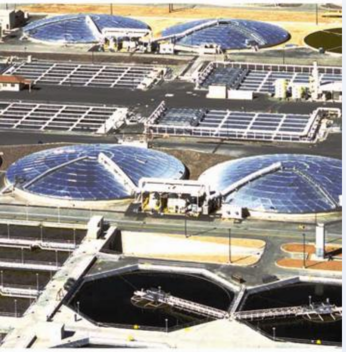



Innovative Energy Conservation Measures at Wastewater Treatment Facilities

Presented by the US EPA
May 17th, 2012

Moderator

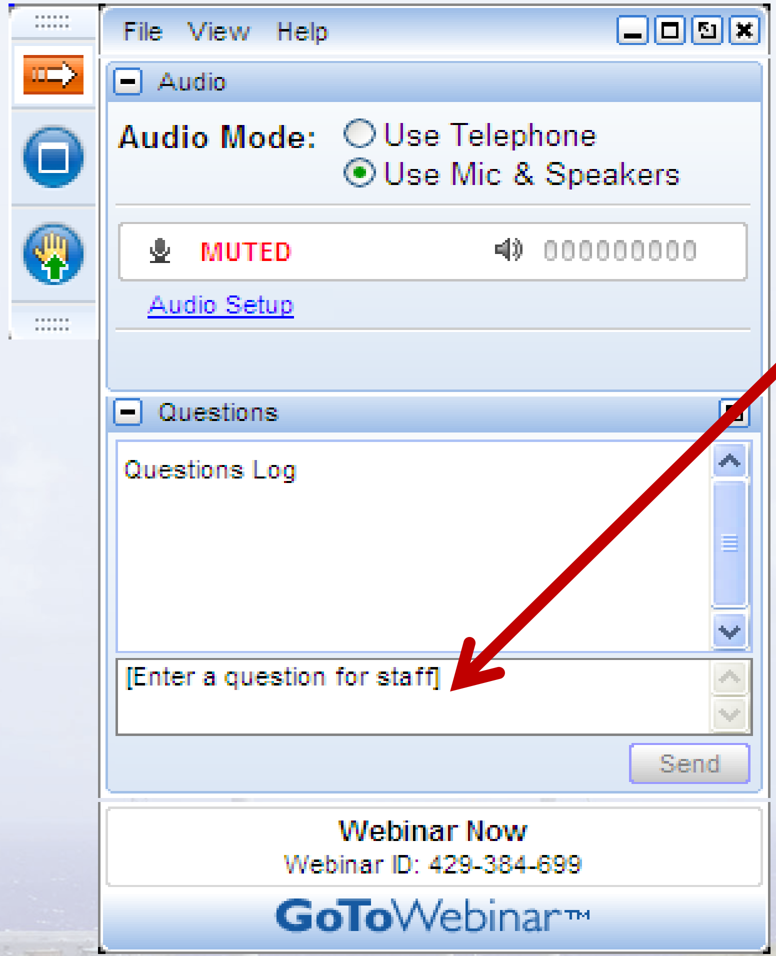
James Horne, US EPA Office of Wastewater Management

Speakers

Phil Zahreddine, Senior Technical Advisor, US EPA Office of Wastewater Management

Dale Doerr, Wastewater Superintendent, Sheboygan Regional WWTP

Questions & Answers



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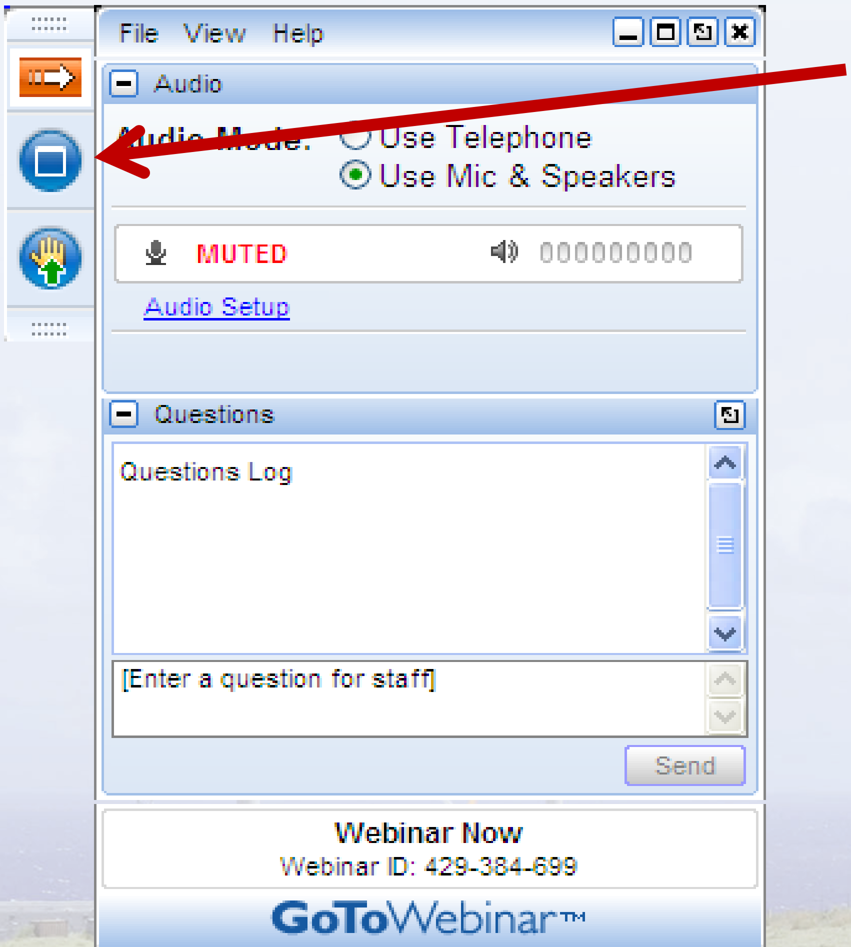

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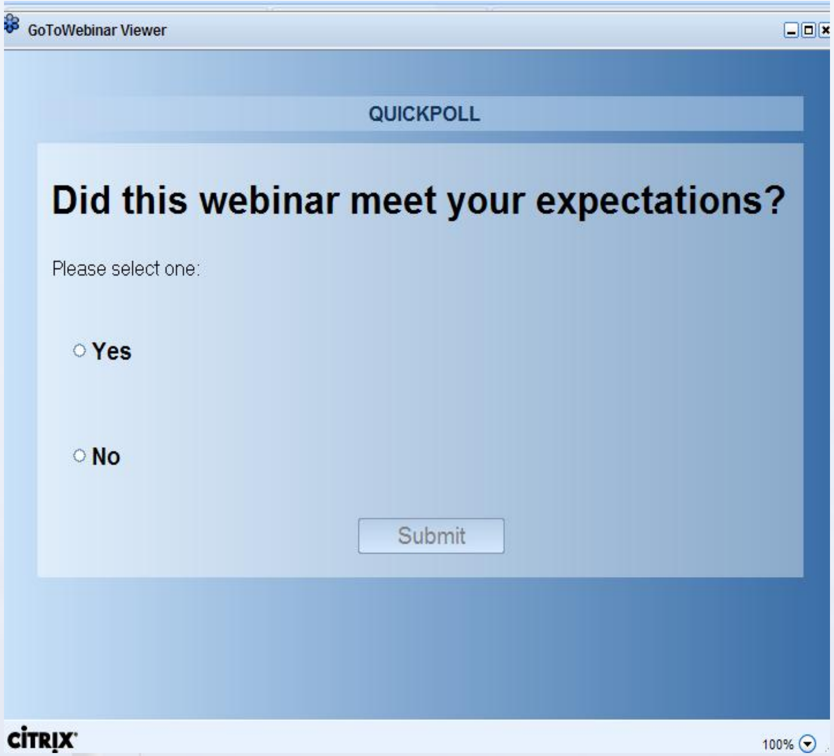


Quick Poll

Today's Agenda

- Background on energy use and management at water utilities
- Energy Conservation and Self Sufficiency Presentation
  - Phil Zahreddine, Senior Technical Advisor, US EPA Office of Wastewater Management
- Case Study of Energy Conservation Measures at the Sheboygan Regional Wastewater Treatment Plant
  - Dale Doerr, Wastewater Superintendent, Sheboygan Regional WWTP
- Q&A Time

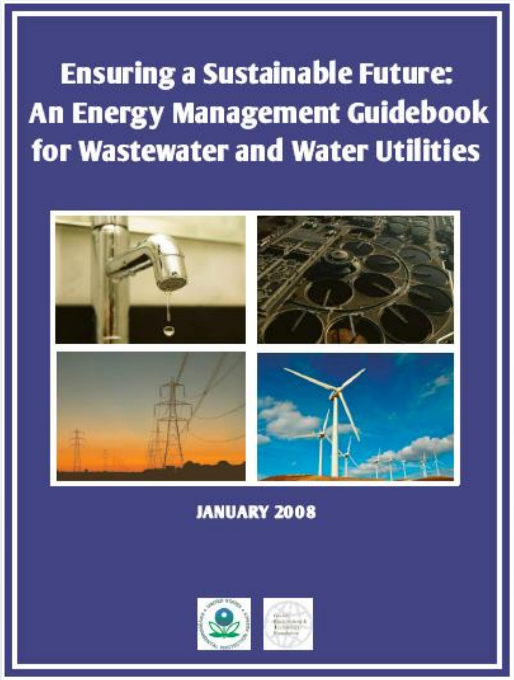
Energy Use and Water Utilities

- Water and Wastewater treatment represents about 3% of the nation's energy consumption
  - About $4 billion is spent annually for energy costs to run drinking water and wastewater utilities
  - Equivalent to approximately 56 billion kilowatt hours (kWh)
  - Equates to adding approximately 45 million tons of greenhouse gas to the atmosphere
  - Electric use for moving and treating water often represents 25-30% of O&M costs
- Energy consumption and costs will continue to rise
- Energy represents the largest controllable cost of providing water and wastewater services to the public

Managing to Maximize Energy Efficiency

Designed to help utilities:

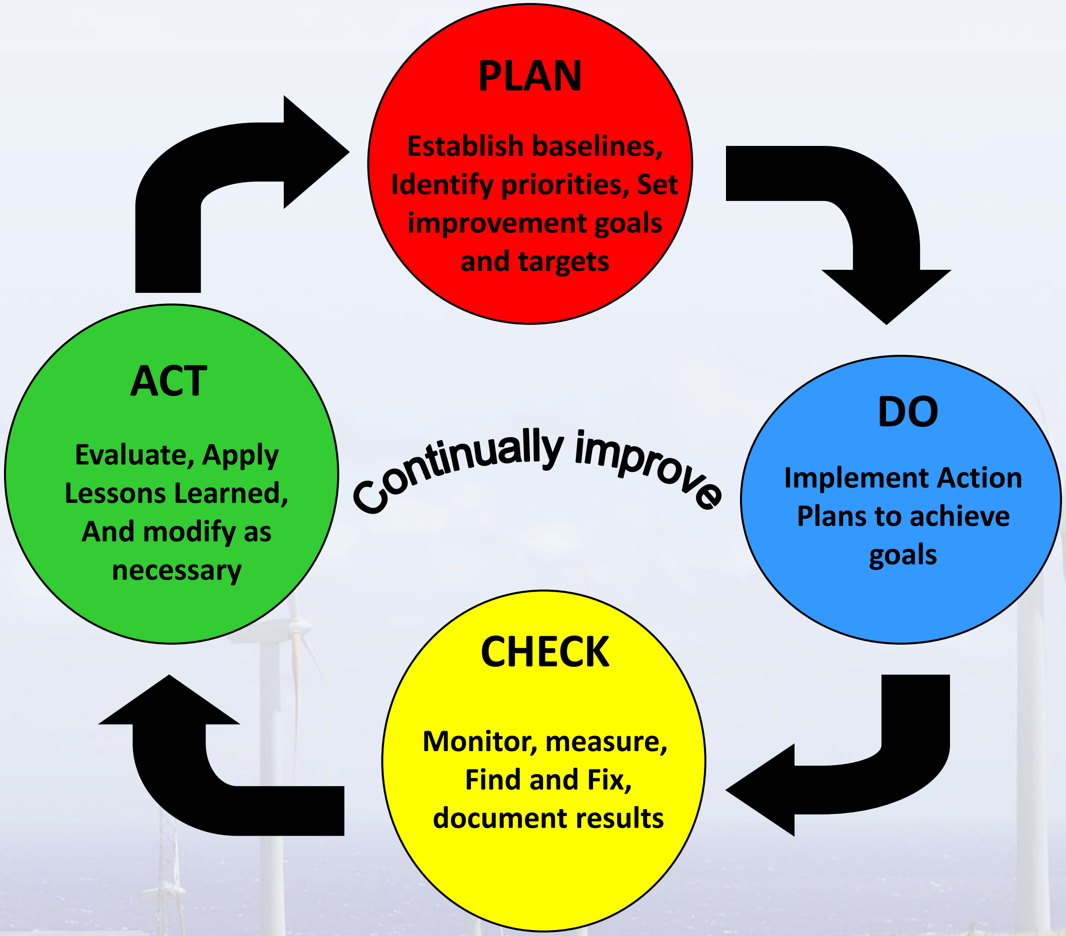
- Systematically assess current energy costs and practices
- Set measurable performance improvement goals
- Monitor and measure progress over time



Uses a management system approach for energy conservation, based on the successful Plan-Do-Check- Act process [based on Environmental Management Systems (EMS)

http://water.epa.gov/infrastructure/sustain/cut_energy.cfm

The Plan-Do-Check-Act Approach



- Allows utilities to systematically assess and manage energy opportunities and take action
- NOT a project—a system to manage for the long haul

Innovative Energy Conservation Measures at Wastewater Treatment Facilities

Phil Zahreddine,
Senior Technical Advisor,
US EPA Office of Wastewater Management

- MS Env Eng. University of Maryland at College Park
- BSCE, Lawrence Tech University, Southfield , MI
- 26 years experience in wastewater treatment operations and energy management at municipal facilities.

United States Environmental Protection Agency

US EPA Energy Management Webcast Series for Water and Wastewater Utilities

Innovative Energy Conservation Measures at Wastewater Treatment Facilities

Phil Zahreddine, MS EnvEng

Senior Technical Advisor
U.S. EPA, Office of Wastewater Management

Presentation Outline

- Significance
- Energy Self Sufficiency
- Document Scope
- Technical Data
- Case Studies

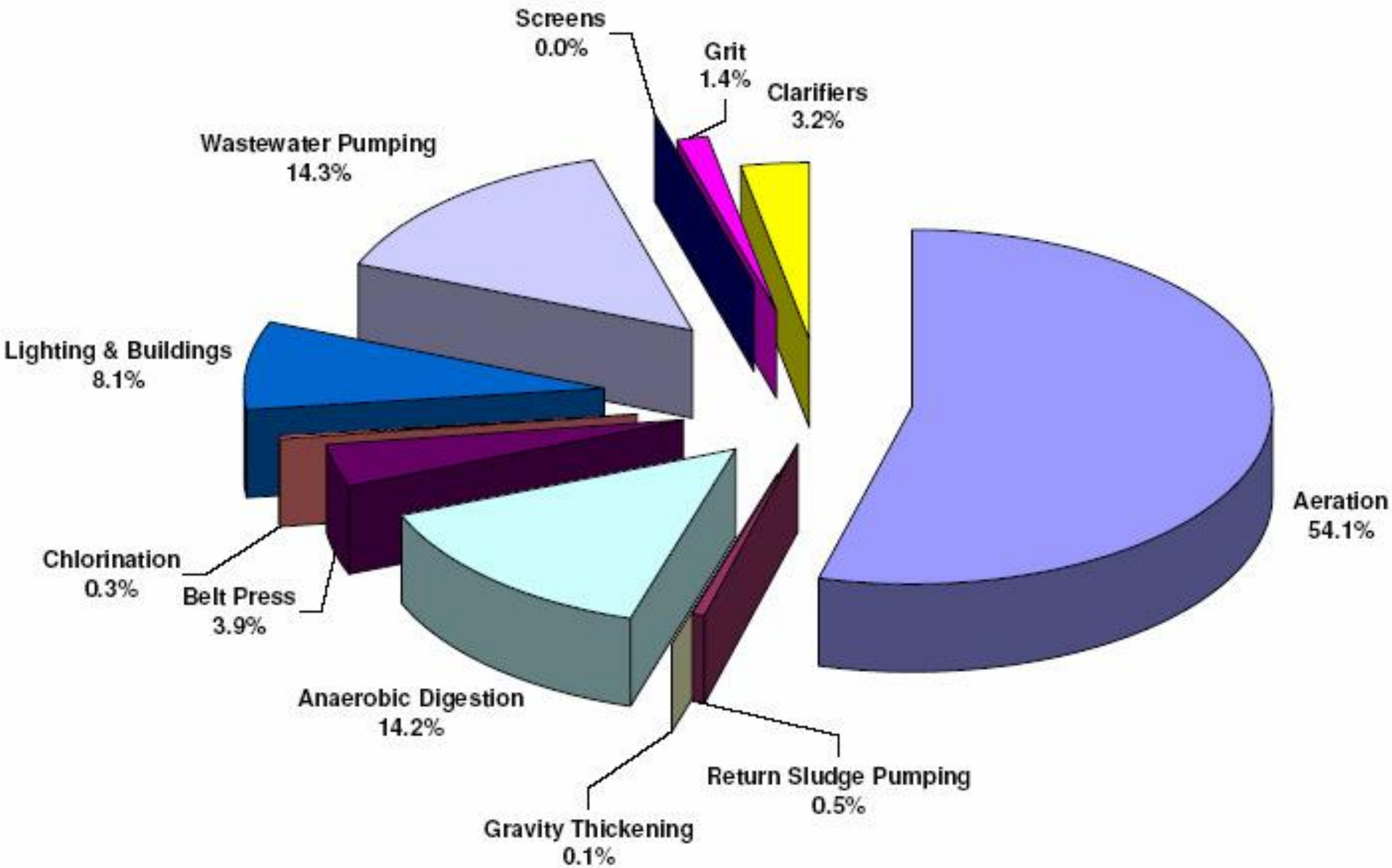
Significance

- Electric use for moving and treating water and wastewater in the US
  - 25-30% of total plant O&M Cost
  - Consumption and costs expected to continue to rise

- Current use of energy for wastewater treatment results in significant GHG emissions.

- Several plants are becoming/approaching energy self sufficiency (net zero energy use)
  - Many plants in the US (Sheboygan, WI; East Bay MUD, CA, several others)
  - Internationally (Many plants - WERF Study: Strass WWTP, Austria)

Energy Used in Wastewater Treatment*



Electricity Requirements for Activated Sludge Wastewater

Derived from data from the Water Environment Energy Conservation Task Force *Energy Conservation in Wastewater Treatment*

Elements of Energy Self-Sufficiency

- Management motivation to implement energy initiatives
- Tolerance for process risk
- Audit & energy management plan
- Process optimization & operator education
- High level of automation and process analysis tools
- **Flexible and efficient designs**
- **ECMs**

- **Anaerobic digestion &:**
  - **Combined Heat & Power**
  - **pre-treatment**
  - **Co-digestion**
- **Enhanced primary sedimentation**
- **Nutrient recovery and side stream flow equalization or treatment**
- **Thermal biosolids processes**
- **Solar**
- **Wind**

Where to Start

1. **Create energy team and assess energy consumption**
   – Examine and analyze bills
   – Plot energy consumption and demand for each process (recommend meters for each unit process)
   – Develop consumption baselines and compare to similar facilities

2. **Assess energy savings opportunities**
   – Evaluate process energy consumption and operational procedures
   – Evaluate operation of each significant piece of equipment
     • Can it be turned off or run efficiently at lower capacity?
     • Are new pieces of equipment much more efficient?

3. **Develop and implement energy conservation plan starting with "low hanging fruit" projects**

4. **Contract specifications for energy efficient equipment**

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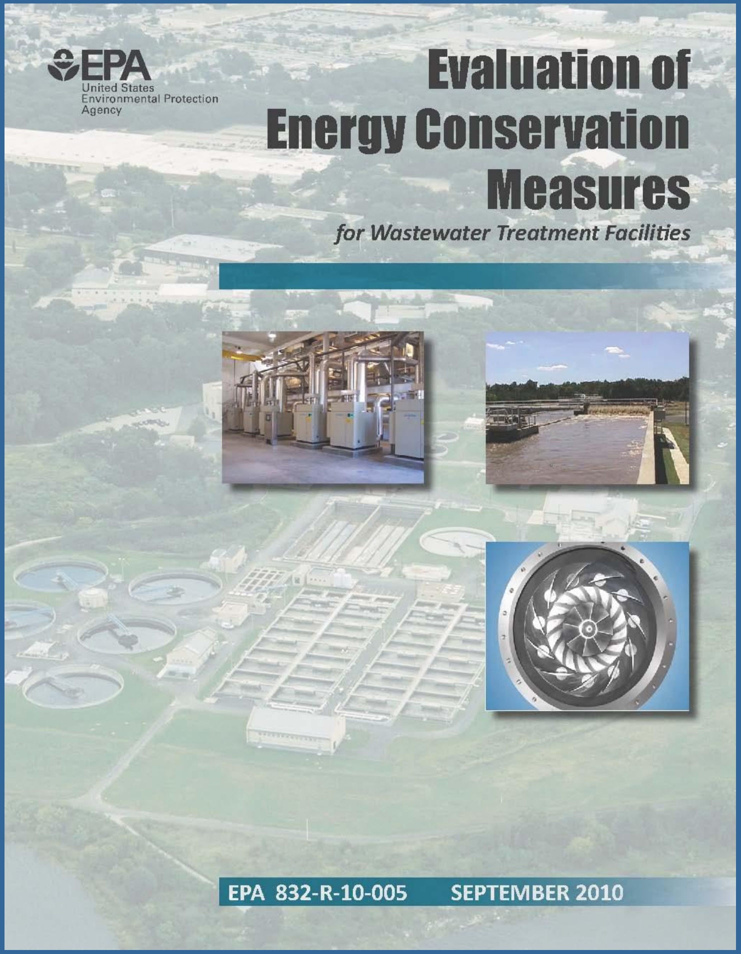
Energy Conservation Measures at Wastewater Facilities

- Main audience: Utility managers and POTW owners and operators.
- Targeted performance, cost, and savings/benefits information .
- Focus on innovative energy efficient *equipment replacements* and *operational modification* projects that result in energy savings with reasonable ay back periods.
- Nine detailed case studies.
- References info.



Acknowledgements - Utility Representatives

- Michael Kersten, Operations Manager - DePere Wastewater Treatment Plant, DePere, WI
- Dale Doerr, Wastewater Superintendent - Sheboygan Regional Wastewater Treatment Plant, Sheboygan, WI
- Thomas G. Bridges, Wastewater Treatment Plant Manager - Big Gulch Wastewater Treatment Facility, Mukilteo, WA
- Larry A. Gamblin, Division Manager - City of Bartlett Wastewater Treatment Plant #1, Bartlett, TN
- Mark Moise, Operation Manager - Oxnard WWTP, Oxnard, CA
- Brent Herring, Superintendent – Bucklin Point WWTF / United Water, East Providence, RI
- Rob Taylor, Energy Manager - Washington Suburban Sanitary Commission, Laurel, MD
- Dale Ihrke, Plant Manager / Bhavani Yerrapotu, Division Manager, San Jose/Santa Clara WPCP, San Jose, CA
- Mike Jupe, Program Administrator / Plant Superintendent - Waco Metropolitan Area Regional Sewer System, Waco, TX

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Acknowledgements

- **Technical Expert Panel:**
  - Steven Bolles, P.E. – Process Energy Services, LLC
  - Jess Burgess – Consortium for Energy Efficiency
  - Joseph Cantwell, P.E. – Science Applications International Corporation (SAIC)
  - Kathleen O’Connor, P.E. – New York State Energy Research and Development Authority (NYSERDA)
  - Andre Schmidt, P.E. – Los Angeles County Sanitation Districts
  - Michael Wilson, P.E. – CH2M Hill, Inc.
- **Expert Peer Reviewers:**
  - George Crawford, P. Eng. – CH2M Hill, Inc.
  - Julia Gass, P.E. – Black & Veatch
  - Thomas Jenkins, P.E. – JenTech, Inc.
  - George Lawrence, CEM - Efficiency Vermont
- **Project Mgt. Team**: EPA HQ, Cadmus, HDR

ECM Category	ECM Description
Mechanical Aeration	Adjustable submergence impeller mechanical aerator
	Dual impeller mechanical aerator
Aeration Control Systems	**Integrated DO and air flow aeration control**
	Automated SRT/DO Control
Blower and Diffuser Technology	**High speed turbo blowers**
	Single-stage centrifugal blowers with inlet guide vanes and variable diffuser vanes
	Ultra-fine bubble diffusers
Solids Processing	**Vertical linear motion mixer**
	Multiple hearth furnace upgrade incorporating combustion air pre-heating and waste heat recovery
	Solar drying
ECMs for Selected Treatment Processes	Low-pressure, high intensity lamps for UV disinfection
	Automated channel routing for UV disinfection
	Membrane air scour for MBRs
	Hyperbolic mixers
	Pulsed air mixing of anoxic and anaerobic zones
	BNR process automation

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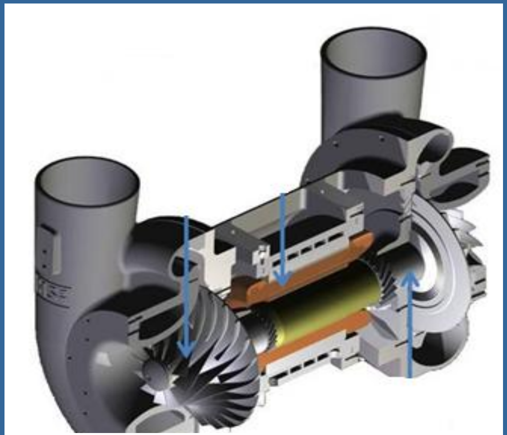
High Speed Turbo Blowers

- Gearless, operate at high speeds.
- Air bearing or magnetic bearing.
- Higher capital costs but nominal efficiency is higher.
- Lower air flow capacity ranges.
- Small footprint, quiet, low vibration.
- See Case Studies: De Pere WWTP, WI and Big Gultch WWTP, WA.



High-Speed Turbo Blower with Air Bearings
Reproduced courtesy of HSI, Inc.

High-Speed Turbo Blower with Magnetic Bearings
Reproduced courtesy of Atlas Copco

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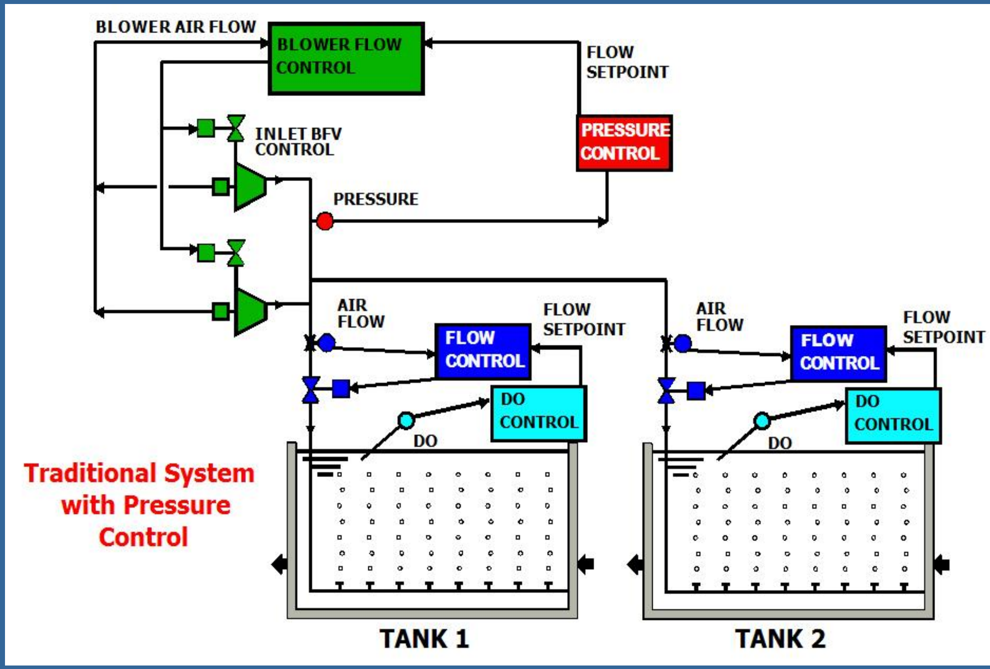
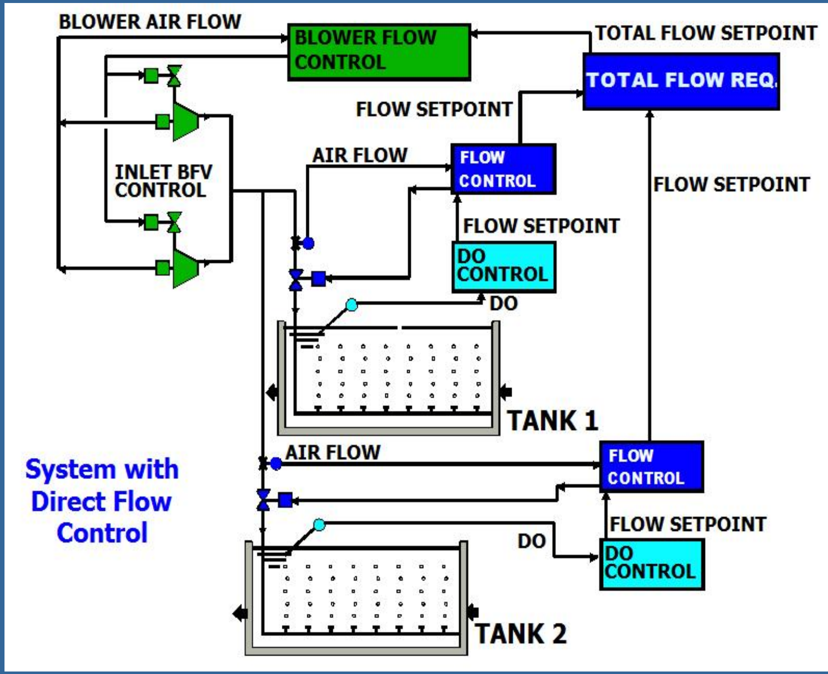
Integrated DO & Air Flow Control



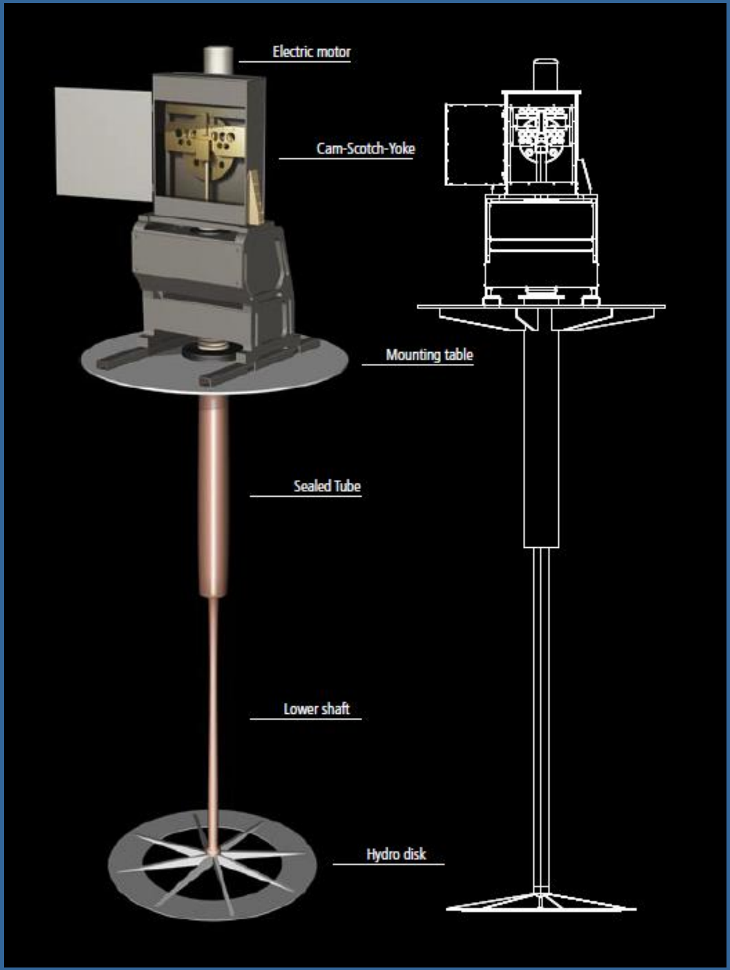


Source: Reproduced courtesy of Dresser, Inc.

- Uses air flow control instead of pressure control.
- Eliminates cyclic oscillation (hunting) at blower and aeration tanks, particularly in small systems.
- Reduces wasted blower power and pressure drop across tank valves. Air valve in zone with highest oxygen demand is fully open.
- See Case Study: Bucklin Point WWTF, RI.

Vertical Linear Motion Mixer

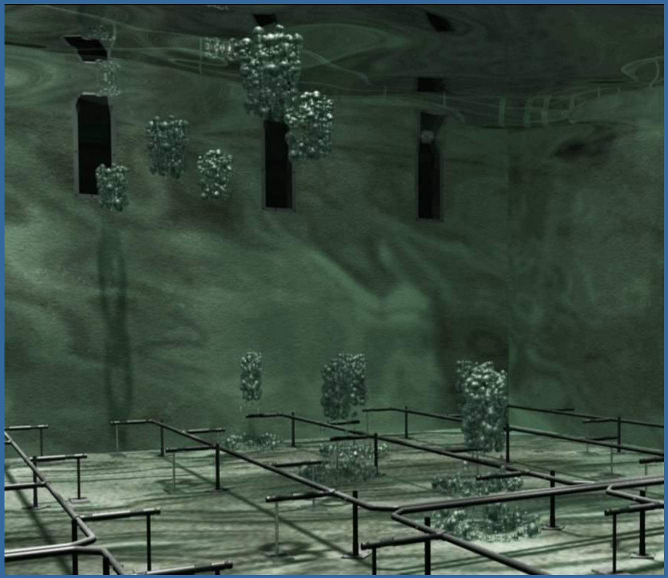
- Thin steel disk to mix digester contents.
- Effective mixing compared to conventional methods.
- Significant energy savings reported.
- Testing at Tucson, AZ in 2007 showed effective mixing at 11% of energy required by impeller draft tube mixers.



Vertical Linear Motion Mixer
Reproduced courtesy of Enersave Fluid Mixers, Inc.

Pulsed Air Mixing of Anoxic and Anaerobic Zones - BioMix

- Efficient mixing in anaerobic and anoxic zones with no significant oxygen transfer.
- Intermittent release of bursts of compressed air at the bottom of the water column zones.
- Testing at F. Wayne Hill Water Resource Center in Buford, GA to compare effectiveness, compatibility with anaerobic and anoxic environments, and power requirements vs. a conventional submersible propeller mixer.
- Effective, fully compatible, simpler maintenance, with substantial power savings.



ECM Project Case Studies

Green Bay (WI) Metropolitan Sewerage District De Pere Wastewater Treatment Facility

United States Environmental Protection Agency

Plant Description:

- 14.2 mgd design
- 8.0 mgd avg. daily flow

- 2-stage AS w/biological P removal and tertiary filtration

ECM Project Description:

- Replaced five 450 HP multi-stage centrifugal blowers with six 330 HP magnetic bearing turbo blowers (operate 2-3 turbo blowers vs. 2-3 multi-stage centrifugal blowers).

Green Bay (WI) Metropolitan Sewerage District De Pere Wastewater Treatment Facility

United States Environmental Protection Agency

- **Energy Savings**

ECM Project Costs	$850,000
Energy Savings Results	2,143,975 kWh/yr (2005) (50% reduction) $63,758 (2005) At $0.0487/kWh (37% reduction)
Payback	13.3 years

- **Ancillary Benefits**
  - ✓ New blowers less maintenance intensive.
  - ✓ Aeration system automation reduces operators' surveillance of aeration process.
  - ✓ Blower cooling air exhaust "recovered" for building heat.

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Mukilteo (WA) Water and Wastewater District
Big Gulch Wastewater Treatment Plant

Plant Description:

- 2.6 mgd design
- 1.45 mgd avg. daily flow

- Two parallel oxidation ditches (A & B – 40/60 flow split) with rotor aerators.

ECM Project Description:

- Replaced rotor aerators with air bearing turbo blowers and fine bubble diffusers.
- Automated aeration system with implementation of DO probes and PLC control of blowers.
- Implemented ORP based denitrification control.

Mukilteo (WA) Water and Wastewater District Big Gulch Wastewater Treatment Plant

United States Environmental Protection Agency

➢ Energy Savings

ECM Project Costs	$1,446,304
Energy Savings Results ***(based on energy cost savings of $0.037 per pound of CBOD removed)***	148,900 kWh/yr * (11% reduction) $43,756/yr (2010 estimated)
Payback	33 years

* While removing approximately 34% additional CBOD compared to base (pre-ECM) period

➢ Ancillary Benefits

✓ Blower maintenance reduced compared to rotor aerators.

✓Automating aeration system improved setting, reduced chemical control of filamentous bacteria.

City of Bartlett (TN) Wastewater Treatment Plant No. 1

Plant Description:

- 2.2 mgd design
- 1.0 mgd avg. daily flow

- Two parallel oxidation ditches with rotor aerators.

ECM Project Description:

- Installed optical DO instrumentation coupled with VFD control of aeration rotor speed.

City of Bartlett (TN)
Wastewater Treatment Plant No. 1

➢ Energy Savings

ECM Project Costs	$13,500
Energy Savings Results	71,905 kWh/yr (13% reduction) $9,176/yr
Payback	1.5 years

➢ Ancillary Benefits

- ✓ Optical DO instrumentation low maintenance requirement.
- ✓ Automation reduces operators' surveillance of aeration process.

City of Oxnard (CA) Wastewater Treatment Plant No. 32

Plant Description:

- 31.7 mgd design
- 22.4 mgd avg. daily flow

- Trickling filter followed by activated sludge (using five 350 HP Turblex blowers).

ECM Project Description:

- Implemented proprietary algorithms (Ekster Associates) for control of SRT (SRTmaster™), replacing blower manufacturer's pressure based control software (DOmaster™) and for SRT and DO set point optimization (OPTImaster™).

City of Oxnard (CA) Wastewater Treatment Plant No. 32

- **Energy Savings**

ECM Project Costs	$135,000
Energy Savings Results	306,600 kWh/yr (20% reduction) $26,980/yr
Payback	5 years

- **Ancillary Benefits**
  - ✓ Process stability, reduced SVI (20% to 50%), and previous foaming problems have not returned.
  - ✓ Effluent quality consistently within NPDES permit limits.

Narragansett Bay Commission (RI)
Bucklin Point Wastewater Treatment Facility

Plant Description:

- 46 mgd design
- 23.7 mgd avg. daily flow

- Four train MLE, activated sludge process.

ECM Project Description:

- Implemented proprietary blower control system (ESCOR/Dresser Roots) employing integrated air flow control (replacing blower manufacturer's proprietary pressure based control algorithm with direct air flow control using PID control).

Narragansett Bay Commission (RI)
Bucklin Point Wastewater Treatment Facility

- **Energy Savings**

ECM Project Costs	$200,000
Energy Savings Results	1,247,033 kWh/yr (20% reduction - average first 3 years operation) $135,788/yr (average first 3 years operation)
Payback	1.5 years

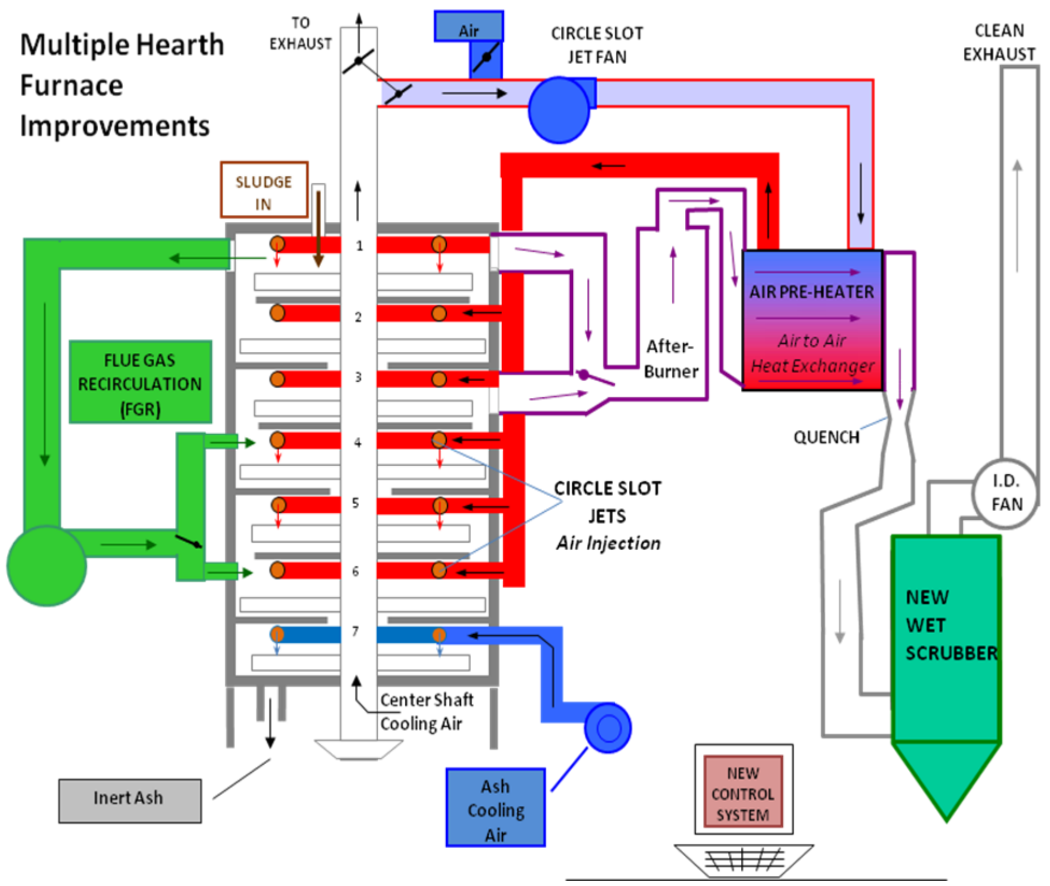
- **Ancillary Benefits**
  - ✓ Reliable blower control eliminated manual DO monitoring and control.
  - ✓ Stabilized operation reduced alkalinity control chemical usage.

Washington Suburban Sanitary Commission - Western Branch Wastewater Treatment Plant (Upper Marlboro, MD)

Plant Description:

- 30 mgd design
- 21.6 mgd avg. daily flow

- Denitrification activated sludge (DNAS) process with sludge incineration.



ECM Project Description:

- Implemented solids processing (multiple hearth furnace) modifications (waste heat recovery, flue gas recirculation and combustion air injection system).

Washington Suburban Sanitary Commission - Western Branch Wastewater Treatment Plant (Upper Marlboro, MD)

- **Energy Savings**

ECM Project Costs	$4,500,000
Energy Savings Results	320,00 therms/yr (76% reduction in natural gas consumption) $400,000/yr
Payback	11.3 years

- **Ancillary Benefits**
  - ✓ Increased MHF capacity from 12 dtpd to 17-19
  - ✓ Delayed construction of additional incineration capacity.

City of San Jose (CA)
San Jose/Santa Clara Water Pollution Control Plant

Plant Description:

- 167 mgd design
- 107 mgd avg. daily flow

- Single stage Biological Nutrient Removal using two parallel activated sludge processes.

ECM Project Description:

- Implemented proprietary algorithms (Ekster Associates) to effect energy savings through pumping systems optimization, pulsed air mixing in the BNR process anoxic/anaerobic zones and DAF pressurization pump control/process optimization.

City of San Jose (CA) San Jose/Santa Clara Water Pollution Control Plant

- Energy Savings

ECM Project Costs	\$269,569
Energy Savings Results ○ ***Pumping systems optimization*** ○ ***Pulsed air mixing*** ○ ***DAF pump/process optimization***	\$1,178,811/yr (natural gas and electricity) 1.83 kW/10^6 gal (20% reduction) 1.2 X 10^{11} BTU/yr (38% reduction) 4.8 X 10^6 kWh/yr (23% reduction 1,603,030 kWh/yr (64% reduction)
Payback	3 months

City of Sheboygan (WI) Sheboygan Regional Wastewater Treatment Plant

United States Environmental Protection Agency

Plant Description:

- 18.4 mgd design
- 11.8 mgd avg. daily flow

- 2-stage AS w/biological nutrient removal.
- Anaerobic digestion w/ microturbines.

ECM Project Description:

- Replaced four 250 HP positive displacement blowers with two 350 HP single-stage centrifugal blowers (with inlet guide vanes and variable outlet vanes).
- Air control valves on headers to aeration basins.
- Upgrades SCADA system, replaced blower controls/programming.

City of Sheboygan (WI) Sheboygan Regional Wastewater Treatment Plant

- **Energy Savings**

ECM Project Costs	$901,000
Energy Savings Results	817,000 kWh/yr (15% reduction) $63,889/yr
Payback	14 years

- **Ancillary Benefits**
  - ✓ New blowers less maintenance intensive.
  - ✓ Automation reduces operators' surveillance and eliminates manual adjustment of aeration process.
  - ✓ Air piping system hammering eliminated along with related system maintenance.

Waco (TX) Metropolitan Area Regional Sewer System Wastewater Treatment Plant

Plant Description:

- 37.8 mgd design
- 22.8 mgd avg. daily flow

- Activated sludge, single-stage nitrification

ECM Project Description:

- Supplemented existing fine bubble diffuser system with additional diffusers.
- Implemented DO probes in each of the aeration basins' three aeration zones.
- Implemented blower and aeration drop leg valve control (based on aeration basin DO readings.

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Waco (TX) Metropolitan Area Regional Sewer System Wastewater Treatment Plant

- Energy Savings

ECM Project Costs	$397,708
Energy Savings Results	6,642,741 kWh/yr (33% reduction in first 2 years of operation) $331,272 (in first two years of operation)
Payback	2.4 years

- Ancillary Benefits

  - ✓ Automation reduced operators' surveillance and eliminated manual adjustment of aeration process.

  - ✓ With nitrification process stabilized, effluent chlorination dosage has been reduced and stabilized

United States Environmental Protection Agency

Questions

Project Report

- *Evaluation of Energy Conservation Measures for Municipal Wastewater Treatment Facilities – EPA 832-R-10-005 – September 2010*.
- Available for free download at:

  http://water.epa.gov/scitech/wastetech/publications.cfm

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Senior Technical Advisor
USEPA OWM
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(202) 564-0587

Case Study of Energy Conservation Measures at the Sheboygan Regional Wastewater Treatment Plant

Dale Doerr, Wastewater Superintendent,
Sheboygan Regional WWTP

- MBA – University of Phoenix, Milwaukee, WI
- BBA – Letourneau University, Longview, TX
- Certified Water and Wastewater Operator in Wisconsin and Texas
- 31 years of water and wastewater experience

Sheboygan Regional WWTP's Journey to Net Zero

Dale Doerr, MBA
Sheboygan Regional Wastewater Treatment Plant

USEPA Webinar: Energy Conservation Measures in WWTP's
May 17, 2012

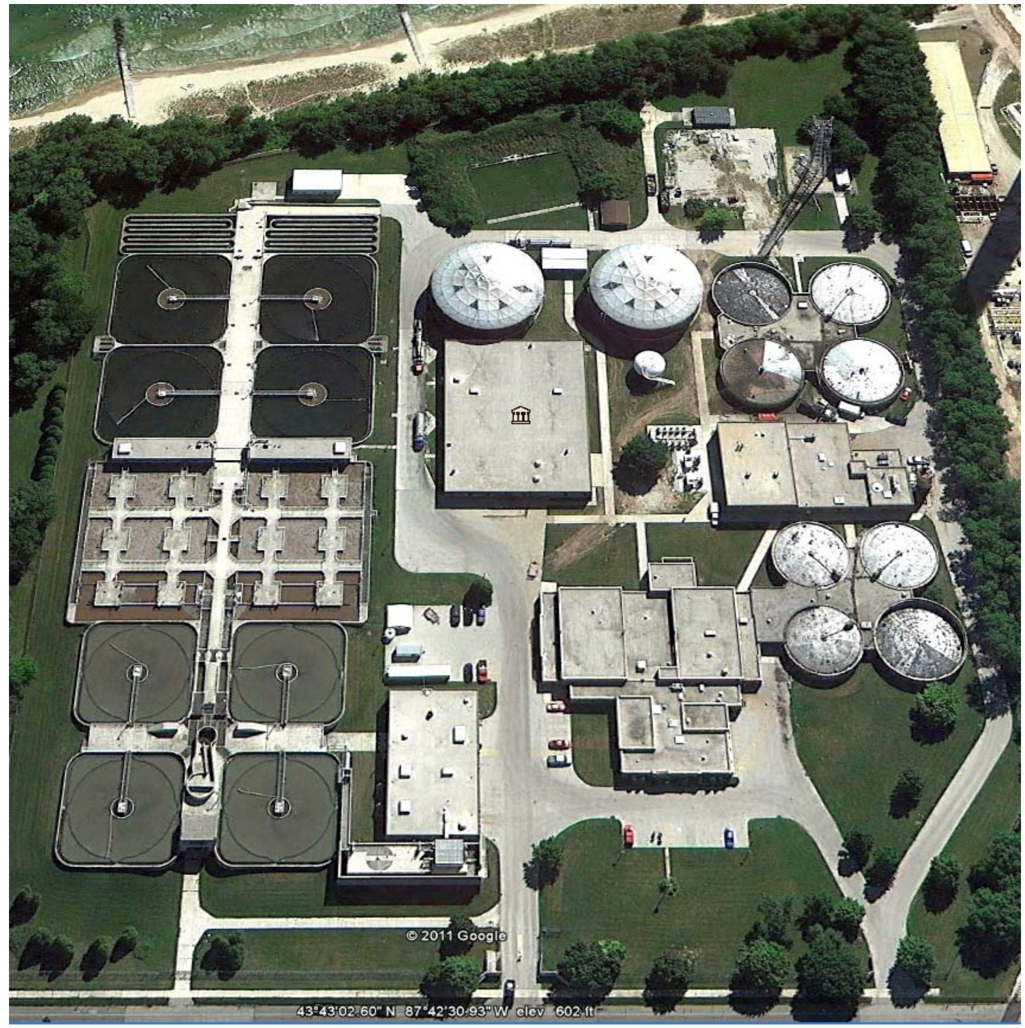
Agenda

- Sheboygan Regional WWTP
- Energy Related Projects
  - Influent Pump Station
  - Aeration Blower Replacement
  - Aeration Air Flow Control Valves
  - Sludge Boiler Replacement
  - Cogeneration Projects
- Optimizing Biogas Production
- Summary of Energy Savings
- Questions

Where is Sheboygan, WI.?

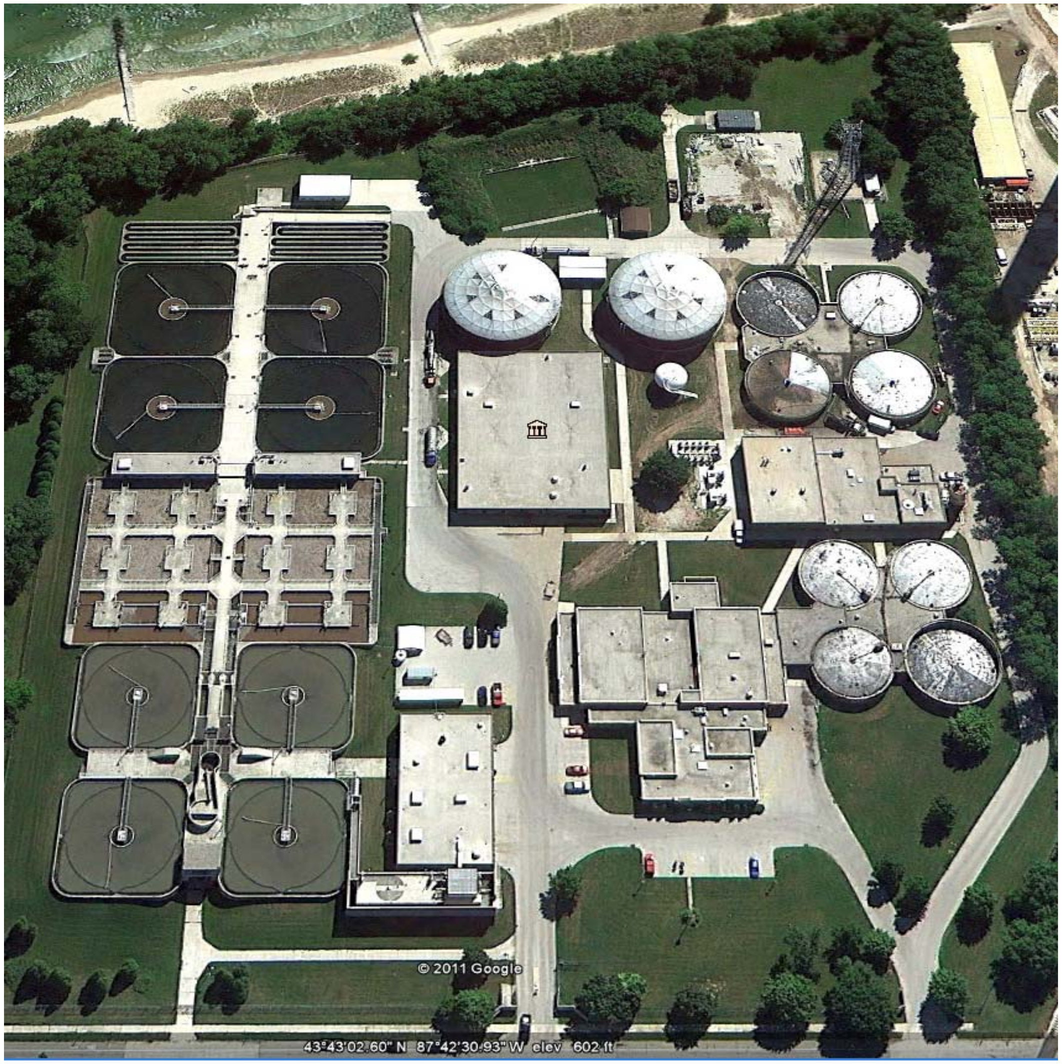
Sheboygan Regional WWTP

- Built 1982
- 18.4 MGD Permitted Flow
- 11.0 MGD Average Flow
- Serves 68,000 People
  - City of Sheboygan
  - City of Sheboygan Falls
  - Village of Kohler
  - Town of Lima
  - Town of Sheboygan
  - Town of Sheboygan Falls
  - Town of Wilson
- 2011 Actual
  - Operating Budget $ 3.780 M
  - Debt Service $ 602 K
  - Capital Outlay $ 600 K
  - Energy Costs $340 K
  - Tipping Fee Revenue $1.013M



3333 Lakeshore Drive

Sheboygan Regional WWTP



Preliminary/Primary Treatment

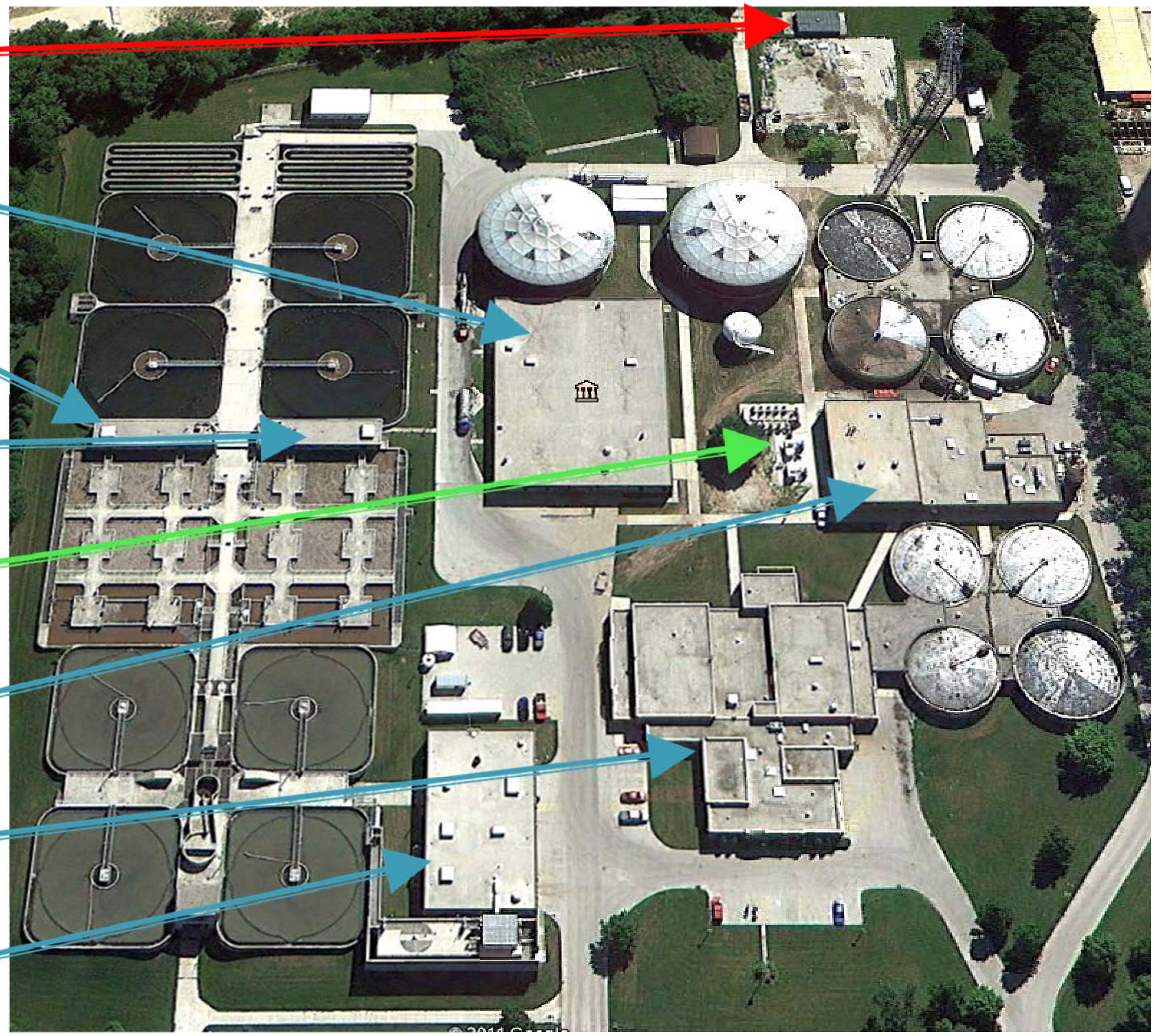
- **Screening**
- **Grit Removal**
- **Primary Clarifiers**

Two Treatment Trains

- **Biological Nutrient Removal**
- **Aeration Basins**
  - **Fine Bubble Membrane Diffusers**
  - **High Efficiency Turblex® Blower**
- **Final Clarifiers**
- **Chlorine Disinfection**
- **Dechlorination**
- **Anaerobic Digestion**
  - **Methane Gas Recovery for Building Heat and Micro-turbine Co-Generation Facility**
- **Gravity Belt Thickening**
- **Bio-solids Storage 6 - MG**
- **Bio-solids are Land Applied**

Monitoring Energy Usage

Power meters monitor energy use in each building and the microturbine output

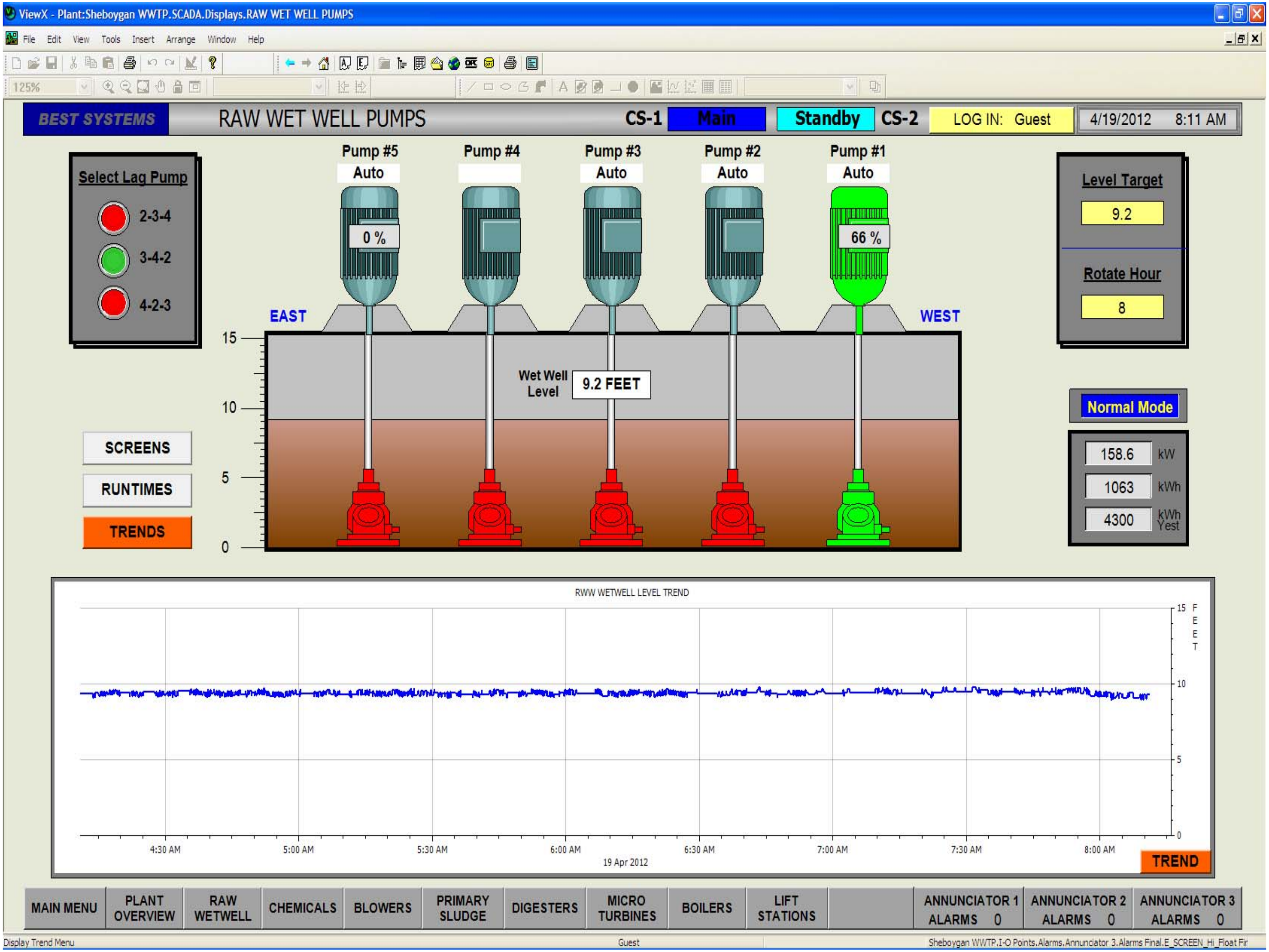


WWTP Energy Reduction Projects

- Influent Pump Station
- Aeration Blower Replacement
- Aeration Air Flow Control Valves
- Sludge Boiler Replacement
- Cogeneration Project

Influent Pump Station Project
Fall 2005

CAT Engine, 200 HP Premium Efficiency Motor,
3 - 250 HP Motor with Eddy-current Drives



ViewX - Plant:Sheboygan WWTP.SCADA.Displays.RAW WET WELL PUMPS
File Edit View Tools Insert Arrange Window Help
BEST SYSTEMS
RAW WET WELL PUMPS
CS-1
Main
Standby
CS-2
LOG IN: Guest
4/19/2012 8:11 AM
Select Lag Pump
2-3-4
3-4-2
4-2-3
Pump #5
Auto
0 %
Pump #4
Pump #3
Auto
Pump #2
Auto
Pump #1
Auto
66 %
EAST
WEST
15
10
5
0
Wet Well Level
9.2 FEET
Level Target
9.2
Rotate Hour
8
Normal Mode
158.6 kW
1063 kWh
4300 kWh Yest
SCREENS
RUNTIMES
TRENDS
RWW WETWELL LEVEL TREND
FEET
4:30 AM
5:00 AM
5:30 AM
6:00 AM
6:30 AM
7:00 AM
7:30 AM
8:00 AM
19 Apr 2012
TREND
MAIN MENU
PLANT OVERVIEW
RAW WETWELL
CHEMICALS
BLOWERS
PRIMARY SLUDGE
DIGESTERS
MICRO TURBINES
BOILERS
LIFT STATIONS
ANNUNCIATOR 1 ALARMS 0
ANNUNCIATOR 2 ALARMS 0
ANNUNCIATOR 3 ALARMS 0
Display Trend Menu
Guest
Sheboygan WWTP.I-O Points.Alarms.Annunciator 3.Alarms Final.E_SCREEN_Hi_Float Fir

Influent Pump Station Project

- **Project Cost $170,000**
  - 2 Premium Efficiency Motors
  - 2 VFDs, 2 Soft Start Motor Starters
  - Energy Component Cost **~$87,000**
- **Focus On Energy Grant**
  - $3,861
- **Annual Savings**
  - 20% reduction in KWH usage for influent pumping
- **Savings 2006 - 2011**
  - $80,892
- **< 7 Year Simple Payback**

Aeration Blower Replacement Late Summer 2005

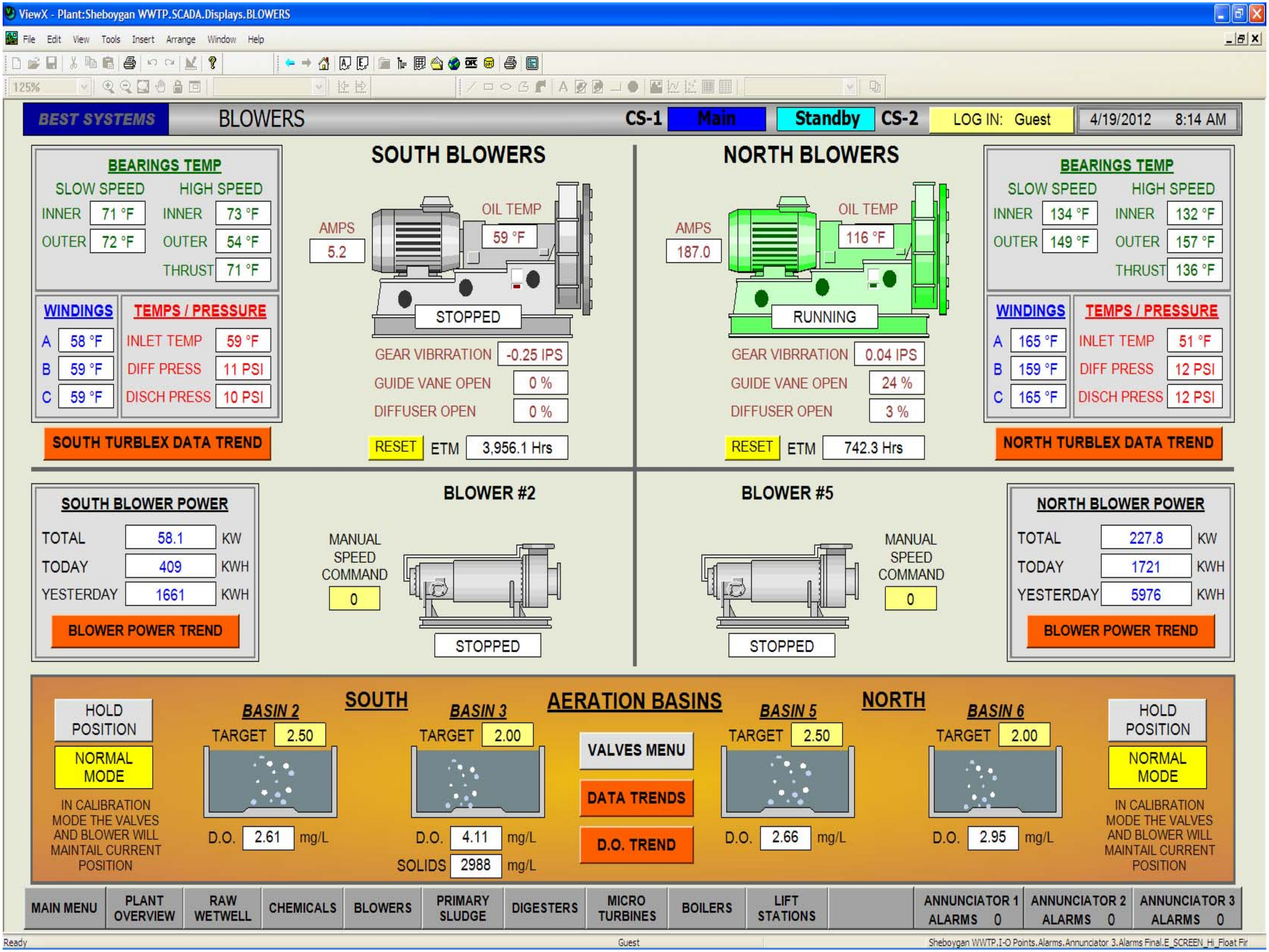
Removed 2 - Gardner Denver® PD Blowers with 250 HP motors

Installed 2 Turblex® High Efficiency Centrifugal Blowers with 350 HP motors

Aeration Blower Replacement

- **Project Cost $790,000**
  - 2 Turblex® Blowers with 350 HP Motors
  - Turblex® Blower and Motor Cost ~$454,000
  - Soft Start Motor Starter Cost ~$50,000
- **Focus On Energy Grant**
  - **$17,000**
- **Annual Savings**
  - 6.2% reduction in KWH usage
- **Savings 2006 - 2011**
  - $160868
- **< 15 Year Simple Payback**

Aeration Blower Replacement Late Summer 2008


ViewX - Plant:Sheboygan WWTP.SCADA.Displays.BLOWERS
File Edit View Tools Insert Arrange Window Help
125%
BEST SYSTEMS
BLOWERS
CS-1 Main Standby CS-2
LOG IN: Guest
4/19/2012 8:14 AM
SOUTH BLOWERS
BEARINGS TEMP
SLOW SPEED
HIGH SPEED
INNER 71 °F
INNER 73 °F
OUTER 72 °F
OUTER 54 °F
THRUST 71 °F
WINDINGS
A 58 °F
B 59 °F
C 59 °F
TEMPS / PRESSURE
INLET TEMP 59 °F
DIFF PRESS 11 PSI
DISCH PRESS 10 PSI
SOUTH TURBLEX DATA TREND
AMPS 5.2
OIL TEMP 59 °F
STOPPED
GEAR VIBRRATION -0.25 IPS
GUIDE VANE OPEN 0 %
DIFFUSER OPEN 0 %
RESET ETM 3,956.1 Hrs
NORTH BLOWERS
AMPS 187.0
OIL TEMP 116 °F
RUNNING
GEAR VIBRRATION 0.04 IPS
GUIDE VANE OPEN 24 %
DIFFUSER OPEN 3 %
RESET ETM 742.3 Hrs
BEARINGS TEMP
SLOW SPEED
HIGH SPEED
INNER 134 °F
INNER 132 °F
OUTER 149 °F
OUTER 157 °F
THRUST 136 °F
WINDINGS
A 165 °F
B 159 °F
C 165 °F
TEMPS / PRESSURE
INLET TEMP 51 °F
DIFF PRESS 12 PSI
DISCH PRESS 12 PSI
NORTH TURBLEX DATA TREND
SOUTH BLOWER POWER
TOTAL 58.1 KW
TODAY 409 KWH
YESTERDAY 1661 KWH
BLOWER POWER TREND
BLOWER #2
MANUAL SPEED COMMAND 0
STOPPED
BLOWER #5
MANUAL SPEED COMMAND 0
STOPPED
NORTH BLOWER POWER
TOTAL 227.8 KW
TODAY 1721 KWH
YESTERDAY 5976 KWH
BLOWER POWER TREND
HOLD POSITION
NORMAL MODE
IN CALIBRATION MODE THE VALVES AND BLOWER WILL MAINTAIL CURRENT POSITION
SOUTH
AERATION BASINS
NORTH
BASIN 2
TARGET 2.50
D.O. 2.61 mg/L
BASIN 3
TARGET 2.00
D.O. 4.11 mg/L
SOLIDS 2988 mg/L
VALVES MENU
DATA TRENDS
D.O. TREND
BASIN 5
TARGET 2.50
D.O. 2.66 mg/L
BASIN 6
TARGET 2.00
D.O. 2.95 mg/L
HOLD POSITION
NORMAL MODE
IN CALIBRATION MODE THE VALVES AND BLOWER WILL MAINTAIL CURRENT POSITION
MAIN MENU
PLANT OVERVIEW
RAW WETWELL
CHEMICALS
BLOWERS
PRIMARY SLUDGE
DIGESTERS
MICRO TURBINES
BOILERS
LIFT STATIONS
ANNUNCIATOR 1 ALARMS 0
ANNUNCIATOR 2 ALARMS 0
ANNUNCIATOR 3 ALARMS 0
Ready
Guest
Sheboygan WWTP.I-O Points.Alarms.Annunciator 3.Alarms Final.E_SCREEN_Hi_Float Fir

Aeration Air Flow Control Valves

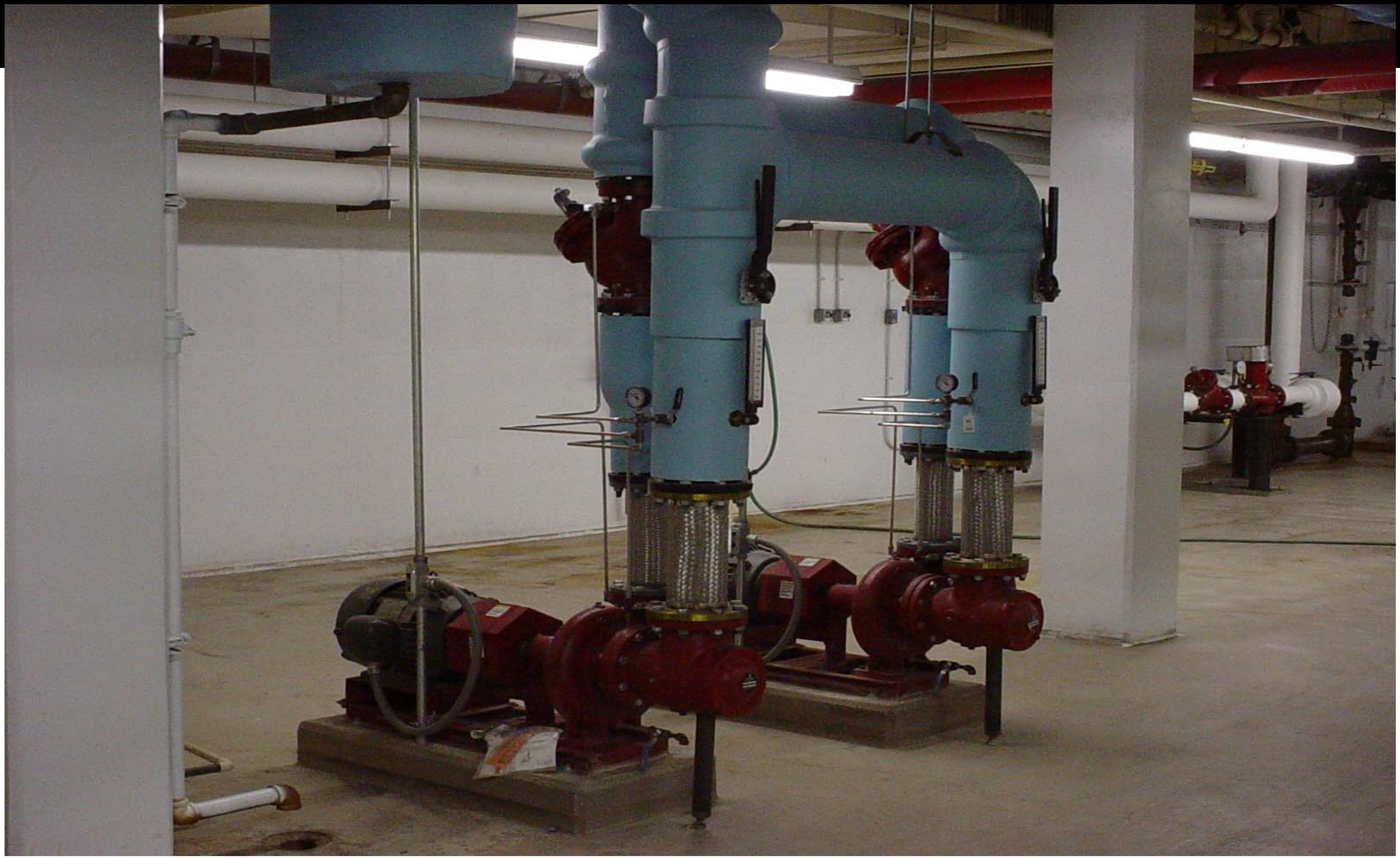
- **Project Cost $128,000**
  - 6 Butterfly valves with Auma® Electric Actuators
  - Air piping modifications
  - SCADA System Modifications
- **Focus On Energy Grant**
  - None
- **Annual Savings**
  - 8.0% reduction in KWH usage
- **Savings 2009 - 2011**
  - $110,526
- **< 4 year Simple Payback**

Sludge Boiler Replacement
Fall 2005

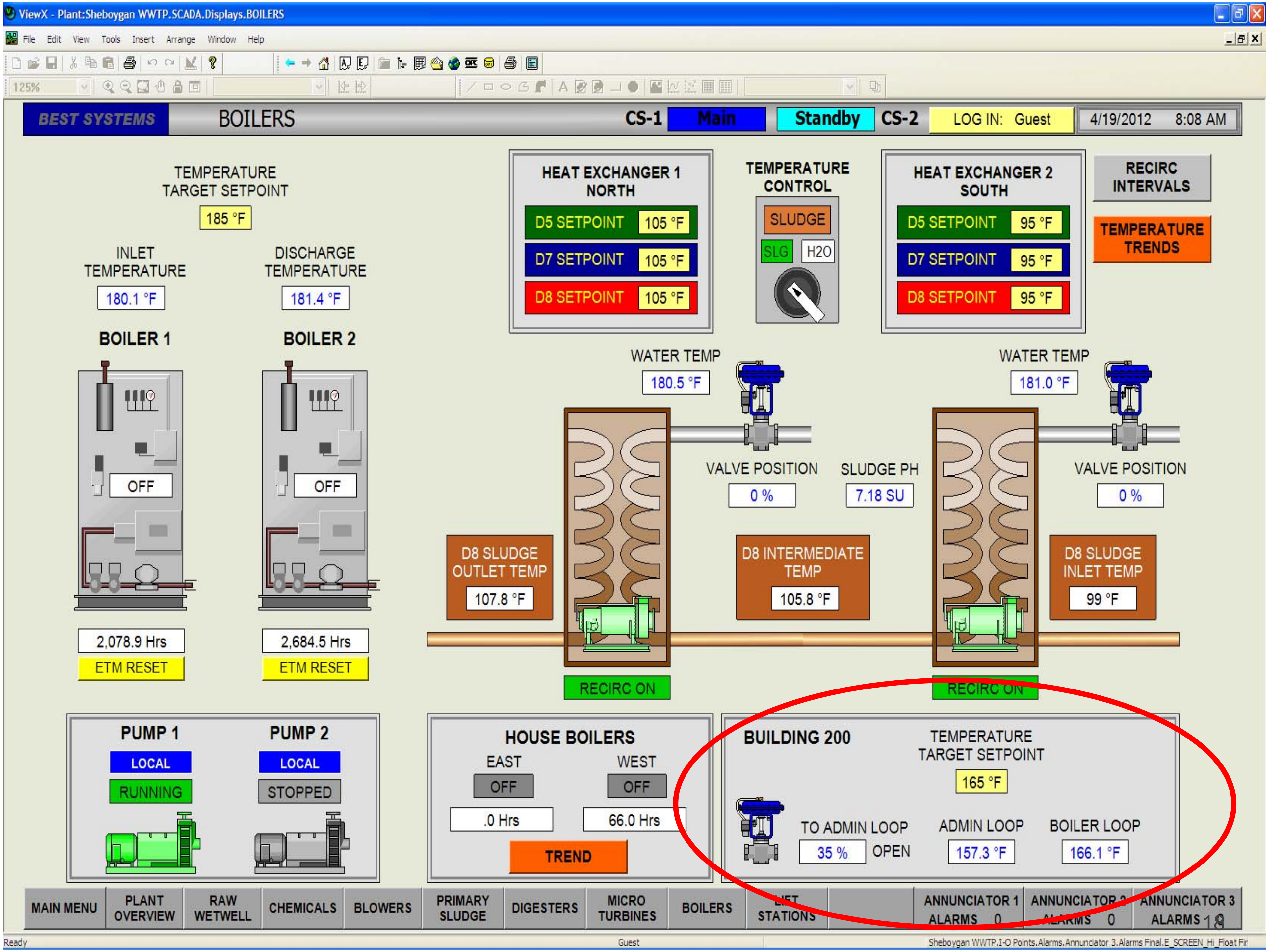
Removed
3 – 2.3 MBTU Ray fire-tube Boilers

Installed
2 - 3.8 MBTU Hurst Fire-tube Boilers

Sludge Boiler Replacement



We tied the digester heat loop piping to the building heat loop piping and installed, two hot water recirculation pumps to push heat into the building heat loop.


ViewX - Plant:Sheboygan WWTP.SCADA.Displays.BOILERS
File Edit View Tools Insert Arrange Window Help
125%
BEST SYSTEMS
BOILERS
CS-1
Main
Standby
CS-2
LOG IN: Guest
4/19/2012 8:08 AM
TEMPERATURE TARGET SETPOINT
185 °F
INLET TEMPERATURE
180.1 °F
DISCHARGE TEMPERATURE
181.4 °F
BOILER 1
OFF
2,078.9 Hrs
ETM RESET
BOILER 2
OFF
2,684.5 Hrs
ETM RESET
HEAT EXCHANGER 1 NORTH
D5 SETPOINT 105 °F
D7 SETPOINT 105 °F
D8 SETPOINT 105 °F
TEMPERATURE CONTROL
SLUDGE
SLG
H2O
HEAT EXCHANGER 2 SOUTH
D5 SETPOINT 95 °F
D7 SETPOINT 95 °F
D8 SETPOINT 95 °F
RECIRC INTERVALS
TEMPERATURE TRENDS
WATER TEMP
180.5 °F
VALVE POSITION
0 %
SLUDGE PH
7.18 SU
WATER TEMP
181.0 °F
VALVE POSITION
0 %
D8 SLUDGE OUTLET TEMP
107.8 °F
D8 INTERMEDIATE TEMP
105.8 °F
D8 SLUDGE INLET TEMP
99 °F
RECIRC ON
RECIRC ON
PUMP 1
LOCAL
RUNNING
PUMP 2
LOCAL
STOPPED
HOUSE BOILERS
EAST
OFF
.0 Hrs
WEST
OFF
66.0 Hrs
TREND
BUILDING 200
TEMPERATURE TARGET SETPOINT
165 °F
TO ADMIN LOOP
35 %
OPEN
ADMIN LOOP
157.3 °F
BOILER LOOP
166.1 °F
MAIN MENU
PLANT OVERVIEW
RAW WETWELL
CHEMICALS
BLOWERS
PRIMARY SLUDGE
DIGESTERS
MICRO TURBINES
BOILERS
LIFT STATIONS
ANNUNCIATOR 1 ALARMS 0
ANNUNCIATOR 2 ALARMS 0
ANNUNCIATOR 3 ALARMS
Ready
Guest
Sheboygan WWTP.I-O Points.Alarms.Annunciator 3.Alarms Final.E_SCREEN_Hi_Float Fir

Sludge Boiler Replacement

- **Project Cost $350,000**
  - 2 - 3.8 MMBTU Hurst Fire Tube Boilers
- **Focus On Energy Grant**
  - None
- **Annual Savings**
  - 90% reduction in Natural Gas usage for Building Heat
- **Savings 2006 - 2011**
  - $293,721
- **< 8 year Simple Payback**

30 kW Capstone ® Micro-turbine Project Startup February 2006

10 - 30 kW Capstone Micro-turbines

200 kW Capstone Micro-turbine Project Started up December 2010

C 200 Capstone Micro-turbines & Cain Heat Exchangers

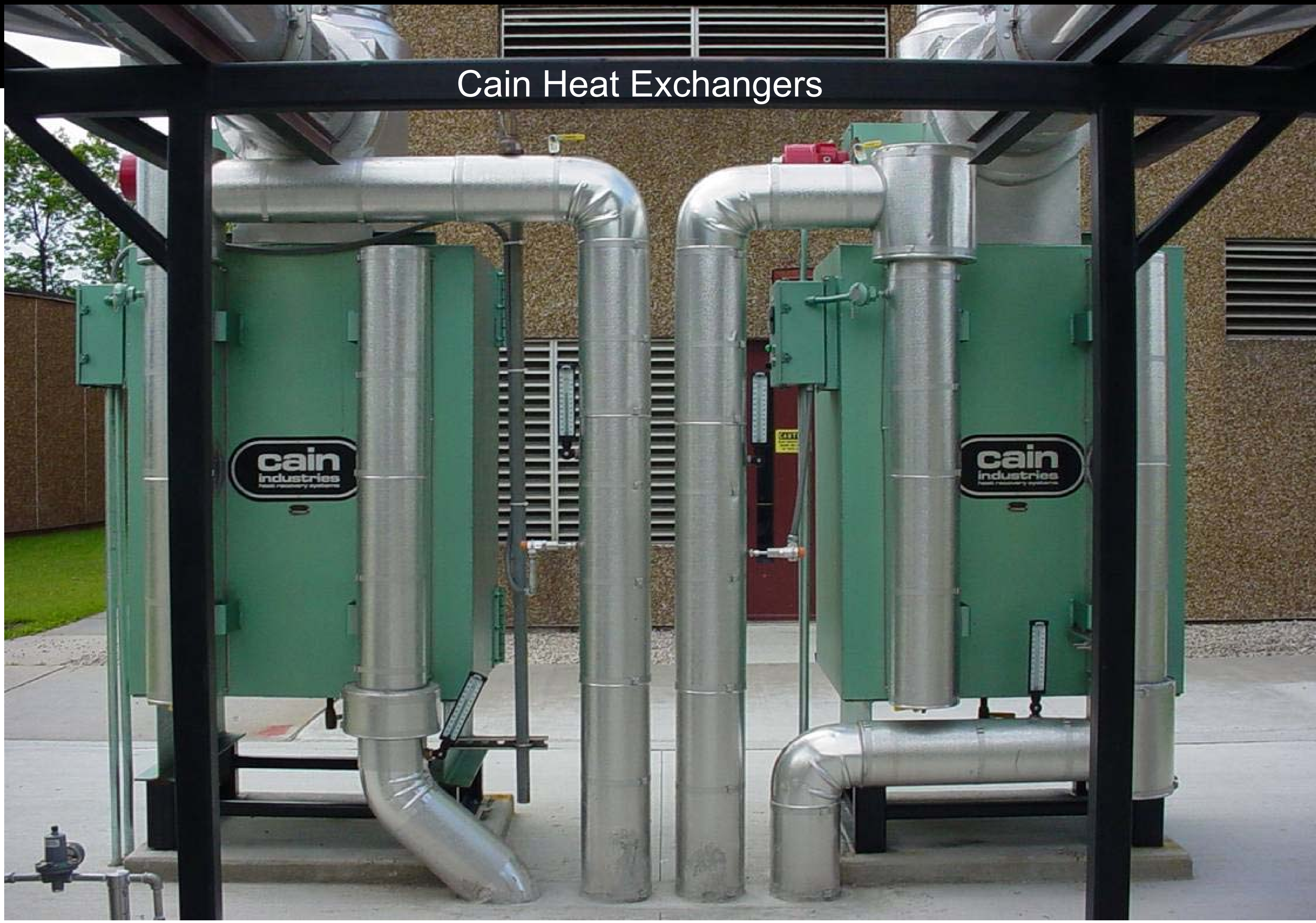
Gas Conditioning

Gas Compression Skid

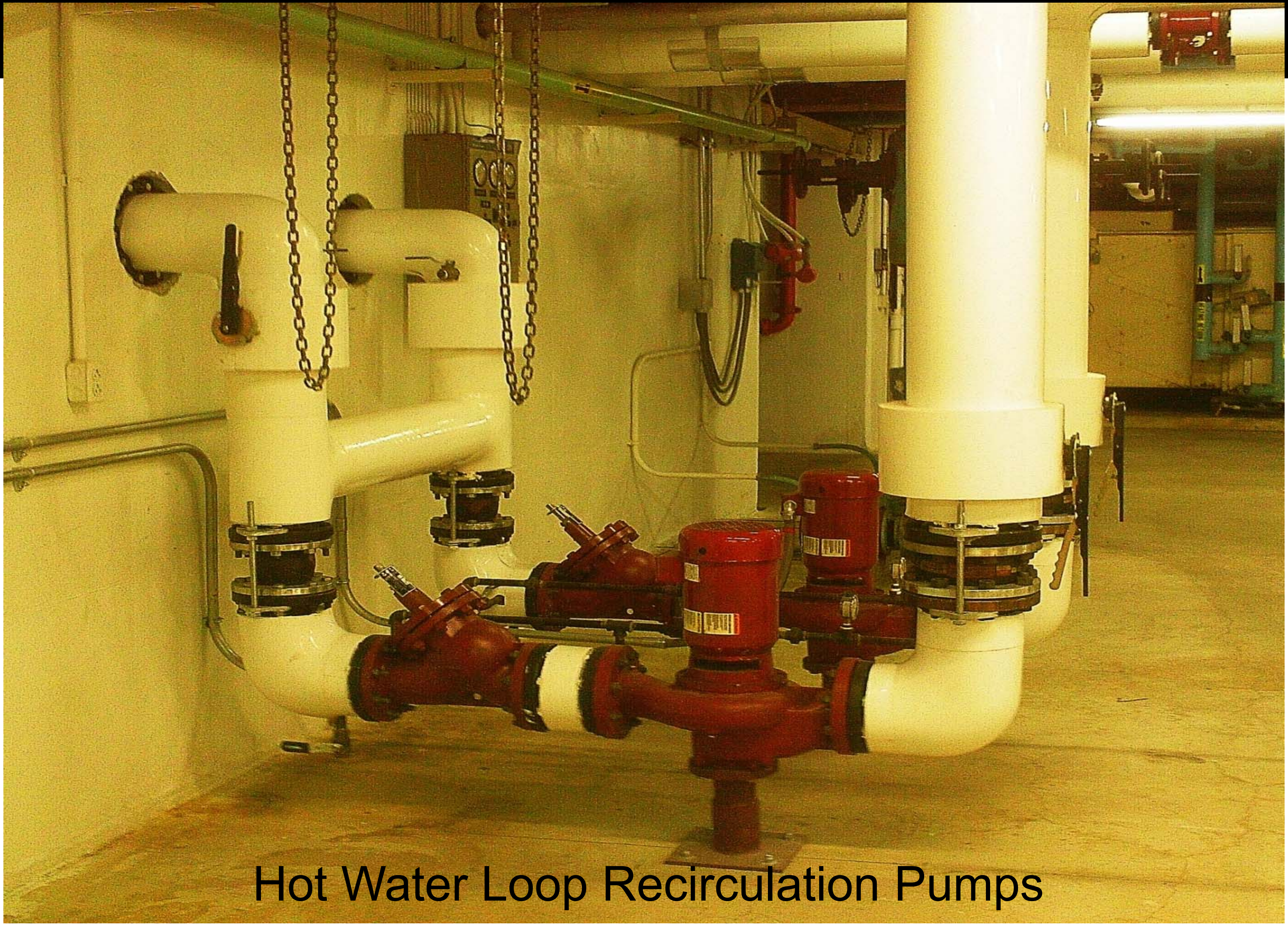

Carbon Vessels

Heat Recovery

Cain Heat Exchangers

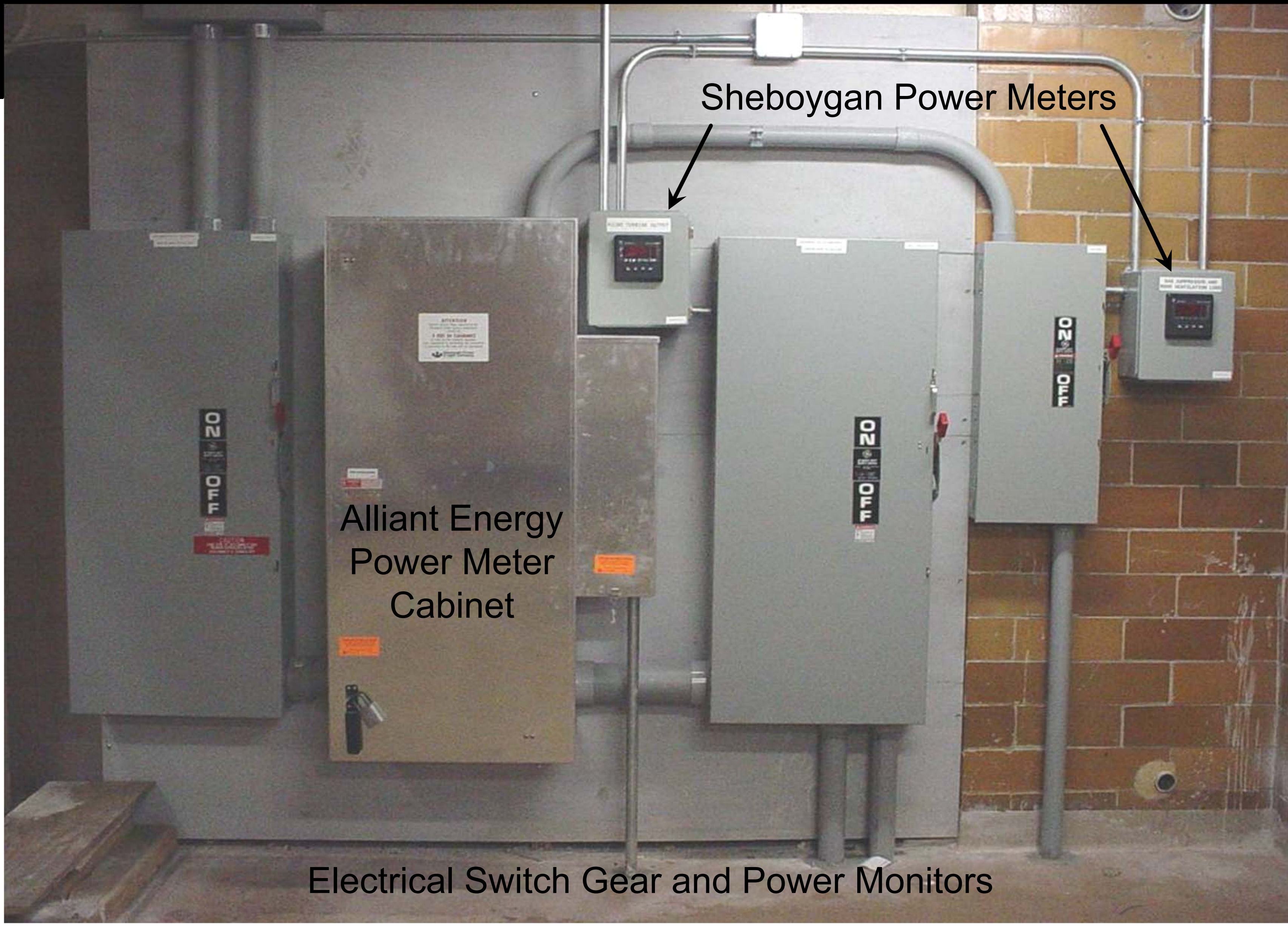


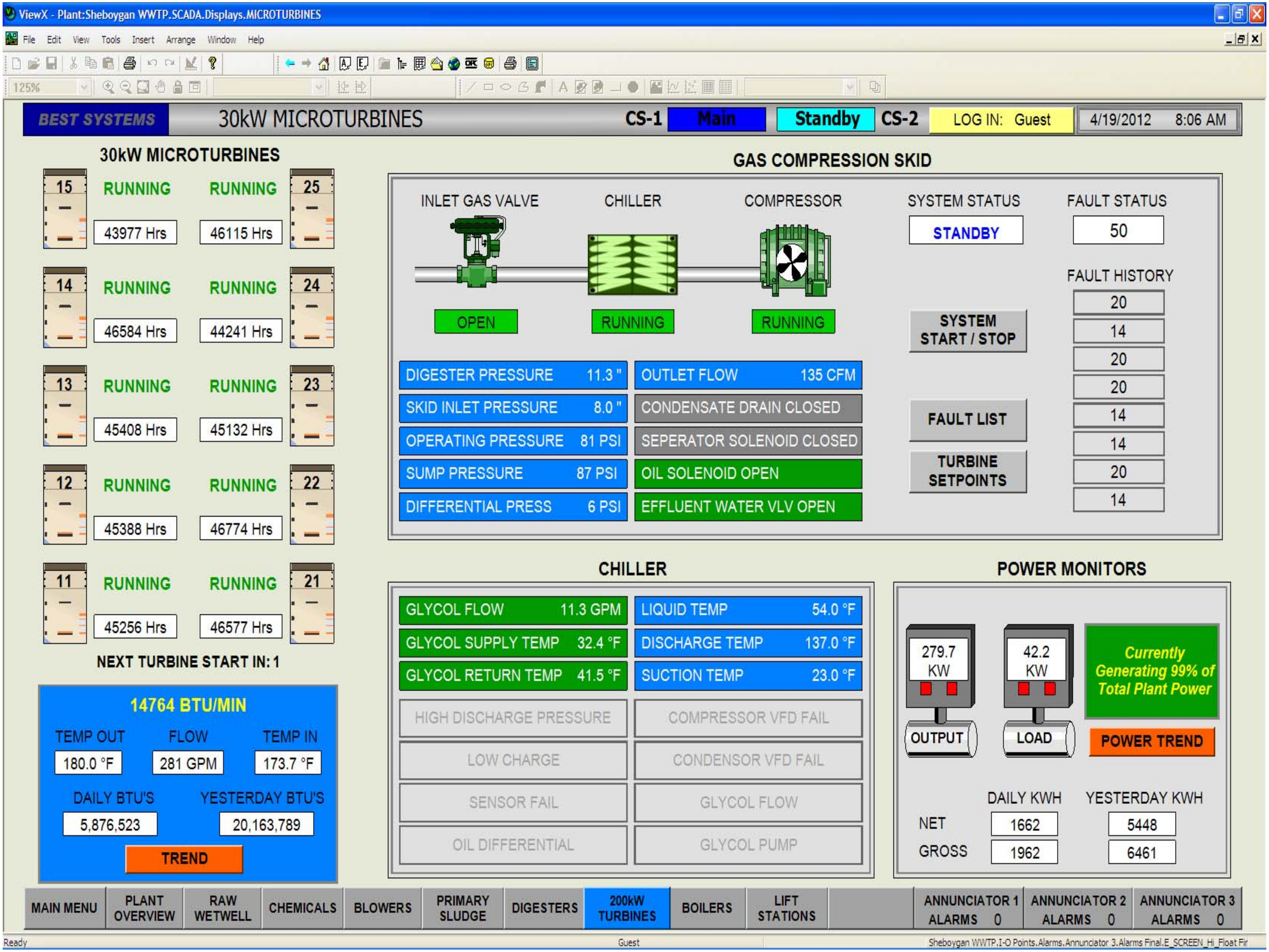
Heat Recovery Recirc Pumps

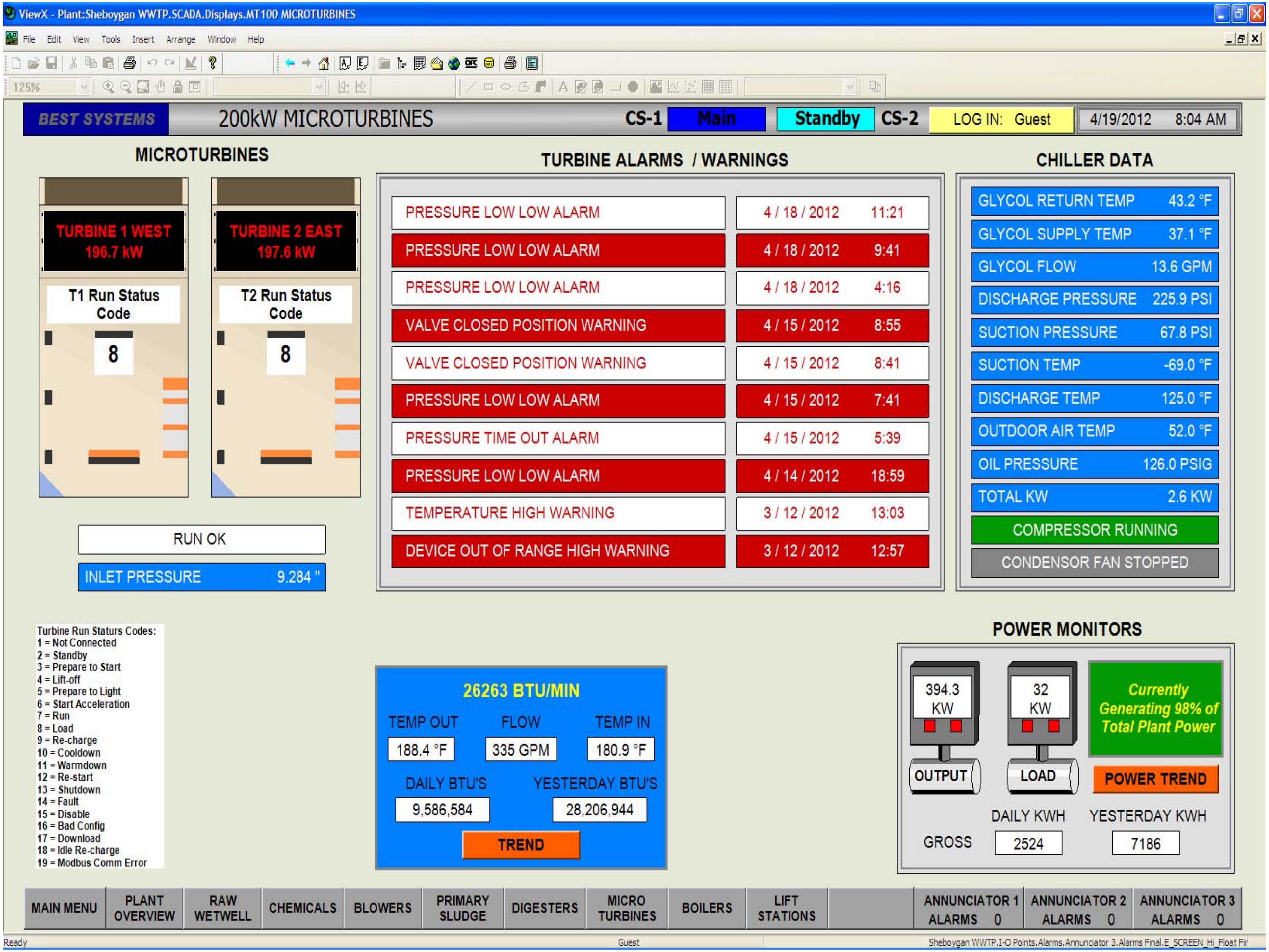


Hot Water Loop Recirculation Pumps

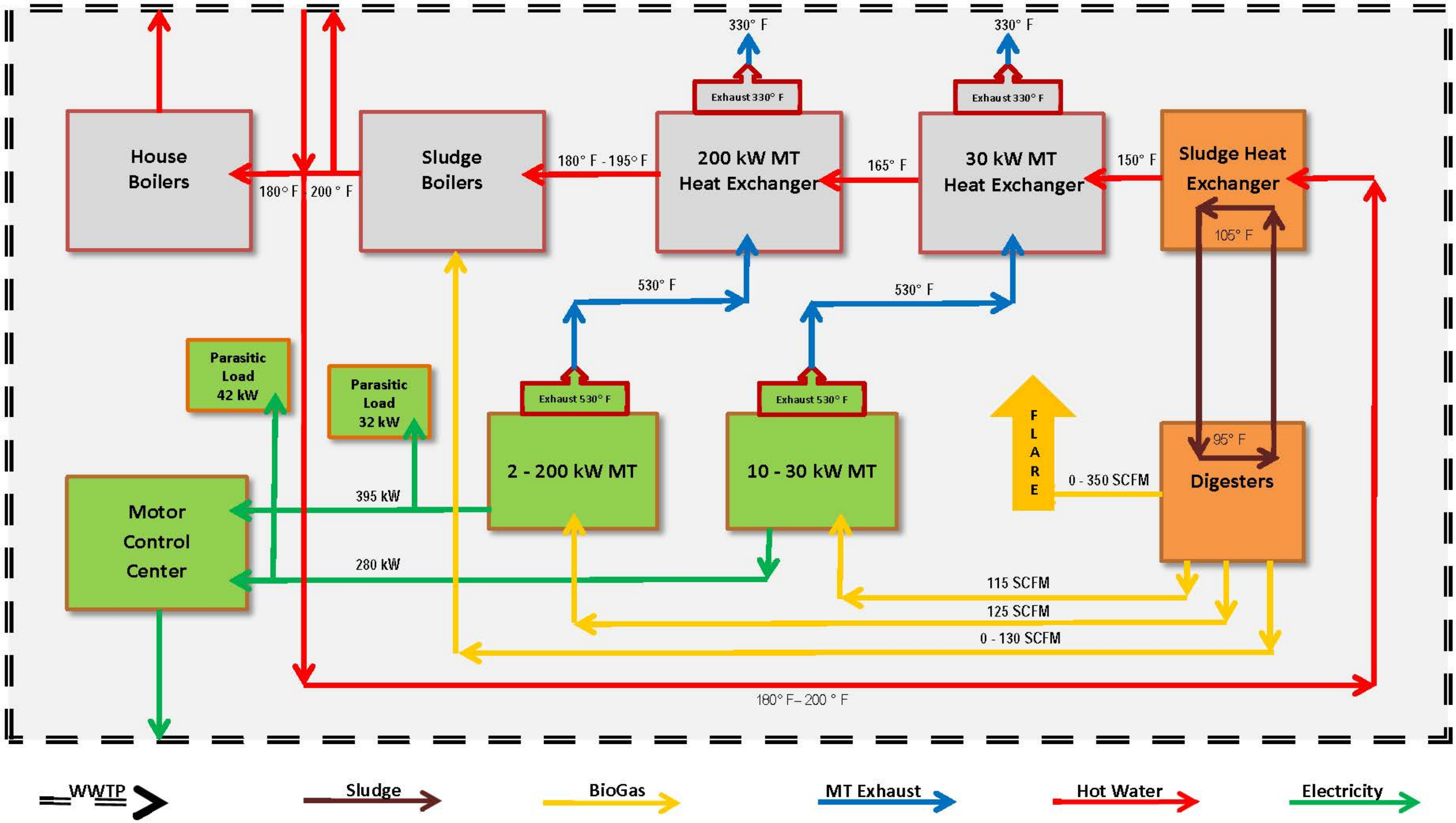
30 kW Micro-turbine Electrical Connection




ViewX - Plant:Sheboygan WWTP.SCADA.Displays.MICROTURBINES
File Edit View Tools Insert Arrange Window Help
BEST SYSTEMS
30kW MICROTURBINES
CS-1 Main Standby CS-2
LOG IN: Guest
4/19/2012 8:06 AM
30kW MICROTURBINES
15 RUNNING 43977 Hrs
25 RUNNING 46115 Hrs
14 RUNNING 46584 Hrs
24 RUNNING 44241 Hrs
13 RUNNING 45408 Hrs
23 RUNNING 45132 Hrs
12 RUNNING 45388 Hrs
22 RUNNING 46774 Hrs
11 RUNNING 45256 Hrs
21 RUNNING 46577 Hrs
NEXT TURBINE START IN: 1
14764 BTU/MIN
TEMP OUT 180.0 °F
FLOW 281 GPM
TEMP IN 173.7 °F
DAILY BTU'S 5,876,523
YESTERDAY BTU'S 20,163,789
TREND
GAS COMPRESSION SKID
INLET GAS VALVE OPEN
CHILLER RUNNING
COMPRESSOR RUNNING
SYSTEM STATUS STANDBY
FAULT STATUS 50
FAULT HISTORY 20 14 20 20 14 14 20 14
SYSTEM START / STOP
FAULT LIST
TURBINE SETPOINTS
DIGESTER PRESSURE 11.3 "
SKID INLET PRESSURE 8.0 "
OPERATING PRESSURE 81 PSI
SUMP PRESSURE 87 PSI
DIFFERENTIAL PRESS 6 PSI
OUTLET FLOW 135 CFM
CONDENSATE DRAIN CLOSED
SEPERATOR SOLENOID CLOSED
OIL SOLENOID OPEN
EFFLUENT WATER VLV OPEN
CHILLER
GLYCOL FLOW 11.3 GPM
GLYCOL SUPPLY TEMP 32.4 °F
GLYCOL RETURN TEMP 41.5 °F
LIQUID TEMP 54.0 °F
DISCHARGE TEMP 137.0 °F
SUCTION TEMP 23.0 °F
HIGH DISCHARGE PRESSURE
COMPRESSOR VFD FAIL
LOW CHARGE
CONDENSOR VFD FAIL
SENSOR FAIL
GLYCOL FLOW
OIL DIFFERENTIAL
GLYCOL PUMP
POWER MONITORS
279.7 KW OUTPUT
42.2 KW LOAD
Currently Generating 99% of Total Plant Power
POWER TREND
DAILY KWH YESTERDAY KWH
NET 1662 5448
GROSS 1962 6461
MAIN MENU
PLANT OVERVIEW
RAW WETWELL
CHEMICALS
BLOWERS
PRIMARY SLUDGE
DIGESTERS
200kW TURBINES
BOILERS
LIFT STATIONS
ANNUNCIATOR 1 ALARMS 0
ANNUNCIATOR 2 ALARMS 0
ANNUNCIATOR 3 ALARMS 0
Ready
Guest
Sheboygan WWTP.I-O Points.Alarms.Annunciator 3.Alarms Final.E_SCREEN_Hi_Float Fir


ViewX - Plant:Sheboygan WWTP.SCADA.Displays.MT100 MICROTURBINES
File Edit View Tools Insert Arrange Window Help
125%
BEST SYSTEMS
200kW MICROTURBINES
CS-1
Main
Standby
CS-2
LOG IN: Guest
4/19/2012 8:04 AM
MICROTURBINES
TURBINE 1 WEST
196.7 kW
TURBINE 2 EAST
197.6 kW
T1 Run Status Code
8
T2 Run Status Code
8
RUN OK
INLET PRESSURE 9.284 "
TURBINE ALARMS / WARNINGS
PRESSURE LOW LOW ALARM 4 / 18 / 2012 11:21
PRESSURE LOW LOW ALARM 4 / 18 / 2012 9:41
PRESSURE LOW LOW ALARM 4 / 18 / 2012 4:16
VALVE CLOSED POSITION WARNING 4 / 15 / 2012 8:55
VALVE CLOSED POSITION WARNING 4 / 15 / 2012 8:41
PRESSURE LOW LOW ALARM 4 / 15 / 2012 7:41
PRESSURE TIME OUT ALARM 4 / 15 / 2012 5:39
PRESSURE LOW LOW ALARM 4 / 14 / 2012 18:59
TEMPERATURE HIGH WARNING 3 / 12 / 2012 13:03
DEVICE OUT OF RANGE HIGH WARNING 3 / 12 / 2012 12:57
CHILLER DATA
GLYCOL RETURN TEMP 43.2 °F
GLYCOL SUPPLY TEMP 37.1 °F
GLYCOL FLOW 13.6 GPM
DISCHARGE PRESSURE 225.9 PSI
SUCTION PRESSURE 67.8 PSI
SUCTION TEMP -69.0 °F
DISCHARGE TEMP 125.0 °F
OUTDOOR AIR TEMP 52.0 °F
OIL PRESSURE 126.0 PSIG
TOTAL KW 2.6 KW
COMPRESSOR RUNNING
CONDENSOR FAN STOPPED
Turbine Run Staturs Codes:
1 = Not Connected
2 = Standby
3 = Prepare to Start
4 = Lift-off
5 = Prepare to Light
6 = Start Acceleration
7 = Run
8 = Load
9 = Re-charge
10 = Cooldown
11 = Warmdown
12 = Re-start
13 = Shutdown
14 = Fault
15 = Disable
16 = Bad Config
17 = Download
18 = Idle Re-charge
19 = Modbus Comm Error
26263 BTU/MIN
TEMP OUT
188.4 °F
FLOW
335 GPM
TEMP IN
180.9 °F
DAILY BTU'S
9,586,584
YESTERDAY BTU'S
28,206,944
TREND
POWER MONITORS
394.3 KW
OUTPUT
32 KW
LOAD
Currently Generating 98% of Total Plant Power
POWER TREND
DAILY KWH
YESTERDAY KWH
GROSS
2524
7186
MAIN MENU
PLANT OVERVIEW
RAW WETWELL
CHEMICALS
BLOWERS
PRIMARY SLUDGE
DIGESTERS
MICRO TURBINES
BOILERS
LIFT STATIONS
ANNUNCIATOR 1 ALARMS 0
ANNUNCIATOR 2 ALARMS 0
ANNUNCIATOR 3 ALARMS 0
Ready
Guest
Sheboygan WWTP.I-O Points.Alarms.Annunciator 3.Alarms Final.E_SCREEN_Hi_Float Fir

Energy Recovery Flow Diagram Sheboygan WWTP



Microturbine Project Costs

30 kW System

- **Project Cost ~$1,200,000**
- **City's Cost $205,000**
  - 10 – 30 kW Capstone MT
  - 2 Cain Heat Exchangers
  - Gas Conditioning System
    - Gas Compression
    - Moisture Removal
    - Siloxane Removal
- **Focus On Energy Grants**
  - Electrical – None ($45,000)
  - Heat Recovery - $20,000
- **< 2 years Simple Payback**

200 kW System

- **Project Cost $1,500,000**
  - 2 – 200 kW Capstone MT
  - 2 Cain Heat Exchangers
  - Gas Conditioning System
    - Gas Compression
    - Moisture Removal
    - Siloxane Removal
- **Focus On Energy Grant**
  - Electrical –$205,960
  - Heat Recovery – None
- **< 7 years Simple Payback**

Benefits from CHP from 30 kW Microturbine Installation

	2006	2007	2008	2009 [1]	2010 [1]	2011 [1]
Renewable Energy Credits (RECs)	924	2,076	1,619			
$ Per REC	$3.15	$3.15	$3.15			
Revenue from RECs	$2,911	$6,539	$5,100	$0	$0	$0
Revenue from Alliant Energy	$23,372	$27,118	$25,730	$27,230	$26,383	$27,077
Therms Recovered	60,449	66,369	65,602	60,247	61,888	62,000
Cost PerTherm	$0.9039	$0.8347	$0.8666	$0.7352	$0.6316	$0.5421
Natural Gas Savings (Avoided Costs)	$54,640	$55,398	$56,851	$44,294	$39,088	$33,610
Wisconsin Focus On Energy Grant	$20,000					
Total Revenue and Avoided Costs	$100,922	$89,056	$87,681	$71,524	$65,472	$60,687

2006 – 2011 Total Revenues and Avoided Costs from 10 - 30 kW Microturbines $475,341

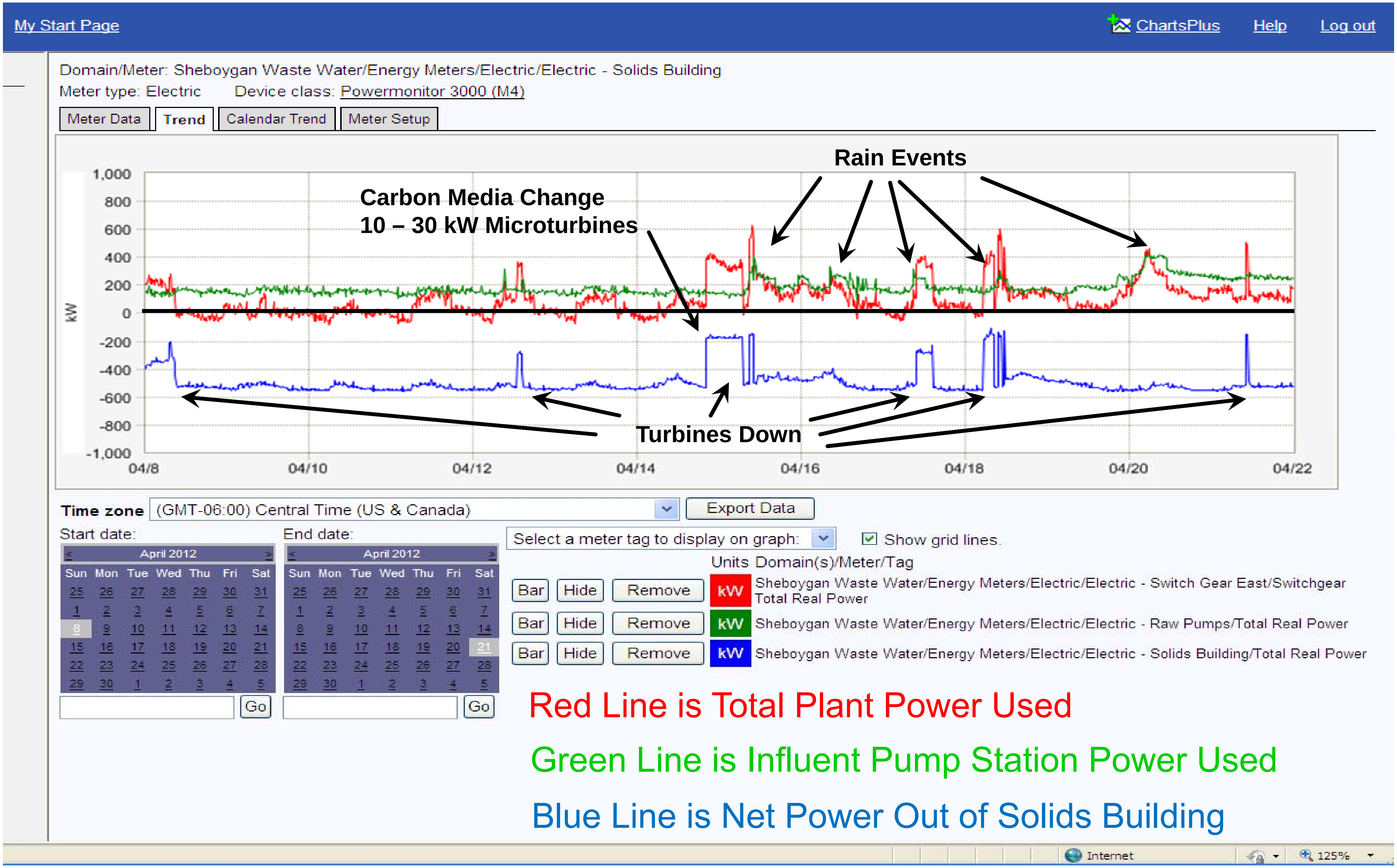
Value of Energy Produced by Microturbines 2006 - 2011

	2006	2007	2008	2009	2010 [1]	2011 [1-2]
Days System Down (All Day)	45	23	3	18	9	NA
Annual Therms	60,449	66,369	65,602	60,247	61,888	134,000
Average Daily BTUs	18,890,313	19,406,140	18,072,176	17,362,248	17,384,270	36,712,329
Value of Heat Produced	$54,640	$55,398	$56,851	$44,294	$39,088	$72,641
Cost Per Therm	$0.9039	$0.8347	$0.8666	$0.7352	$0.6316	$0.5421
Annual kWH	1,590,800	1,768,600	1,666,200	1,620,600	1,622,800	3,177,800
Average Daily kWH	4,971	5,171	4,603	4,670	4,558	8,706
Value of Electricity Produced	$103,879	$122,918	$122,966	$120,897	$127,552	$278,375
Cost Per kWH	$0.0653	$0.0695	$0.0738	$0.0746	$0.0786	$0.0876
Total Value of Energy Produced	$158,519	$178,316	$179,816	$165,190	$166,641	$351,017

[1] Digester Rehab project underway at WWTP, 1 of 3 digesters out of service

[2] 2011 includes the energy produced by both microturbine installations, due to technical issue the C200 microturbines did not operate at full capcity for most of the year

Total value of Energy Produced all Micrturbines = **$1,199,499**



When the Red ——— Line is below the Black ——— Line, we are pushing electricity out to the Grid.

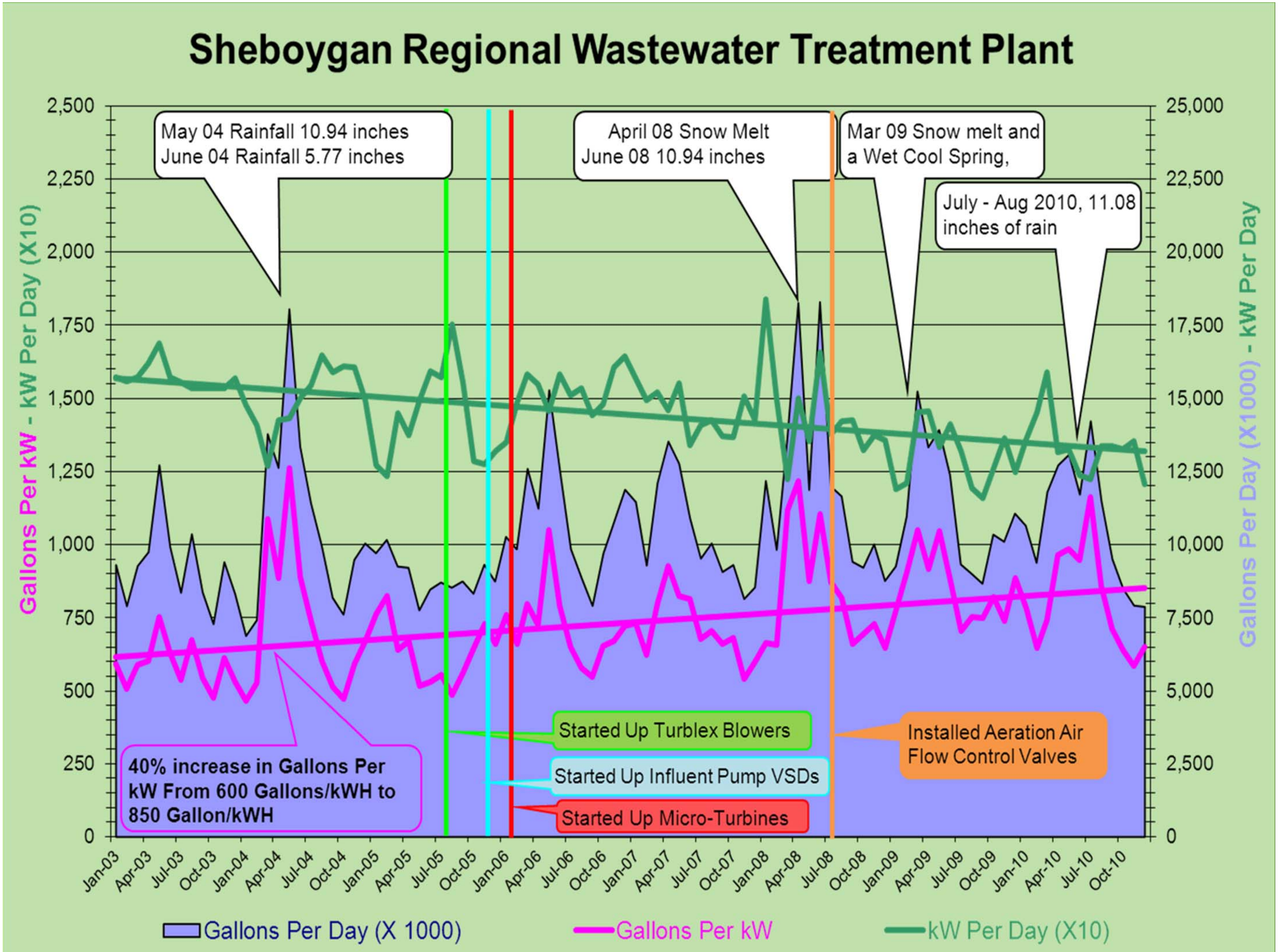
700 kWs of Generating Capacity using Capstone® Micro-turbines

Unplugged

Sheboygan Regional Wastewater Treatment Plant

Alliant Energy Edgewater Coal Fired Power Plant

Summary of WWTP Project Energy Savings



Sheboygan Regional Wastewater Treatment Plant
May 04 Rainfall 10.94 inches
June 04 Rainfall 5.77 inches
April 08 Snow Melt
June 08 10.94 inches
Mar 09 Snow melt and
a Wet Cool Spring,
July - Aug 2010, 11.08
inches of rain
Started Up Turblex Blowers
Started Up Influent Pump VSDs
Started Up Micro-Turbines
Installed Aeration Air
Flow Control Valves
40% increase in Gallons Per
kW From 600 Gallons/kWH to
850 Gallon/kWH
Gallons Per kW - kW Per Day (X10)
Gallons Per Day (X1000) - kW Per Day
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
25,000
22,500
20,000
17,500
15,000
12,500
10,000
7,500
5,000
2,500
0
Jan-03 Apr-03 Jul-03 Oct-03 Jan-04 Apr-04 Jul-04 Oct-04 Jan-05 Apr-05 Jul-05 Oct-05 Jan-06 Apr-06 Jul-06 Oct-06 Jan-07 Apr-07 Jul-07 Oct-07 Jan-08 Apr-08 Jul-08 Oct-08 Jan-09 Apr-09 Jul-09 Oct-09 Jan-10 Apr-10 Jul-10 Oct-10
Gallons Per Day (X 1000)
Gallons Per kW
kW Per Day (X10)

Annual Energy Savings Summary All Projects

Projects	2006		2007		2008		2009		2010		2011 [1]		2012 [2]	
Energy Reduced	kWH	Therms	kWH	Therms	kWH	Therms	kWH	Therms	kWH	Therms	kWH	Therms	kWH	Therms
Influent Pump VFDs	180,000		180,000		180,000		180,000		180,000		180,000		180,000	
Aeration Blower Replacement	358,560		358,560		358,560		358,560		358,560		358,560		358,560	
Sludge Boiler Replacement		67,757		61,837		75,057		67,959		66,318		63,206		63,206
Aeration Valves Installation							459,000		459,000		459,000		459,000	
Subtotal Energy Reduction	**538,560**	**67,757**	**538,560**	**61,837**	**538,560**	**75,057**	**997,560**	**67,959**	**997,560**	**66,318**	**997,560**	**63,206**	**997,560**	**63,206**
Energy Produced onsite														
CR 30 kW Micro-turbines Installation		60,449		66,369		65,602		60,247		61,888		65,000	1,400,000	65,000
C 200 kW Micro-turbine Installation											1,600,000	69,000	2,800,000	138,000
Subtotal Energy Produced	**0**	**60,449**	**0**	**66,369**	**0**	**65,602**	**0**	**60,247**	**0**	**61,888**	**1,600,000**	**134,000**	**4,200,000**	**203,000**
Total Energy Reduction	538,560	128,206	538,560	128,206	538,560	140,659	997,560	128,206	997,560	128,206	2,597,560	197,206	5,197,560	266,206
Energy Rate	$0.0653	$0.9039	$0.0695	$0.8347	$0.0738	$0.8666	$0.0746	$0.7352	$0.0786	$0.6316	$0.0876	$0.5421	$0.0926	$0.5061
Total $ Savings	$35,168	$115,885	$37,430	$107,014	$39,746	$121,895	$74,418	$94,257	$78,408	$80,975	$227,546	$106,905	$481,294	$134,727
Total Combined Energy Savings	**$151,053**		**$144,443**		**$161,641**		**$168,675**		**$159,383**		**$334,452**		**$616,021**	

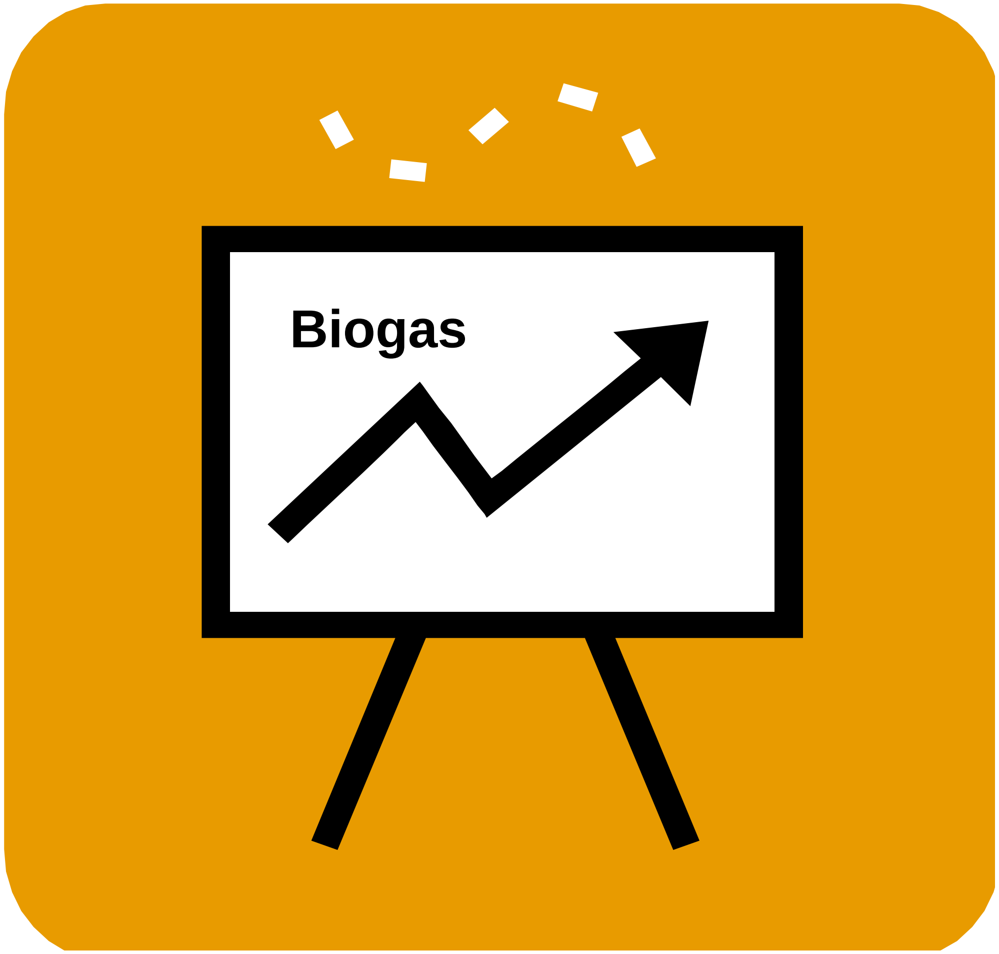
Total Energy Savings 2006 - 2012 **$1,735,668**

Total Project Costs **$2,874,000** **Simple Pay Back 8 1/2 Years**

1 Due to technical issues the C200 Capstone Micro-turbines did not operate at full capcity for most of 2011

2 Estimated based on operating 90 percent of the year and icludes the purchase of the 10 - C30 kW Micro-turbines from Alliant Energy in March 2012

Biogas Optimization



Co-digestion of High Strength Wastes

- High Soluble Organic Wastes
  - High Biochemical Oxygen Demand (BOD) > 25,000 mg/l
  - Low Total Suspended Solids (TSS) < 10,000 mg/l
  - Can have high dissolved solids, up to 50 percent TDS (mostly sugars)
  - Easy to work with, pump, etc…
  - Usually see an increase in Methane Gas Production within 60 minutes

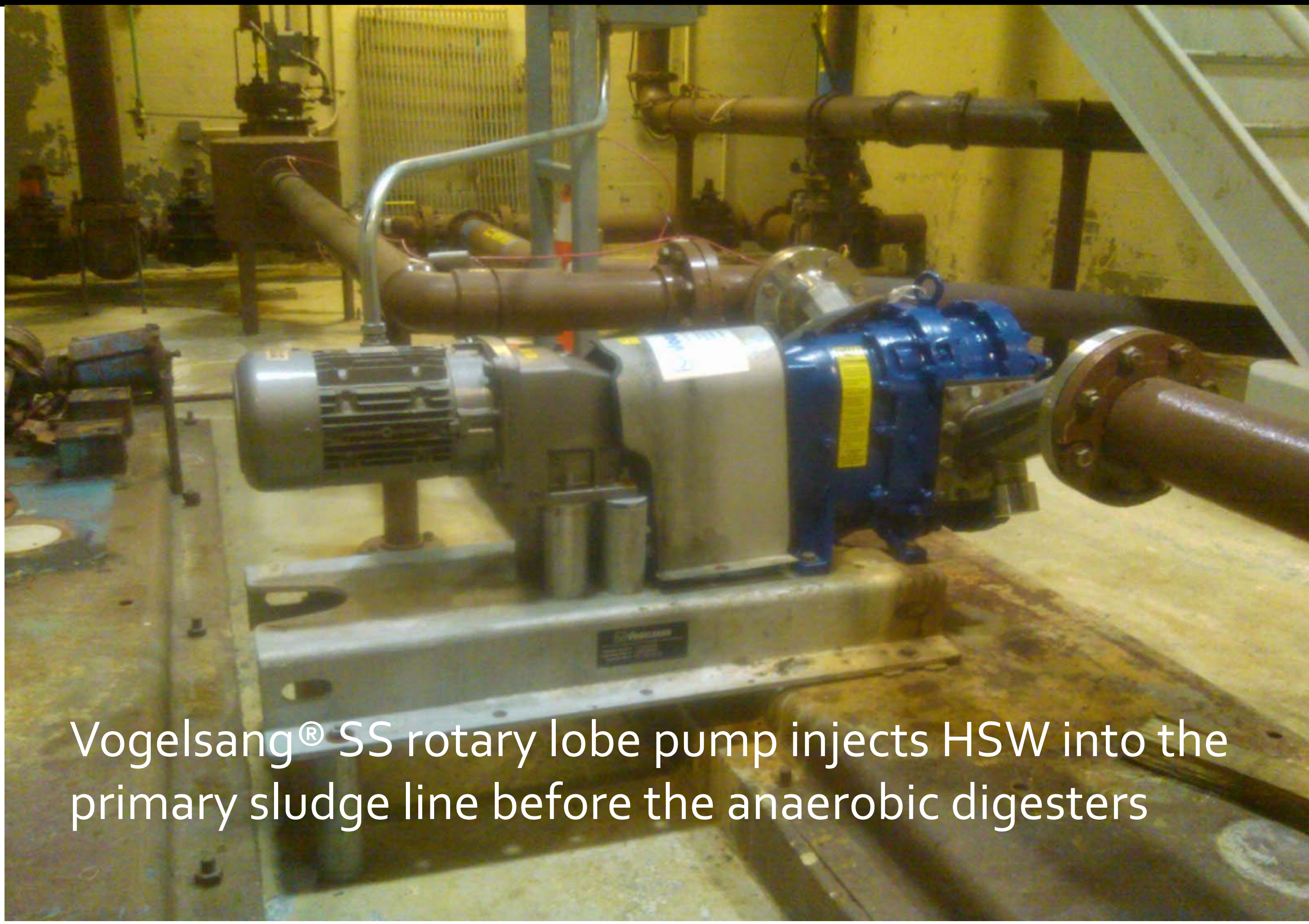
- Handling HSWs
  - Usually has a low pH 5.0 s.u. pH or less
  - Delivery temperature usually around 120 ° F
  - Stay away from wastes high in chloride > 4,000 mg/L
  - Use all stainless steel pumps , glass lined pipe or CPVC
  - Use 6" diameter or larger pipe

Co-digestion of High Strength Wastes

- Currently using the following Food Processing Waste
  - **Whey Processing**
    - Mother Liquor, ~120,000 BOD
    - Permeate, ~100,000 BOD
    - Other Whey Processing Wastes, ~60,000 BOD
  - **Food Processing**
    - Flavorings for Dairy Products, ~25,000 BOD
    - Cheese processing Wastes ~ 40,000 BOD
    - Soda Processing Waste ~ 35,000 BOD
    - Off Spec Soda - 80,000 BOD
    - Off Spec Beer – 75,000 BOD
  - **Ethanol Production Waste**
    - Thin Stillage ~ 170,000 BOD
    - Corn Syrup ~ 200,000 BOD

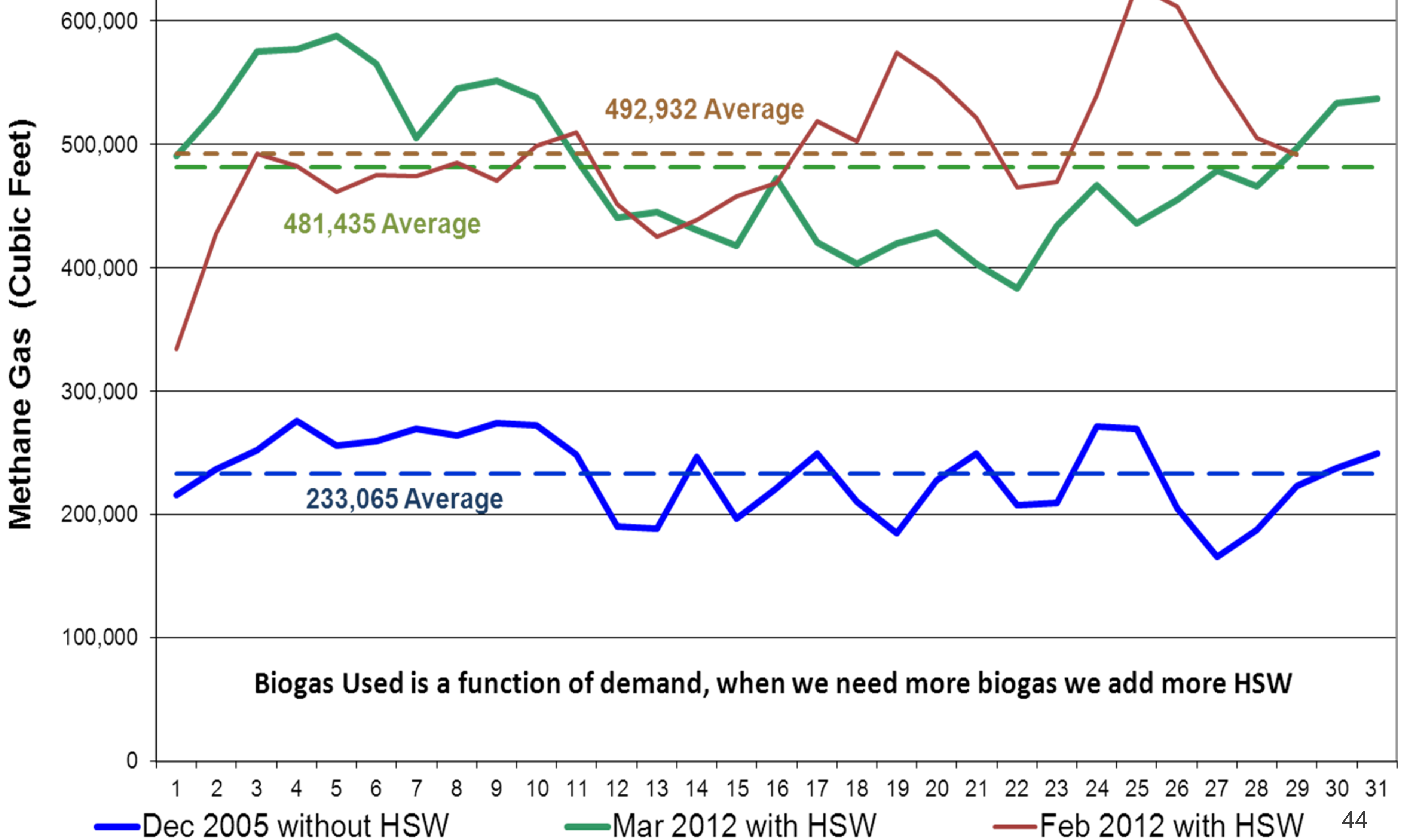
Unloading into HSW Holding Tank

High Strength Waste (HSW) Feed



HSW makes up ~35% of total feed to the anaerobic digesters

Methane Gas Used (Metered)



Sustainability

- By metering-in the High strength wastes into our Anaerobic Digesters we have increased our methane gas production by more than 200 percent.
- Optimizing biogas production has resulted in a reduction in the purchase of energy from outside sources. (electric and natural gas).
- By burning methane gas in the micro-turbines we have significantly reduced our green house gas emissions (Methane and Carbon Dioxide)
- The installation of energy efficient motors and VFDs has reduced our energy consumption by 5,600 MWH through 2011 and reduced our green house gas emissions by 8,400,000 pounds, equivalent to planting 4,200 trees. **(1 tree will remove 1 ton of CO_2 over 40 years, Source EcoSwitch.com)**
- The Capstone® Micro-turbines produced 11,446 MWH of Electrical Energy and 448,555 Therms of heat since startup in February 2006.
- The electricity produce by the Micro-turbines reduced our carbon dioxide emissions by more than 15,000,000 pounds, the equivalent of planting 7,500 trees.

Take Home

- Dealing with Decision Makers
  - Do Your Homework
  - Make Your Case
  - Let Them Decide
- Keys to Success
  - We Did Not Try To Do Everything At Once
  - Tapped Resources
- Challenges
  - High Strength Waste
  - Moisture in the Biogas
- Unexpected
  - Notoriety

PRESS RELEASE:

City of Sheboygan Wins Sustainability Best Practices Award at Wastewater Treatment...

* Reuters is not responsible for the content in this press release.

Thu Jul 7, 2011 8:31am EDT

City of Sheboygan Wins Sustainability Best Practices Award at Wastewater Treatment Plant

CHATSWORTH, Calif., July 7, 2011 (GLOBE NEWSWIRE) -- Capstone Turbine Corporation (www.capstoneturbine.com) (Nasdaq:CPST), the world's leading clean technology manufacturer of microturbine energy systems, today announced that the City of Sheboygan, Wisconsin received a prestigious award from the Great Lakes and St. Lawrence Cities Initiative (GLSLCI) for nearing self-sufficiency at its wastewater treatment plant using Capstone microturbines.

The city of Sheboygan was the only GLSLCI member city in the U.S. and Canada to receive the Wege Small Cities Sustainability Best Practices Award, which recognizes GLSLCI member cities working to protect the Great Lakes and St. Lawrence River, restore them, and improve the quality of the water resources for future generations. GLSLCI is a bi-national coalition of mayors and other local officials that work actively with federal, state, and provincial governments.

Rather than flare excess methane gas -- the byproduct from sewage treatment processes that has a greenhouse gas impact on the atmosphere 21 times greater than carbon dioxide -- the Sheboygan plant uses the methane to fuel 10 Capstone C30 and two C200 microturbines in a combined heat and power (CHP) application. Using waste methane as fuel, the microturbines fulfill 90 percent of the plant's annual energy needs and nearly eliminate the need to purchase natural gas for heating.

Questions ????

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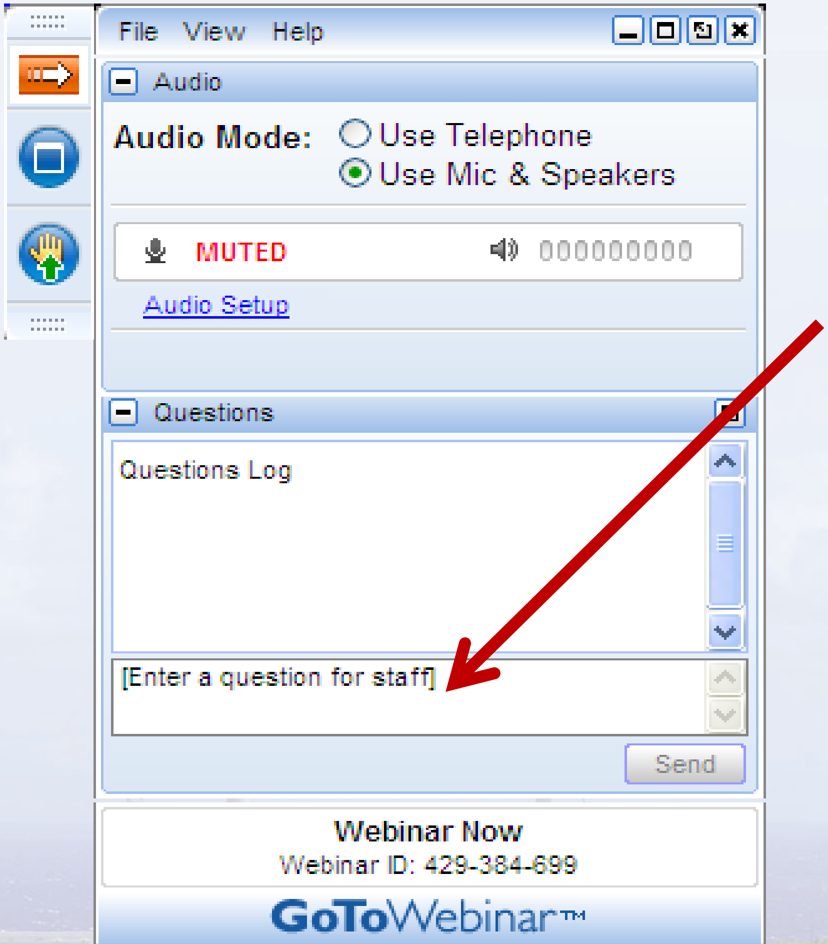
Questions

Questions & Answers



- You can submit questions/comments
- Just use the question and answer pane that is located on your screen
- The speakers will address as many questions as possible

Survey

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