Power S ystems an Alaska Company for the project

SCADA

Supervisory

Control

And

Data

Acquisition

SCADA

- ***KEA has upgraded the power plant from 600-800 amps output to 1200 amps. This almost doubles our power plant capacity***
- ***KEA completed the automation of the power plant and controls for the wind system***
- ***This gives us better information and control of our power system. It also gives us better information on all of our systems***

SCADA

- ***The SCADA system has made the power system more efficient, provided better fuel economy, better maintenance, easier trouble shooting .***
- ***The system gives information about all electrical characteristics of the engines, feeders, fuel levels and fuel inventory control, radiator performance, city water heat system performance, system metering, and controls for the wind system***

SCADA – Powerplant Upgrade

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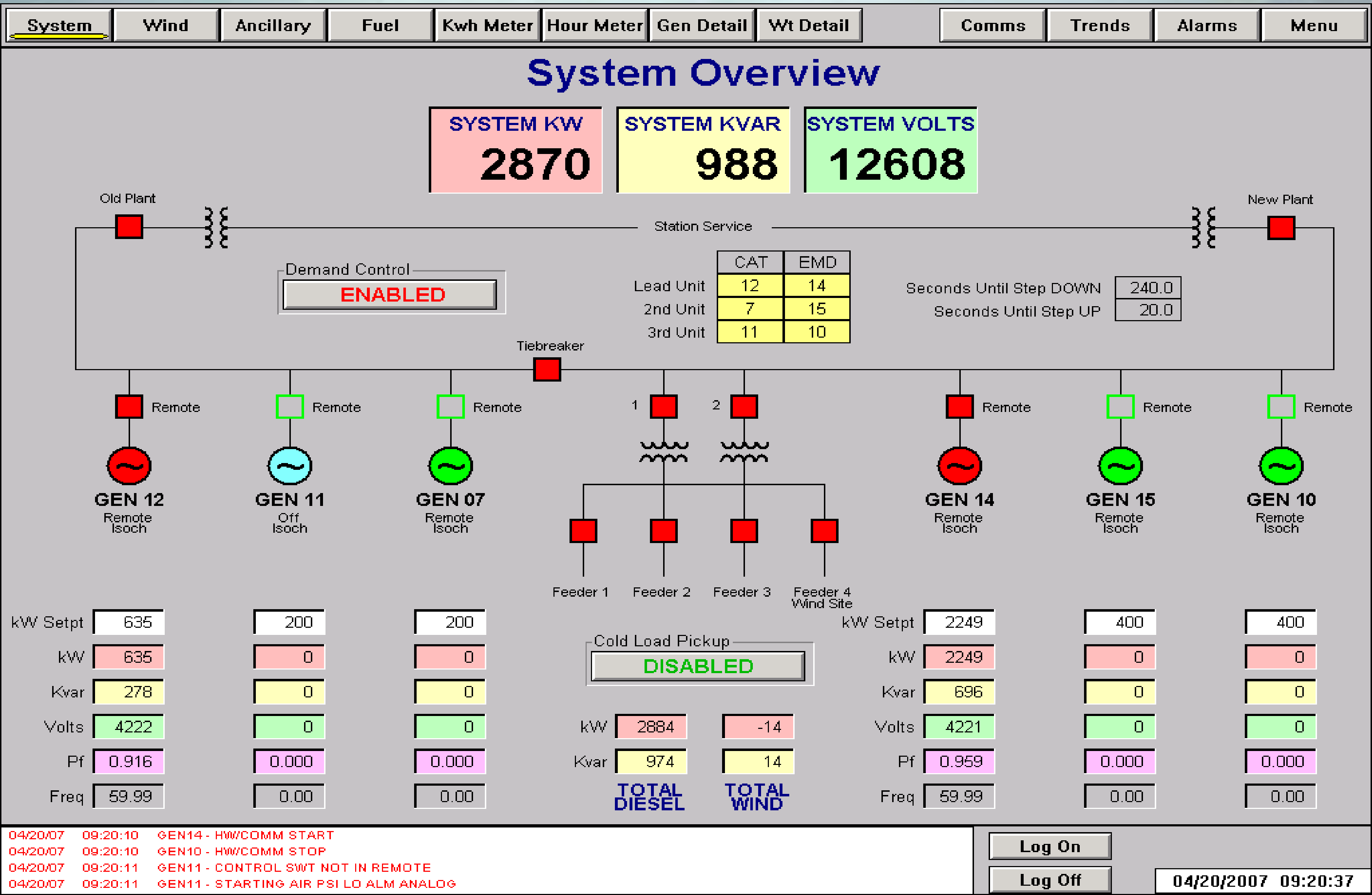
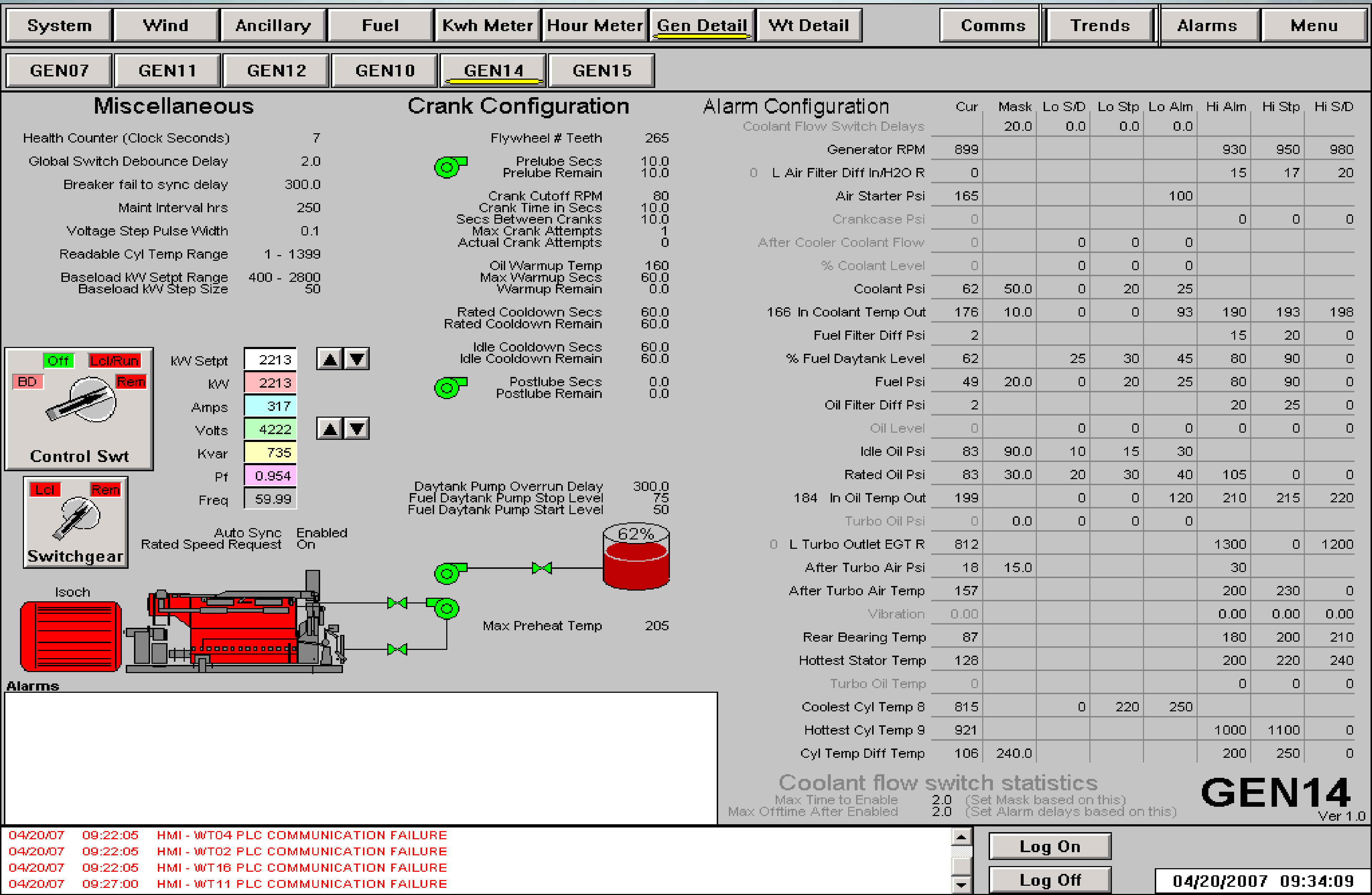
SCADA – Powerplant Upgrade

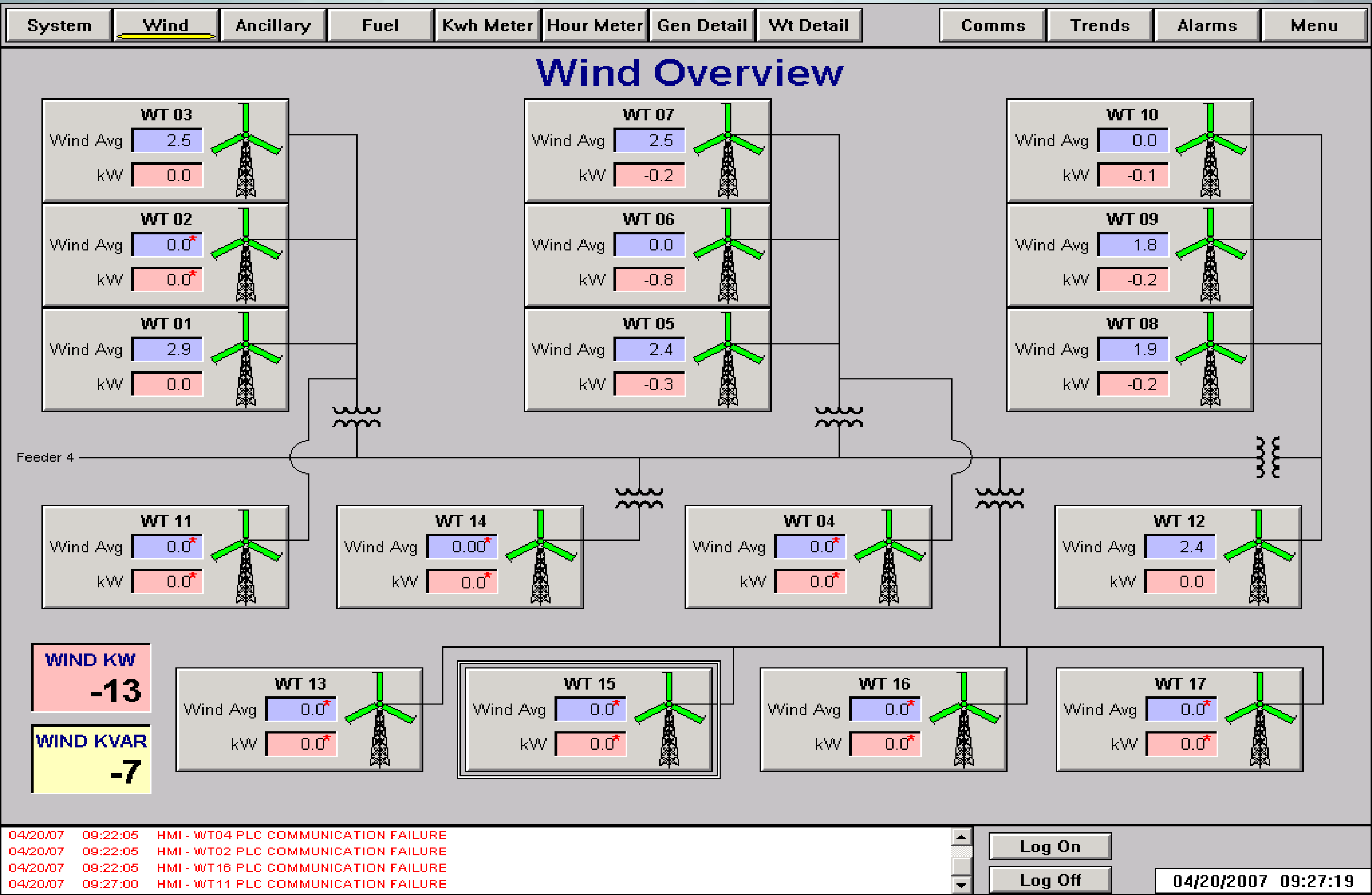
SCADA


System
Wind
Ancillary
Fuel
Kwh Meter
Hour Meter
Gen Detail
Wt Detail
Comms
Trends
Alarms
Menu
System Overview
SYSTEM KW
2870
SYSTEM KVAR
988
SYSTEM VOLTS
12608
Old Plant
Station Service
New Plant
Demand Control
ENABLED
CAT
EMD
Lead Unit 12 14
2nd Unit 7 15
3rd Unit 11 10
Seconds Until Step DOWN 240.0
Seconds Until Step UP 20.0
Tiebreaker
Remote
1
2
GEN 12
Remote
Isoch
GEN 11
Off
Isoch
GEN 07
Remote
Isoch
GEN 14
Remote
Isoch
GEN 15
Remote
Isoch
GEN 10
Remote
Isoch
Feeder 1
Feeder 2
Feeder 3
Feeder 4
Wind Site
kW Setpt 635 200 200
kW 635 0 0
Kvar 278 0 0
Volts 4222 0 0
Pf 0.916 0.000 0.000
Freq 59.99 0.00 0.00
Cold Load Pickup
DISABLED
kW 2884 -14
Kvar 974 14
TOTAL DIESEL
TOTAL WIND
kW Setpt 2249 400 400
kW 2249 0 0
Kvar 696 0 0
Volts 4221 0 0
Pf 0.959 0.000 0.000
Freq 59.99 0.00 0.00
04/20/07 09:20:10 GEN14 - HW/COMM START
04/20/07 09:20:10 GEN10 - HW/COMM STOP
04/20/07 09:20:11 GEN11 - CONTROL SWT NOT IN REMOTE
04/20/07 09:20:11 GEN11 - STARTING AIR PSI LO ALM ANALOG
Log On
Log Off
04/20/2007 09:20:37

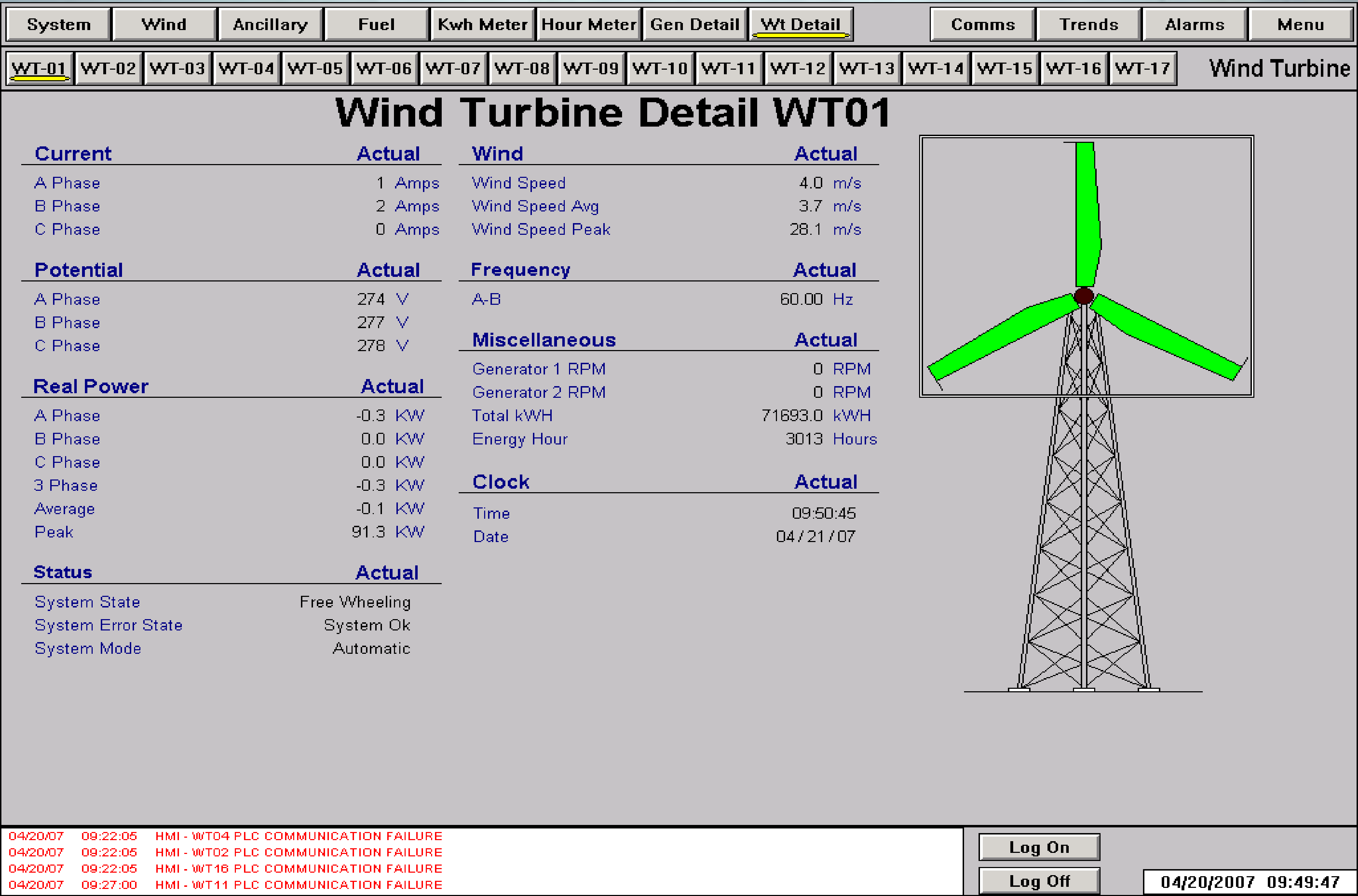
SCADA


System
Wind
Ancillary
Fuel
Kwh Meter
Hour Meter
Gen Detail
Wt Detail
Comms
Trends
Alarms
Menu
GEN07
GEN11
GEN12
GEN10
GEN14
GEN15
Miscellaneous
Health Counter (Clock Seconds) 7
Global Switch Debounce Delay 2.0
Breaker fail to sync delay 300.0
Maint Interval hrs 250
Voltage Step Pulse Width 0.1
Readable Cyl Temp Range 1 - 1399
Baseload kW Setpt Range 400 - 2800
Baseload kW Step Size 50
Off
Lcl/Run
BD
Rem
Control Swt
kW Setpt 2213
kW 2213
Amps 317
Volts 4222
Kvar 735
Pf 0.954
Freq 59.99
Lcl
Rem
Switchgear
Auto Sync Enabled
Rated Speed Request On
Isoch
Crank Configuration
Flywheel # Teeth 265
Prelube Secs 10.0
Prelube Remain 10.0
Crank Cutoff RPM 80
Crank Time in Secs 10.0
Secs Between Cranks 10.0
Max Crank Attempts 1
Actual Crank Attempts 0
Oil Warmup Temp 160
Max Warmup Secs 60.0
Warmup Remain 0.0
Rated Cooldown Secs 60.0
Rated Cooldown Remain 60.0
Idle Cooldown Secs 60.0
Idle Cooldown Remain 60.0
Postlube Secs 0.0
Postlube Remain 0.0
Daytank Pump Overrun Delay 300.0
Fuel Daytank Pump Stop Level 75
Fuel Daytank Pump Start Level 50
62%
Max Preheat Temp 205
Alarm Configuration
Cur Mask Lo S/D Lo Stp Lo Alm Hi Alm Hi Stp Hi S/D
Coolant Flow Switch Delays 20.0 0.0 0.0 0.0
Generator RPM 899 930 950 980
0 L Air Filter Diff In/H2O R 0 15 17 20
Air Starter Psi 165 100
Crankcase Psi 0 0 0 0
After Cooler Coolant Flow 0 0 0 0
% Coolant Level 0 0 0 0
Coolant Psi 62 50.0 0 20 25
166 In Coolant Temp Out 176 10.0 0 0 93 190 193 198
Fuel Filter Diff Psi 2 15 20 0
% Fuel Daytank Level 62 25 30 45 80 90 0
Fuel Psi 49 20.0 0 20 25 80 90 0
Oil Filter Diff Psi 2 20 25 0
Oil Level 0 0 0 0 0 0 0
Idle Oil Psi 83 90.0 10 15 30
Rated Oil Psi 83 30.0 20 30 40 105 0 0
184 In Oil Temp Out 199 0 0 120 210 215 220
Turbo Oil Psi 0 0.0 0 0 0
0 L Turbo Outlet EGT R 812 1300 0 1200
After Turbo Air Psi 18 15.0 30
After Turbo Air Temp 157 200 230 0
Vibration 0.00 0.00 0.00 0.00
Rear Bearing Temp 87 180 200 210
Hottest Stator Temp 128 200 220 240
Turbo Oil Temp 0 0 0 0
Coolest Cyl Temp 8 815 0 220 250
Hottest Cyl Temp 9 921 1000 1100 0
Cyl Temp Diff Temp 106 240.0 200 250 0
Coolant flow switch statistics
Max Time to Enable 2.0 (Set Mask based on this)
Max Offtime After Enabled 2.0 (Set Alarm delays based on this)
GEN14
Ver 1.0
Alarms
04/20/07 09:22:05 HMI - WT04 PLC COMMUNICATION FAILURE
04/20/07 09:22:05 HMI - WT02 PLC COMMUNICATION FAILURE
04/20/07 09:22:05 HMI - WT16 PLC COMMUNICATION FAILURE
04/20/07 09:27:00 HMI - WT11 PLC COMMUNICATION FAILURE
Log On
Log Off
04/20/2007 09:34:09

SCADA

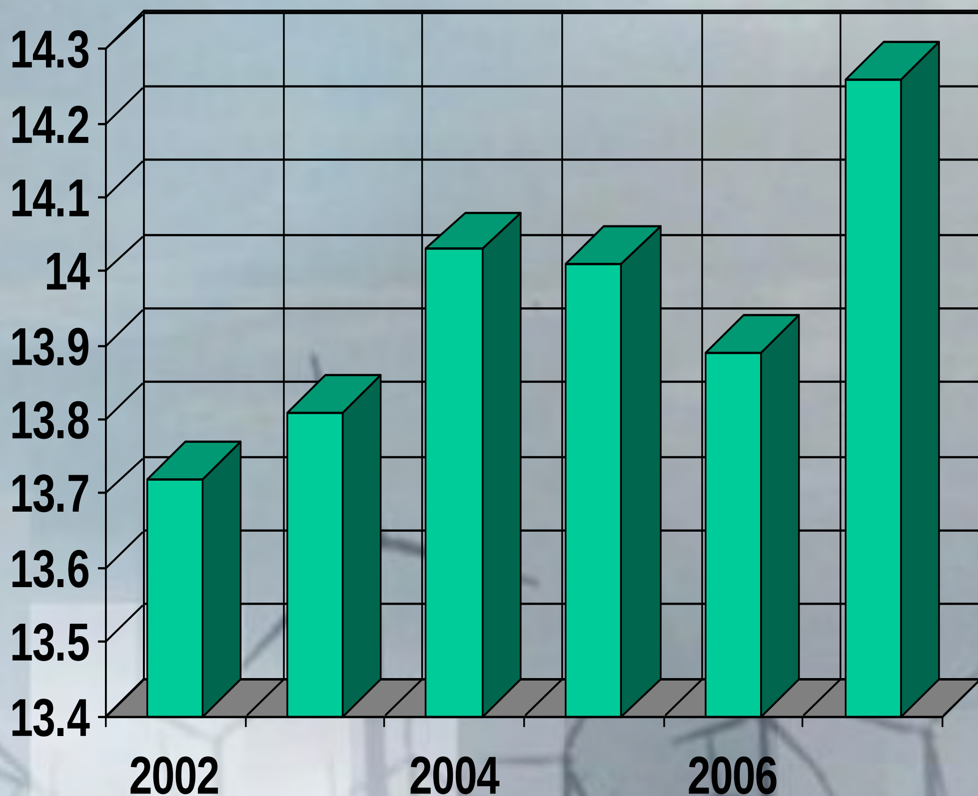

System
Wind
Ancillary
Fuel
Kwh Meter
Hour Meter
Gen Detail
Wt Detail
Comms
Trends
Alarms
Menu
Wind Overview
WT 03 Wind Avg 2.5 kW 0.0
WT 02 Wind Avg 0.0* kW 0.0*
WT 01 Wind Avg 2.9 kW 0.0
WT 07 Wind Avg 2.5 kW -0.2
WT 06 Wind Avg 0.0 kW -0.8
WT 05 Wind Avg 2.4 kW -0.3
WT 10 Wind Avg 0.0 kW -0.1
WT 09 Wind Avg 1.8 kW -0.2
WT 08 Wind Avg 1.9 kW -0.2
Feeder 4
WT 11 Wind Avg 0.0* kW 0.0*
WT 14 Wind Avg 0.00* kW 0.0*
WT 04 Wind Avg 0.0* kW 0.0*
WT 12 Wind Avg 2.4 kW 0.0
WIND KW -13
WIND KVAR -7
WT 13 Wind Avg 0.0* kW 0.0*
WT 15 Wind Avg 0.0* kW 0.0*
WT 16 Wind Avg 0.0* kW 0.0*
WT 17 Wind Avg 0.0* kW 0.0*
04/20/07 09:22:05 HMI - WT04 PLC COMMUNICATION FAILURE
04/20/07 09:22:05 HMI - WT02 PLC COMMUNICATION FAILURE
04/20/07 09:22:05 HMI - WT16 PLC COMMUNICATION FAILURE
04/20/07 09:27:00 HMI - WT11 PLC COMMUNICATION FAILURE
Log On
Log Off
04/20/2007 09:27:19

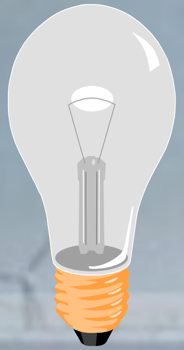
SCADA



System
Wind
Ancillary
Fuel
Kwh Meter
Hour Meter
Gen Detail
Wt Detail
Comms
Trends
Alarms
Menu
WT-01 WT-02 WT-03 WT-04 WT-05 WT-06 WT-07 WT-08 WT-09 WT-10 WT-11 WT-12 WT-13 WT-14 WT-15 WT-16 WT-17
Wind Turbine
Wind Turbine Detail WT01
Current Actual
A Phase 1 Amps
B Phase 2 Amps
C Phase 0 Amps
Potential Actual
A Phase 274 V
B Phase 277 V
C Phase 278 V
Real Power Actual
A Phase -0.3 KW
B Phase 0.0 KW
C Phase 0.0 KW
3 Phase -0.3 KW
Average -0.1 KW
Peak 91.3 KW
Status Actual
System State Free Wheeling
System Error State System Ok
System Mode Automatic
Wind Actual
Wind Speed 4.0 m/s
Wind Speed Avg 3.7 m/s
Wind Speed Peak 28.1 m/s
Frequency Actual
A-B 60.00 Hz
Miscellaneous Actual
Generator 1 RPM 0 RPM
Generator 2 RPM 0 RPM
Total kWH 71693.0 kWH
Energy Hour 3013 Hours
Clock Actual
Time 09:50:45
Date 04 / 21 / 07
04/20/07 09:22:05 HMI - WT04 PLC COMMUNICATION FAILURE
04/20/07 09:22:05 HMI - WT02 PLC COMMUNICATION FAILURE
04/20/07 09:22:05 HMI - WT16 PLC COMMUNICATION FAILURE
04/20/07 09:27:00 HMI - WT11 PLC COMMUNICATION FAILURE
Log On
Log Off
04/20/2007 09:49:47

Fuel Efficiency - kWh Sold





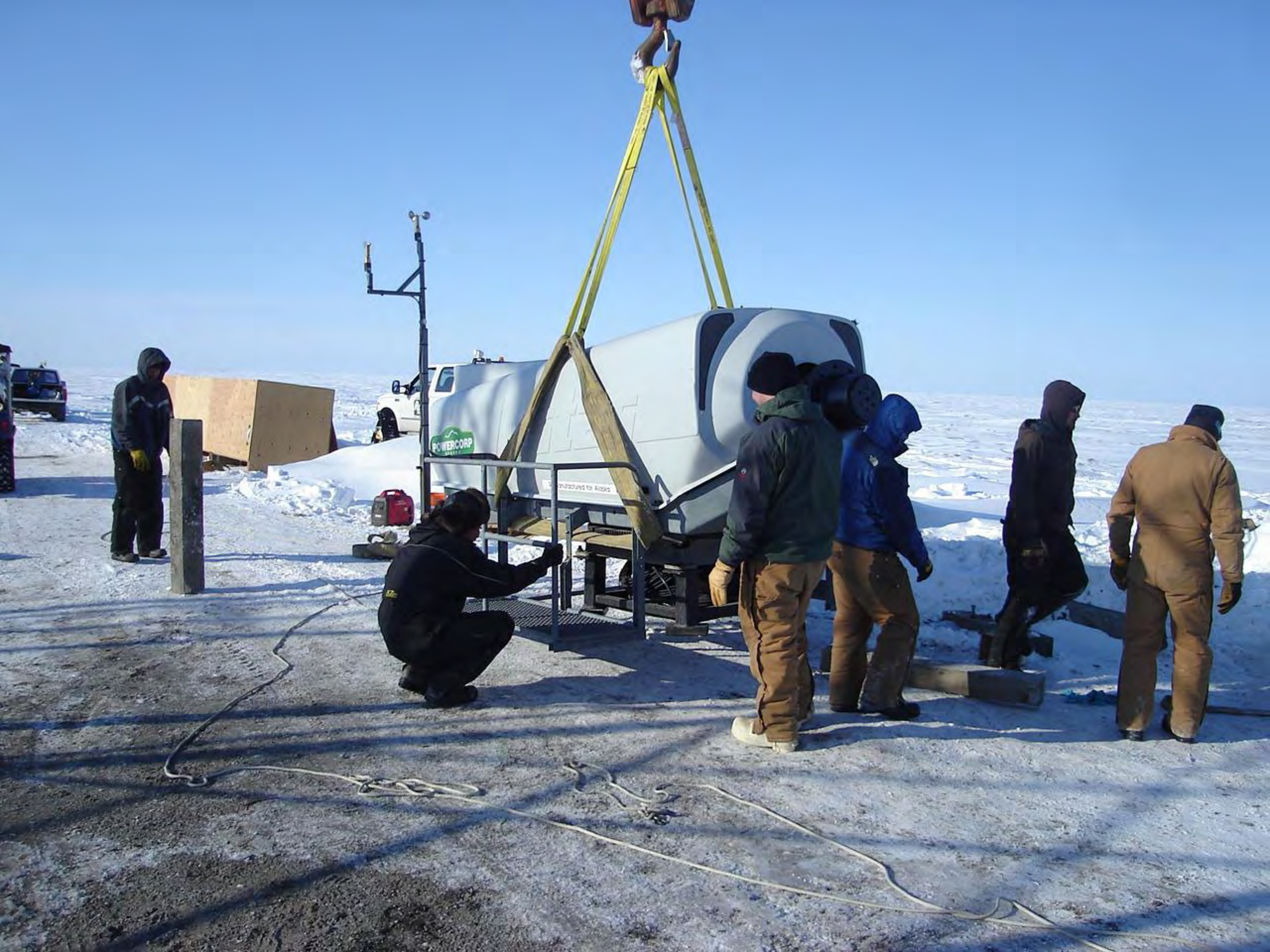
Economic Development

- Renewable energy projects provide local employment opportunities
- Projects require seasonal workers and represents a good opportunity for rural residents
- Development of technical, construction & engineering skills

Local Training - Work Force Development

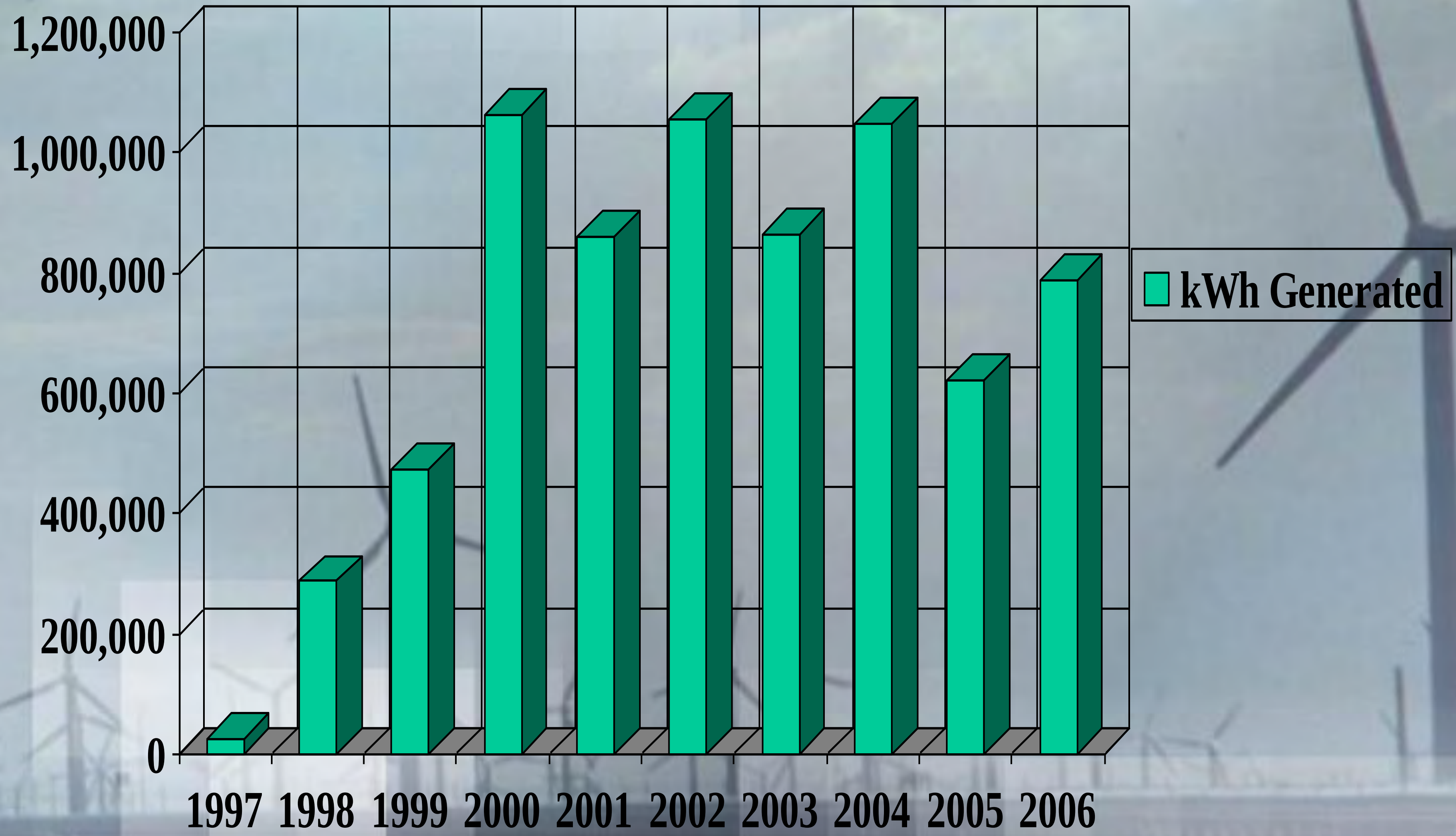

KOTZ


MICHIGAN 75 B

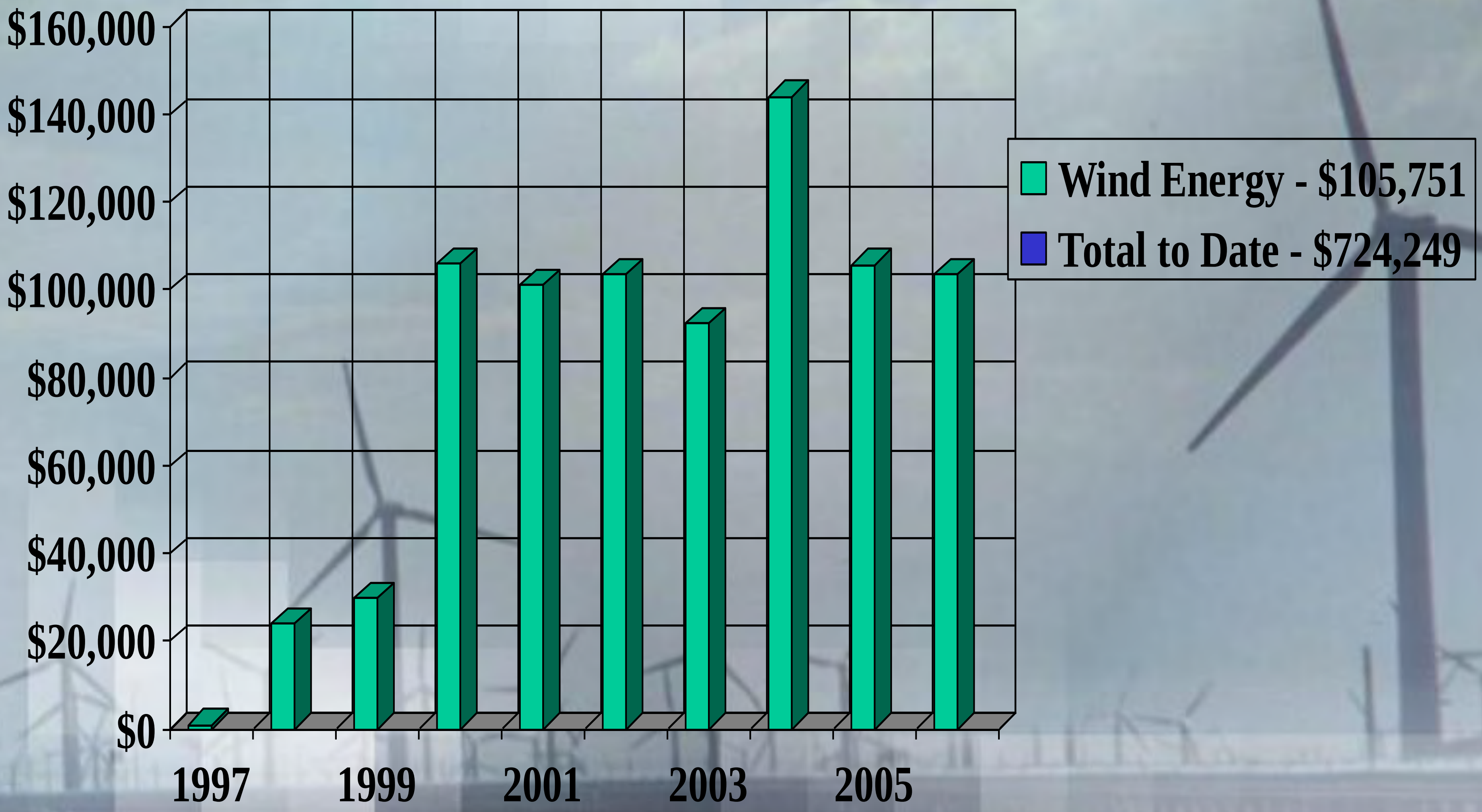

POWERCORP


MIDWEST

Wind Energy Generated



Wind Energy Savings



Other Benefits

- Selling Green Tags through Bonneville Environmental Foundation and the Renewable Energy Alaska Project REAP– Denali Green Tags
- Renewable Energy Production Incentive (REPI)
- Community goodwill

Reality Check

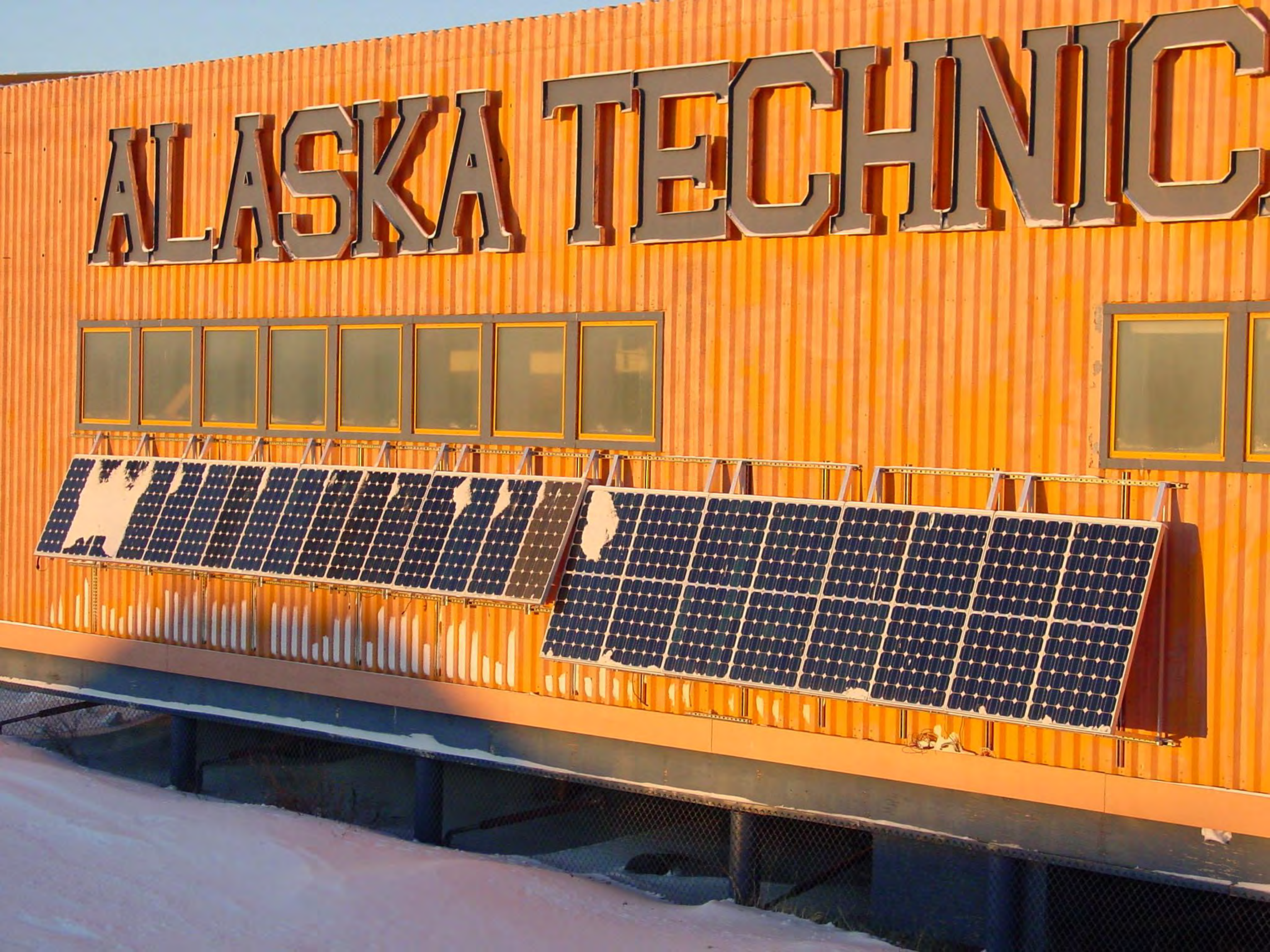
- **Wind without storage will not completely replace diesel**
- **Wind under the right conditions can displace 20-30% of diesel**
- **Wind currently provides 5 - 7% of all the energy for Kotzebue**
- **This represents about 90k gallons annually**

Conclusions

- Rural Alaska needs new energy solutions
- Experience and skills are being built in Kotzebue, and elsewhere in the state
- There are economic, technical, and operational obstacles to overcome, through persistence they will be
- Diversifying generation sources helps rural Alaska build a balanced energy future

Educational Outreach

- KEA has developed a teacher/student guide on wind energy for middle school that has been approved for use by the NW Arctic Borough School District Curriculum Committee
- Wind Monitoring Buckland Alaska Science Class
- Joint Solar Project AK Tech. Ctr.


ALASKA TECHNIC

Bird Issues

- KEA has worked with the Fish and Wildlife Service to document activity
- The species of concern are the Spectacled Eider and the Stellar Eider, both considered endangered
- KEA site monitored since 1997
- No avian mortalities

Compact Florescent Lights (CFL)

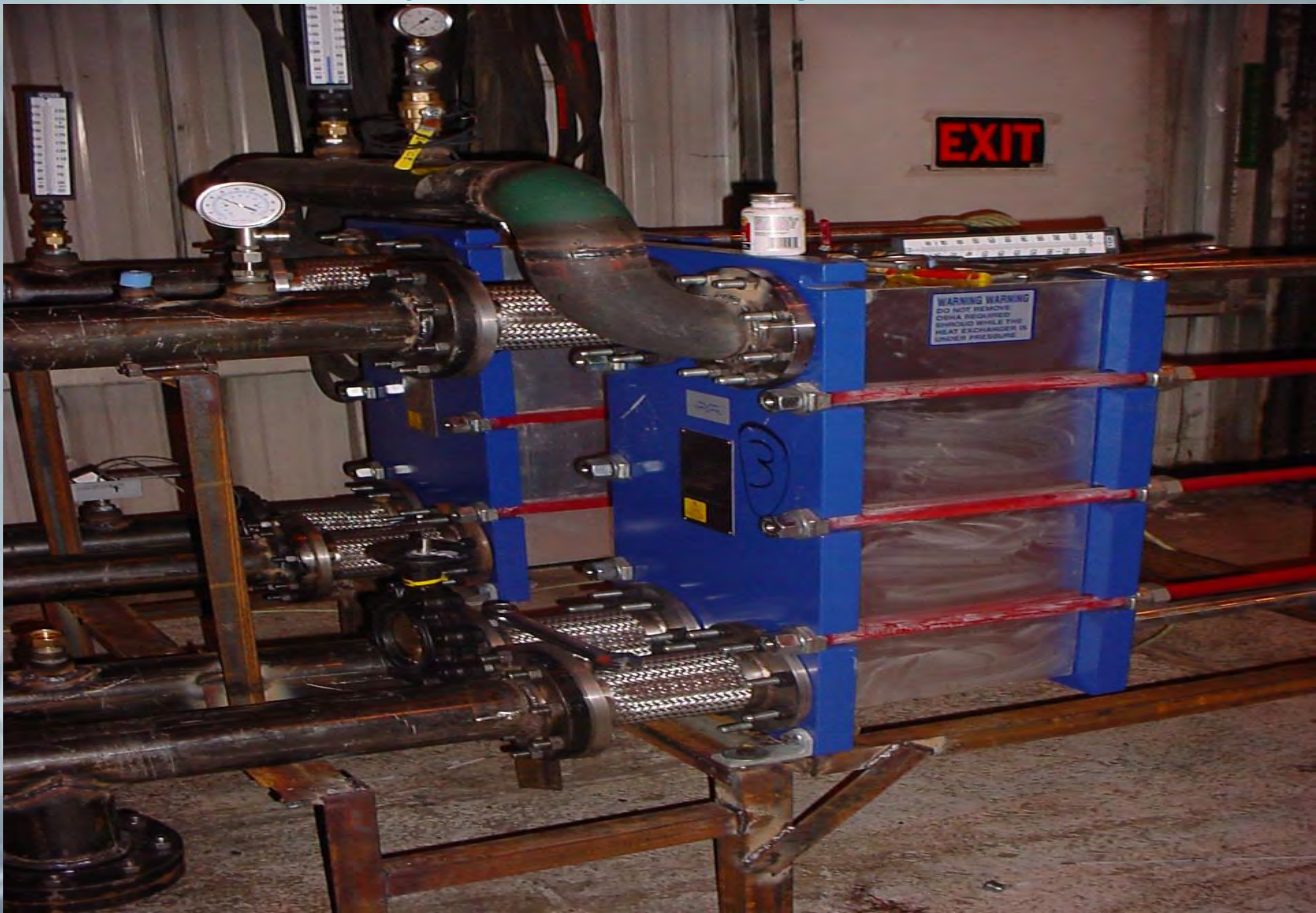
- ***Energy Efficiency***
- ***CFL***
- ***60 watt equivalent***
  - ***14 Watts***
- ***75 watt equivalent***
  - ***20 Watts***
- ***100 watt equivalent***
  - ***23 Watts***
- ***Sold over 800***

Change a Light – Save the World

- ***KEA is a member of the EPA Energy Efficiency Program "Change a Light Save the World" campaign***

City Heat Project

City Heat Project



City Heat Project

- The City contracted KEA to provide the heat for the water system
- The agreement provide a 30% savings on fuel cost to the city for heating the city water supply
- Fuel profits that previously left the community now stay in Kotzebue
- This is a new revenue stream for KEA

Wind is Taking Off